(19)国家知识产权局

(12)发明专利申请

(10)申请公布号 CN 115552655 A
(43)申请公布日 2022.12.30

(21)申请号 202180034656.3

(22)申请日 2021.05.25

(30)优先权数据
20176926.2 2020.05.27 EP

(85)PCT国际申请进入国家阶段日
2022.11.11

(86)PCT国际申请的申请数据
PCT/EP2021/063873 2021.05.25

(87)PCT国际申请的公布数据
WO2021/160898 DE 2021.08.19

(71)申请人 默克专利有限公司
地址 德国达姆施塔特

(72)发明人 延斯·恩格哈特
埃尔维拉·蒙特内格罗
西蒙·谢米亚诺夫斯基

(74)专利代理机构 中原信达知识产权代理有限责任公司 11219
专利代理师 郭国清 宫方斌

(51)Int.Cl.
H01L 51/54(2006.01)
C07C 211/00(2006.01)

权利要求书27页 说明书180页

(54)发明名称

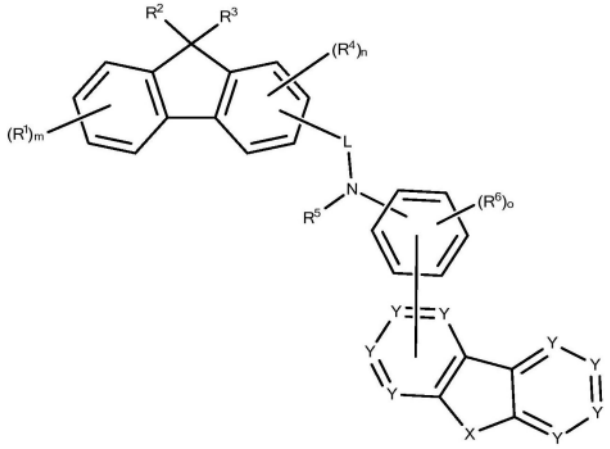
用于电子器件的材料

(57)摘要

本申请涉及用于电子器件的材料、制备所述材料的方法以及含有所述材料的电子器件。

CN 115552655 A

1.一种式(1)的化合物，



式(1)

其中所用符号如下：

X是O或S，优选O；

Y在每种情况下相同或不同并且是CR^7或N，优选Y^7是CR；

L是具有6至40个芳族环原子的二价芳族环系；

R^1、R^4、R^6和R^7在每种情况下相同或不同，并且选自H、D、F、Cl、Br、I、C(=O)R^{11}、CN、Si$(R^{11})_3$、N$(R^{11})_2$、P(=O)$(R^{11})_2$、OR^{11}、S(=O)R^{11}、S(=O)$_2R^{11}$、具有1至20个碳原子的直链烷基或烷氧基基团、具有3至20个碳原子的支链或环状的烷基或烷氧基基团、具有2至20个碳原子的烯基或炔基基团、具有6至40个芳族环原子的芳族环系以及具有5至40个芳族环原子的杂芳族环系；其中两个或更多个R^1基团可彼此连接并可形成环，和/或两个或更多个R^4基团可彼此连接并可形成环，和/或两个或更多个R^6基团可彼此连接并可形成环，和/或两个或更多个R^7基团可彼此连接并可形成环；其中所提到的烷基、烷氧基、烯基和炔基基团以及所提到的芳族环系和杂芳族环系各自可被R^{11}基团取代；其中所述烷基、烷氧基、烯基和炔基基团中的一个或多个CH_2基团可被-R^{11}C=CR^{11}-、-C≡C-、Si$(R^{11})_2$、C=O、C=NR^{11}、-C(=O)O-、-C(=O)NR^{11}-、NR^{11}、P(=O)(R^{11})、-O-、-S-、SO或SO_2代替；优选地，两个或更多个R^1基团不彼此形成环，和/或两个或更多个R^4基团不彼此形成环，和/或两个或更多个R^6基团不彼此形成环，和/或两个或更多个R^7基团不彼此形成环；

R^2和R^3在每种情况下相同或不同并且选自具有1至20个碳原子的直链烷基或烷氧基基团、具有3至20个碳原子的支链或环状的烷基或烷氧基基团、具有2至20个碳原子的烯基或炔基基团、具有6至40个芳族环原子的芳族环系以及具有5至40个芳族环原子的杂芳族环系；其中两个R^2和R^3基团可彼此连接并可形成环；其中所提到的烷基、烷氧基、烯基和炔基基团和所提到的芳族环系和杂芳族环系各自可被R^{11}基团取代；其中所述烷基、烷氧基、烯基和炔基基团中的一个或多个CH_2基团可被-R^{11}C=CR^{11}-、-C≡C-、Si$(R^{11})_2$、C=O、C=NR^{11}、-C(=O)O-、-C(=O)NR^{11}-、NR^{11}、P(=O)(R^{11})、-O-、-S-、SO或SO_2代替；如果两个R^2和R^3基团形成环，则结果是螺环化合物，优选螺二芴；特别优选两个R^2和R^3基团不彼此形成环；

R^5是具有6至40个芳族环原子并可被一个或多个R^{11}基团取代的芳族环系或具有5至40个芳族环原子并可被一个或多个R^{11}基团取代的杂芳族环系；

R^{11}在每种情况下相同或不同，并且选自H、D、F、Cl、Br、I、C(=O)R^{12}、CN、Si$(R^{12})_3$、N

$(R^{12})_2$、P(=O)$(R^{12})_2$、OR^{12}、S(=O)R^{12}、$S(=O)_2R^{12}$、具有1至20个碳原子的直链烷基或烷氧基基团、具有3至20个碳原子的支链或环状的烷基或烷氧基基团、具有2至20个碳原子的烯基或炔基基团、具有6至40个芳族环原子的芳族环系以及具有5至40个芳族环原子的杂芳族环系;其中两个或更多个R^{11}基团可彼此连接并可形成环;其中所提到的烷基、烷氧基、烯基和炔基基团以及所提到的芳族环系和杂芳族环系各自被R^{12}基团取代;其中所提到的烷基、烷氧基、烯基和炔基基团中的一个或多个CH_2基团可被-R^{12}C=CR^{12}-、-C≡C-、Si$(R^{12})_2$、C=O、C=NR^{12}、-C(=O)O-、-C(=O)NR^{12}-、NR^{12}、P(=O)(R^{12})、-O-、-S-、SO或SO_2代替;其中两个或更多个R^{11}基团不彼此形成环;

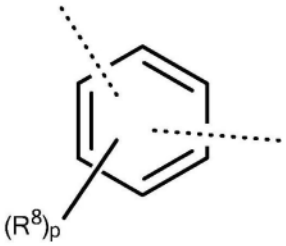
R^{12}在每种情况下相同或不同,并且选自H、D、F、Cl、Br、I、CN、具有1至20个碳原子的烷基或烷氧基基团、具有2至20个碳原子的烯基或炔基基团、具有6至40个芳族环原子的芳族环系以及具有5至40个芳族环原子的杂芳族环系;其中所提到的烷基、烷氧基、烯基和炔基基团、芳族环系和杂芳族环系可被选自F和CN的一个或多个基团取代;

m是0、1、2、3或4;优选m是0或1,非常优选m是1,最优选m是0;

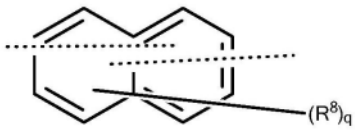
n是0、1、2或3;优选n是0或1,非常优选n是1,最优选n是0;

o是0、1、2或3;优选o是0或1,非常优选o是1,最优选o是0。

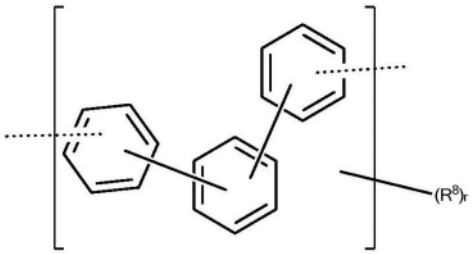
2.根据权利要求1所述的化合物,其特征在于L选自下式:



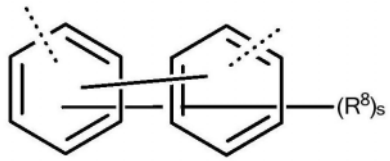
式(L-1)



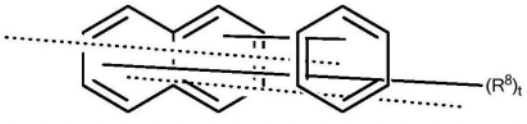
式(L-2)



式(L-3)



式(L-4)



式(L-5)

其中:

R^8在每种情况下相同或不同,并且选自H、D、F、Cl、Br、I、C(=O)R^{11}、CN、Si$(R^{11})_3$、N$(R^{11})_2$、P(=O)$(R^{11})_2$、OR^{11}、S(=O)R^{11}、$S(=O)_2R^{11}$、具有1至20个碳原子的直链烷基或烷氧基基团、具有3至20个碳原子的支链或环状的烷基或烷氧基基团、具有2至20个碳原子的烯基

或炔基基团、具有6至40个芳族环原子的芳族环系以及具有5至40个芳族环原子的杂芳族环系;其中两个或更多个R^8基团可彼此连接并可形成环;其中所提到的烷基、烷氧基、烯基和炔基基团以及所提到的芳族环系和杂芳族环系各自可被R^{11}基团取代;其中所提到的烷基、烷氧基、烯基和炔基基团中的一个或多个CH_2基团可被$-R^{11}C=CR^{11}-$、$-C\equiv C-$、$Si(R^{11})_2$、$C=O$、$C=NR^{11}$、$-C(=O)O-$、$-C(=O)NR^{11}-$、NR^{11}、$P(=O)(R^{11})$、$-O-$、$-S-$、SO或SO_2代替;优选地,两个或更多个R^8基团不彼此形成环;

其中R^{11}的定义是根据权利要求1所述的;

p是0、1、2、3或4;优选p是0或1,非常优选p是1,最优选p是0;

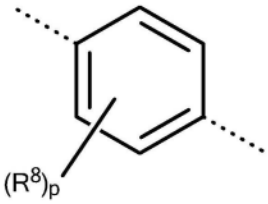
q是0、1、2、3、4、5或6;优选q是0或1,非常优选q是1,最优选q是0;

r是0、1、2、3、4、5、7、8、9、10、11或12;优选r是0或1,非常优选r是1,最优选r是0;

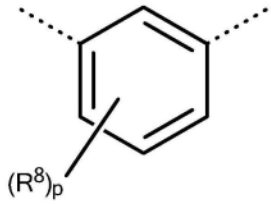
s是0、1、2、3、4、5、7或8;优选s是0或1,非常优选s是1,最优选s是0;

t是0、1、2、3、4、5、7、8、9或10;优选t是0或1,非常优选t是1,最优选t是0。

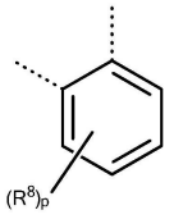
3.根据权利要求1或2所述的化合物,其特征在于L选自下式:



式(L-1-1)



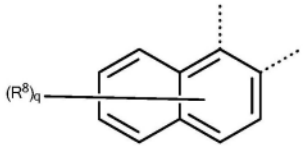
式(L-1-2)



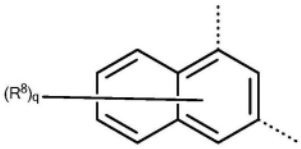
式(L-1-3)

其中所用符号符合上述权利要求所述的定义。

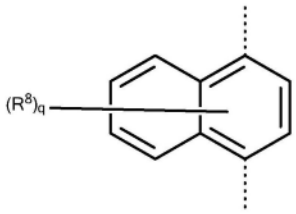
4.根据权利要求1或2所述的化合物,其特征在于L选自下式:



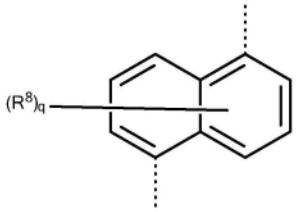
式(L-2-1)



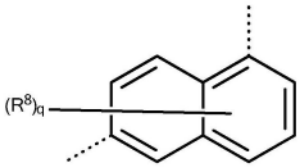
式(L-2-2)



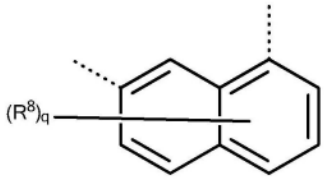
式(L-2-3)



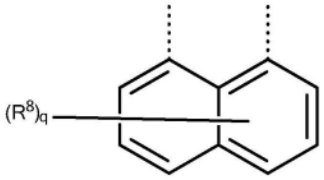
式(L-2-4)



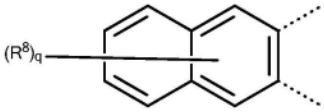
式(L-2-5)



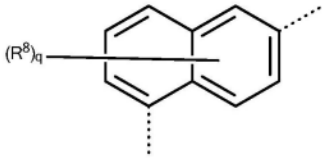
式(L-2-6)



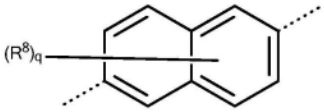
式(L-2-7)



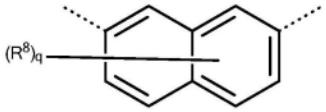
式(L-2-8)



式(L-2-9)



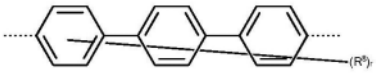
式(L-2-10)



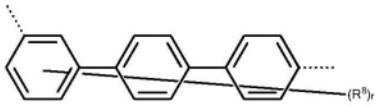
式(L-2-11)

其中所用符号符合上述权利要求所述的定义。

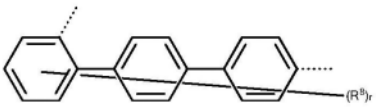
5.根据权利要求1或2所述的化合物,其特征在于L选自下式:



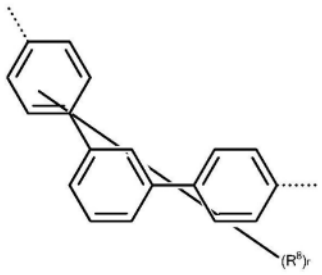
式(L-3-1)



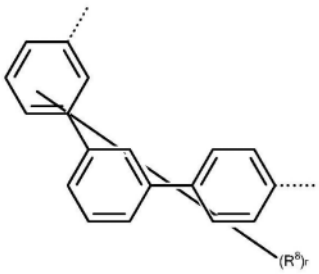
式(L-3-2)



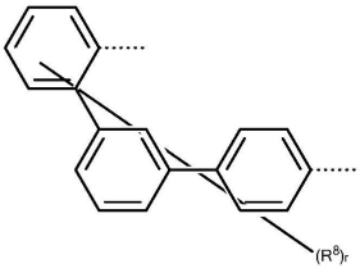
式(L-3-3)



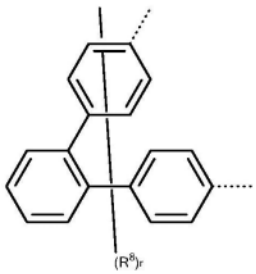
式(L-3-4)



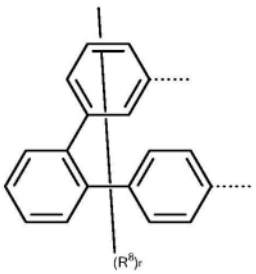
式(L-3-5)



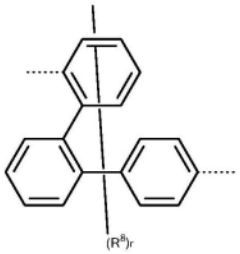
式(L-3-6)



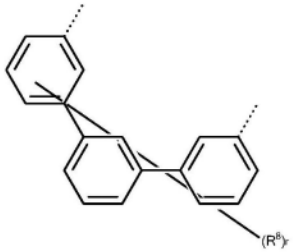
式(L-3-7)



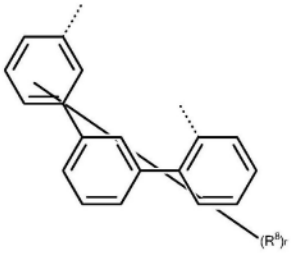
式(L-3-8)



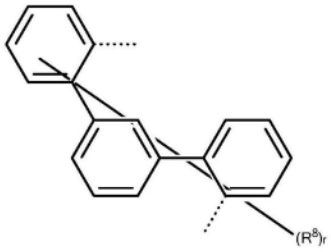
式(L-3-9)



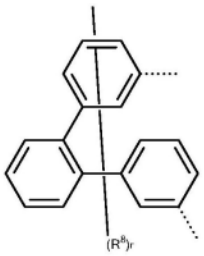
式(L-3-10)



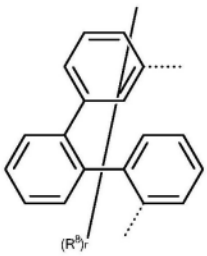
式(L-3-11)



式(L-3-12)



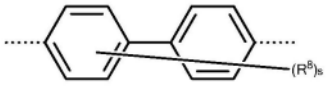
式(L-3-13)



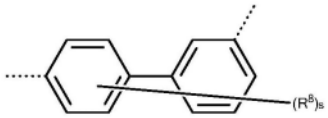
式(L-3-14)

其中所用符号符合上述权利要求所述的定义。

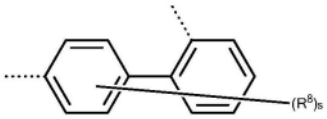
6.根据权利要求1或2所述的化合物,其特征在于L选自下式:



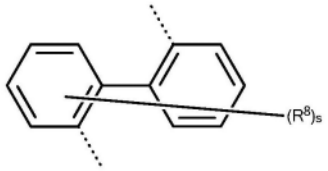
式(L-4-1)



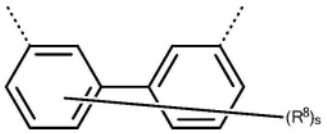
式(L-4-2)



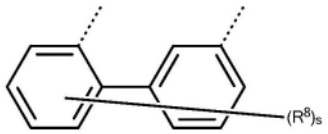
式(L-4-3)



式(L-4-4)



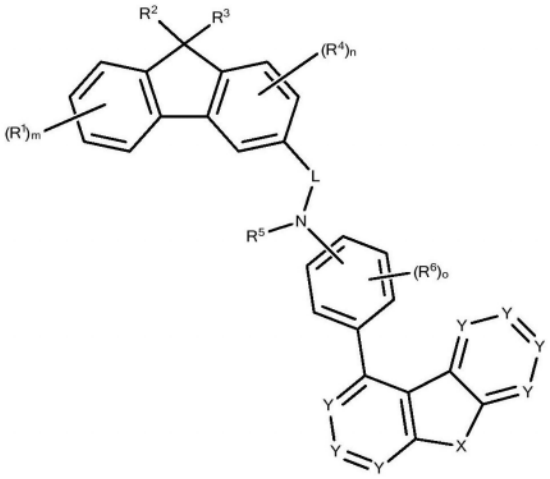
式(L-4-5)



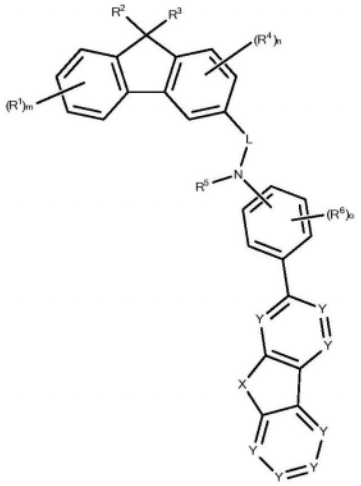
式(L-4-6)

其中所用符号符合上述权利要求所述的定义。

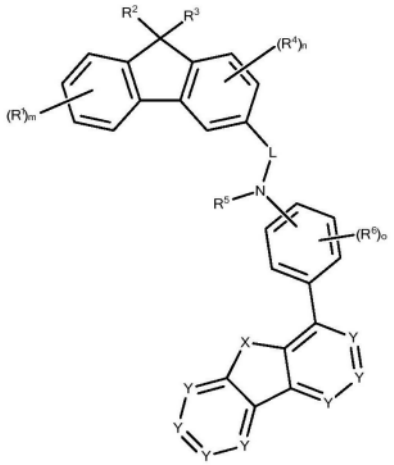
7.根据权利要求1至6中的一项或多项所述的化合物,其特征在于所述化合物选自下式:



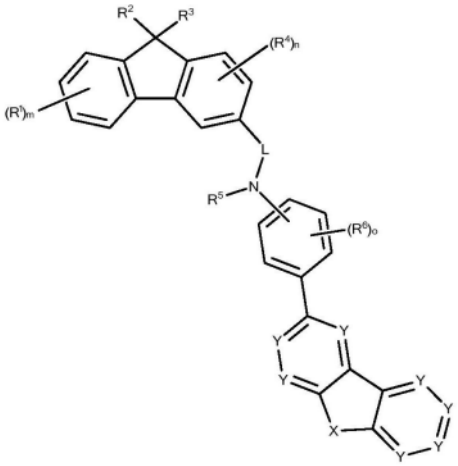
式(3)



式(4)



式(5)



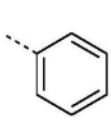
式(6)

其中所用符号符合上述权利要求所述的定义。

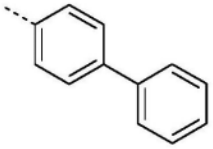
8.根据权利要求1至7中的一项或多项所述的化合物,其特征在于所述化合物是单胺化合物。

9.根据权利要求1至8中的一项或多项所述的化合物,其特征在于R^2和R^3在每种情况下相同或不同并且选自具有1至10个碳原子的直链烷基基团、具有3至10个碳原子的支链或环状的烷基基团或具有6至18个芳族原子的芳族环系;其中两个R^2和R^3基团可彼此连接并可形成环;其中所提到的烷基基团和所提到的芳族环系各自可被R^{11}基团取代;如果两个R^2和R^3基团形成环,则结果是螺环化合物,优选螺二芴;特别优选两个R^2和R^3基团不彼此形成环。

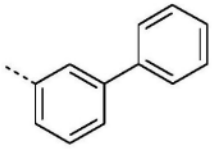
10.根据权利要求1至9中的一项或多项所述的化合物,其特征在于所述R^5基团选自下式:



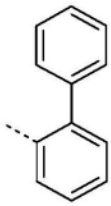
R5-1



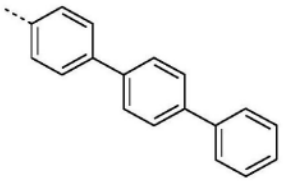
R5-2



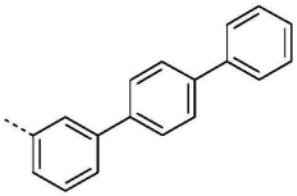
R5-3



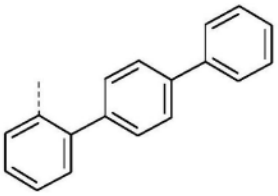
R5-4



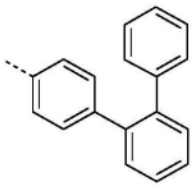
R5-5



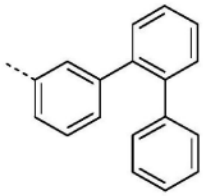
R5-6



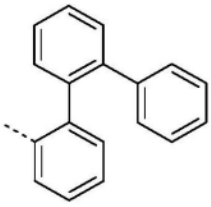
R5-7



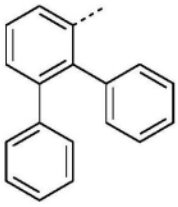
R5-8



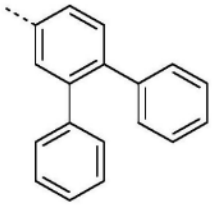
R5-9



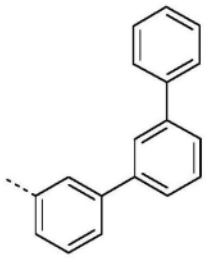
R5-10



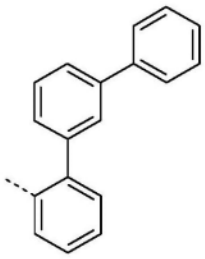
R5-11



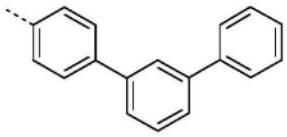
R5-12



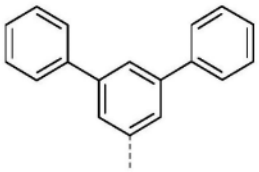
R5-13



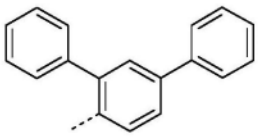
R5-14



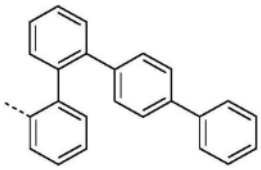
R5-15



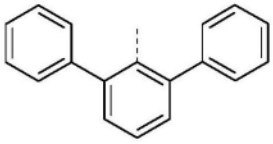
R5-16



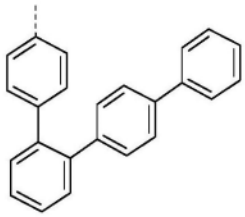
R5-17



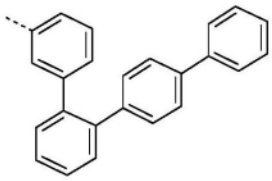
R5-18



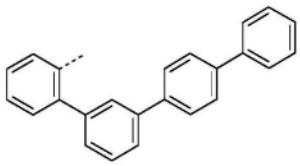
R5-19



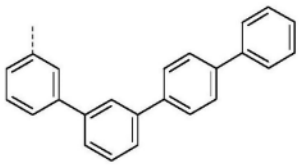
R5-20



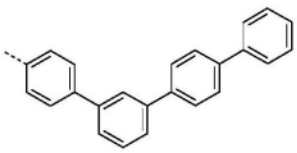
R5-21



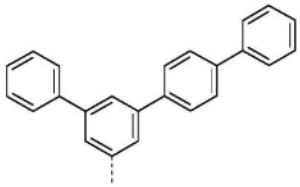
R5-22



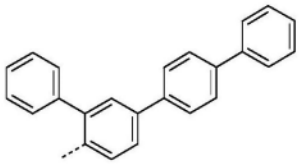
R5-23



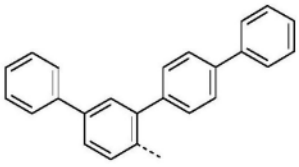
R5-24



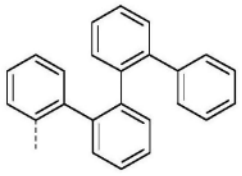
R5-25



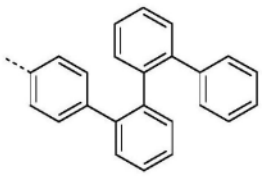
R5-26

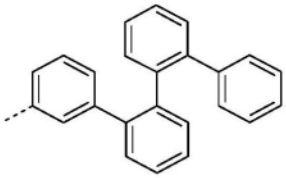


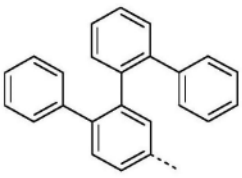
R5-27



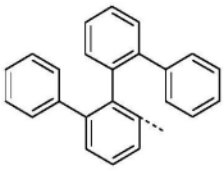
R5-28



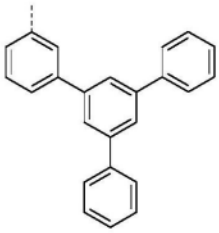




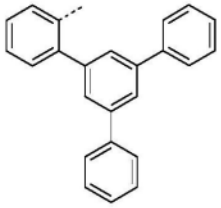
R5-29



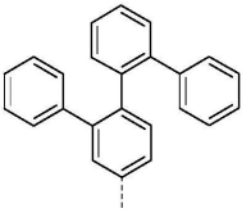
R5-30



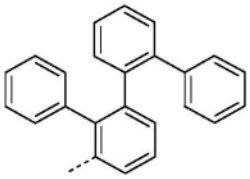
R5-31



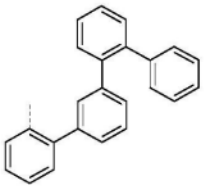
R5-32



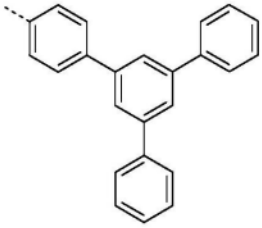
R5-33



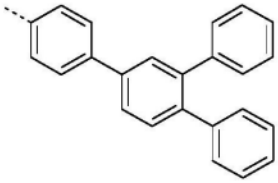
R5-34



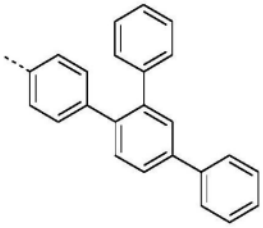
R5-35



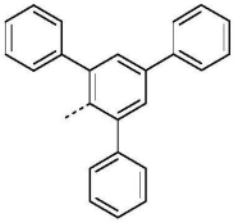
R5-36



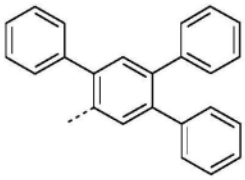
R5-37



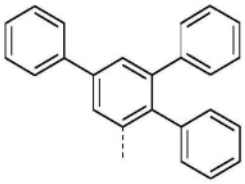
R5-38



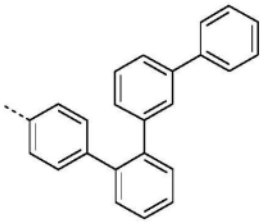
R5-39



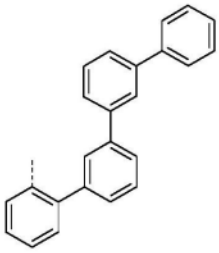
R5-40



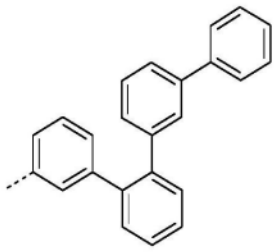
R5-41



R5-42

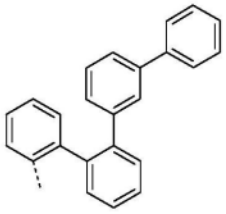


R5-43



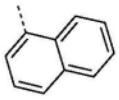
R5-44

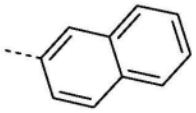
R5-45

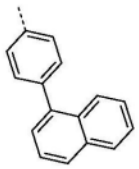


R5-46

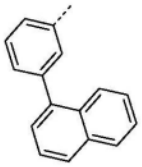
R5-47



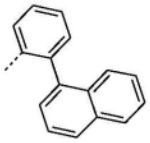




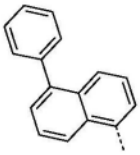
R5-48



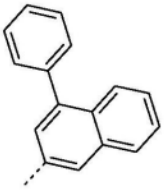
R5-49



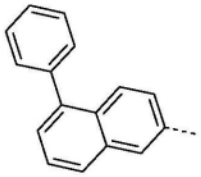
R5-50



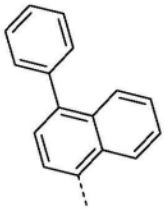
R5-51



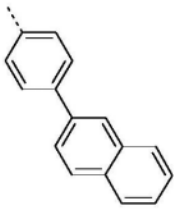
R5-52



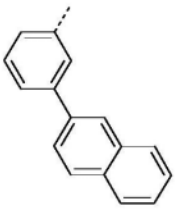
R5-53



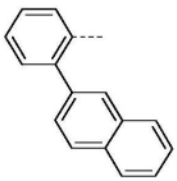
R5-54



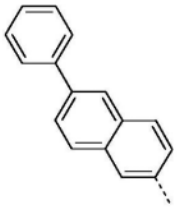
R5-55



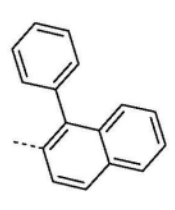
R5-56



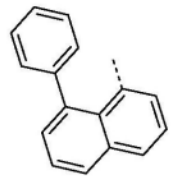
R5-57



R5-58



R5-59

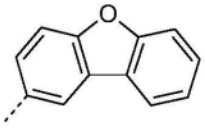


R5-60

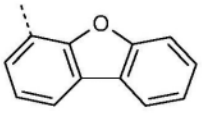
R5-61

R5-62

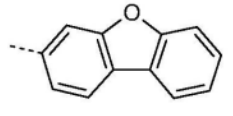
R5-63



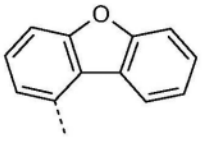
R5-64



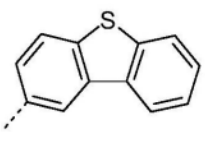
R5-65



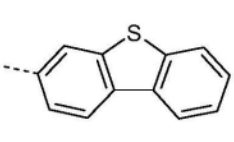
R5-66

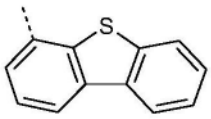


R5-67

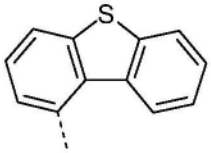


R5-68

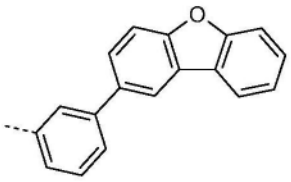




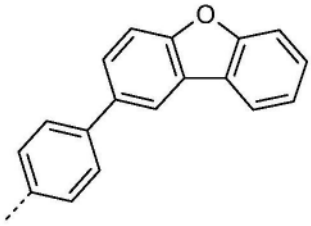
R5-69



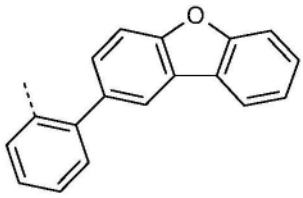
R5-70



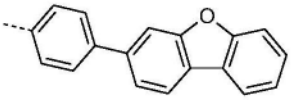
R5-71



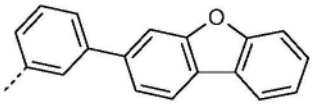
R5-72



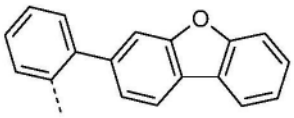
R5-73



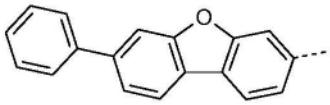
R5-74



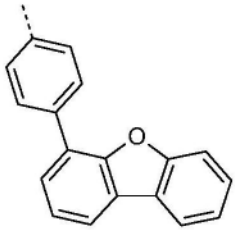
R5-75



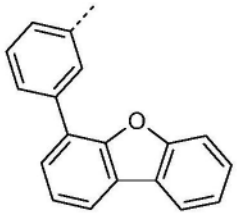
R5-76



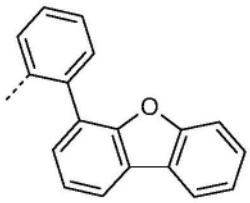
R5-77



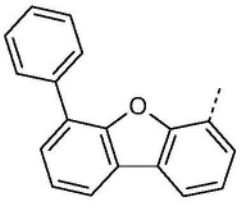
R5-78



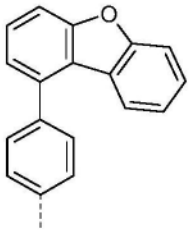
R5-79



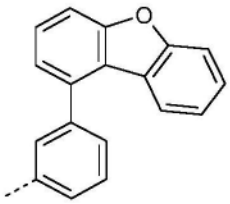
R5-80



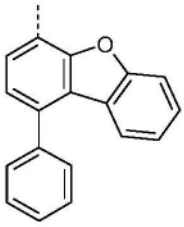
R5-81



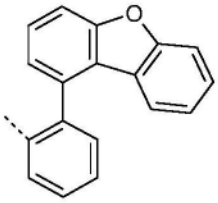
R5-82



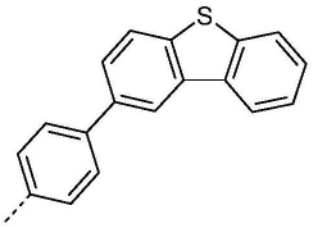
R5-83



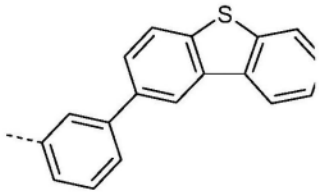
R5-84



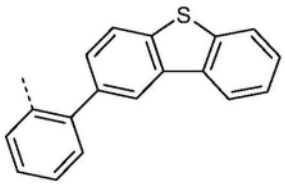
R5-85



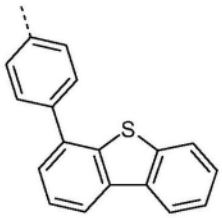
R5-86



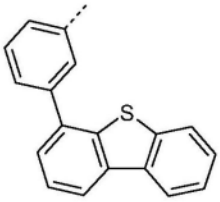
R5-87



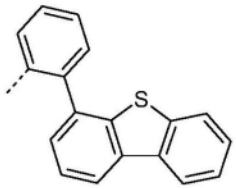
R5-88



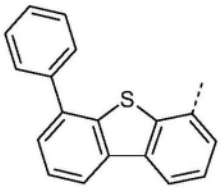
R5-89



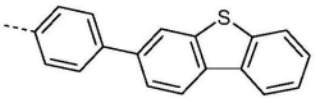
R5-90



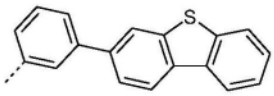
R5-91



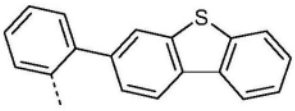
R5-92



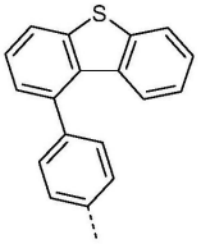
R5-93



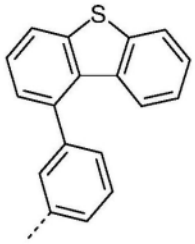
R5-94



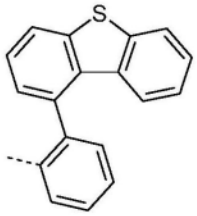
R5-95



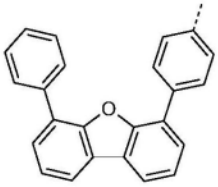
R5-96



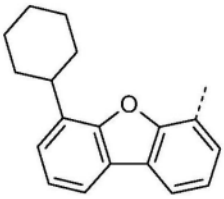
R5-97



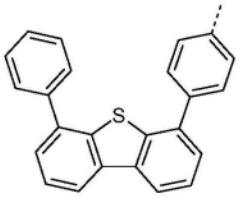
R5-98



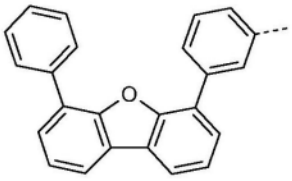
R5-99



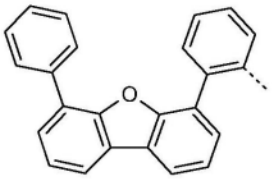
R5-100



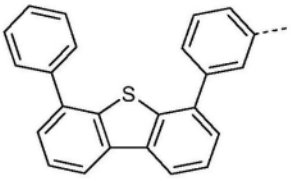
R5-101



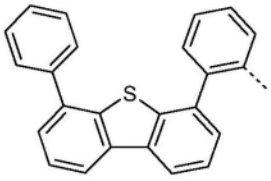
R5-102



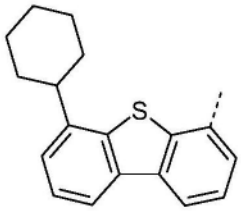
R5-103

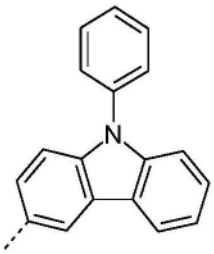


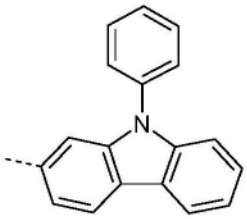
R5-104



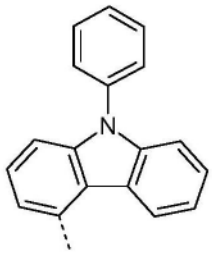
R5-105

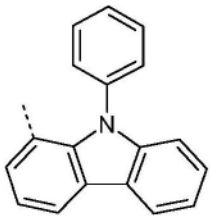


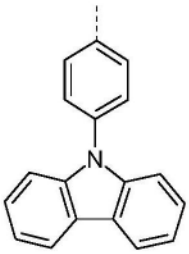




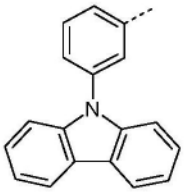
R5-106 R5-107 R5-108

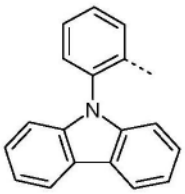




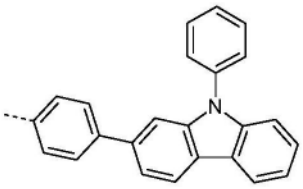


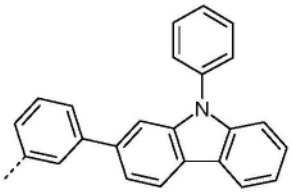
R5-109 R5-110 R5-111

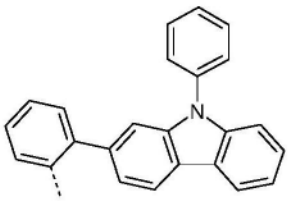




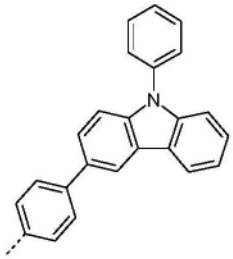
R5-112 R5-113

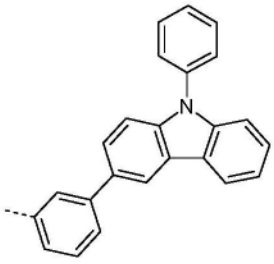


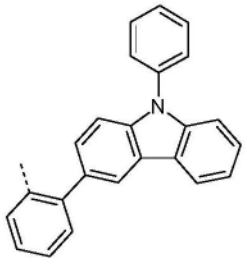




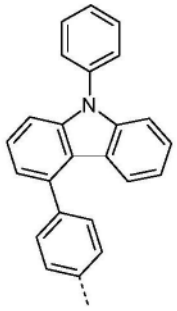
R5-114 R5-115 R5-116



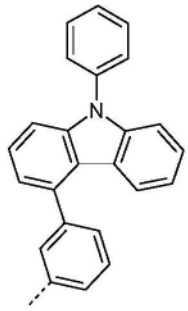




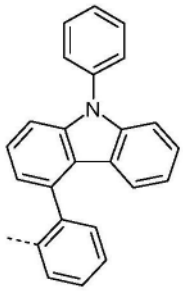
R5-117 R5-118 R5-119



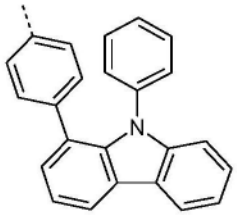
R5-120



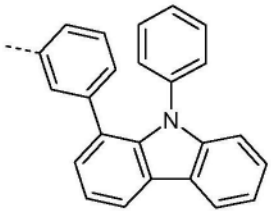
R5-121



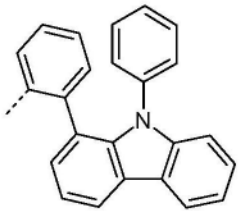
R5-122



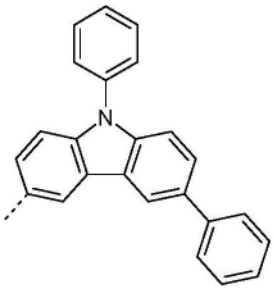
R5-123



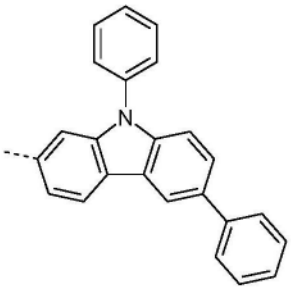
R5-124



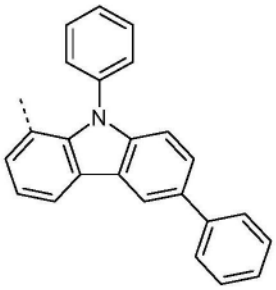
R5-125



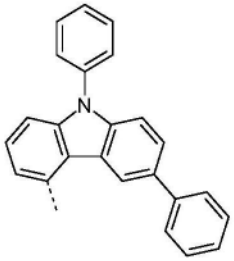
R5-126



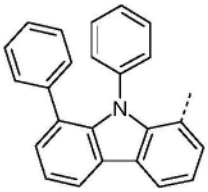
R5-127



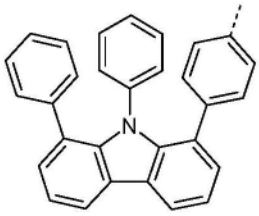
R5-128



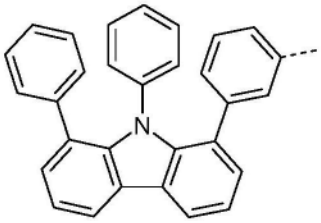
R5-129



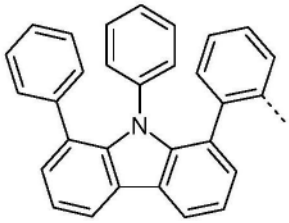
R5-130



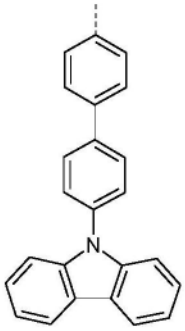
R5-131



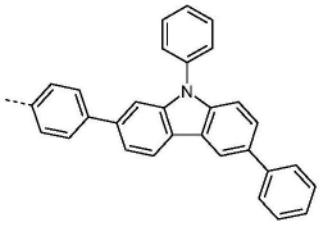
R5-132



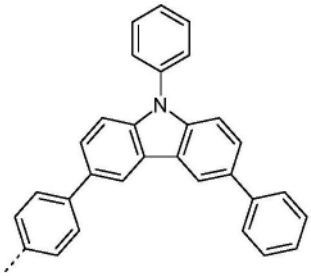
R5-133



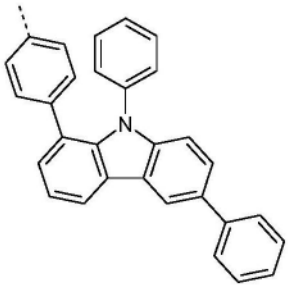
R5-134



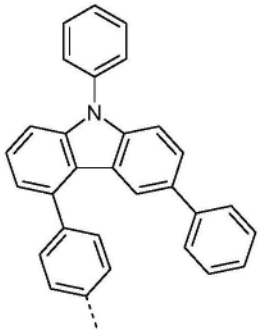
R5-135



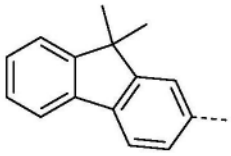
R5-136



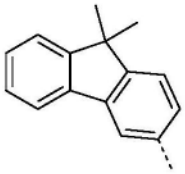
R5-137



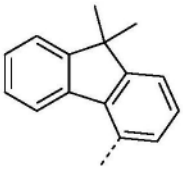
R5-138



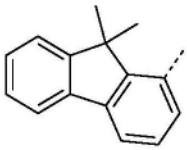
R5-139



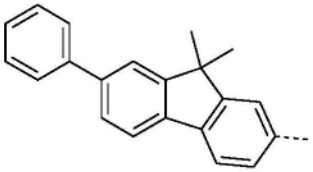
R5-140



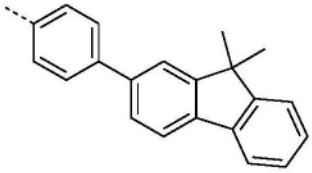
R5-141



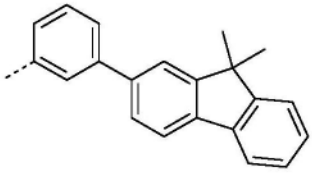
R5-142



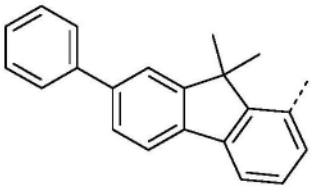
R5-143



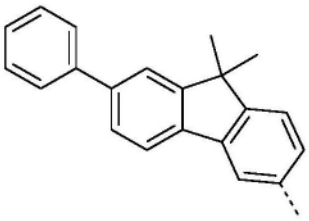
R5-144



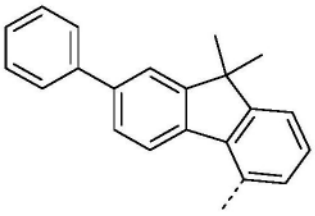
R5-145



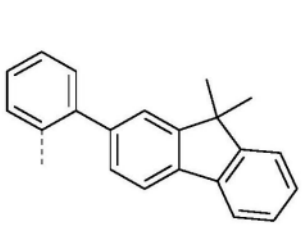
R5-146



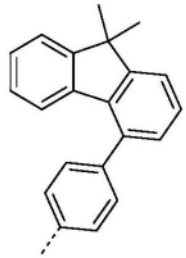
R5-147



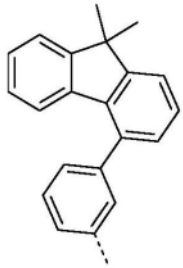
R5-148



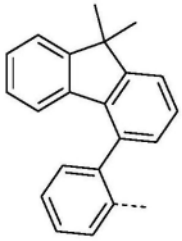
R5-149



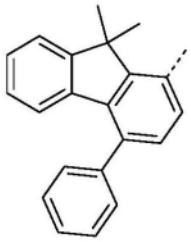
R5-150



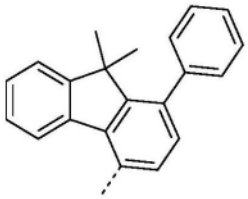
R5-151



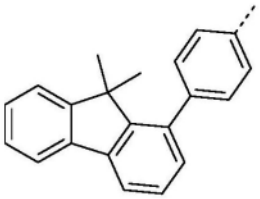
R5-152



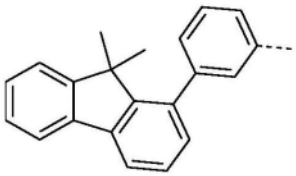
R5-153



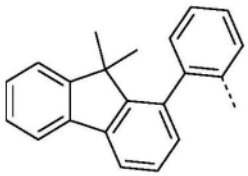
R5-154



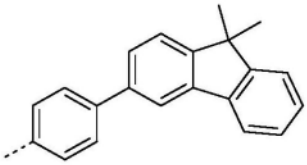
R5-155



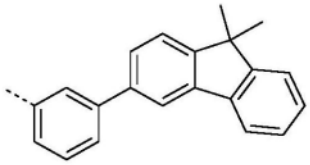
R5-156



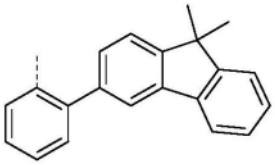
R5-157



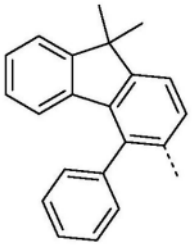
R5-158



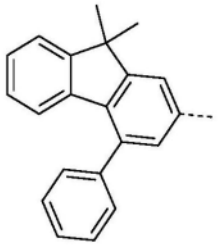
R5-159



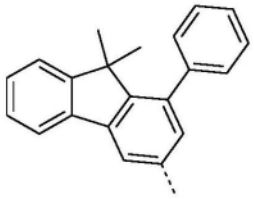
R5-160



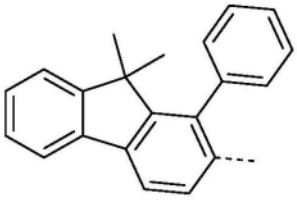
R5-161



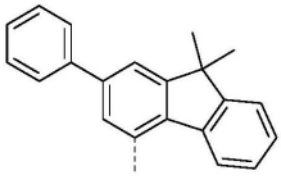
R5-162



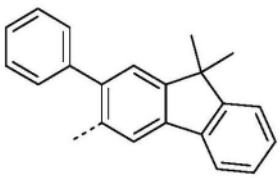
R5-163



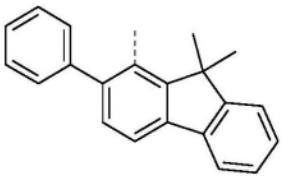
R5-164



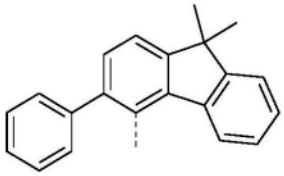
R5-165



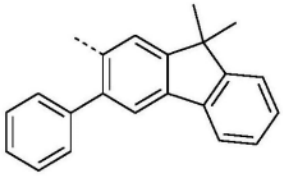
R5-166



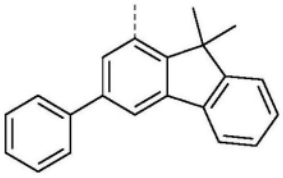
R5-167



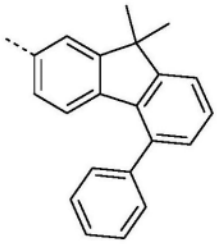
R5-168



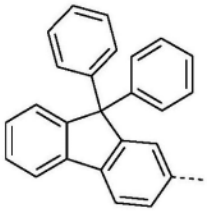
R5-169



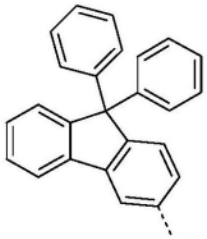
R5-170



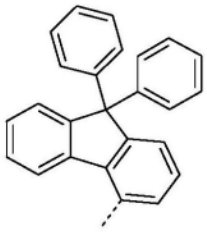
R5-171



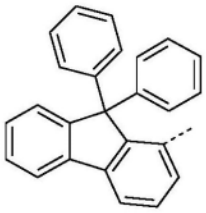
R5-172



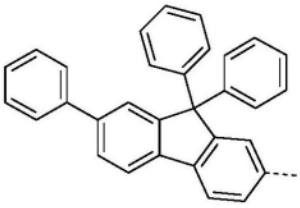
R5-173



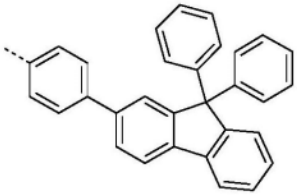
R5-174



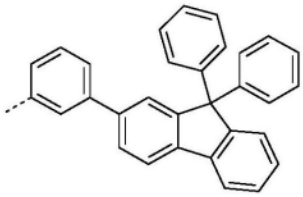
R5-175



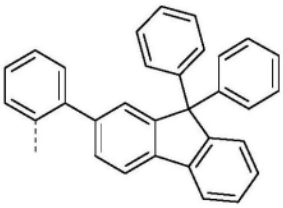
R5-176



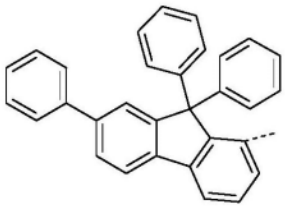
R5-177



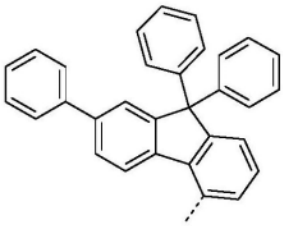
R5-178



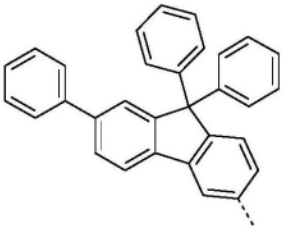
R5-179



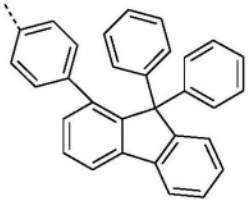
R5-180



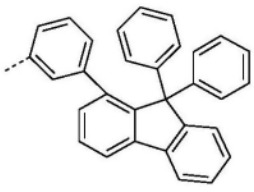
R5-181



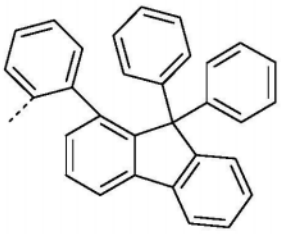
R5-182



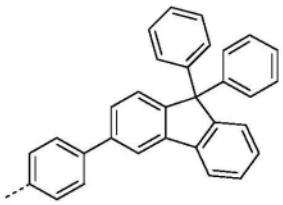
R5-183



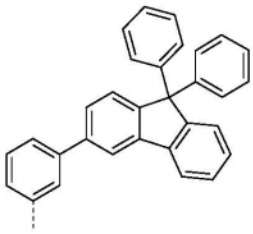
R5-184



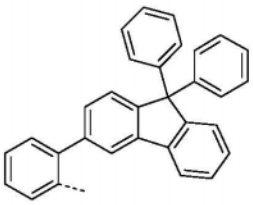
R5-185



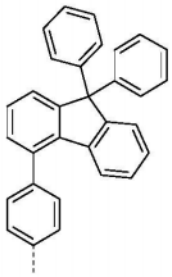
R5-186



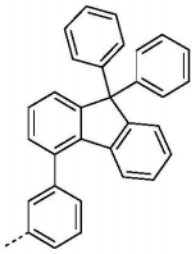
R5-187



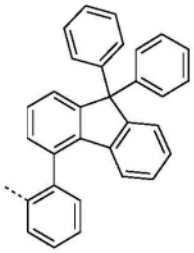
R5-188



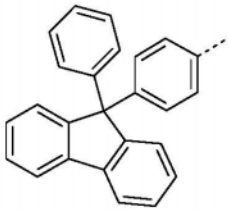
R5-189



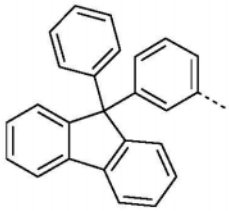
R5-190



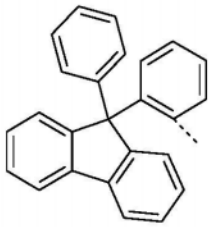
R5-191



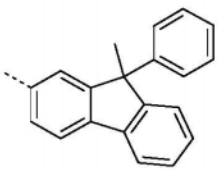
R5-192



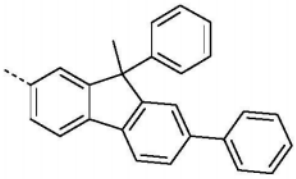
R5-193



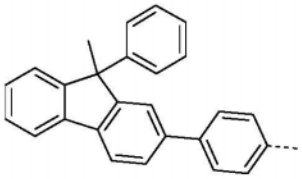
R5-194



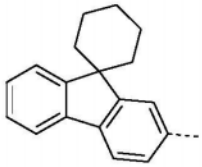
R5-195



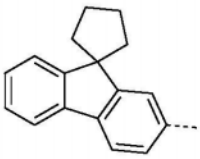
R5-196



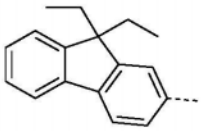
R5-197



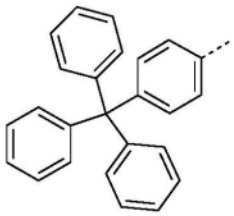
R5-198



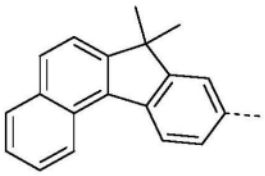
R5-199



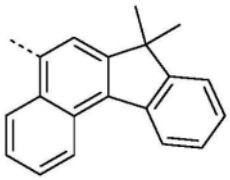
R5-200



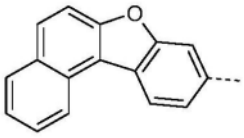
R5-201



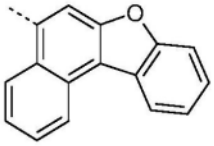
R5-202



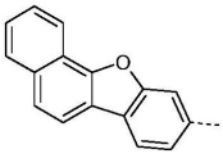
R5-203



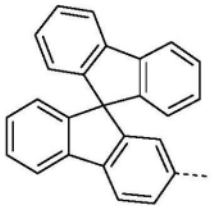
R5-204



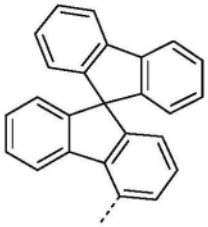
R5-205



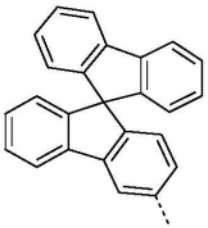
R5-206



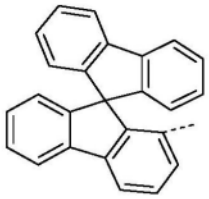
R5-207



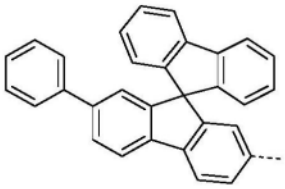
R5-208



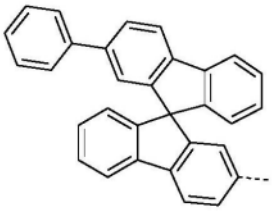
R5-209



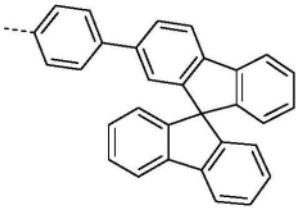
R5-210



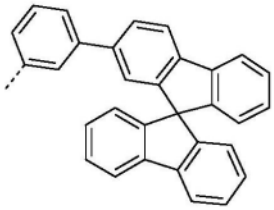
R5-211



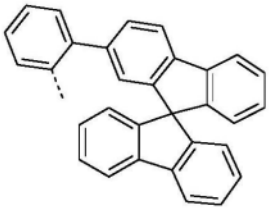
R5-212



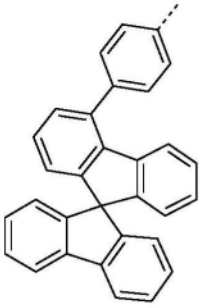
R5-213



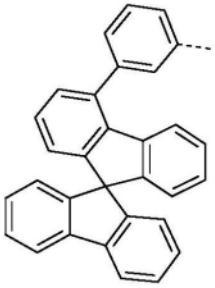
R5-214



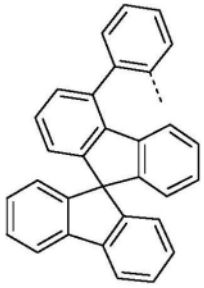
R5-215



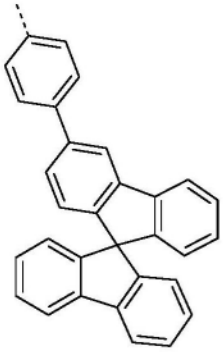
R5-216



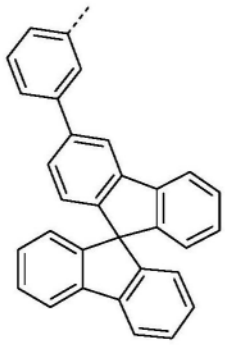
R5-217



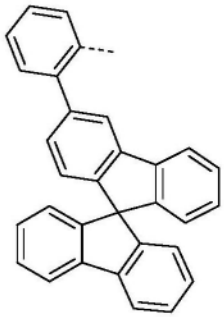
R5-218



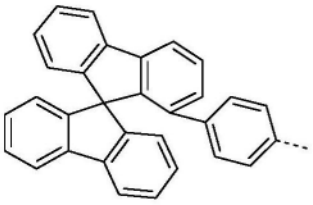
R5-219



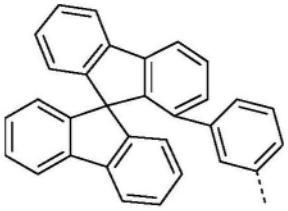
R5-220



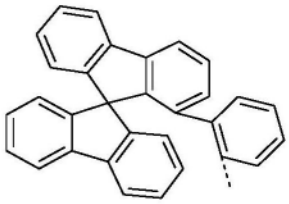
R5-221



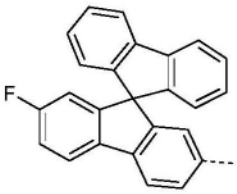
R5-222



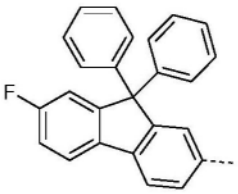
R5-223



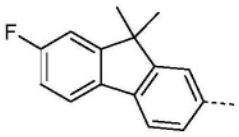
R5-224



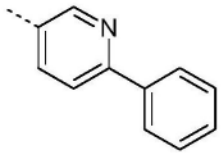
R5-225



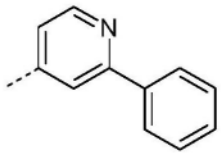
R5-226



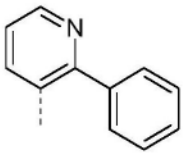
R5-227



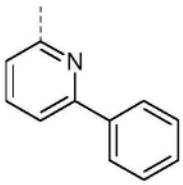
R5-228



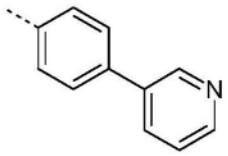
R5-229



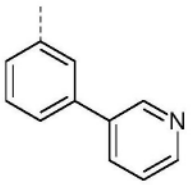
R5-230



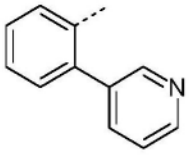
R5-231



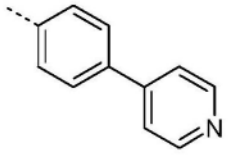
R5-232



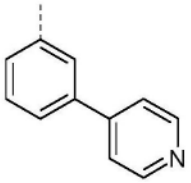
R5-233



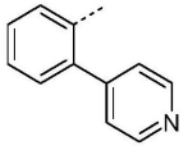
R5-234



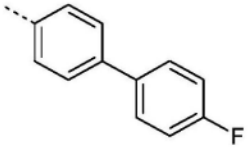
R5-235



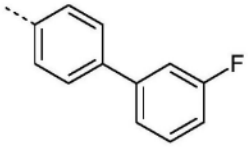
R5-236



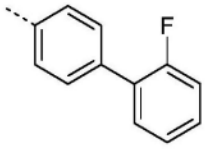
R5-237



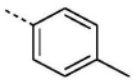
R5-238



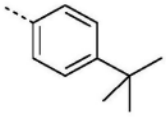
R5-239



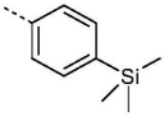
R5-240



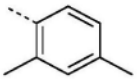
R5-241



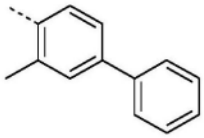
R5-242



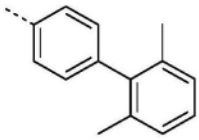
R5-243



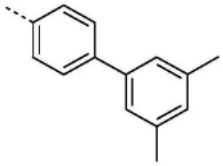
R5-244



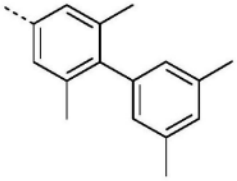
R5-245



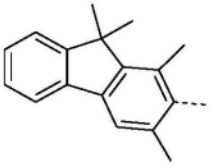
R5-246



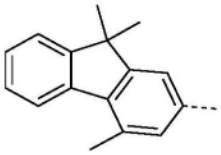
R5-247



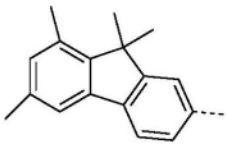
R5-248



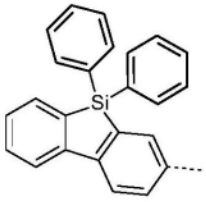
R5-250



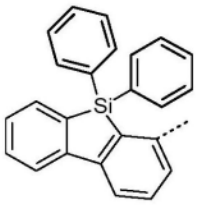
R5-251



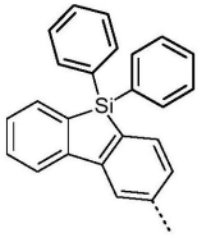
R5-252



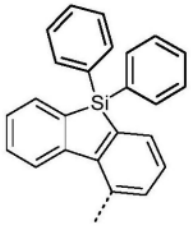
R5-253



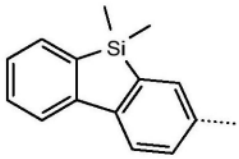
R5-254



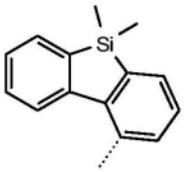
R5-255



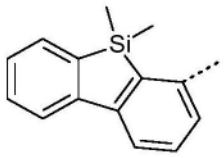
R5-256



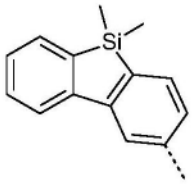
R5-257



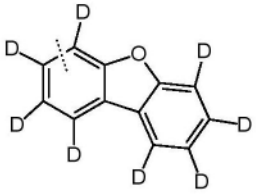
R5-258



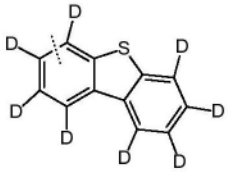
R5-259



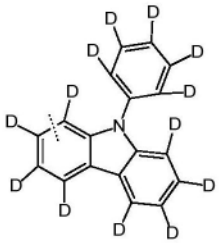
R5-260



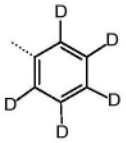
R5-261



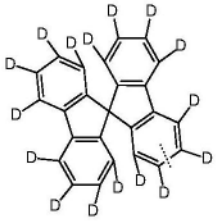
R5-262



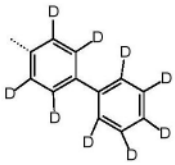
R5-263



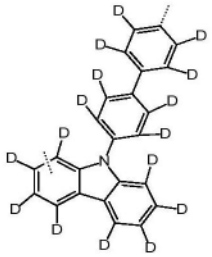
R5-264



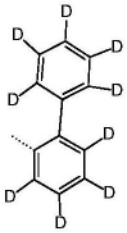
R5-265



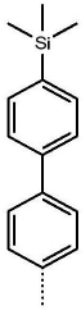
R5-266



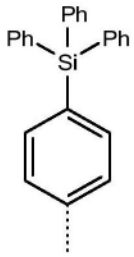
R5-267



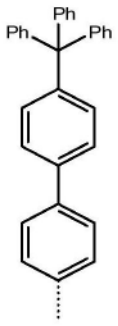
R5-268



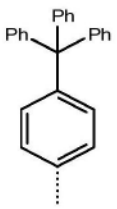
R5-269



R5-270



R5-271



R5-272

其中所提到的R^5基团可以在显示为未取代的位置上被R^{11}基团取代,其中这些位置上的R^{11}优选为H,其中虚线键是与胺氮原子连接的键;其中所用符号符合上述权利要求所述的定

义。

11.根据权利要求1至10中的一项或多项所述的化合物,其特征在于m、n和o是0。

12.一种制备根据权利要求1至11中的一项或多项所述的化合物的方法,所述方法借助于Suzuki偶联或Buchwald反应。

13.一种低聚物、聚合物或树枝状大分子,所述低聚物、聚合物或树枝状大分子含有一种或多种根据权利要求1至11中的一项或多项所述的化合物,其中与所述聚合物、低聚物或树枝状大分子连接的键可以位于式(1)中被R^1、R^2、R^3、R^4、R^5、R^6、R^7、R^8、R^{11}或R^{12}取代的任何所需位置。

14.一种组合物,所述组合物包含一种或多种式(1)的化合物和至少一种选自空穴传输材料、空穴注入材料、p型掺杂剂、电子阻挡材料、基质材料、发光体和电子传输材料的其它材料。

15.一种制剂,所述制剂包含至少一种根据权利要求1至11中的一项或多项所述的化合物或至少一种根据权利要求13所述的聚合物、低聚物或树枝状大分子或至少一种根据权利要求14所述的组合物和至少一种溶剂。

16.一种电子器件,所述电子器件包含至少一种根据权利要求1至11中的一项或多项所述的化合物或至少一种根据权利要求13所述的聚合物、低聚物或树枝状大分子或至少一种根据权利要求14所述的组合物。

17.根据权利要求16所述的电子器件,其特征在于所述电子器件是有机电致发光器件并包括阳极、阴极和至少一个发光层,以及所述化合物存在于所述器件的电子阻挡性层或空穴传输性层或发光层中。

18.根据权利要求17所述的有机电致发光器件,其特征在于所述化合物存在于空穴传输性层中,所述空穴传输性层是空穴传输层或电子阻挡层。

19.根据权利要求1至11中的一项或多项所述的化合物在电子器件中的用途。

用于电子器件的材料

[0001] 本申请涉及芳族和杂芳族化合物、其制备、包含所述化合物的混合物和制剂，以及包含所述化合物或所述混合物的电子器件。

[0002] 在本申请的上下文中，电子器件应理解为意指包含有机半导体材料作为功能材料的所谓的有机电子器件。更具体地，这些应理解为意指有机电致发光器件，并且OLED(有机发光二极管)是非常特别优选的有机电致发光器件。术语OLED应理解为意指具有一个或多个包含有机化合物的层并且在施加电压时发光的有机电致发光器件。OLED的构造和一般功能原理是本领域技术人员已知的。

[0003] 在电子器件，尤其是OLED中，对性能数据的改进有极大的兴趣。在这些方面，还未发现任何完全令人满意的解决方案。

[0004] 发光层和具有空穴传输性功能的层对电子器件的性能数据具有很大影响。这些不仅包括发光层，尤其还包括空穴传输层(HTL)、电子阻挡层(EBL)和空穴注入层(HIL)。还在继续寻找用于这些层的新型化合物，尤其是空穴传输性化合物以及以下化合物，所述化合物可以在电子阻挡层中用作空穴传导电子阻挡材料、在空穴传输层中作为空穴导体、或在发光层中作为空穴传输性基质材料、尤其是用于磷光发光体的空穴传输性基质材料。为此目的，特别寻找具有高玻璃化转变温度、高稳定性和高空穴传导性的化合物。化合物的高稳定性是实现电子器件的长寿命的先决条件。

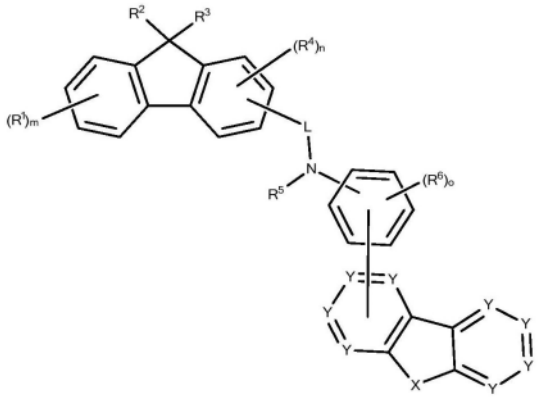
[0005] 在现有技术中，特别是已知三芳基胺化合物作为电子器件的电子阻挡和空穴传输材料以及空穴传输性基质材料。用于电子器件的已知三芳基胺化合物还包括芴基胺化合物，即其中至少一个芳基基团是芴基基团的三芳基胺化合物。

[0006] 然而，仍然需要适合用于电子器件的替代化合物，尤其是具有一种或多种上述有利性能的化合物。当所述化合物用于电子器件时，仍然需要改进所获得的性能数据，尤其是在器件的寿命、工作电压以及效率方面。

[0007] 已经发现，下文更详细说明的在芴基基团和胺基团之间含有特定的连接基L并且在胺上以特定方式被芳族和杂芳族基团取代的特定芴基胺化合物非常适合用于有机电子器件，尤其用于OLED，更特别用作空穴传输材料，用作空穴传输性基质材料，尤其用于磷光发光体的空穴传输性基质材料，非常特别在电子阻挡层(EBL)中用作电子阻挡材料(EBM)。含有所述化合物的器件的性能数据比起现有技术有明显改进。更特别地，器件的寿命和工作电压的值有明显改进。

[0008] 所述化合物本身也具有高稳定性，尤其对于空气和光。所述化合物因高储存稳定性而值得注意。此外，所述化合物具有高玻璃化转变温度和高空穴传导性。

[0009] 本发明化合物涉及下式(1)的那些化合物：

[0010] 

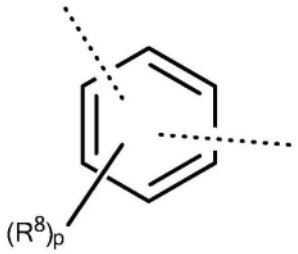
[0011] 式(1)

[0012] 其中出现的变量如下：

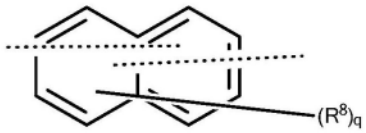
[0013] X是O或S，其中在一个非常特别优选的实施方式中，X是O；在另一个优选实施方式中，X是S；

[0014] Y在每种情况下相同或不同并且是CR^7或N，优选Y是CR^7；

[0015] L是连接式(1)中的芴基基团与胺基团的二价基团，其中L是具有6至40个芳族环原子的二价芳族环系，L优选为选自以下式(L-1)、(L-2)、(L-3)、(L-4)和(L-5)的二价基团：

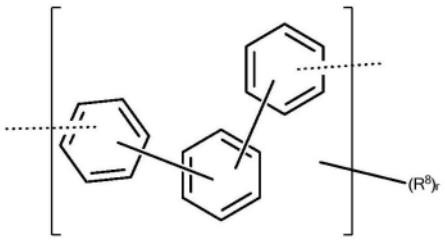


式(L-1)

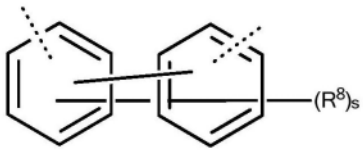


式(L-2)

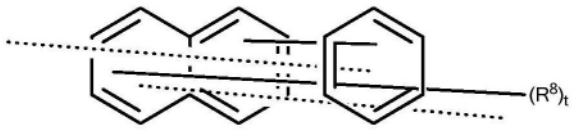
[0016]



式(L-3)



式(L-4)

[0017] 

式(L-5)

[0018] 其中一方面，两条虚线中的一条表示L基团与氮连接的键，另一方面，另一条虚线表示与芴基基团连接的键，其中式(L-1)、(L-2)、(L-3)、(L-4)和(L-5)的基团是被一个或多个R^8基团取代或未被取代的苯亚基、萘亚基、三联苯亚基、联苯亚基或萘基-苯基基团。

[0019] 式(L-2)和式(L-3)中R^8基团的符号意指R^8基团可以出现在式(L-2)的两个环或式(L-3)的全部三个环中。

[0020] R^1、R^4、R^6、R^7和R^8在每种情况下相同或不同并选自H、D、F、Cl、Br、I、C(=O)R^{11}、CN、Si$(R^{11})_3$、N$(R^{11})_2$、P(=O)$(R^{11})_2$、OR^{11}、S(=O)R^{11}、S(=O)$_2R^{11}$、具有1至20个碳原子的直链烷基或烷氧基基团、具有3至20个碳原子的支链或环状的烷基或烷氧基基团、具有2至20个碳原子的烯基或炔基基团、具有6至40个芳族环原子的芳族环系和具有5至40个芳族环原子的杂芳族环系;其中两个或更多个R^1基团可以彼此连接并可形成环,和/或两个或更多个R^4基团可以彼此连接并可形成环,和/或两个或更多个R^6基团可以彼此连接并可形成环,和/或两个或更多个R^7基团可以彼此连接并可形成环,和/或两个或更多个R^8基团可以彼此连接并可形成环;其中所提到的烷基、烷氧基、烯基和炔基基团以及所提到的芳族环系和杂芳族环系各自可被R^{11}基团取代;其中所述烷基、烷氧基、烯基和炔基基团中的一个或多个CH_2基团可被-R^{11}C=CR^{11}-、-C≡C-、Si$(R^{11})_2$、C=O、C=NR^{11}、-C(=O)O-、-C(=O)NR^{11}-、NR^{11}、P(=O)(R^{11})、-O-、-S-、SO或SO_2代替;优选地,两个或更多个R^1基团不彼此形成环,和/或两个或更多个R^4基团不彼此形成环,和/或两个或更多个R^6基团不彼此形成环,和/或两个或更多个R^7基团不彼此形成环,和/或两个或更多个R^8基团不彼此形成环;

[0021] R^2和R^3在每种情况下相同或不同并且选自具有1至20个碳原子的直链烷基或烷氧基基团、具有3至20个碳原子的支链或环状的烷基或烷氧基基团、具有2至20个碳原子的烯基或炔基基团、具有6至40个芳族环原子的芳族环系以及具有5至40个芳族环原子的杂芳族环系;其中两个R^2和R^3基团可以彼此连接并可形成环;其中所提到的烷基、烷氧基、烯基和炔基基团和所提到的芳族环系和杂芳族环系各自可被R^{11}基团取代;其中所述烷基、烷氧基、烯基和炔基基团中的一个或多个CH_2基团可被-R^{11}C=CR^{11}-、-C≡C-、Si$(R^{11})_2$、C=O、C=NR^{11}、-C(=O)O-、-C(=O)NR^{11}-、NR^{11}、P(=O)(R^{11})、-O-、-S-、SO或SO_2代替;如果两个R^2和R^3基团形成环,则结果是螺环化合物,优选螺二芴;特别优选两个R^2和R^3基团不彼此形成环;

[0022] R^5是具有6至40个芳族环原子并可被一个或多个R^{11}基团取代的芳族环系或具有5至40个芳族环原子并可被一个或多个R^{11}基团取代的杂芳族环系;

[0023] R^{11}在每种情况下相同或不同,并且选自H、D、F、Cl、Br、I、C(=O)R^{12}、CN、Si$(R^{12})_3$、N$(R^{12})_2$、P(=O)$(R^{12})_2$、OR^{12}、S(=O)R^{12}、S(=O)$_2R^{12}$、具有1至20个碳原子的直链烷基或烷氧基基团、具有3至20个碳原子的支链或环状的烷基或烷氧基基团、具有2至20个碳原子的烯基或炔基基团、具有6至40个芳族环原子的芳族环系以及具有5至40个芳族环原子的杂芳族环系;其中两个或更多个R^{11}基团可以彼此连接并可形成环;其中所提到的烷基、烷氧基、烯基和炔基基团以及所提到的芳族环系和杂芳族环系各自被R^{12}基团取代;其中所提到的烷基、烷氧基、烯基和炔基基团中的一个或多个CH_2基团可被-R^{12}C=CR^{12}-、-C≡C-、Si$(R^{12})_2$、C=O、C=NR^{12}、-C(=O)O-、-C(=O)NR^{12}-、NR^{12}、P(=O)(R^{12})、-O-、-S-、SO或SO_2代替;其中两个或更多个R^{11}基团可以不彼此形成环;

[0024] R^{12}在每种情况下相同或不同,并且选自H、D、F、Cl、Br、I、CN、具有1至20个碳原子的烷基或烷氧基基团、具有2至20个碳原子的烯基或炔基基团、具有6至40个芳族环原子的芳族环系以及具有5至40个芳族环原子的杂芳族环系;其中所提到的烷基、烷氧基、烯基和炔基基团、芳族环系和杂芳族环系可被选自F和CN的一个或多个基团取代;

[0025] m是0、1、2、3或4;优选m是0或1,非常优选m是1,最优选m是0;

[0026] n是0、1、2或3;优选n是0或1,非常优选n是1,最优选n是0;

[0027] o是0、1、2或3;优选o是0或1,非常优选o是1,最优选o是0;

[0028] p是0、1、2、3或4;优选p是0或1,非常优选p是1,最优选p是0;

[0029] q是0、1、2、3、4、5或6;优选q是0或1,非常优选q是1,最优选q是0;

[0030] r是0、1、2、3、4、5、7、8、9、10、11或12;优选r是0或1,非常优选r是1,最优选r是0;

[0031] s是0、1、2、3、4、5、7或8;优选s是0或1,非常优选s是1,最优选s是0;

[0032] t是0、1、2、3、4、5、7、8、9或10;优选t是0或1,非常优选t是1,最优选t是0。

[0033] 在一个优选实施方式中,R^1基团不含具有超过12个芳族碳原子在芳族或杂芳族环系中作为环原子的任何稠合芳族和/或杂芳族环系;非常优选地,R^1基团不含具有超过10个芳族碳原子在芳族或杂芳族环系中作为环原子的任何稠合芳族和/或杂芳族环系;甚至更优选地,R^1基团不含任何咔唑;尤其优选地,R^1基团不含任何稠合杂芳族环系;最优选地,R^1基团既不含芳族稠合环系又不含杂芳族稠合环系。

[0034] 在一个优选实施方式中,R^2基团不含具有超过12个芳族碳原子在芳族或杂芳族环系中作为环原子的任何稠合芳族和/或杂芳族环系;非常优选地,R^2基团不含具有超过10个芳族碳原子在芳族或杂芳族环系中作为环原子的任何稠合芳族和/或杂芳族环系;甚至更优选地,R^2基团不含任何咔唑;尤其优选地,R^2基团不含任何稠合杂芳族环系;最优选地,R^2基团既不含芳族稠合环系又不含杂芳族稠合环系。

[0035] 在另一个优选实施方式中,R^3基团不含具有超过12个芳族碳原子在芳族或杂芳族环系中作为环原子的任何稠合芳族和/或杂芳族环系;非常优选地,R^3基团不含具有超过10个芳族碳原子在芳族或杂芳族环系中作为环原子的任何稠合芳族和/或杂芳族环系;甚至更优选地,R^3基团不含任何咔唑;尤其优选地,R^3基团不含任何稠合杂芳族环系;最优选地,R^3基团既不含芳族稠合环系又不含杂芳族稠合环系。

[0036] 在另一个优选实施方式中,R^4基团不含具有超过12个芳族碳原子在芳族或杂芳族环系中作为环原子的任何稠合芳族和/或杂芳族环系;非常优选地,R^4基团不含具有超过10个芳族碳原子在芳族或杂芳族环系中作为环原子的任何稠合芳族和/或杂芳族环系;甚至更优选地,R^4基团不含任何咔唑;尤其优选地,R^4基团不含任何稠合杂芳族环系;最优选地,R^4基团既不含芳族稠合环系又不含杂芳族稠合环系。

[0037] 在另一个优选实施方式中,R^5基团不含具有超过12个芳族碳原子在芳族或杂芳族环系中作为环原子的任何稠合芳族和/或杂芳族环系;非常优选地,R^5基团不含具有超过10个芳族碳原子在芳族或杂芳族环系中作为环原子的任何稠合芳族和/或杂芳族环系;甚至更优选地,R^5基团不含任何咔唑;尤其优选地,R^5基团不含任何稠合杂芳族环系;最优选地,R^5基团既不含芳族稠合环系又不含杂芳族稠合环系。

[0038] 在另一个优选实施方式中,R^6基团不含具有超过12个芳族碳原子在芳族或杂芳族环系中作为环原子的任何稠合芳族和/或杂芳族环系;非常优选地,R^6基团不含具有超过10个芳族碳原子在芳族或杂芳族环系中作为环原子的任何稠合芳族和/或杂芳族环系;甚至更优选地,R^6基团不含任何咔唑;尤其优选地,R^6基团不含任何稠合杂芳族环系;最优选地,R^6基团既不含芳族稠合环系又不含杂芳族稠合环系。

[0039] 在另一个优选实施方式中,R^7基团不含具有超过12个芳族碳原子在芳族或杂芳族环系中作为环原子的任何稠合芳族和/或杂芳族环系;非常优选地,R^7基团不含具有超过10

个芳族碳原子在芳族或杂芳族环系中作为环原子的任何稠合芳族和/或杂芳族环系;甚至更优选地,R^7基团不含任何咔唑;尤其优选地,R^7基团不含任何稠合杂芳族环系;最优选地,R^7基团既不含芳族稠合环系又不含杂芳族稠合环系。

[0040] 在另一个优选实施方式中,R^8基团不含具有超过12个芳族碳原子在芳族或杂芳族环系中作为环原子的任何稠合芳族和/或杂芳族环系;非常优选地,R^8基团不含具有超过10个芳族碳原子在芳族或杂芳族环系中作为环原子的任何稠合芳族和/或杂芳族环系;甚至更优选地,R^8基团不含任何咔唑;尤其优选地,R^8基团不含任何稠合杂芳族环系;最优选地,R^8基团既不含芳族稠合环系又不含杂芳族稠合环系。

[0041] 在另一个优选实施方式中,R^{11}基团不含具有超过12个芳族碳原子在芳族或杂芳族环系中作为环原子的任何稠合芳族和/或杂芳族环系;非常优选地,R^{11}基团不含具有超过10个芳族碳原子在芳族或杂芳族环系中作为环原子的任何稠合芳族和/或杂芳族环系;甚至更优选地,R^{11}基团不含任何咔唑;尤其优选地,R^{11}基团不含任何稠合杂芳族环系;最优选地,R^{11}基团既不含芳族稠合环系又不含杂芳族稠合环系。

[0042] 在另一个优选实施方式中,R^{12}基团不含具有超过12个芳族碳原子在芳族或杂芳族环系中作为环原子的任何稠合芳族和/或杂芳族环系;非常优选地,R^{12}基团不含具有超过10个芳族碳原子在芳族或杂芳族环系中作为环原子的任何稠合芳族和/或杂芳族环系;甚至更优选地,R^{12}基团不含任何咔唑;尤其优选地,R^{12}基团不含任何稠合杂芳族环系;最优选地,R^{12}基团既不含芳族稠合环系又不含杂芳族稠合环系。

[0043] 在一个特别优选的实施方式中,R^1至R^8基团中没有一个含有具有超过12个芳族碳原子在芳族或杂芳族环系中作为环原子的稠合芳族和/或杂芳族环系;非常优选地,R^1至R^8基团中没有一个含有具有超过10个芳族碳原子在芳族或杂芳族环系中作为环原子的稠合芳族和/或杂芳族环系;甚至更优选地,R^1至R^8基团中没有一个含有咔唑;尤其优选地,R^1至R^8基团中没有一个含有稠合杂芳族环系;最优选地,R^1至R^8基团中没有一个含有芳族或杂芳族稠合环系。

[0044] 在一个特别优选的实施方式中,R^1至R^8、R^{11}和R^{12}基团中没有一个含有具有超过12个芳族碳原子在芳族或杂芳族环系中作为环原子的稠合芳族和/或杂芳族环系;非常优选地,R^1至R^8、R^{11}和R^{12}基团中没有一个含有具有超过10个芳族碳原子在芳族或杂芳族环系中作为环原子的稠合芳族和/或杂芳族环系;甚至更优选地,R^1至R^8、R^{11}和R^{12}基团中没有一个含有咔唑;尤其优选地,R^1至R^8、R^{11}和R^{12}基团中没有一个含有稠合杂芳族环系;最优选地,R^1至R^8、R^{11}和R^{12}基团中没有一个含有芳族或杂芳族稠合环系。

[0045] 以下定义适用于本申请所用的化学基团。除非给出了任何更具体的定义,否则它们就适用。

[0046] 在本发明的上下文中,芳基基团理解为意指单个芳族环,即苯,或稠合芳族多环,例如萘、菲或蒽。在本申请的上下文中,稠合芳族多环由两个或更多个彼此稠合的单个芳族环组成。环之间的稠合在这里理解为意指环彼此共有至少一条边。在本发明的上下文中,芳基基团含有6至40个芳族环原子,其中没有一个是杂原子。

[0047] 在本发明的上下文中,杂芳基基团理解为意指单个杂芳族环,例如吡啶、嘧啶或噻吩,或稠合杂芳族多环,例如喹啉或咔唑。在本申请的上下文中,稠合杂芳族多环由两个或更多个彼此稠合的单个芳族或杂芳族环组成,其中所述芳族和杂芳族环中的至少一个是杂

芳族环。环之间的稠合在这里理解为意指环彼此共有至少一条边。在本发明的上下文中，杂芳基基团含有5至40个芳族环原子，其中至少一个是杂原子。杂芳基基团的杂原子优选地选自N、O和S。

[0048] 各自可被上述基团取代的芳基或杂芳基基团，尤其理解为意指衍生自以下物质的基团：苯、萘、蒽、菲、芘、二氢芘、苊、茚、联三苯叉、荧蒽、苯并蒽、苯并菲、并四苯、并五苯、苯并芘、呋喃、苯并呋喃、异苯并呋喃、二苯并呋喃、噻吩、苯并噻吩、异苯并噻吩、二苯并噻吩、吡咯、吲哚、异吲哚、咔唑、吡啶、喹啉、异喹啉、吖啶、菲啶、苯并-5,6-喹啉、苯并-6,7-喹啉、苯并-7,8-喹啉、吩噻嗪、吩噁嗪、吡唑、吲唑、咪唑、苯并咪唑、苯并咪唑并[1,2-a]苯并咪唑、萘并咪唑、菲并咪唑、吡啶并咪唑、吡嗪并咪唑、喹喔啉并咪唑、噁唑、苯并噁唑、萘并噁唑、蒽并噁唑、菲并噁唑、异噁唑、1,2-噻唑、1,3-噻唑、苯并噻唑、哒嗪、苯并哒嗪、嘧啶、苯并嘧啶、喹喔啉、吡嗪、吩嗪、萘啶、氮杂咔唑、苯并咔啉、菲咯啉、1,2,3-三唑、1,2,4-三唑、苯并三唑、1,2,3-噁二唑、1,2,4-噁二唑、1,2,5-噁二唑、1,3,4-噁二唑、1,2,3-噻二唑、1,2,4-噻二唑、1,2,5-噻二唑、1,3,4-噻二唑、1,3,5-三嗪、1,2,4-三嗪、1,2,3-三嗪、四唑、1,2,4,5-四嗪、1,2,3,4-四嗪、1,2,3,5-四嗪、嘌呤、蝶啶、吲哚嗪和苯并噻二唑。

[0049] 在本发明的上下文中，芳族环系是如下体系：不必仅含有芳基基团，而是可另外含有一个或多个与至少一个芳基基团稠合的非芳族环。这些非芳族环仅含有碳原子作为环原子。该定义涵盖的基团的实例是四氢萘、芴和螺二芴。此外，术语“芳族环系”包括由两个或更多个经由单键彼此连接的芳族环系组成的体系，例如联苯基、三联苯基、7-苯基-2-芴基、四联苯基和3,5-二苯基-1-苯基。在本发明的上下文中，芳族环系含有6至40个碳原子，并且在环系中没有杂原子。“芳族环系”的定义不包括杂芳基基团。

[0050] 杂芳族环系符合芳族环系的上述定义，但它必须含有至少一个杂原子作为环原子。如同芳族环系的情况，杂芳族环系不必仅含有芳基基团和杂芳基基团，而是可另外含有一个或多个与至少一个芳基或杂芳基基团稠合的非芳族环。非芳族环可仅含有碳原子作为环原子，或者它们可另外含有一个或多个杂原子，其中所述杂原子优选地选自N、O和S。此类杂芳族环系的一个实例是苯并吡喃基。此外，术语“杂芳族环系”应理解为意指由两个或更多个经由单键彼此键合的芳族或杂芳族环系组成的体系，例如4,6-二苯基-2-三嗪基。在本发明的上下文中，杂芳族环系含有5至40个选自碳和杂原子的环原子，其中至少一个所述环原子是杂原子。杂芳族环系的杂原子优选地选自N、O和S。

[0051] 因此，如本申请所定义，术语“杂芳族环系”和“芳族环系”彼此不同，因为芳族环系不能具有杂原子作为环原子，而杂芳族环系必须具有至少一个杂原子作为环原子。该杂原子可以作为非芳族杂环的环原子或作为芳族杂环的环原子存在。

[0052] 根据上述定义，术语“芳族环系”涵盖任何芳基基团，而术语“杂芳族环系”涵盖任何杂芳基基团。

[0053] 具有6至40个芳族环原子的芳族环系或具有5至40个芳族环原子的杂芳族环系尤其理解为意指衍生自上文在芳基基团和杂芳基基团下所提到的基团，以及衍生自联苯、三联苯、四联苯、芴、螺二芴、二氢菲、二氢芘、四氢芘、茚并芴、三聚茚、异三聚茚、螺三聚茚、螺异三聚茚、茚并咔唑的基团，或者衍生自这些基团的组合的基团。

[0054] 在本发明的上下文中，个别氢原子或CH_2基团还可被上文在基团定义中提到的基团取代的具有1至20个碳原子的直链烷基基团和具有3至20个碳原子的支链或环状烷基基

团以及具有2至40个碳原子的烯基或炔基基团，优选地理解为意指甲基、乙基、正丙基、异丙基、正丁基、异丁基、仲丁基、叔丁基、2-甲基丁基、正戊基、仲戊基、环戊基、新戊基、正己基、环己基、新己基、正庚基、环庚基、正辛基、环辛基、2-乙基己基、三氟甲基、五氟乙基、2,2,2-三氟乙基、乙烯基、丙烯基、丁烯基、戊烯基、环戊烯基、己烯基、环己烯基、庚烯基、环庚烯基、辛烯基、环辛烯基、乙炔基、丙炔基、丁炔基、戊炔基、己炔基或辛炔基基团。

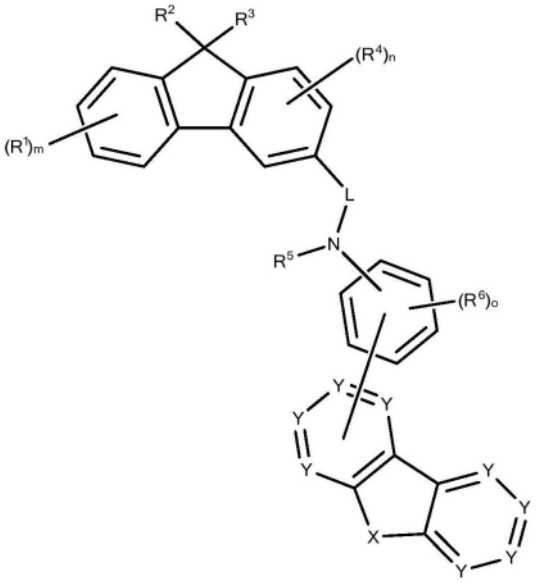
[0055] 个别氢原子或CH_2基团还可被上文在基团定义中提到的基团取代的具有1至20个碳原子的烷氧基或硫代烷基基团，优选地理解为意指甲氧基、三氟甲氧基、乙氧基、正丙氧基、异丙氧基、正丁氧基、异丁氧基、仲丁氧基、叔丁氧基、正戊氧基、仲戊氧基、2-甲基丁氧基、正己氧基、环己氧基、正庚氧基、环庚氧基、正辛氧基、环辛氧基、2-乙基己氧基、五氟乙氧基、2,2,2-三氟乙氧基、甲硫基、乙硫基、正丙硫基、异丙硫基、正丁硫基、异丁硫基、仲丁硫基、叔丁硫基、正戊硫基、仲戊硫基、正己硫基、环己硫基、正庚硫基、环庚硫基、正辛硫基、环辛硫基、2-乙基己硫基、三氟甲硫基、五氟乙硫基、2,2,2-三氟乙硫基、乙烯硫基、丙烯硫基、丁烯硫基、戊烯硫基、环戊烯硫基、己烯硫基、环己烯硫基、庚烯硫基、环庚烯硫基、辛烯硫基、环辛烯硫基、乙炔硫基、丙炔硫基、丁炔硫基、戊炔硫基、己炔硫基、庚炔硫基或辛炔硫基。

[0056] 在本申请的上下文中，两个或更多个基团一起可形成环的措辞应理解为尤其意指所述两个基团通过化学键彼此连接。然而，此外，上述措辞还应当理解为意指如果两个基团中的一个是氢，则第二个基团结合到所述氢原子键合的位置，从而形成环。

[0057] 式(1)的化合物优选地为单胺。单胺理解为意指含有单个三芳基氨基基团并且没有其它三芳基氨基基团的化合物，更优选地为含有单个氨基基团并且没有其它氨基基团的化合物。

[0058] 本发明化合物优选地具有通式(2)

[0059]



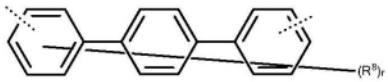
式(2)

[0060] 在一个优选实施方式中，L基团是式(L-1)的基团。

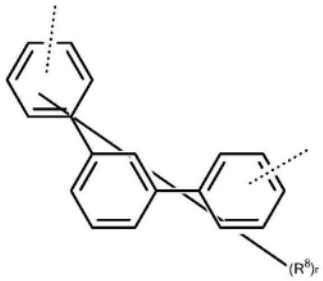
[0061] 在另一个优选实施方式中，L基团是式(L-2)的基团。

[0062] 而在另一个优选实施方式中，L基团是式(L-3)的基团，其中以下基团在式(L-3)的

基团中非常优选：

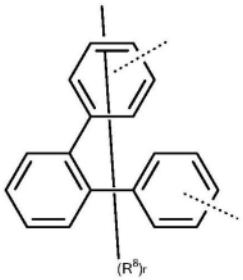


式(L-3-a)



式(L-3-b)

[0063]



式(L-3-c)

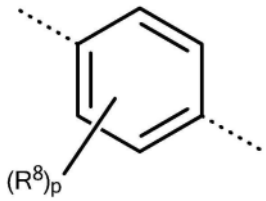
[0064] 完全类似于上文对式(L-3)的描述，式(L-3-a)至(L-3-c)中的符号意指R^8基团可出现在全部三个芳族环中。

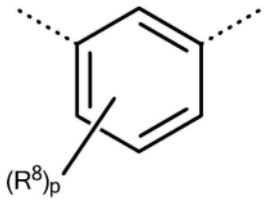
[0065] 在另一个优选实施方式中，L基团是式(L-4)的基团。

[0066] 在另一个优选实施方式中，L基团是式(L-5)的基团。

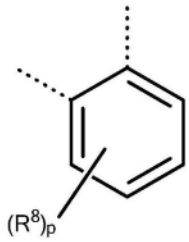
[0067] L最优选地选自以下基团：

[0068]

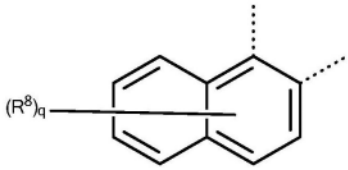




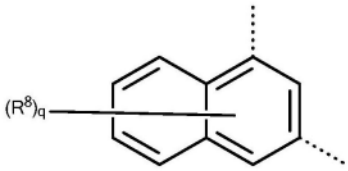
式(L-1-1)



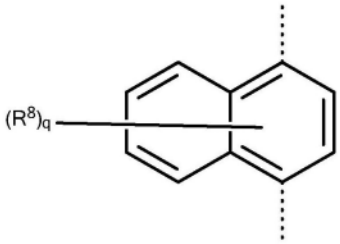
式(L-1-2)



式(L-1-3)

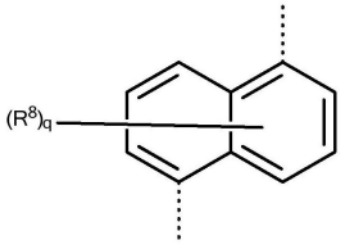


式(L-2-1)

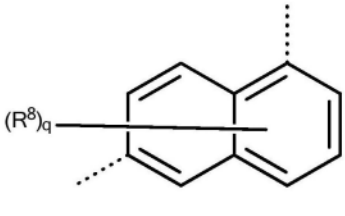


[0069]

式(L-2-2)

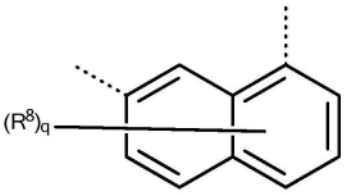


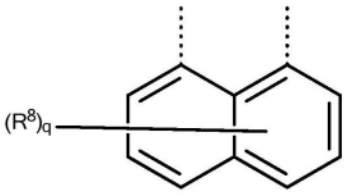
式(L-2-3)



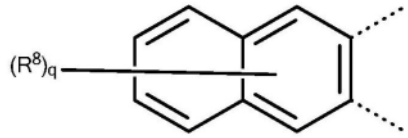
式(L-2-4)

式(L-2-5)

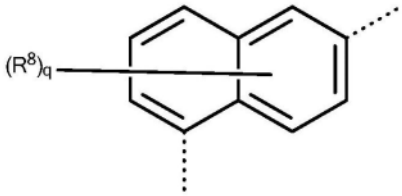




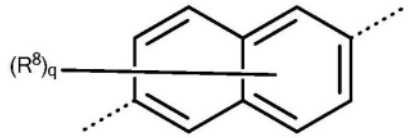
式(L-2-6)



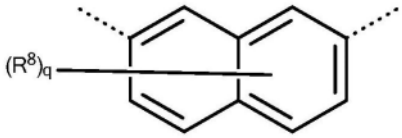
式(L-2-7)



式(L-2-8)

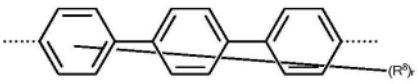


式(L-2-9)

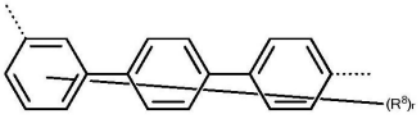


[0070]

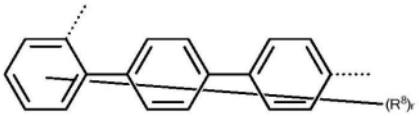
式(L-2-10)



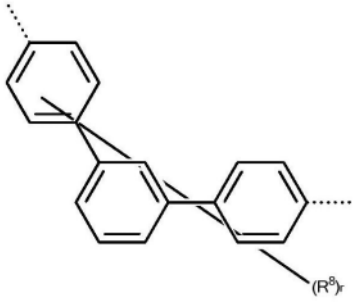
式(L-2-11)



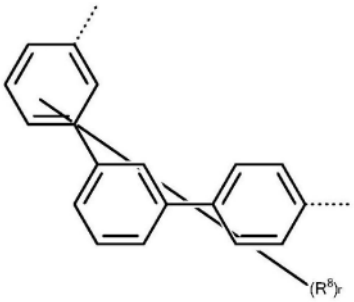
式(L-3-1)



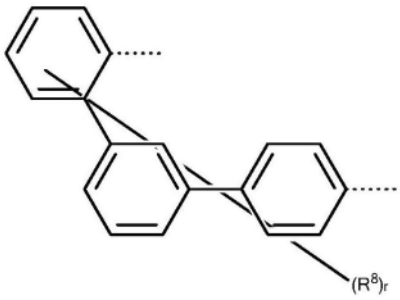
式(L-3-2)



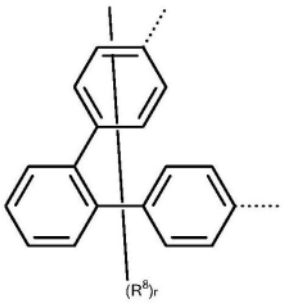
式(L-3-3)



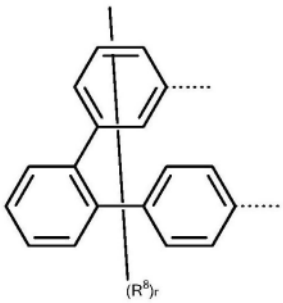
式(L-3-4)



式(L-3-5)

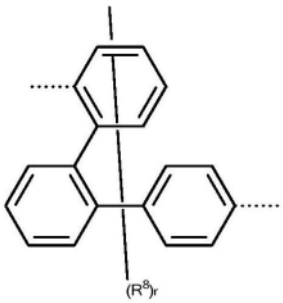


式(L-3-6)

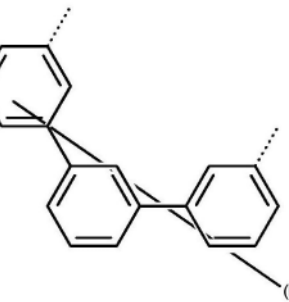


[0071]

式(L-3-7)

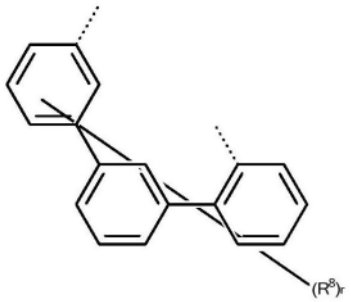


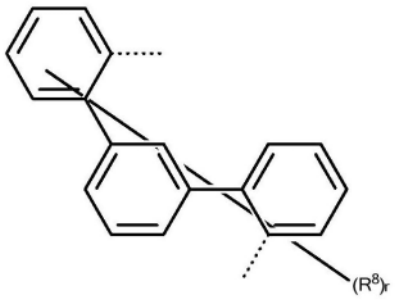
式(L-3-8)



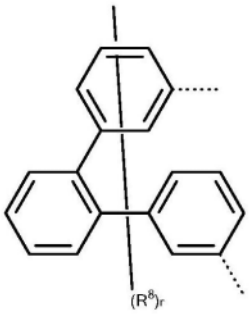
式(L-3-9)

式(L-3-10)

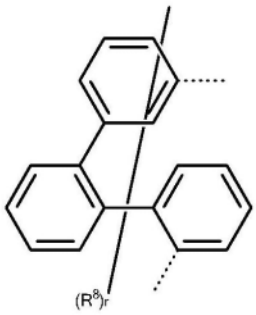




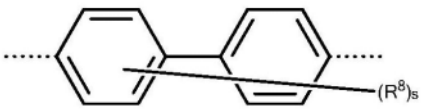
式(L-3-11)



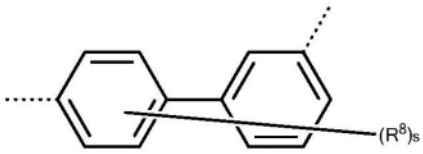
式(L-3-12)



式(L-3-13)

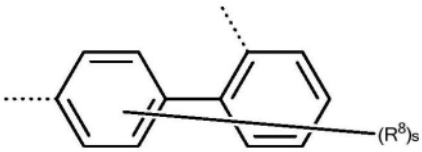


式(L-3-14)

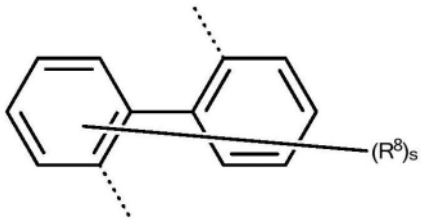


[0072]

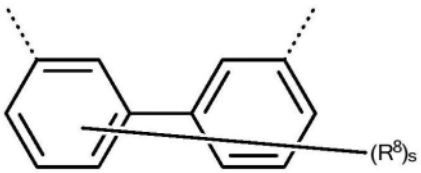
式(L-4-1)



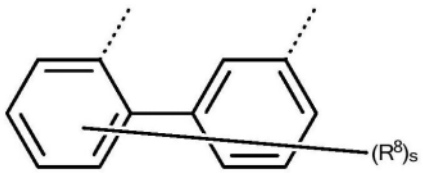
式(L-4-2)



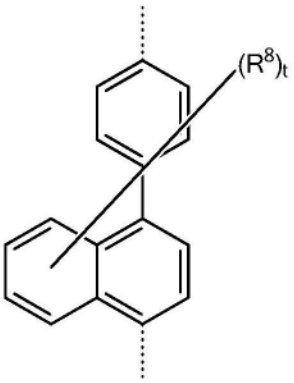
式(L-4-3)



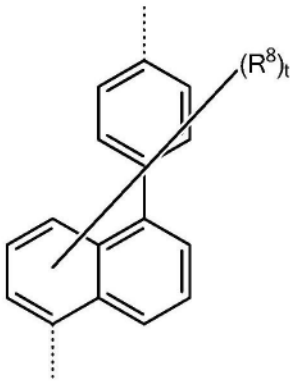
式(L-4-4)



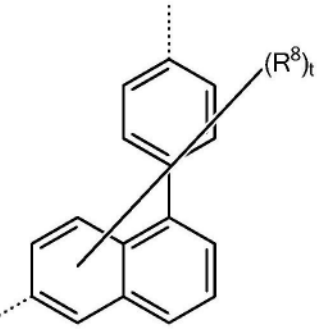
式(L-4-5)



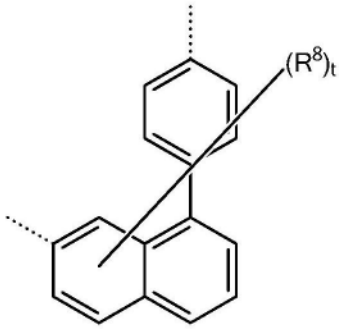
式(L-4-6)



式(L-5-1)



式(L-5-2)

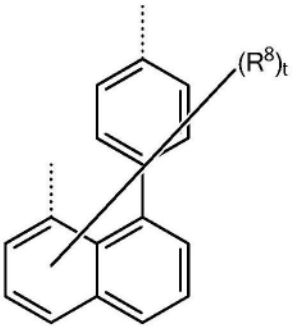


[0073]

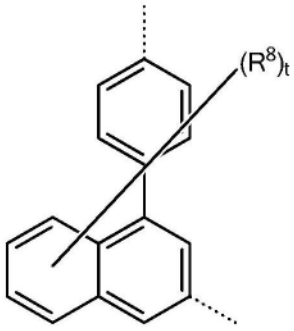
式(L-5-3)

式(L-5-4)

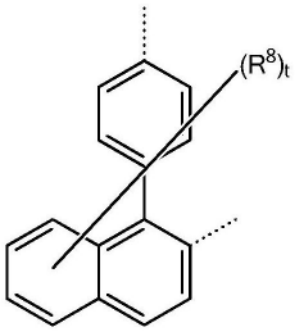
式(L-5-5)



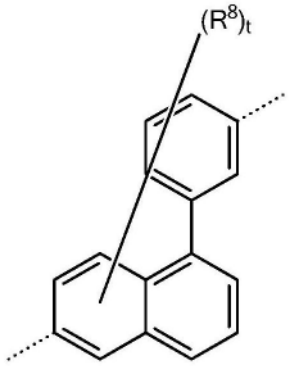
式(L-5-6)



[0074]



式(L-5-7)



式(L-5-8)

[0075] 其中,尤其优选的L基团是式(L-1-1)至(L-1-3)的那些基团。

[0076] 另外尤其优选的L基团是式(L-2-1)至(L-2-11)的那些基团。

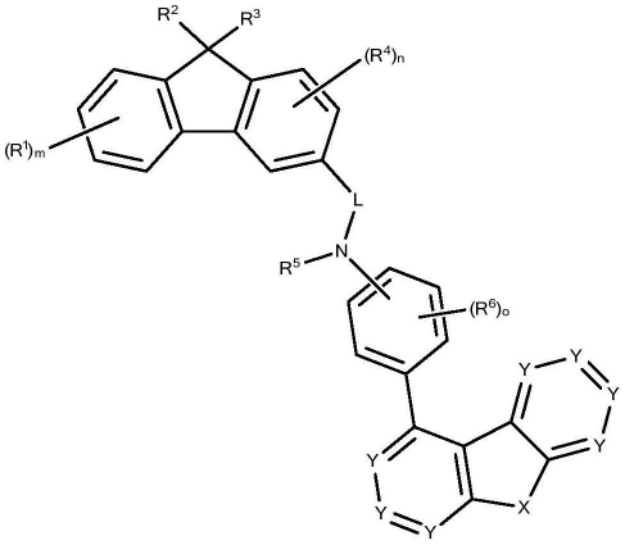
[0077] 另外尤其优选的L基团是式(L-3-1)至(L-3-14)的那些基团。

[0078] 另外尤其优选的L基团是式(L-4-1)至(L-4-6)的那些基团。

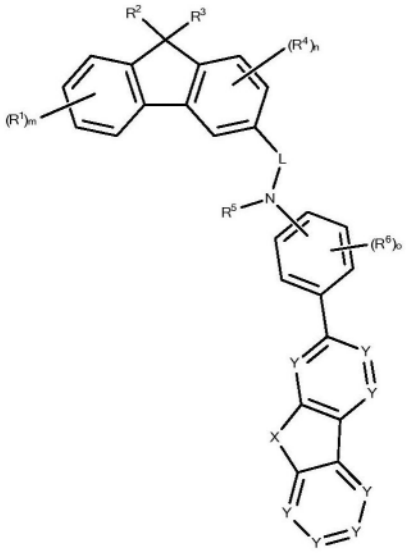
[0079] 另外尤其优选的L基团是式(L-5-1)至(L-5-8)的那些基团。

[0080] 另外优选的本发明化合物选自以下式(3)至(6):

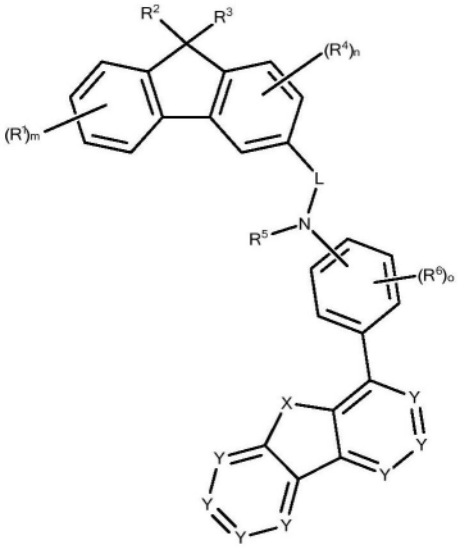
[0081]



式(3)

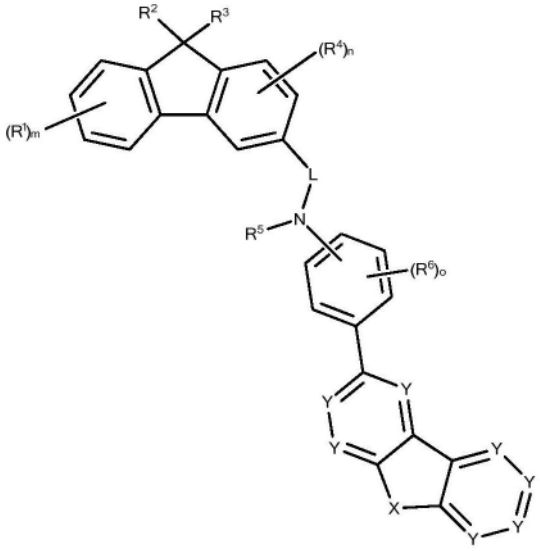


[0082] 式(4)



式(5)

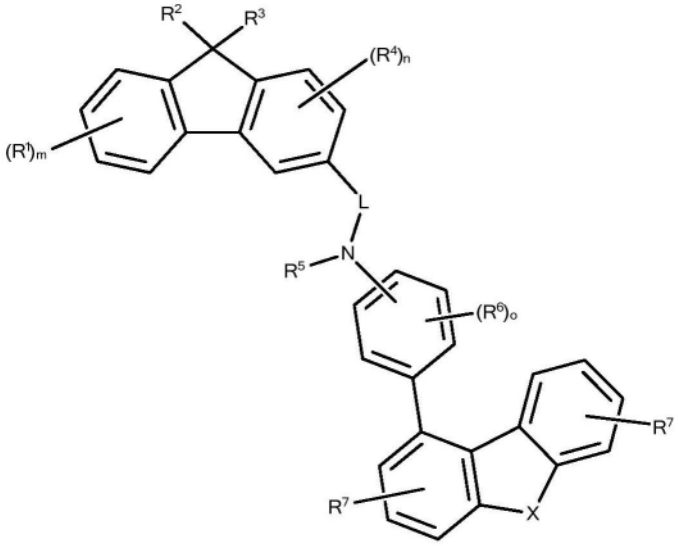
[0083]



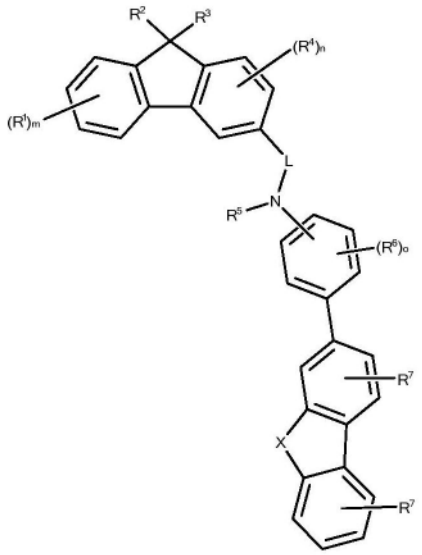
式(6)

[0084] 甚至更优选的本发明化合物选自以下式(7)至(10)：

[0085]

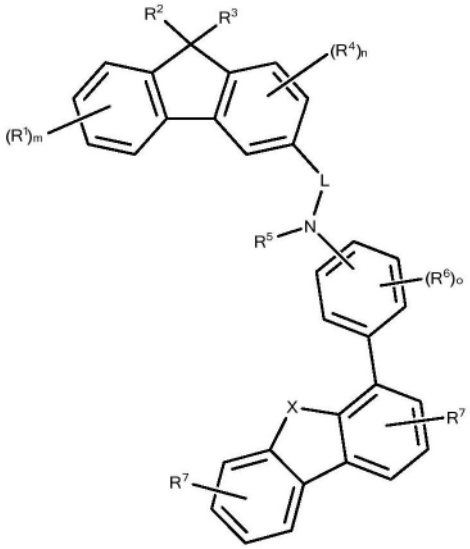


式(7)



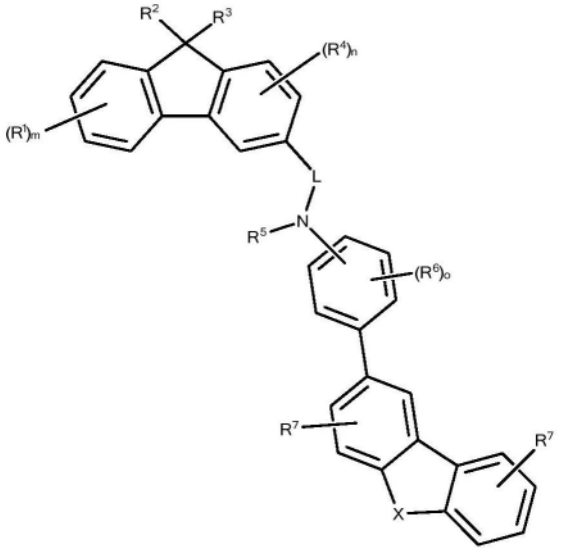
式(8)

[0086]



式(9)

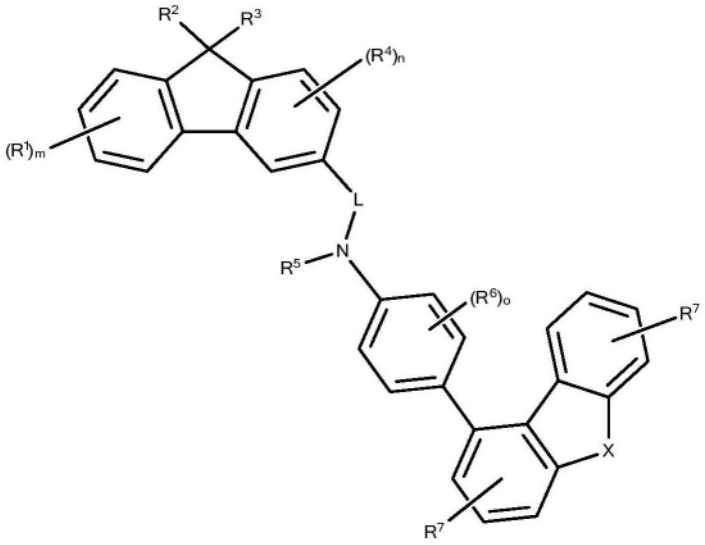
[0087]



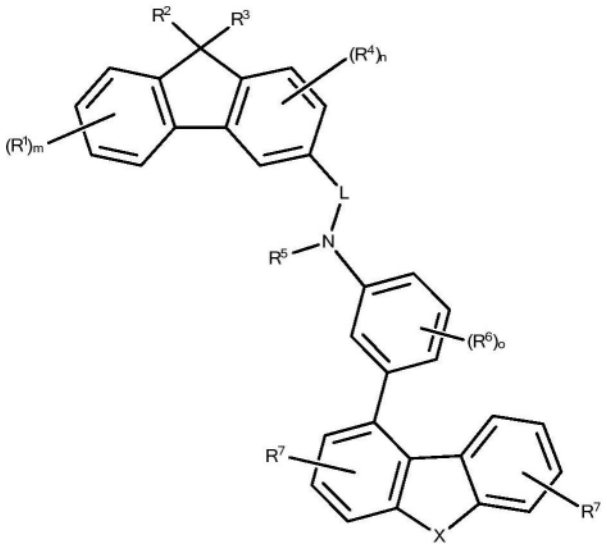
式(10)

[0088] 非常特别优选的本发明化合物是式(11)至(22)的那些化合物。

[0089]

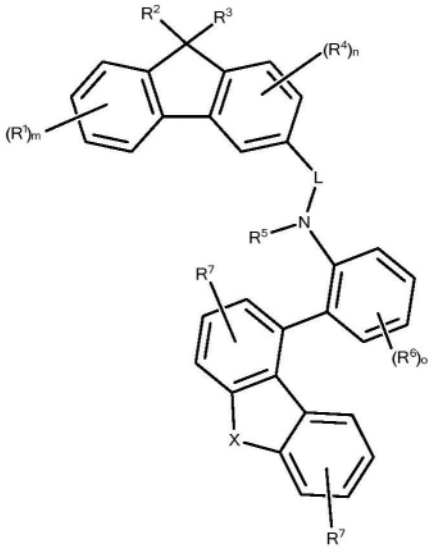


式(11)

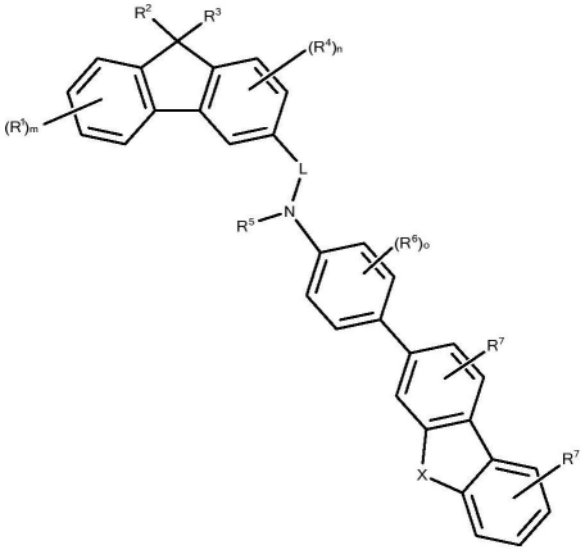


式(12)

[0090]

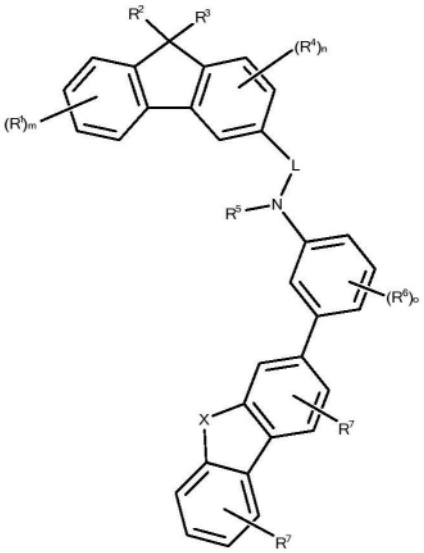


式(13)

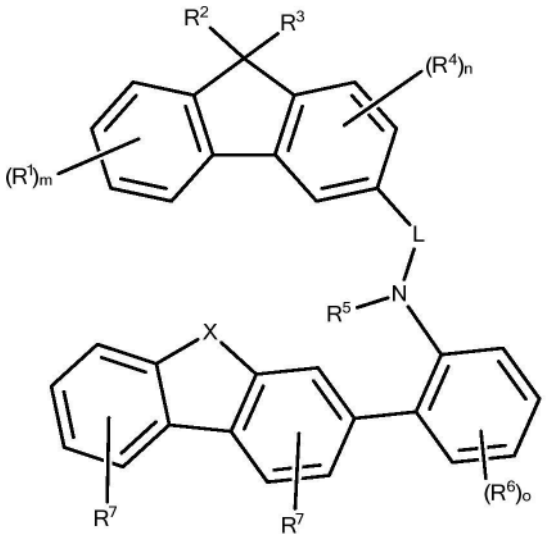


式(14)

[0091]

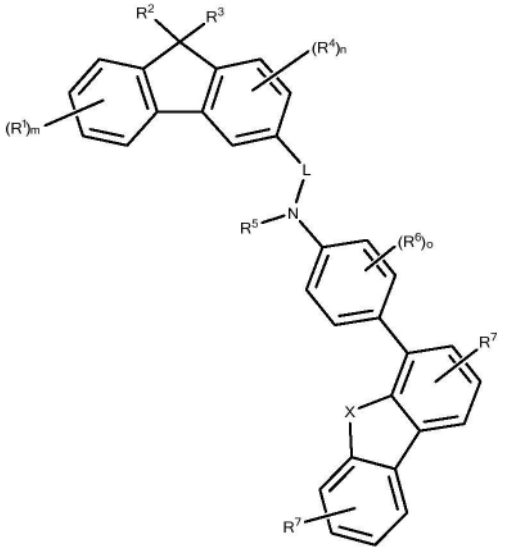


式(15)

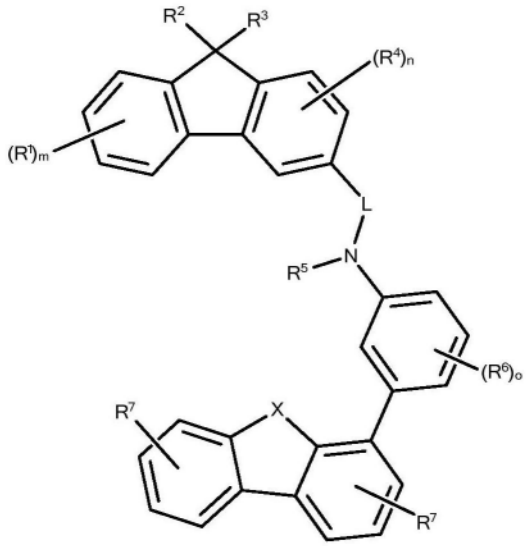


式(16)

[0092]

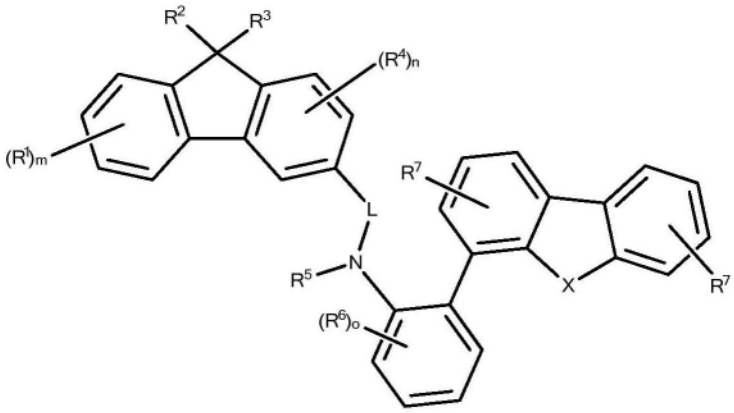


式(17)

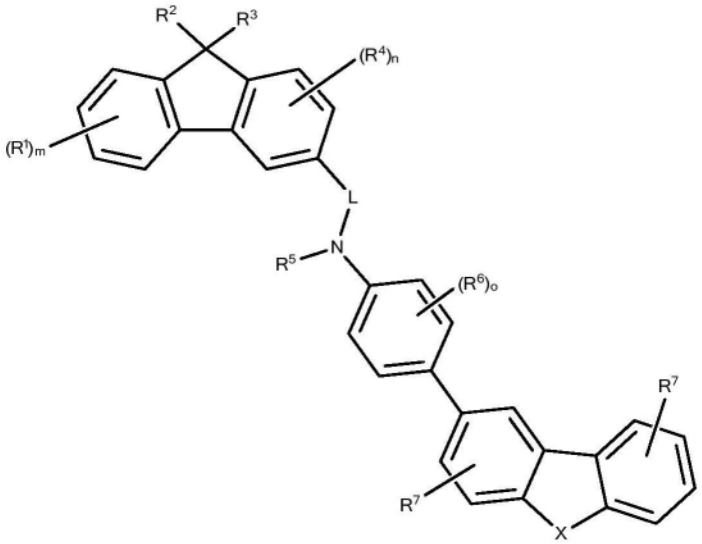


式(18)

[0093]

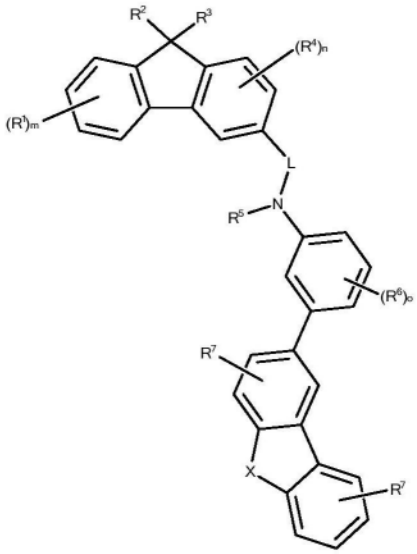


式(19)



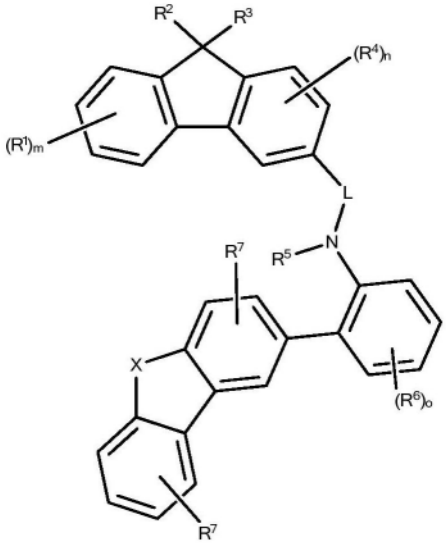
式(20)

[0094]



式(21)

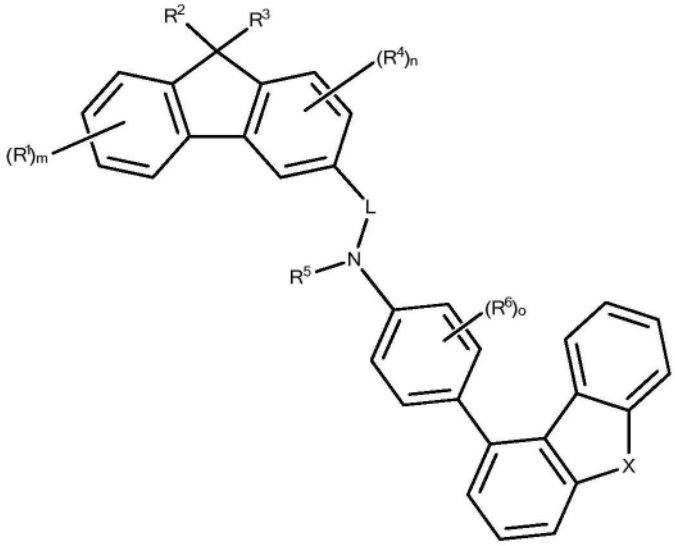
[0095]



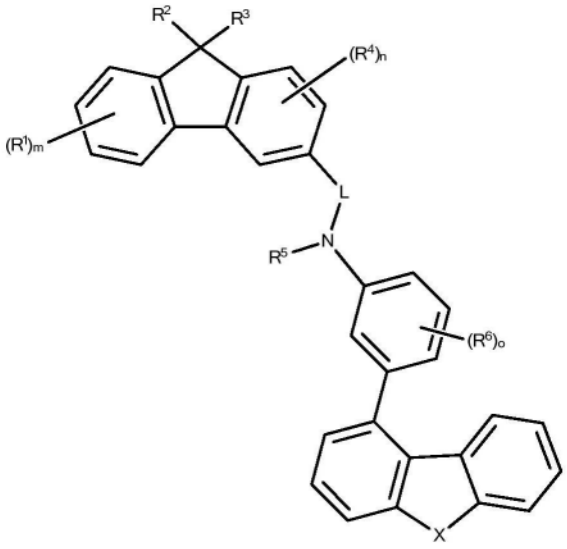
式(22)

[0096] 非常特别优选的本发明化合物是式(23)至(34)的那些化合物。

[0097]

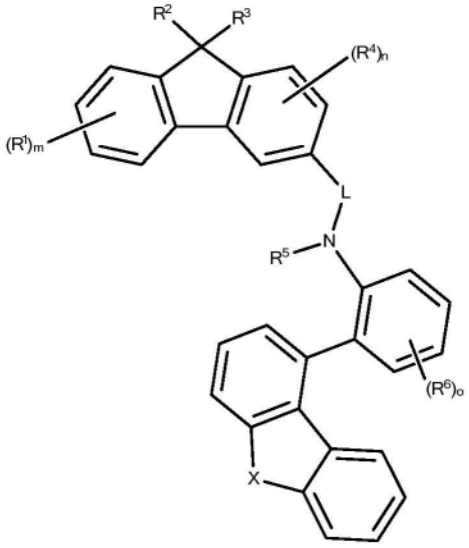


式(23)

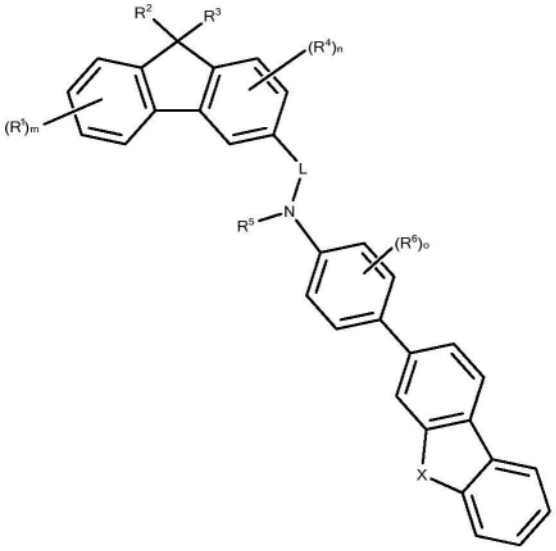


式(24)

[0098]

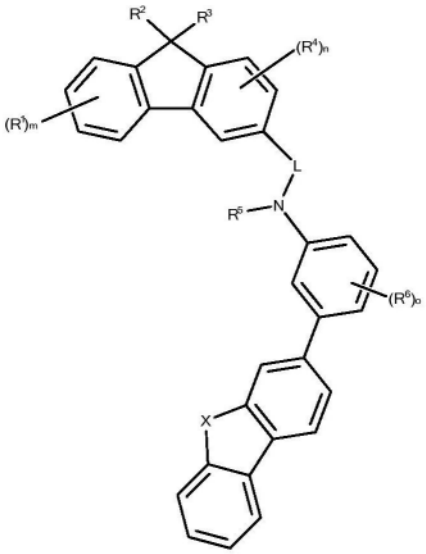


式(25)

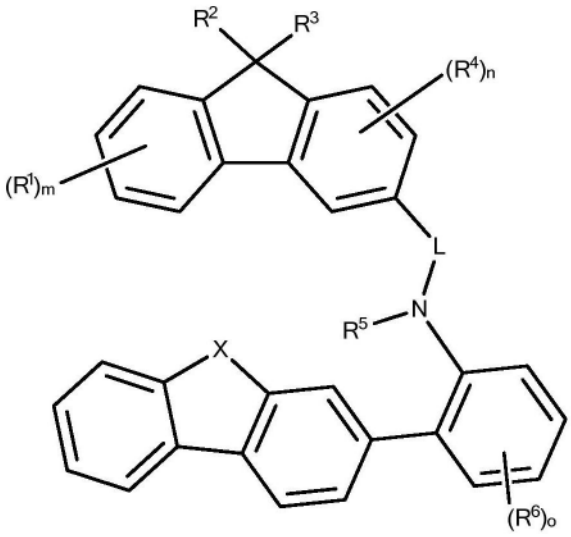


式(26)

[0099]

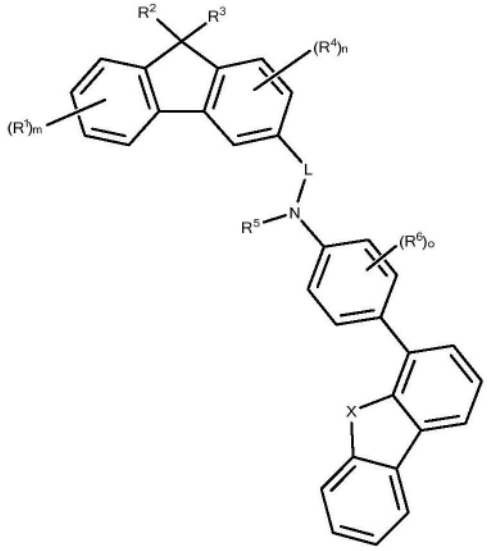


式(27)

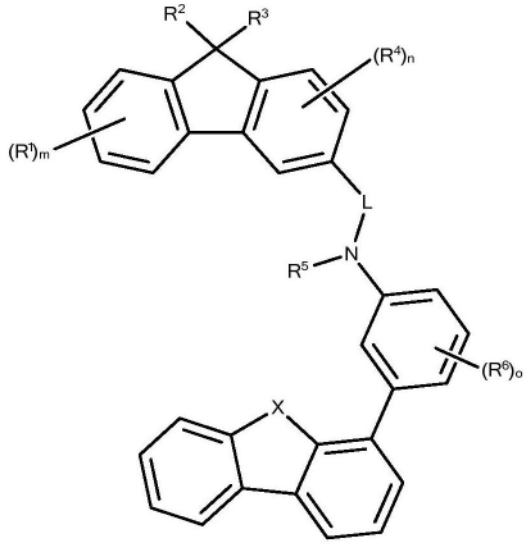


式(28)

[0100]

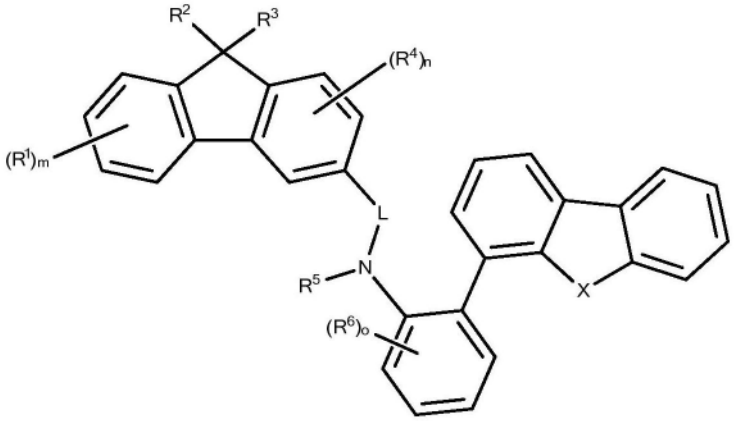


式(29)

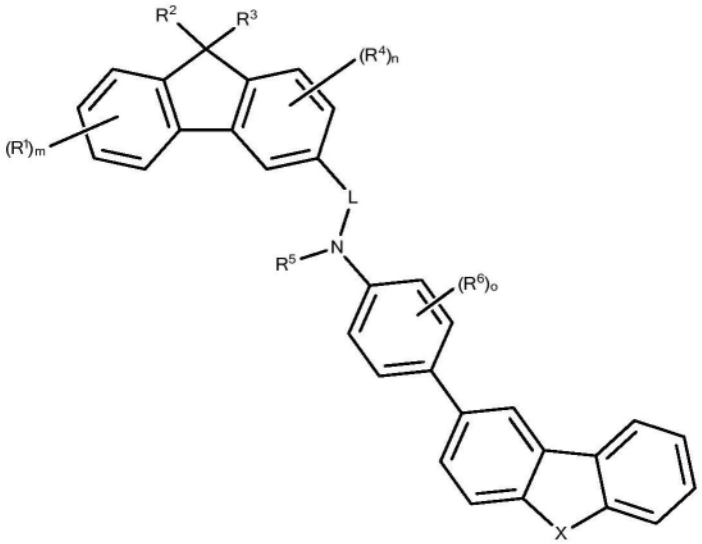


式(30)

[0101]

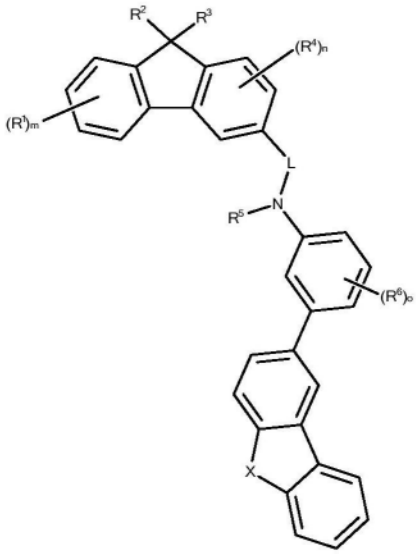


式(31)



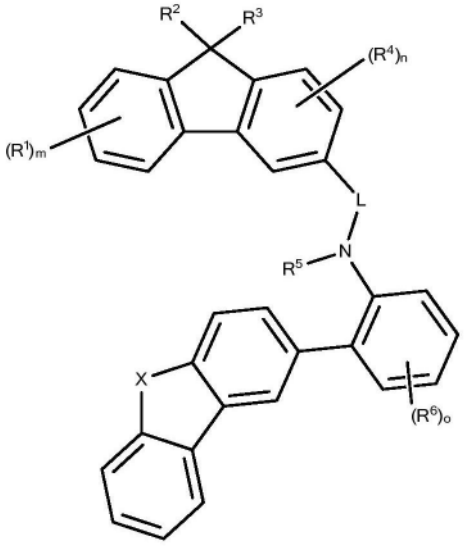
式(32)

[0102]



式(33)

[0103]



式(34)

[0104] 本发明的一个优选实施方式涉及式(3)的化合物，非常优选式(7)的化合物，特别优选式(11)至(13)的化合物，非常特别优选式(23)至(25)的化合物，尤其优选式(11)的化合物，最优选式(23)的化合物，其中所提到的化合物中的L基团具有式(L-1)，优选式(L-1-1)至(L-1-3)之一，非常优选式(L-1-1)。

[0105] 本发明的另一个优选实施方式涉及式(4)的化合物，非常优选式(8)的那些化合物，特别优选式(14)至(16)的那些化合物，非常特别优选式(26)至(28)的那些化合物，尤其优选式(14)的那些化合物，最优选式(26)的那些化合物，其中所提到的化合物中的L基团具有式(L-1)，优选式(L-1-1)至(L-1-3)之一，非常优选式(L-1-1)。

[0106] 本发明的另一个优选实施方式涉及式(3)或(4)的化合物，非常优选式(7)或(8)的那些化合物，特别优选式(11)至(16)的那些化合物，非常特别优选式(11)或(14)的那些化合物，其中所提到的化合物中的L基团具有式(L-1)，优选式(L-1-1)至(L-1-3)之一，非常优选式(L-1-1)。

[0107] 本发明的另一个优选实施方式涉及式(5)的化合物，非常优选式(9)的那些化合物，特别优选式(17)至(19)的那些化合物，非常特别优选式(29)至(31)的那些化合物。

[0108] 本发明的另一个优选实施方式涉及式(6)的化合物，非常优选式(10)的那些化合物，特别优选式(20)至(22)的那些化合物，非常特别优选式(32)至(34)的那些化合物。

[0109] 更优选在上述化合物中，R^2和R^3基团在每种情况下相同或不同，并且选自具有1至20个碳原子的直链烷基基团、具有3至20个碳原子的支链或环状的烷基基团、具有6至40个芳族环原子的芳族环系和具有5至40个芳族环原子的杂芳族环系；其中两个R^2和R^3基团可彼此连接并可形成环；其中所提到的烷基基团以及所提到的芳族环系和杂芳族环系各自可被R^{11}基团取代；其中所述烷基基团中的一个或多个CH_2基团可被$-R^{11}C=CR^{11}-$、$-C\equiv C-$、$Si(R^{11})_2$、$C=O$、$C=NR^{11}$、$-C(=O)O-$、$-C(=O)NR^{11}-$、NR^{11}、$P(=O)(R^{11})$、$-O-$、$-S-$、SO或SO_2代替；如果两个R^2和R^3基团形成环，则结果是螺环化合物，优选螺二芴；特别优选两个R^2和R^3基团不彼此形成环。

[0110] 在本发明的上下文中，甚至更优选在上述化合物中，R^2和R^3基团在每种情况下相同或不同，并且选自具有1至10个碳原子的直链烷基基团、具有3至10个碳原子的支链或环状

的烷基基团、具有6至18个芳族环原子的芳族环系和具有5至18个芳族环原子的杂芳族环系;其中两个R^2和R^3基团可彼此连接并可形成环;其中所提到的烷基基团以及所提到的芳族环系和杂芳族环系各自可被R^{11}基团取代;其中所述烷基基团中的一个或多个CH_2基团可被-$R^{11}C=CR^{11}$-、-C≡C-、$Si(R^{11})_2$、C=O、C=NR^{11}、-C(=O)O-、-C(=O)NR^{11}-、NR^{11}、P(=O)(R^{11})、-O-、-S-、SO或SO_2代替;如果两个R^2和R^3基团形成环,则结果是螺环化合物,优选螺二芴;特别优选两个R^2和R^3基团不彼此形成环。

[0111] 在本发明的上下文中,甚至更优选在上述化合物中,R^2和R^3基团在每种情况下相同或不同,并且选自具有1至10个碳原子的直链烷基基团、具有3至10个碳原子的支链或环状的烷基基团或具有6至18个芳族原子的芳族环系;其中两个R^2和R^3基团可彼此连接并可形成环;其中所提到的烷基基团以及所提到的芳族环系各自可被R^{11}基团取代;如果两个R^2和R^3基团形成环,则结果是螺环化合物,优选螺二芴;特别优选两个R^2和R^3基团不彼此形成环。

[0112] 在本发明的上下文中,尤其优选在上述化合物中,R^2和R^3基团在每种情况下相同或不同,并且选自具有1至10个碳原子的直链烷基基团、具有3至10个碳原子的支链或环状的烷基基团和具有6至18个芳族环原子的芳族环系;其中所提到的烷基基团以及所提到的芳族环系各自可被R^{11}基团取代;优选地,两个R^2和R^3基团呈未取代的形式。

[0113] 在本发明的上下文中,还尤其优选在上述化合物中,R^2和R^3基团在每种情况下相同或不同,并且选自具有1至10个碳原子的直链烷基基团和具有6至18个芳族环原子的芳族环系;其中所提到的烷基基团以及所提到的芳族环系各自可被R^{11}基团取代;优选地,两个R^2和R^3基团呈未取代的形式。

[0114] 在本发明的上下文中,非常特别优选在上述化合物中,R^2和R^3基团在每种情况下相同或不同,并且选自具有1至5个碳原子的直链烷基基团,其中最优选甲基基团。

[0115] 在本发明的上下文中,非常特别优选在上述化合物中,R^2和R^3基团在每种情况下相同或不同,并且选自具有6至12个芳族环原子的芳族环系,其中最优选苯基基团。

[0116] 在本发明的一个优选实施方式中,R^2和R^3相同。

[0117] 在本发明的另一个优选实施方式中,R^2和R^3不同。

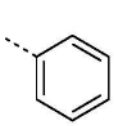
[0118] R^5基团优选地选自衍生自苯、联苯、三联苯、四联苯、萘、芴(尤其是9,9'-二甲基芴和9,9'-二苯基芴)、9-硅芴(尤其是9,9'-二甲基-9-硅芴和9,9'-二苯基-9-硅芴)、苯并芴、螺二芴、茚并芴、茚并咔唑、二苯并呋喃、二苯并噻吩、苯并咔唑、咔唑、苯并呋喃、苯并噻吩、吲哚、喹啉、吡啶、嘧啶、吡嗪、哒嗪和三嗪的单价基团,其中所述单价基团各自被一个或多个R^{11}基团取代。或者,R^5基团可以优选地选自衍生自苯、联苯、三联苯、四联苯、萘、芴(尤其是9,9'-二甲基芴和9,9'-二苯基芴)、9-硅芴(尤其是9,9'-二甲基-9-硅芴和9,9'-二苯基-9-硅芴)、苯并芴、螺二芴、茚并芴、茚并咔唑、二苯并呋喃、二苯并噻吩、咔唑、苯并呋喃、苯并噻吩、吲哚、喹啉、吡啶、嘧啶、吡嗪、哒嗪和三嗪的基团的组合,其中所述基团各自被一个或多个R^{11}取代。

[0119] 特别优选的R^5基团选自苯基、联苯基、三联苯基、四联苯基、萘基、芴基(尤其是9,9'-二甲基芴基和9,9'-二苯基芴基)、苯并芴基、螺二芴基、茚并芴基、茚并咔唑基、二苯并呋喃基、二苯并噻吩基、咔唑基、苯并呋喃基、苯并噻吩基、苯并稠合二苯并呋喃基、苯并稠合二苯并噻吩基、萘基取代的苯基、芴基取代的苯基、螺二芴基取代的苯基、二苯并呋喃基取代的苯基、二苯并噻吩基取代的苯基、咔唑基取代的苯基、吡啶基取代的苯基、嘧啶基取

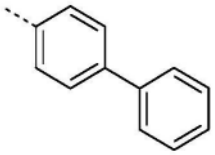
代的苯基和三嗪基取代的苯基，其中所提到的基团各自被一个或多个R^{11}基团取代。

[0120] 对R^5特别优选的基团选自以下各式：

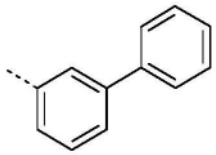
[0121]



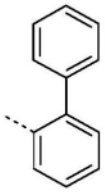
R5-1



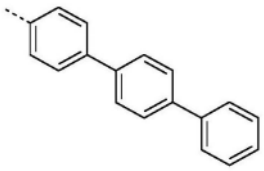
R5-2



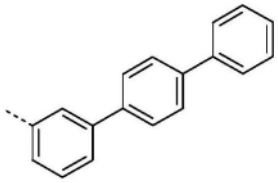
R5-3



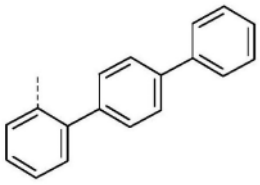
R5-4



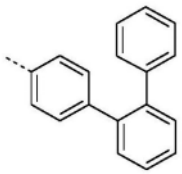
R5-5



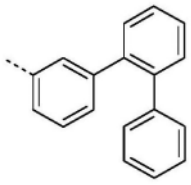
R5-6



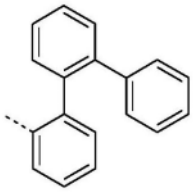
R5-7



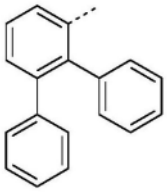
R5-8



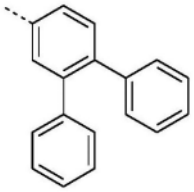
R5-9



R5-10

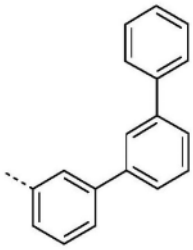


R5-11

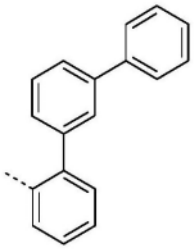


R5-12

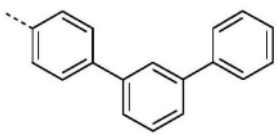
[0122]



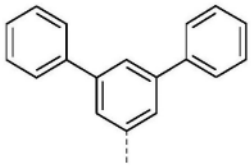
R5-13



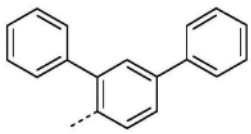
R5-14



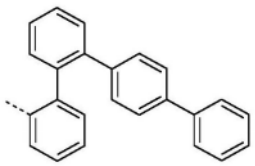
R5-15



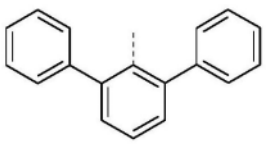
R5-16



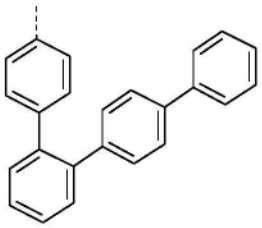
R5-17



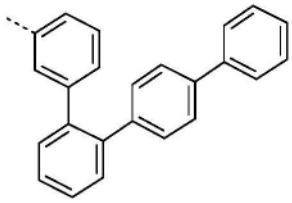
R5-18



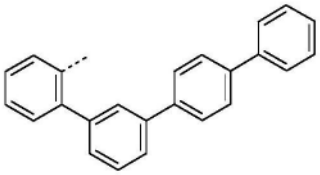
R5-19



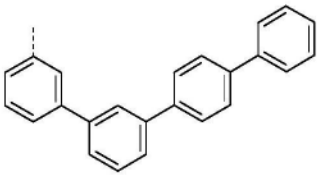
R5-20



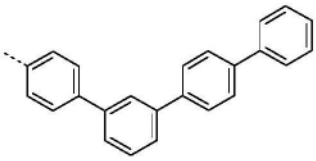
R5-21



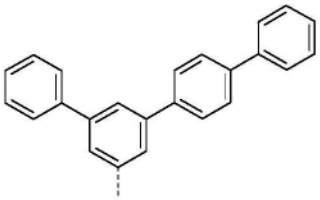
R5-22



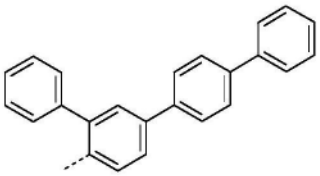
R5-23



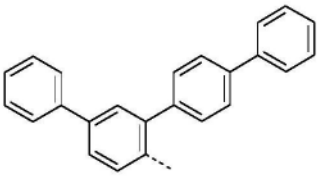
R5-24



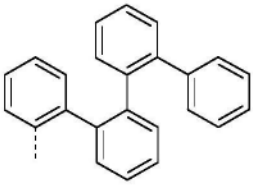
R5-25



R5-26

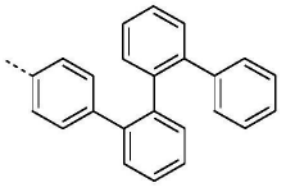


R5-27

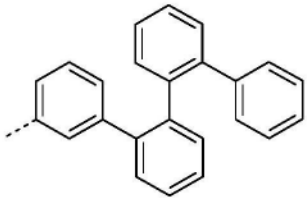


R5-28

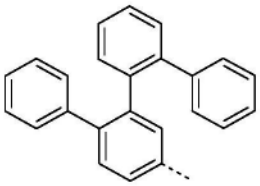
[0123]



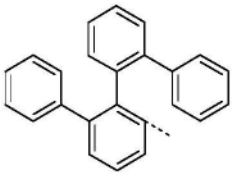
R5-29



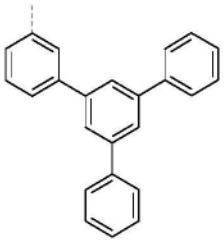
R5-30



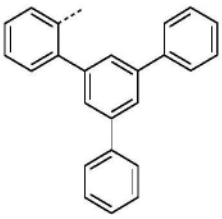
R5-31



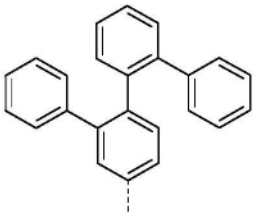
R5-32



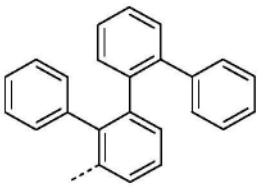
R5-33



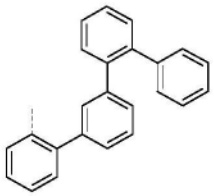
R5-34



R5-35

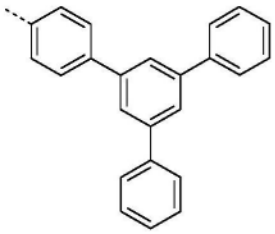


R5-36

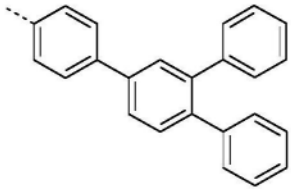


R5-37

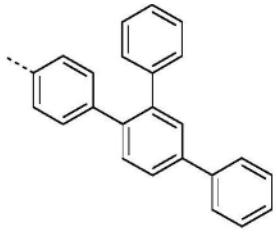
[0124]



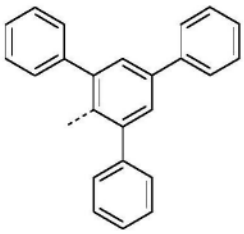
R5-38



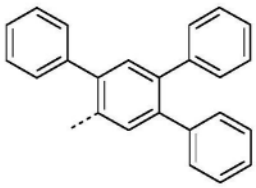
R5-39



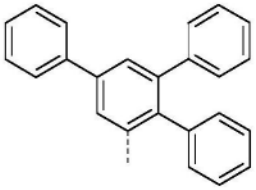
R5-40



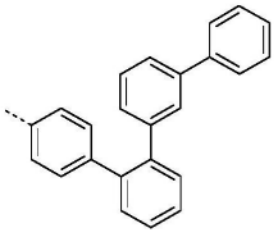
R5-41



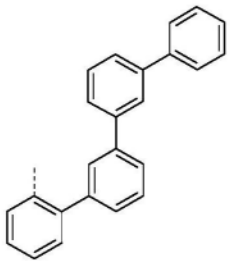
R5-42



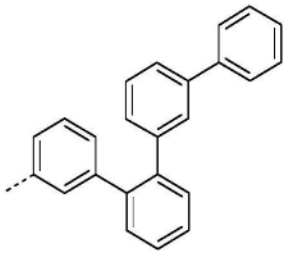
R5-43



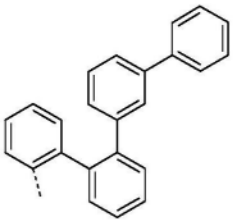
R5-44



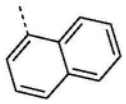
R5-45



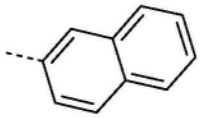
R5-46



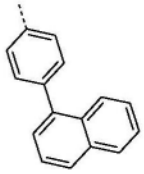
R5-47



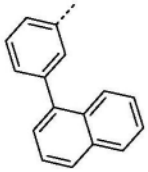
R5-48



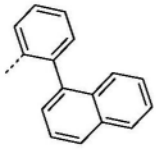
R5-49



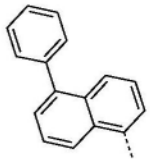
R5-50



R5-51

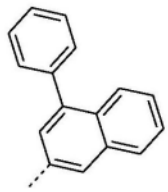


R5-52

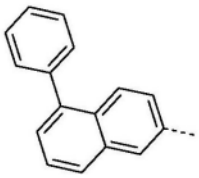


R5-53

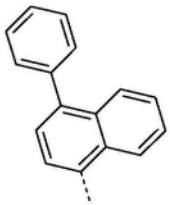
[0125]



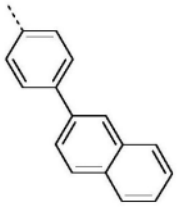
R5-54



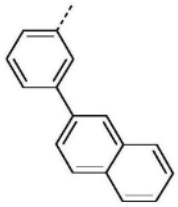
R5-55



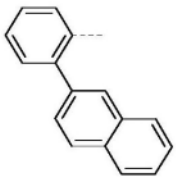
R5-56



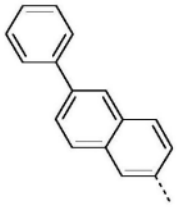
R5-57



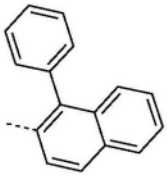
R5-58



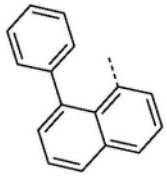
R5-59



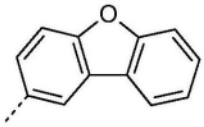
R5-60



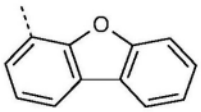
R5-61



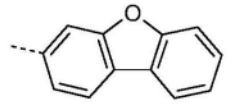
R5-62



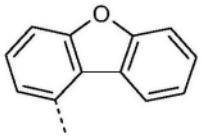
R5-63



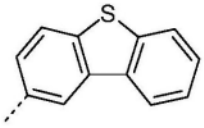
R5-64



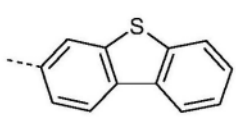
R5-65



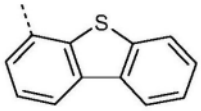
R5-66



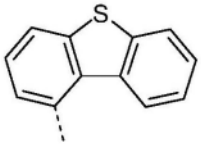
R5-67



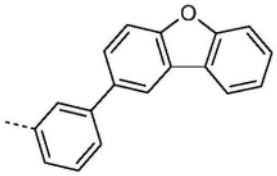
R5-68



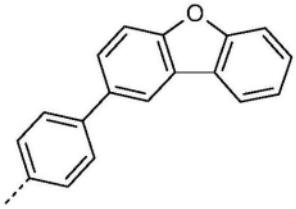
R5-69



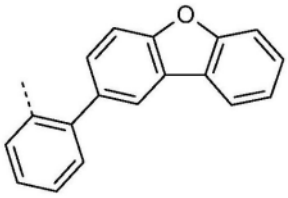
R5-70



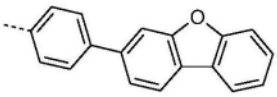
R5-71



R5-72

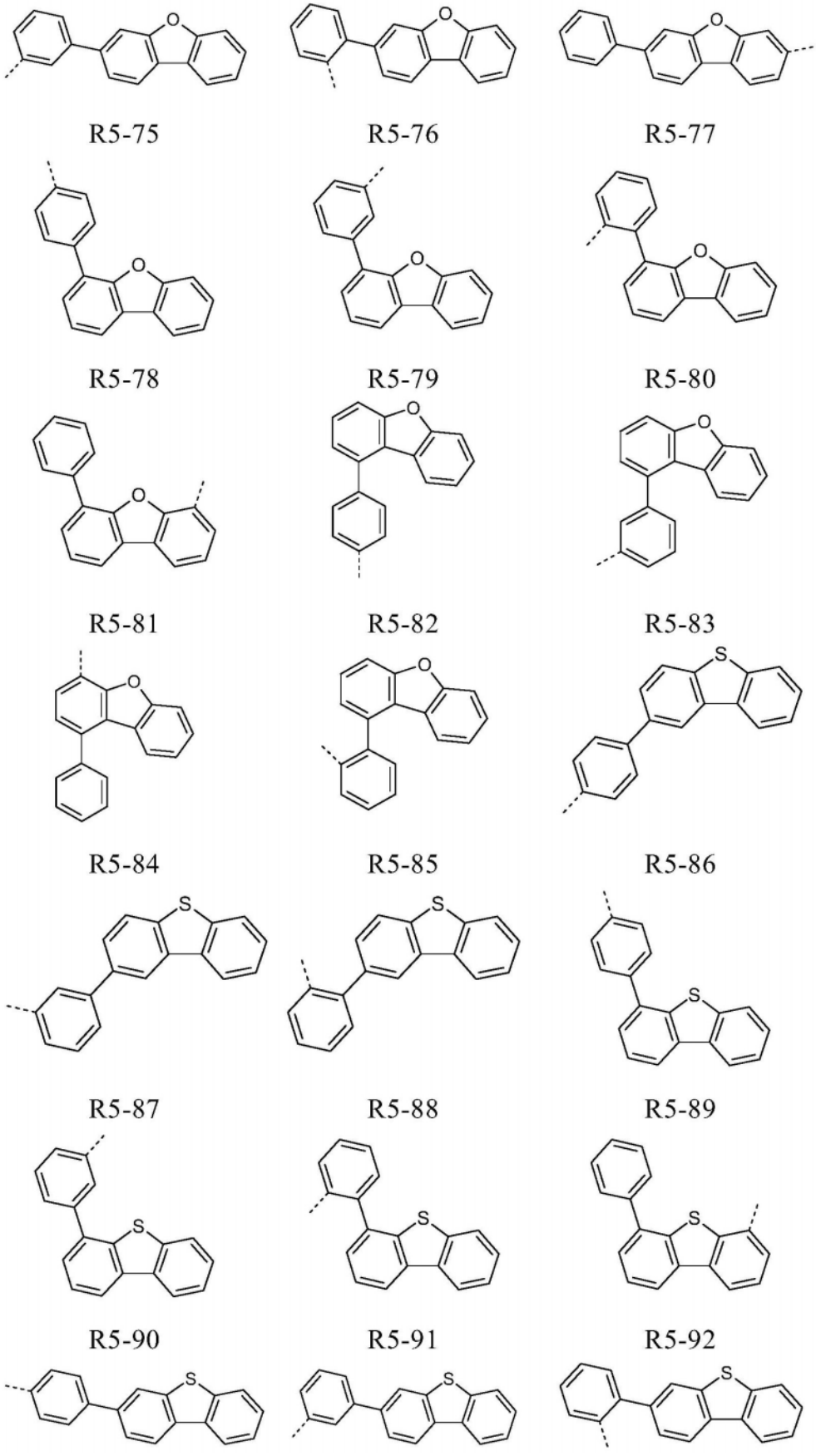


R5-73



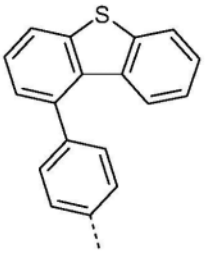
R5-74

[0126]

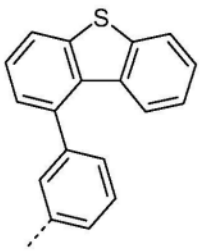

R5-75
R5-76
R5-77
R5-78
R5-79
R5-80
R5-81
R5-82
R5-83
R5-84
R5-85
R5-86
R5-87
R5-88
R5-89
R5-90
R5-91
R5-92

[0127]

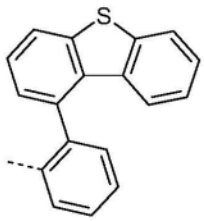
R5-93



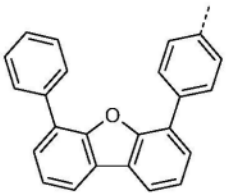
R5-94



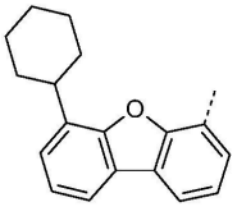
R5-95



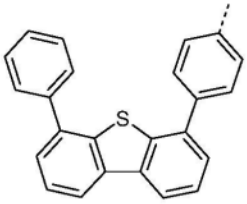
R5-96



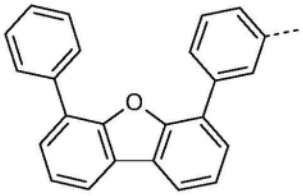
R5-97



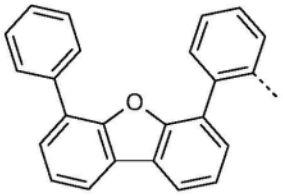
R5-98



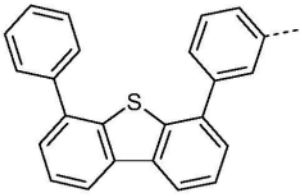
R5-99



R5-100

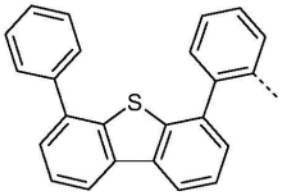


R5-101



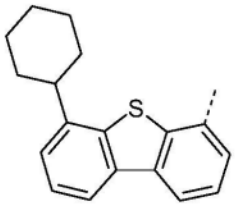
R5-102

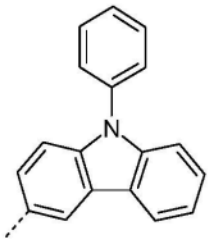
R5-103

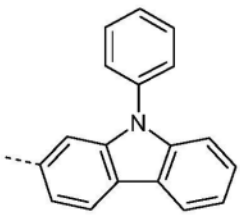


R5-104

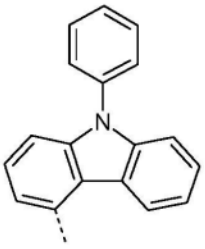
R5-105



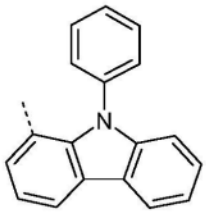




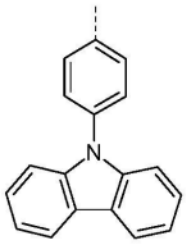
R5-106



R5-107

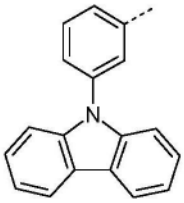


R5-108

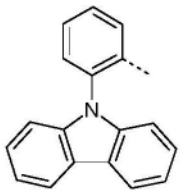


[0128]

R5-109

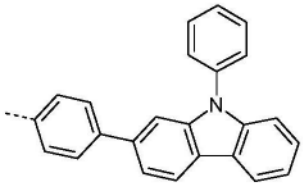


R5-110

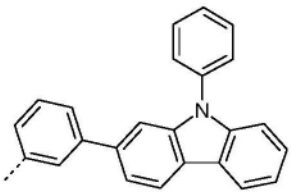


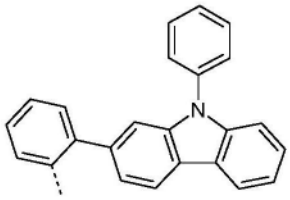
R5-111

R5-112

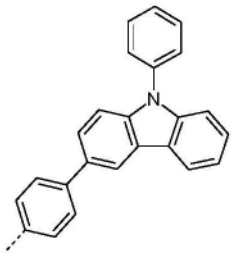


R5-113

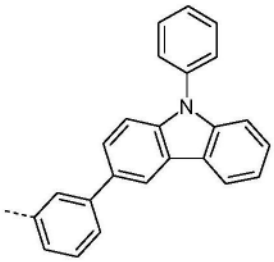




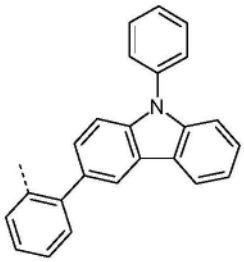
R5-114



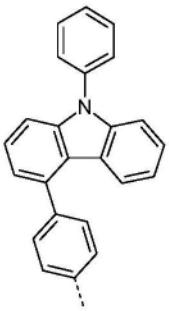
R5-115



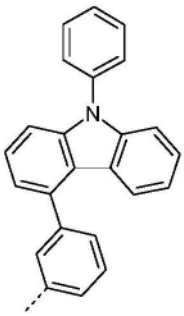
R5-116



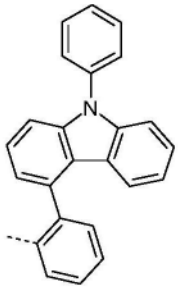
R5-117



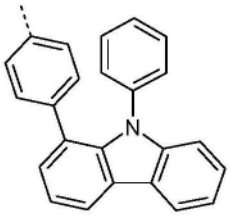
R5-118



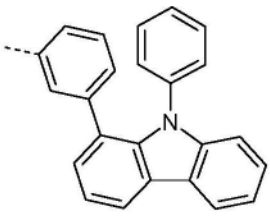
R5-119



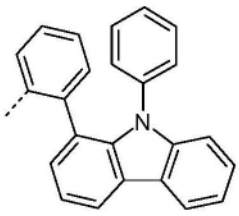
R5-120



R5-121



R5-122

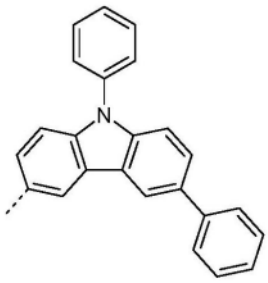


R5-123

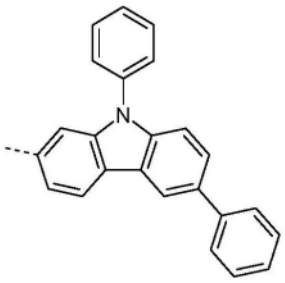
R5-124

R5-125

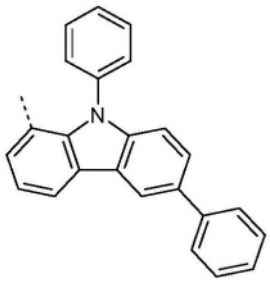
[0129]



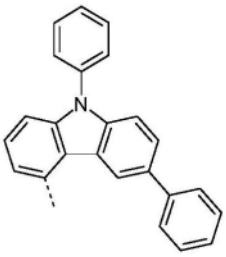
R5-126



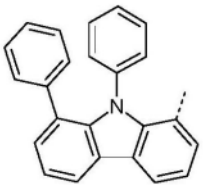
R5-127



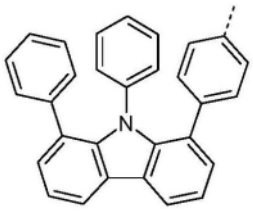
R5-128



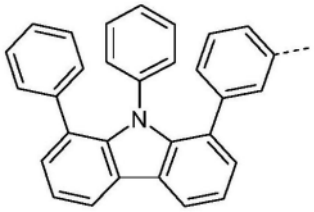
R5-129



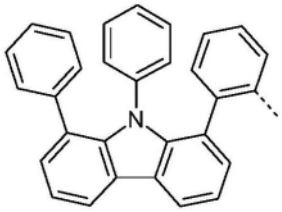
R5-130



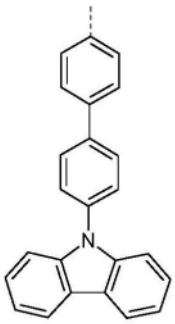
R5-131



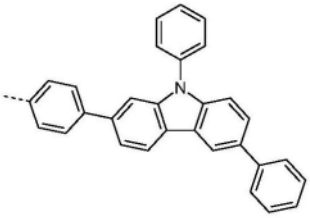
R5-132



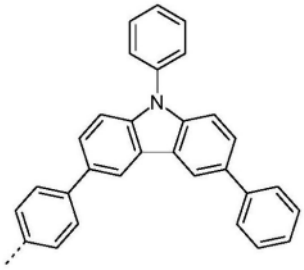
R5-133



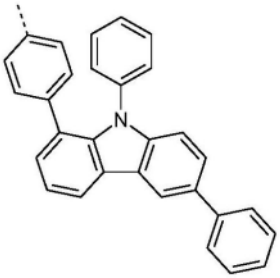
R5-134



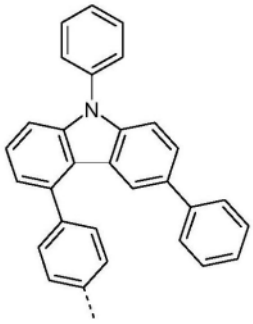
R5-135



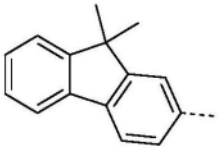
R5-136



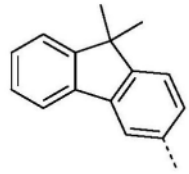
R5-137



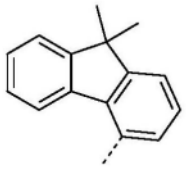
R5-138



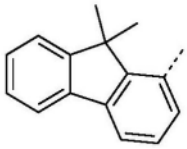
R5-139



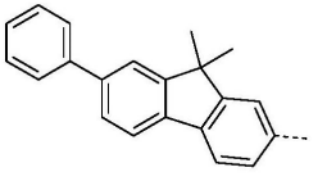
R5-140



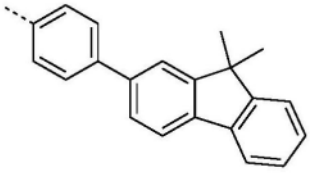
R5-141



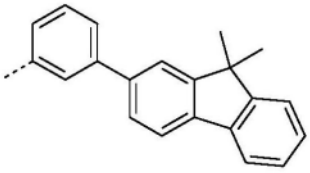
R5-142



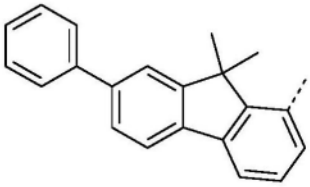
R5-143



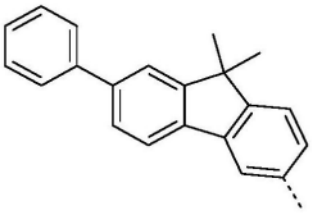
R5-144



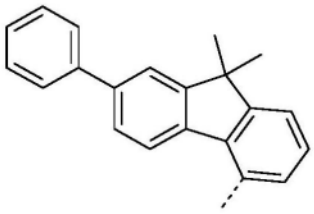
R5-145



R5-146

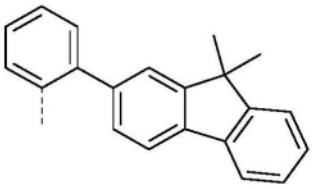


R5-147

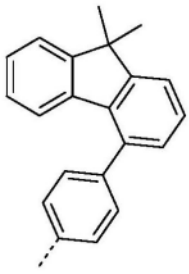


R5-148

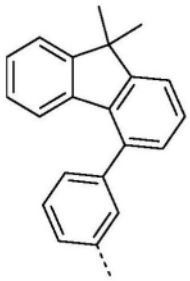
[0130]



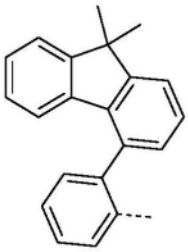
R5-149



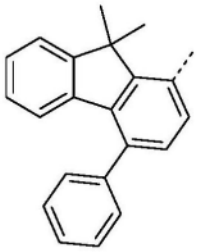
R5-150



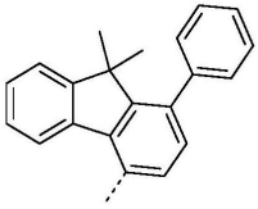
R5-151



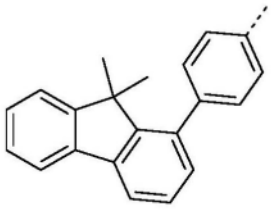
R5-152



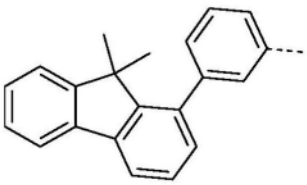
R5-153



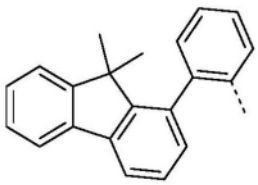
R5-154



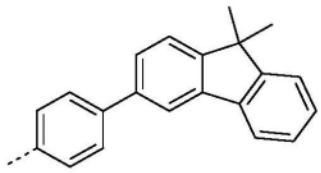
R5-155



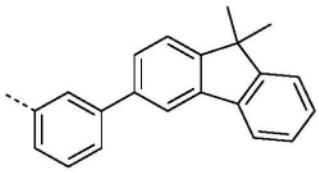
R5-156



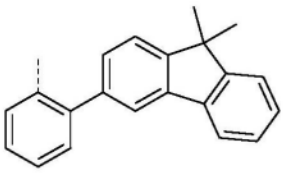
R5-157



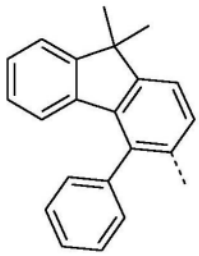
R5-158



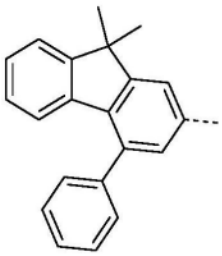
R5-159



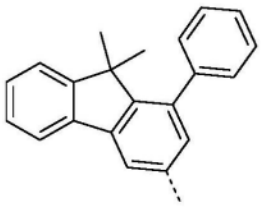
R5-160



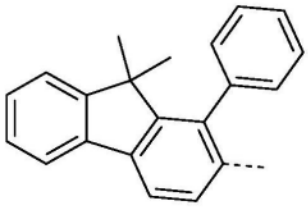
R5-161



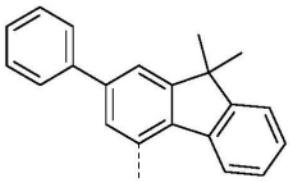
R5-162



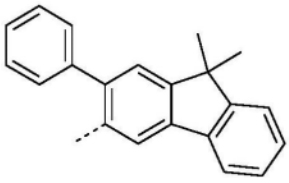
R5-163



R5-164

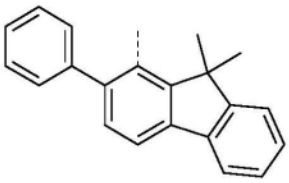


R5-165

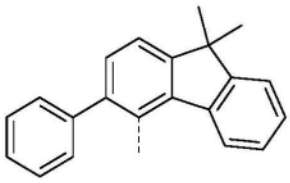


R5-166

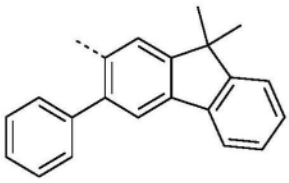
[0131]



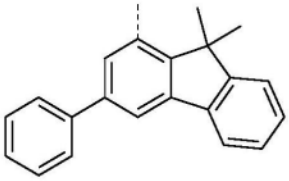
R5-167



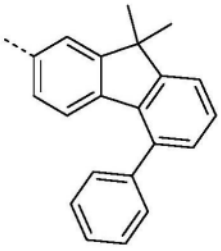
R5-168



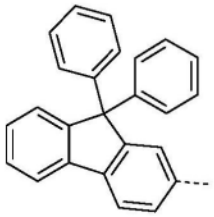
R5-169



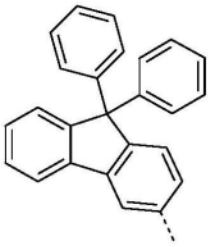
R5-170



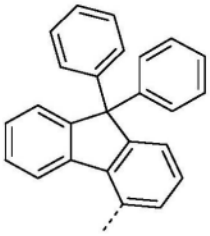
R5-171



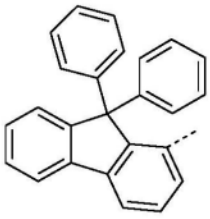
R5-172



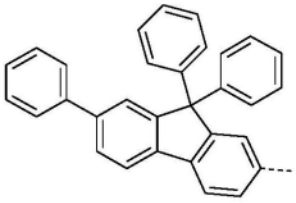
R5-173



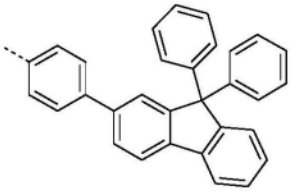
R5-174



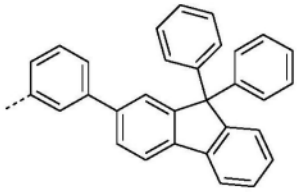
R5-175



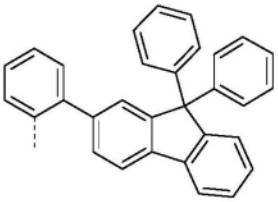
R5-176



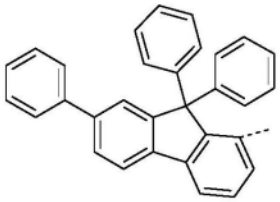
R5-177



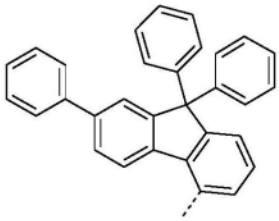
R5-178



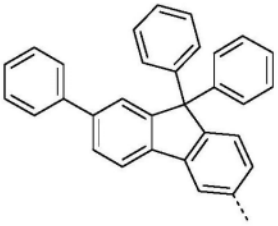
R5-179



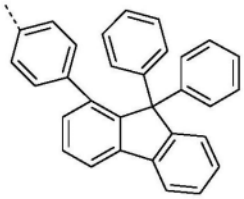
R5-180



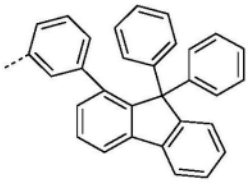
R5-181



R5-182

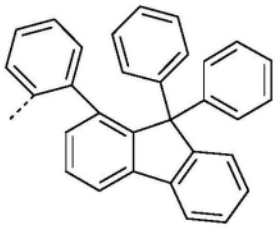


R5-183

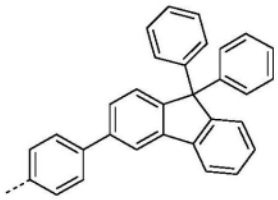


R5-184

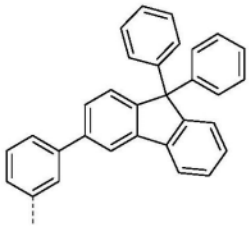
[0132]



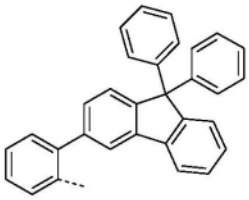
R5-185



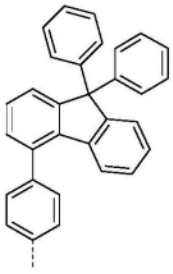
R5-186



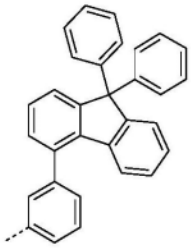
R5-187



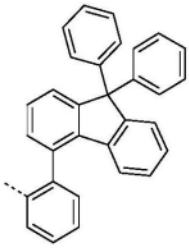
R5-188



R5-189

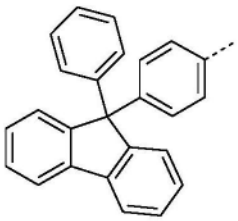


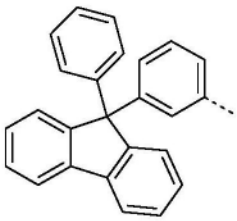
R5-190

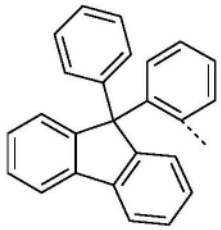


[0133]

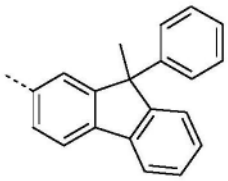
R5-191



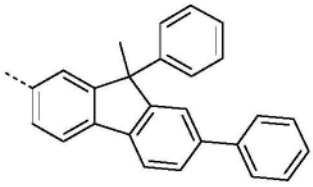




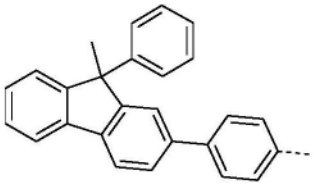
R5-192



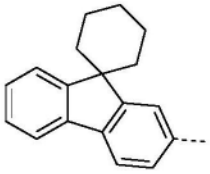
R5-193



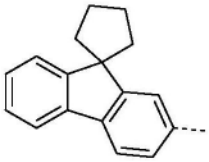
R5-194



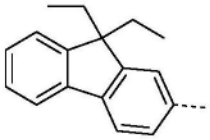
R5-195



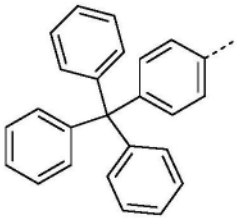
R5-196



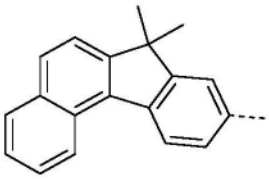
R5-197



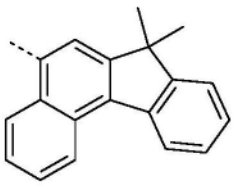
R5-198



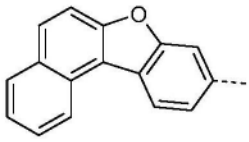
R5-199



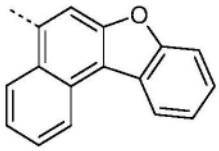
R5-200



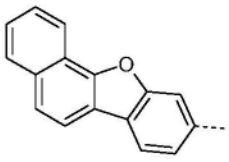
R5-201



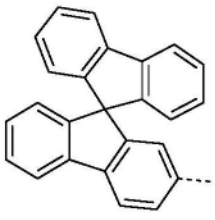
R5-202



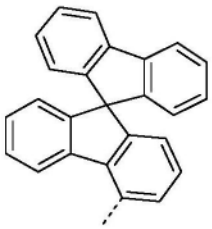
R5-203



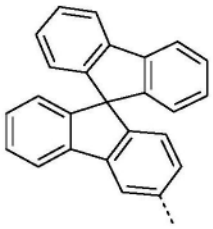
R5-204



R5-205



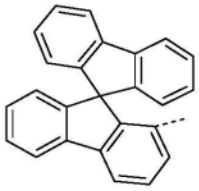
R5-206



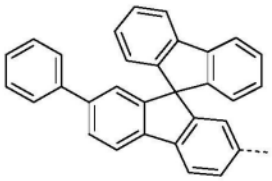
R5-207

R5-208

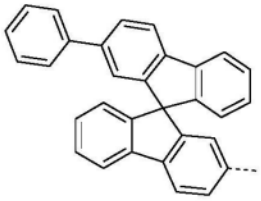
R5-209



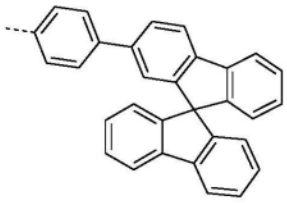
R5-210



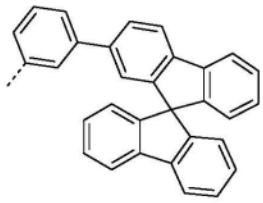
R5-211



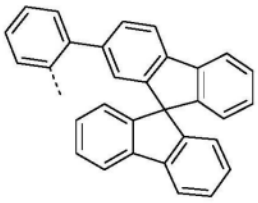
R5-212



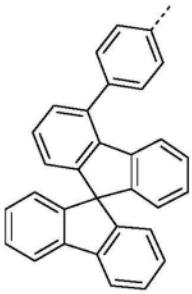
R5-213



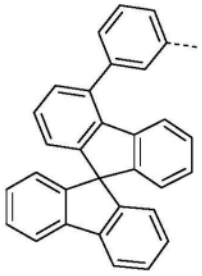
R5-214



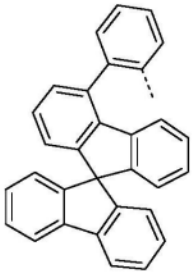
R5-215



R5-216

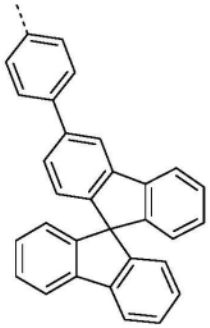


R5-217

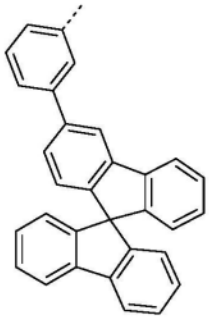


R5-218

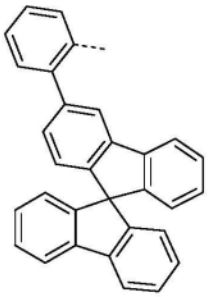
[0134]



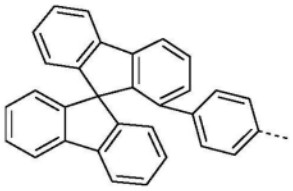
R5-219



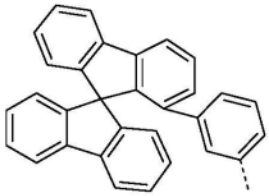
R5-220



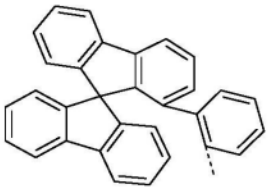
R5-221



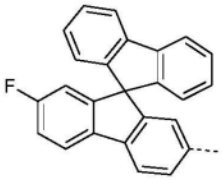
R5-222

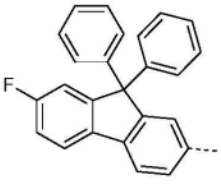


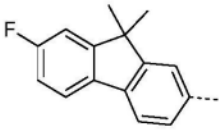
R5-223



R5-224

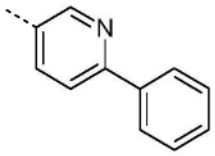




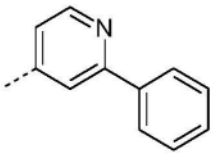


[0135]

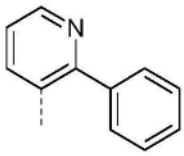
R5-225



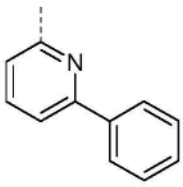
R5-226



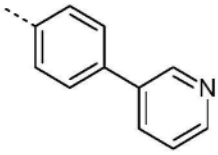
R5-227



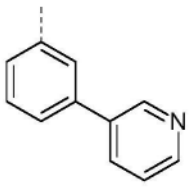
R5-228



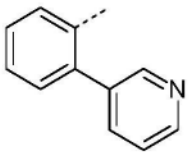
R5-229



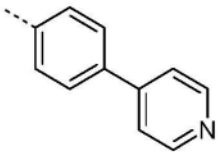
R5-230



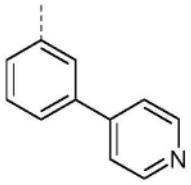
R5-231



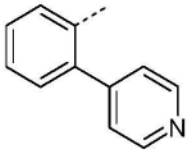
R5-232



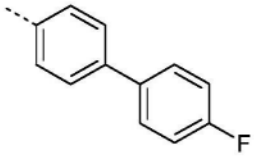
R5-233



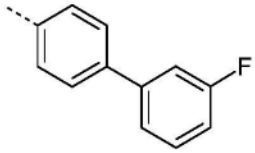
R5-234



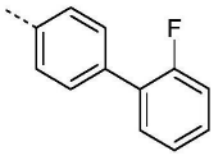
R5-235



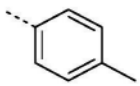
R5-236



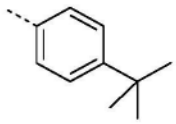
R5-237



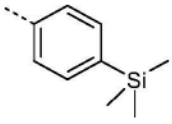
R5-238



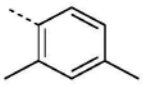
R5-239



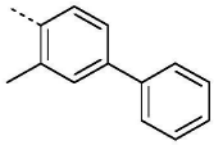
R5-240



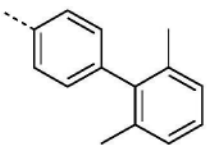
R5-241



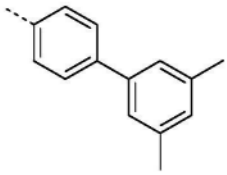
R5-242



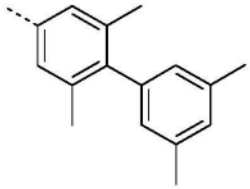
R5-243



R5-244



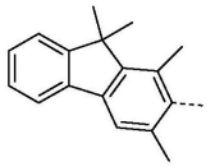
R5-245



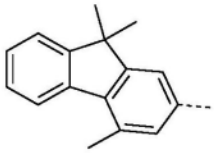
R5-246

R5-247

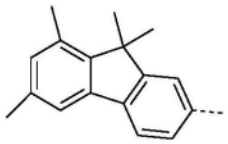
R5-248



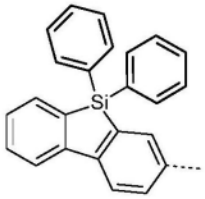
R5-250



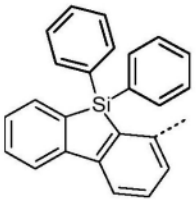
R5-251



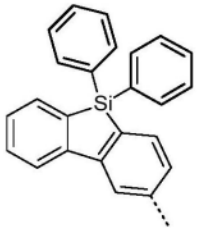
R5-252



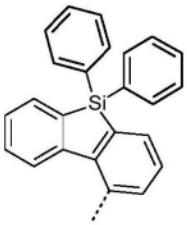
R5-253



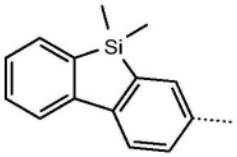
R5-254



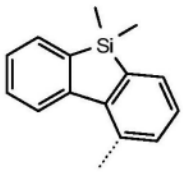
R5-255



R5-256

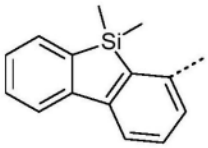


R5-257

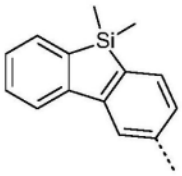


R5-258

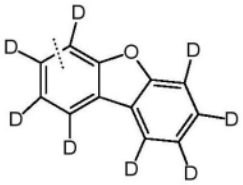
[0136]



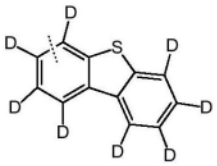
R5-259



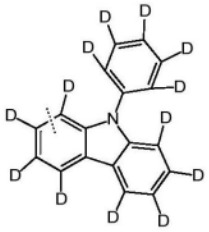
R5-260



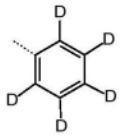
R5-261



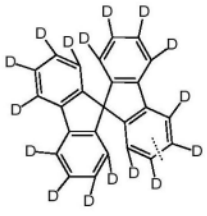
R5-262



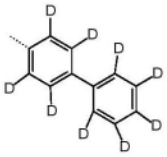
R5-263



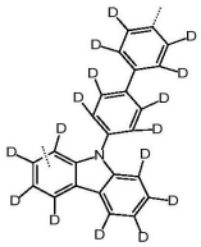
R5-264



R5-265

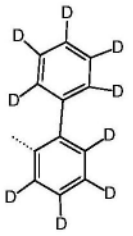


R5-266

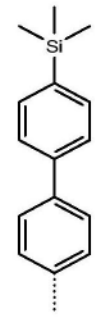


R5-267

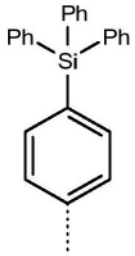
[0137]



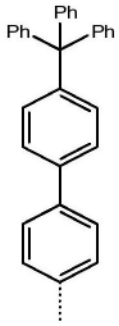
R5-268



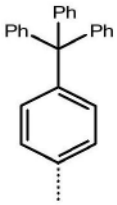
R5-269



R5-270



R5-271



R5-272

[0138] 其中所述基团在显示为未取代的位置上可被R^{11}基团取代，其中这些位置上的R^{11}优选为H，其中虚线键是与胺氮原子连接的键。

[0139] 另外优选具有所提到的式的上述本发明化合物以及不同实施方式所述的优选化合物具有仅一个R^1基团，优选不具有R^1基团。

[0140] 另外优选具有所提到的式的上述本发明化合物以及不同实施方式所述的优选化合物具有仅一个R^4基团，优选不具有R^4基团。

[0141] 另外优选具有所提到的式的上述本发明化合物以及不同实施方式所述的优选化合物具有仅一个R^6基团，优选不具有R^6基团。

[0142] 另外优选具有所提到的式的上述本发明化合物以及不同实施方式所述的优选化合物具有仅一个R^7基团，优选不具有R^7基团。

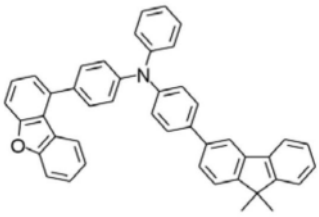
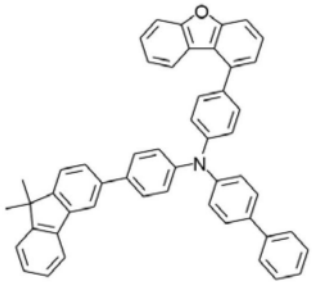
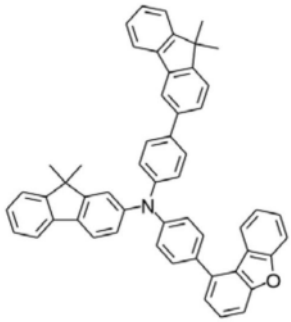
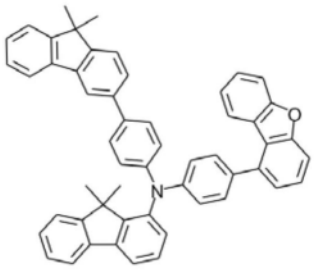
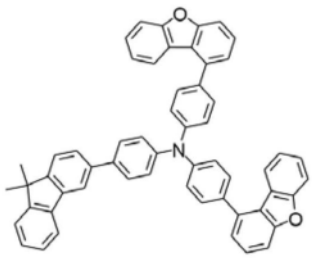
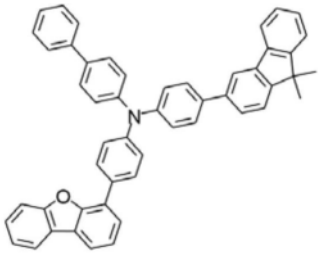
[0143] 最后，甚至更优选具有所提到的式的上述本发明化合物以及不同实施方式所述的优选化合物具有仅一个R^1基团和仅一个R^4基团和仅一个R^6基团和仅一个R^7基团，并且所述化合物优选不具有R^1、R^4、R^6和R^7基团。

[0144] 在一个优选实施方式中，具有所提到的式的上述本发明化合物以及不同实施方式所述的优选化合物中的X是O。包含这些化合物的电子器件具有非常好的寿命。在绿色发光有机电子器件中可以观察到特别好的寿命。

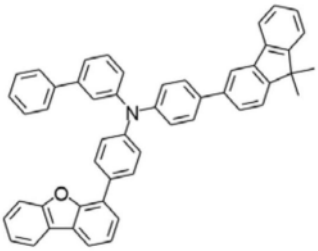
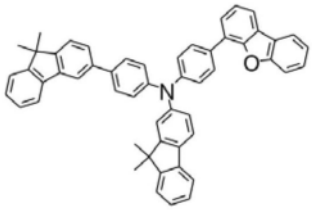
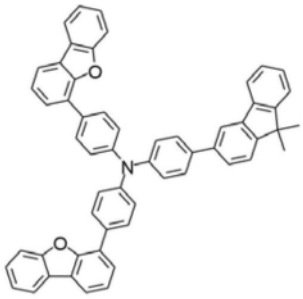
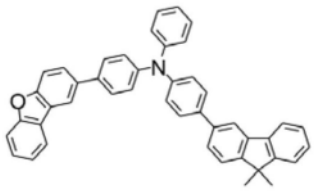
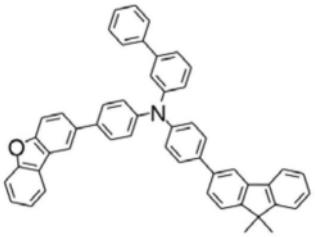
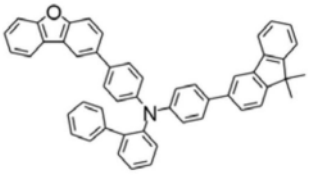
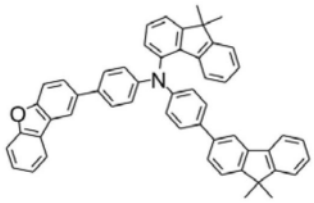
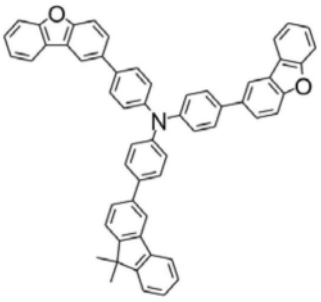
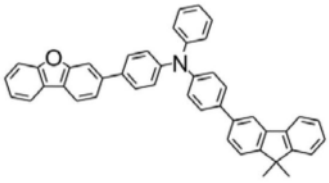
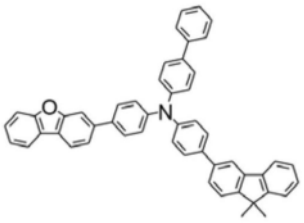
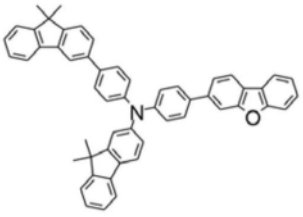
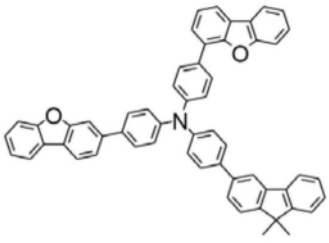
[0145] 在另一个优选实施方式中，具有所提到的式的上述本发明化合物以及不同实施方式所述的优选化合物中的X是S。

[0146] 本发明式(1)的化合物的优选实施方式如下所示：

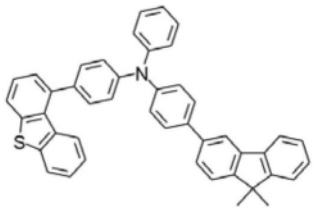
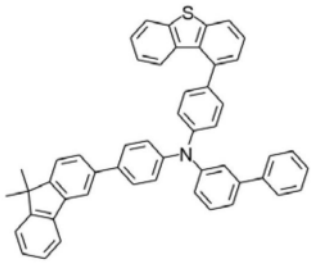
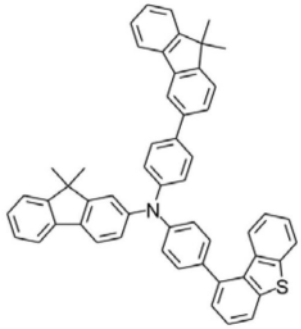
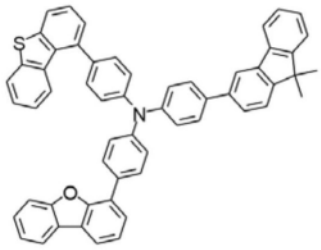
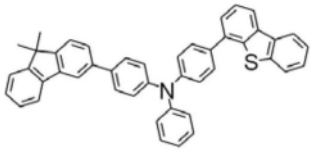
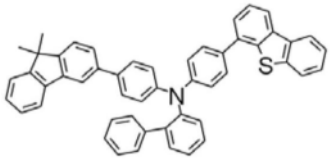
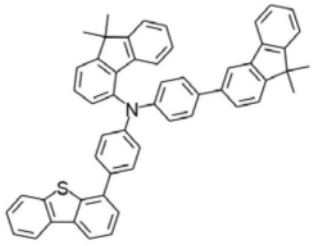
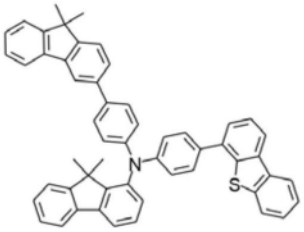
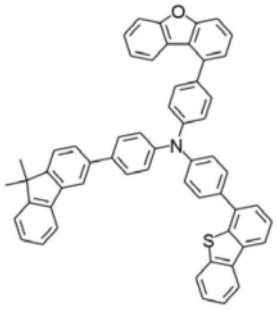
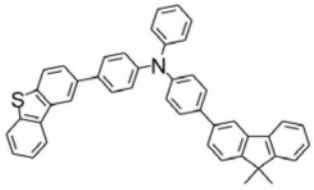
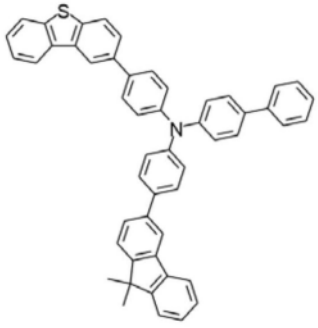
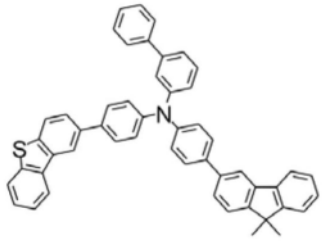
[0147]

1 	2 	3 
4 	5 	6 
7	8	9

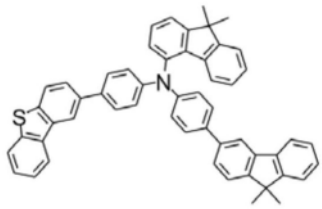
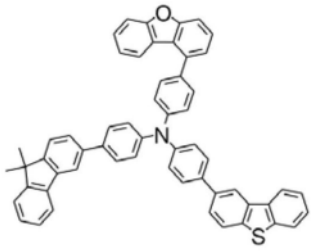
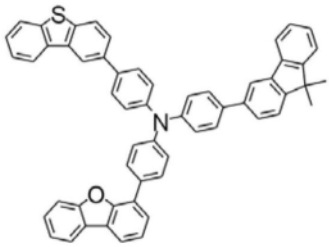
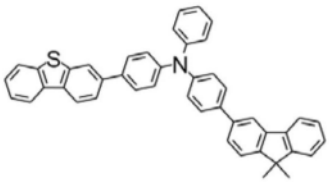
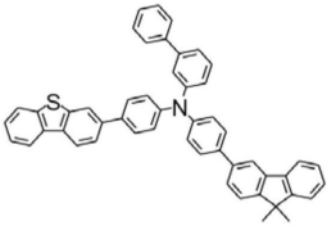
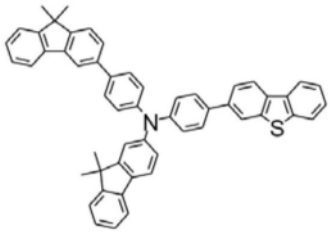
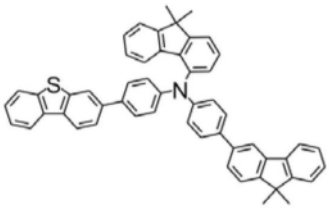
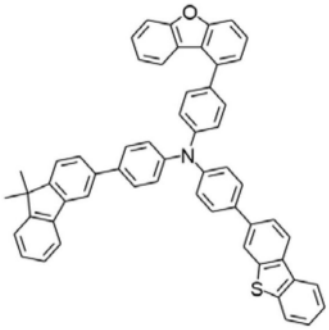
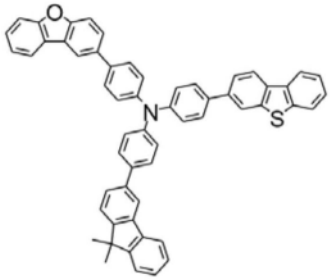
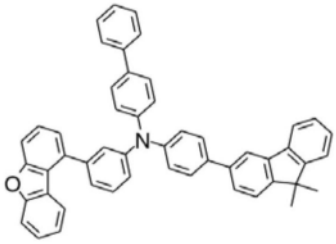
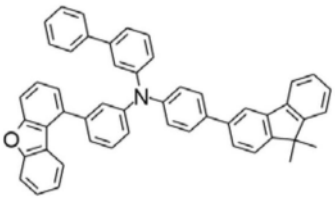
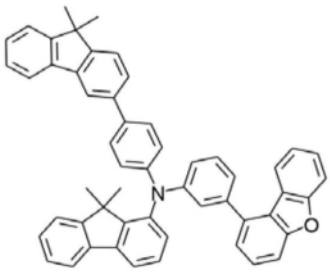
[0148]

		
10 	11 	12 
13 	14 	15 
16 	17 	18 

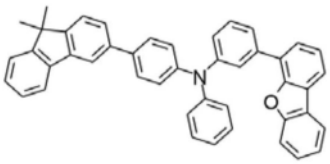
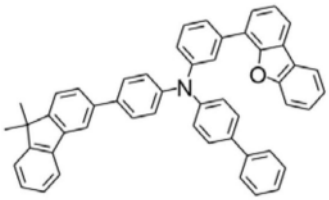
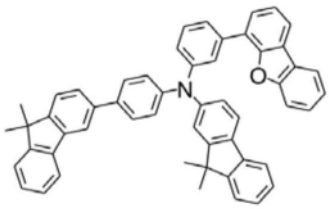
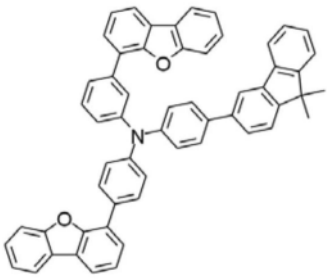
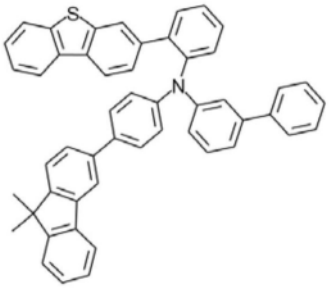
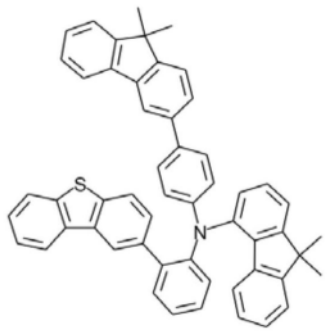
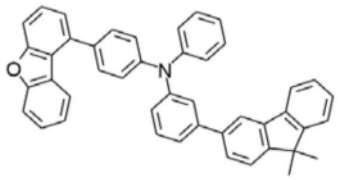
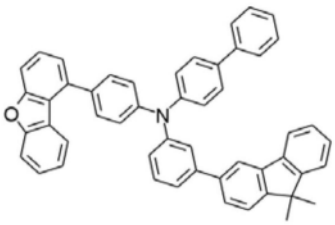
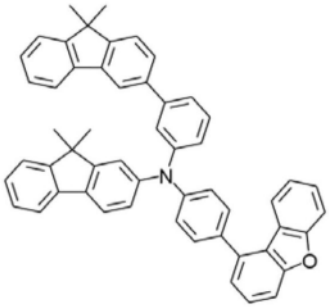
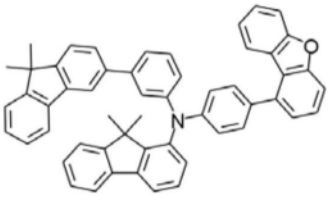
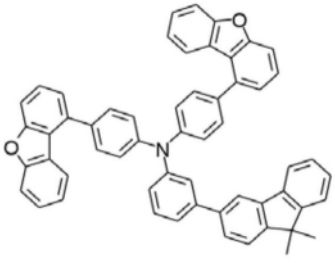
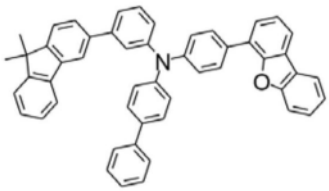
[0149]

19 	20 	21 
22 	23 	24 
25 	26 	27 
28 	29 	30 
31	32	33

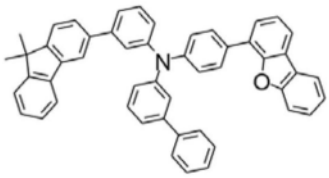
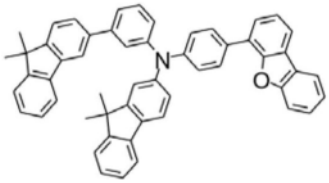
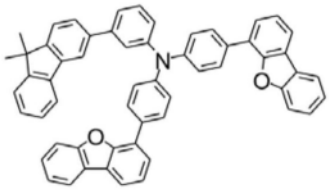
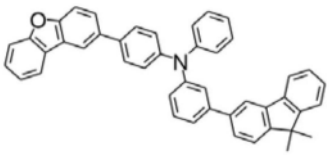
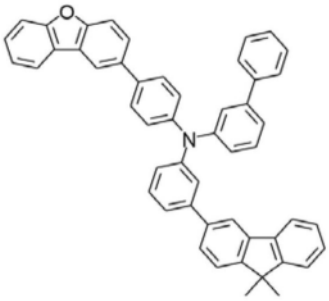
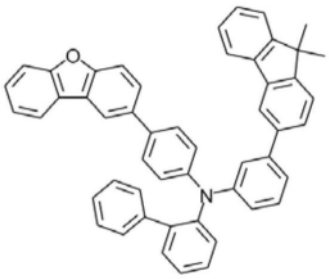
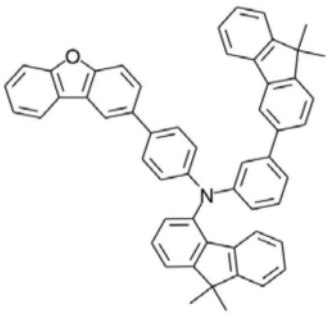
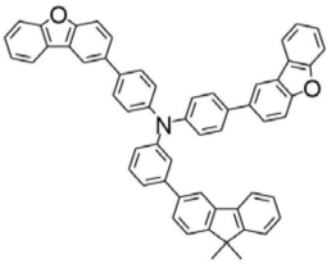
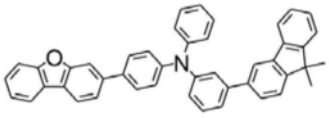
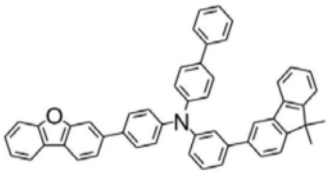
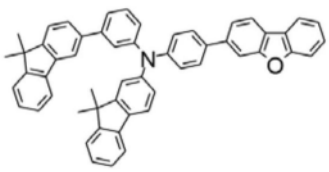
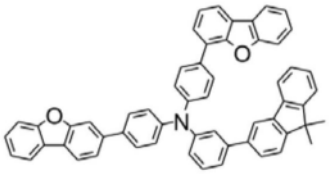
[0150]

		
34 	35 	36 
37 	38 	39 
40 	41 	42 
43	44	45

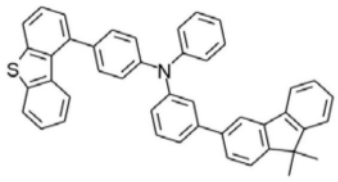
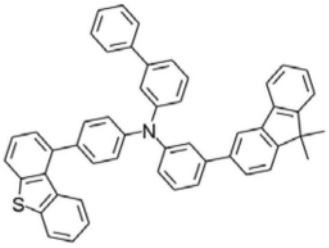
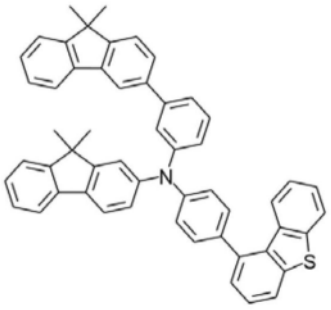
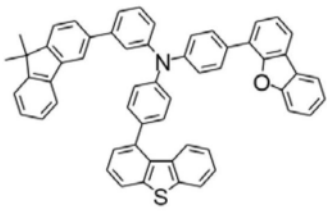
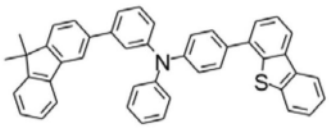
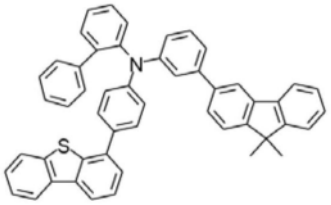
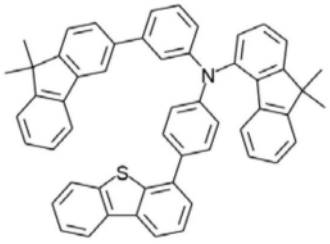
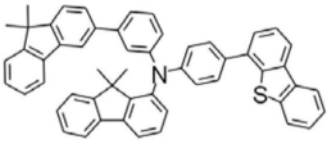
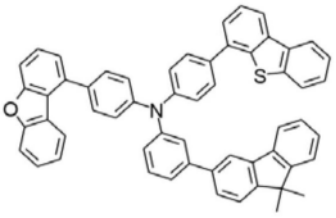
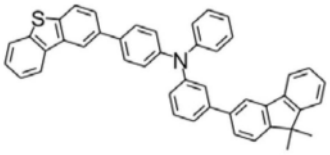
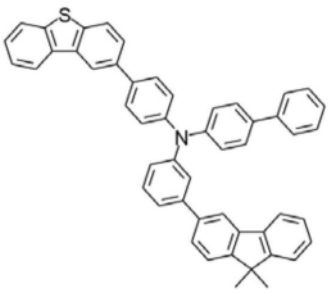
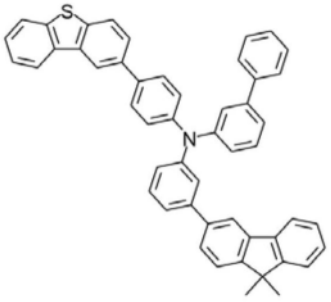
[0151]

		
46 	47 	48 
49 	50 	51 
52 	53 	54 
55	56	57

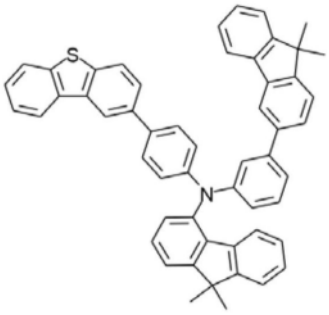
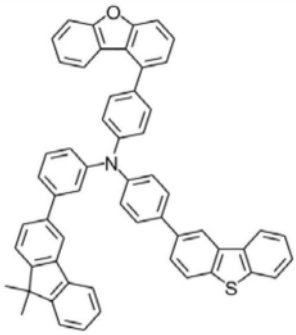
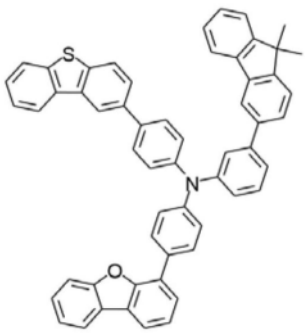
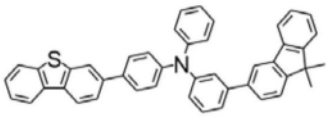
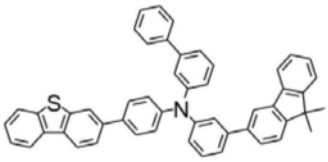
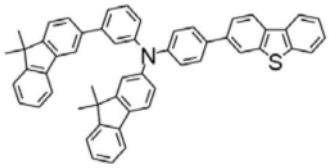
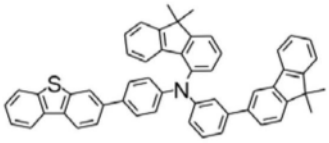
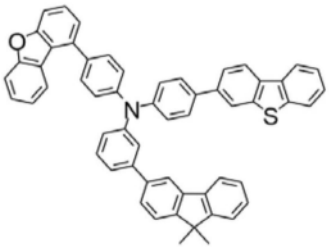
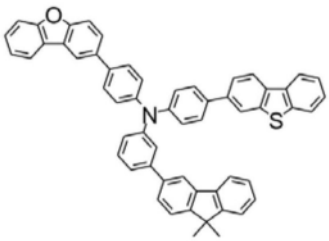
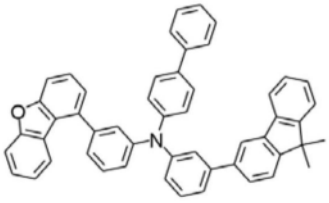
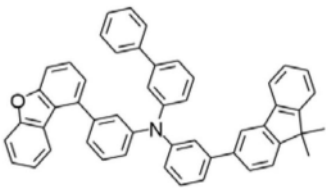
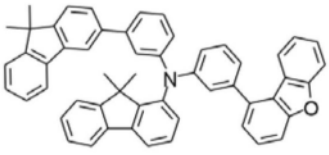
[0152]

		
58 	59 	60 
61 	62 	63 
64 	65 	66 
67	68	69

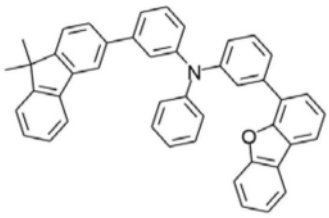
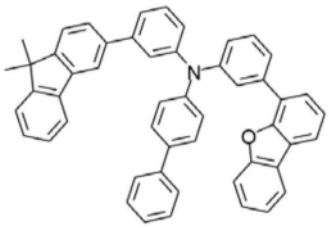
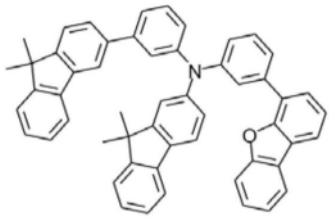
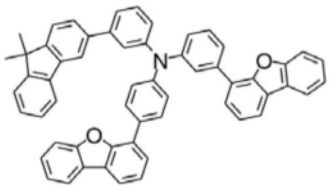
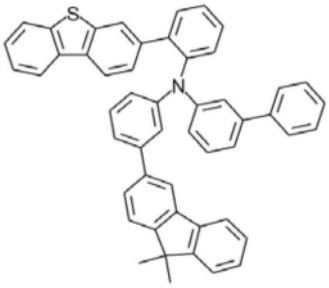
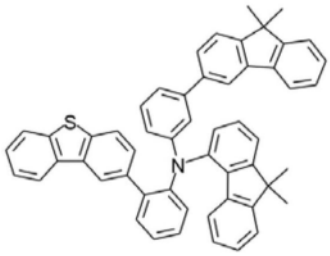
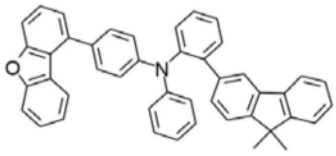
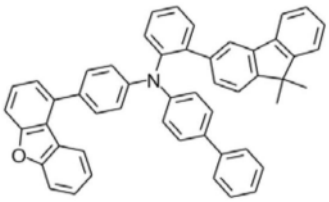
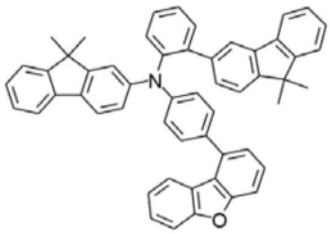
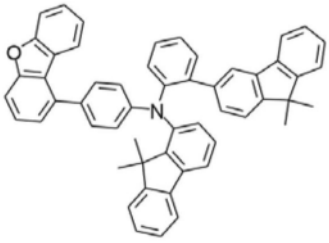
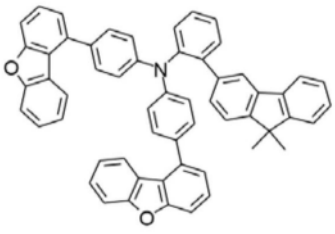
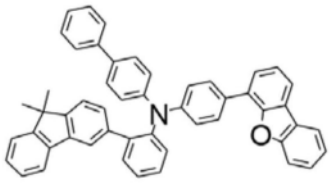
[0153]

		
70 	71 	72 
73 	74 	75 
76 	77 	78 
79	80	81

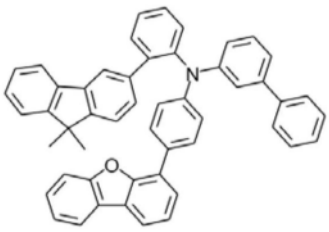
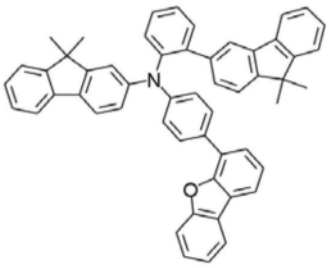
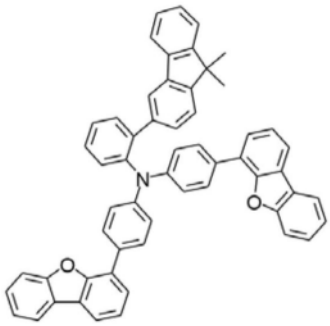
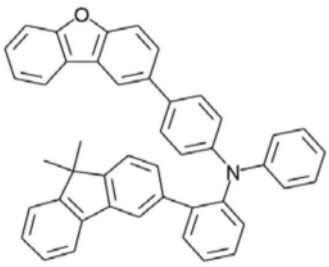
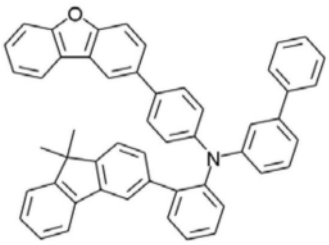
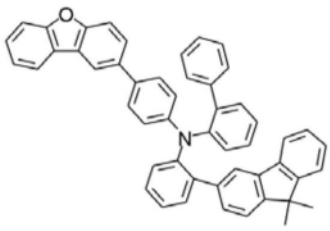
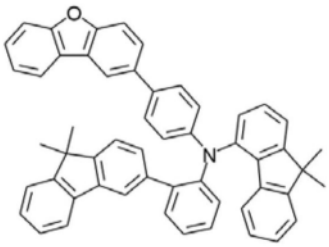
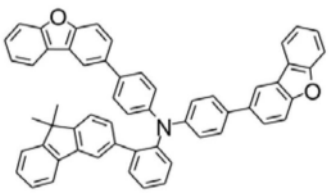
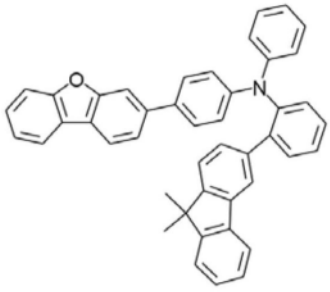
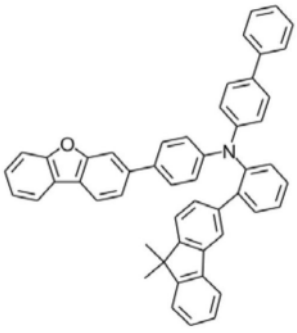
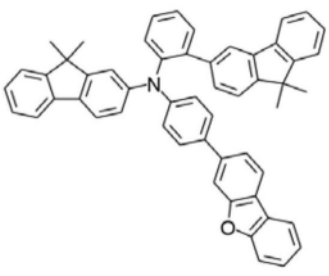
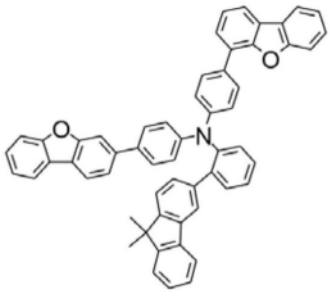
[0154]

		
82 	83 	84 
85 	86 	87 
88 	89 	90 
91	92	93

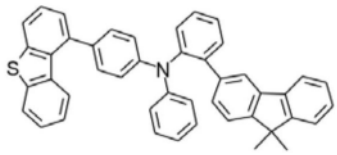
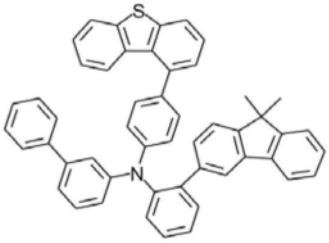
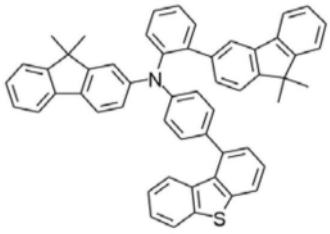
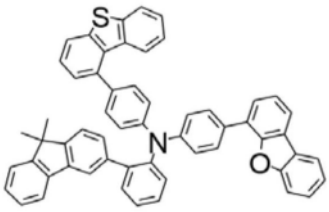
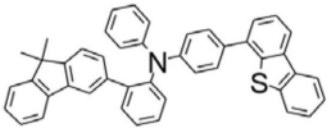
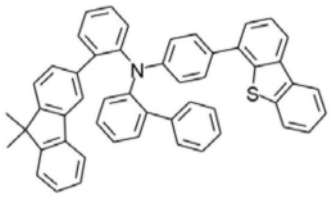
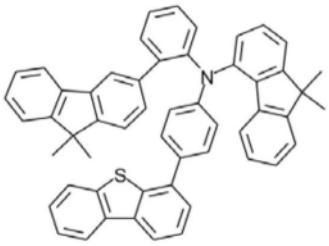
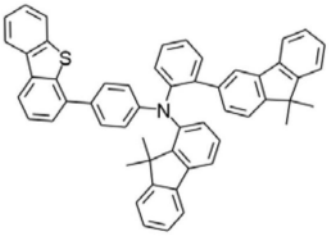
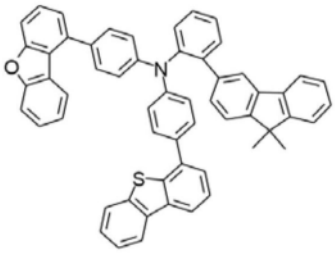
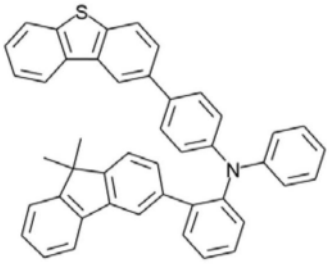
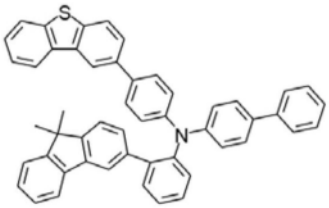
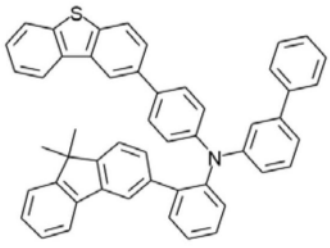
[0155]

		
94 	95 	96 
97 	98 	99 
100 	101 	102 
103	104	105

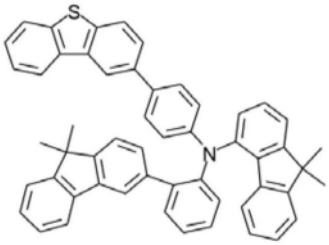
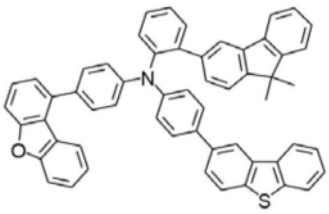
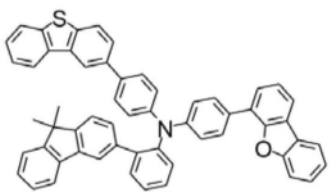
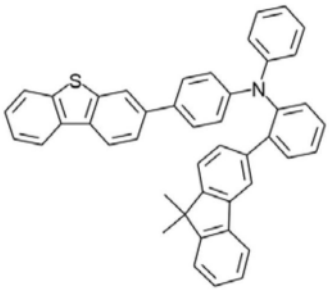
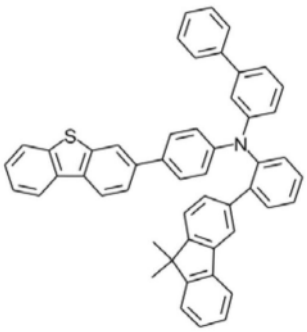
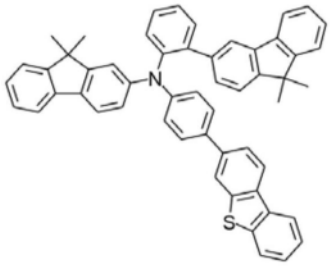
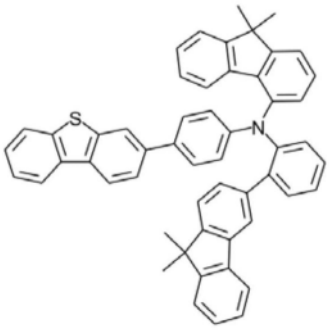
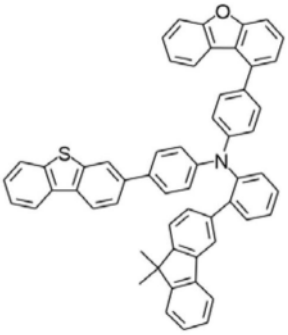
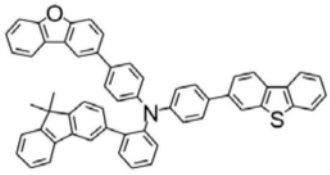
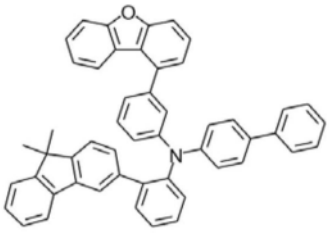
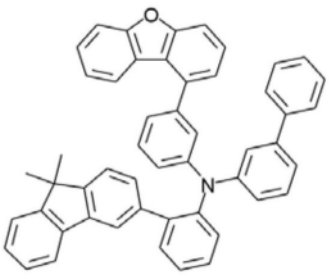
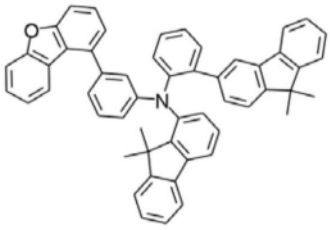
[0156]

		
106 	107 	108 
109 	110 	111 
112 	113 	114 
115	116	117

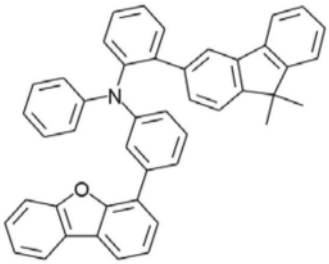
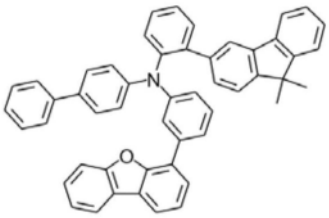
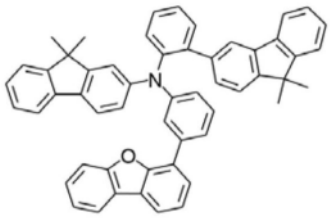
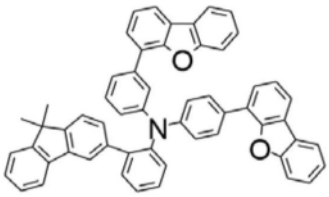
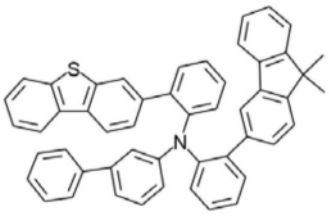
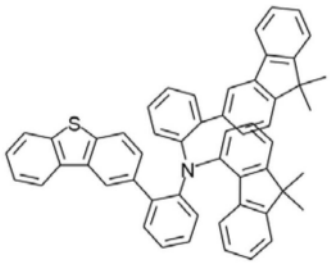
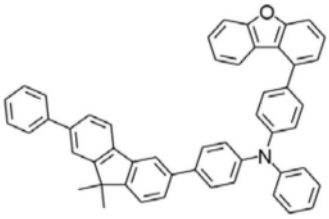
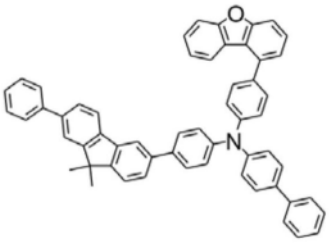
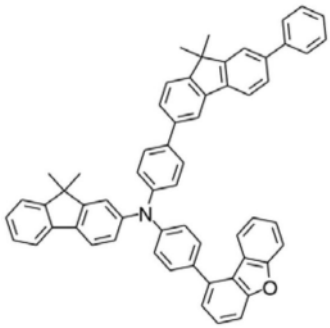
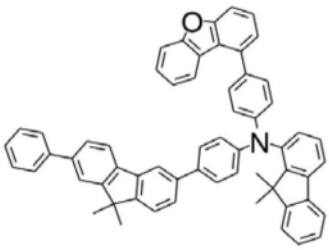
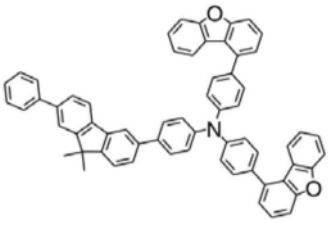
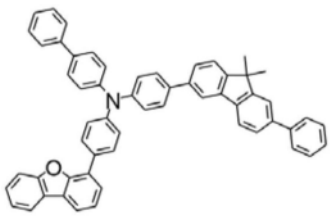
[0157]

		
118 	119 	120 
121 	122 	123 
124 	125 	126 
127	128	129

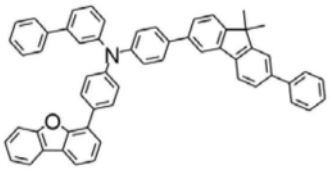
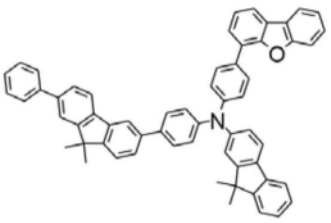
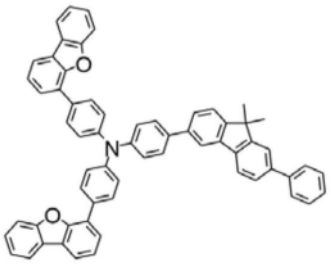
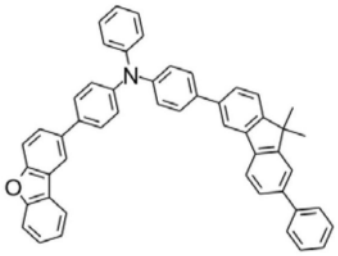
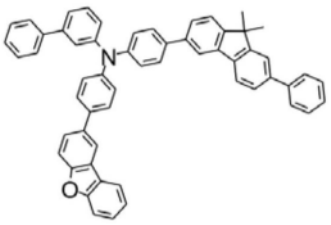
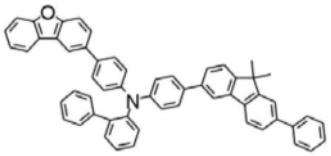
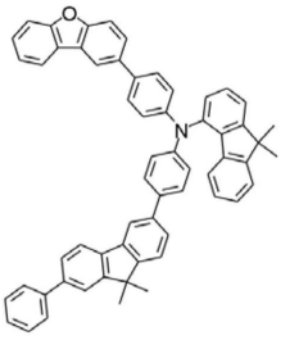
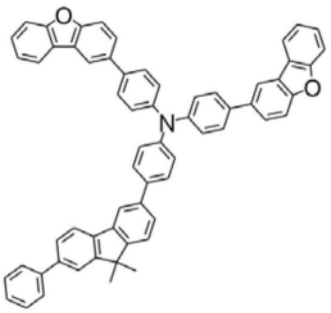
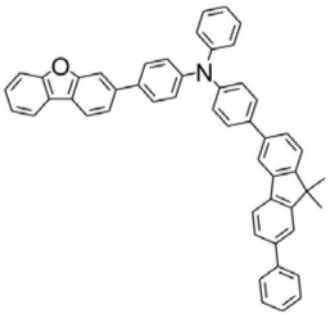
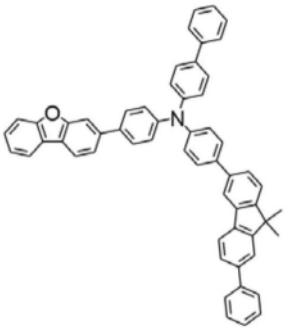
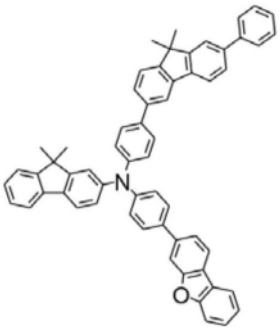
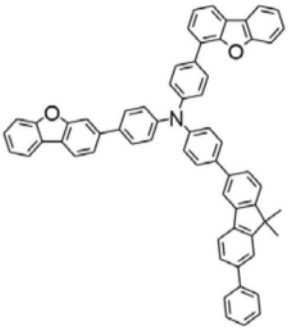
[0158]

		
130 	131 	132 
133 	134 	135 
136 	137 	138 
139	140	141

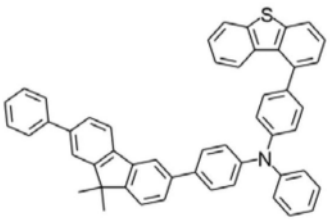
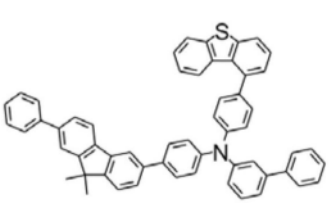
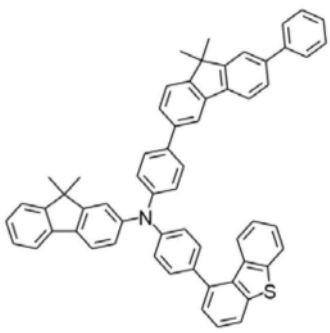
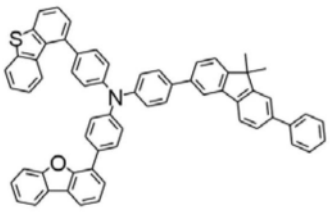
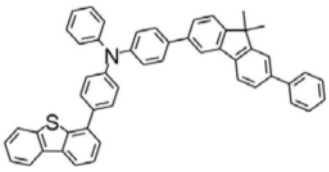
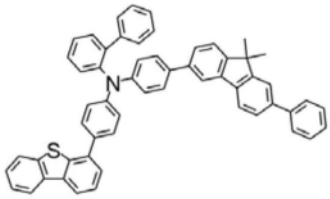
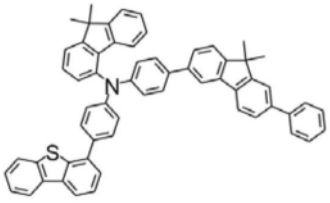
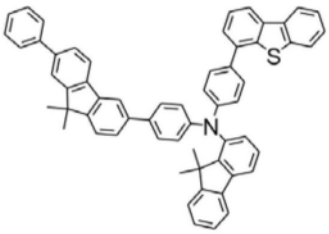
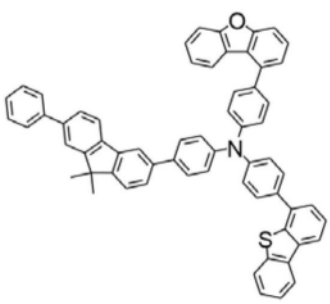
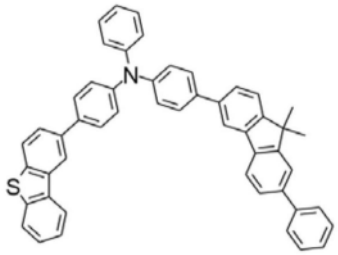
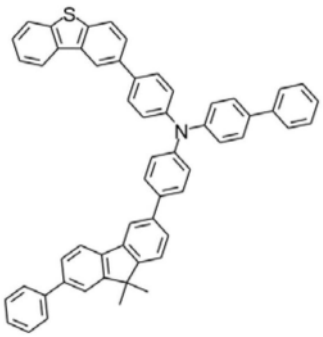
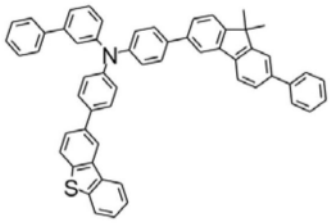
[0159]

		
142 	143 	144 
145 	146 	147 
148 	149 	150 
151	152	153

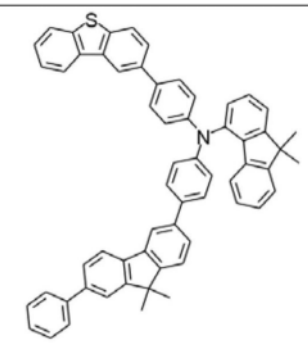
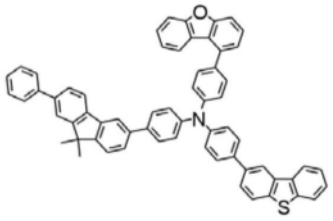
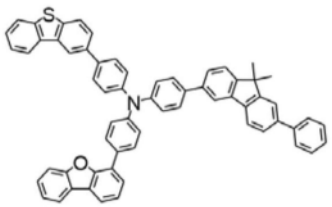
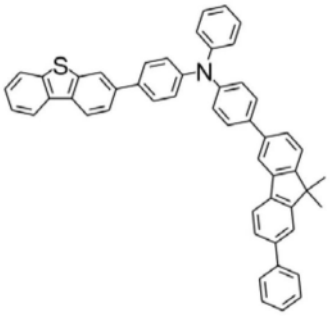
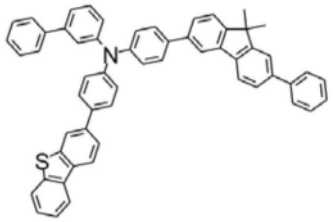
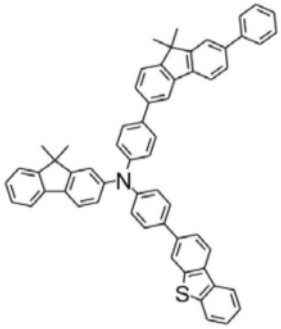
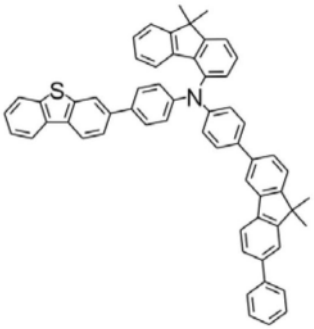
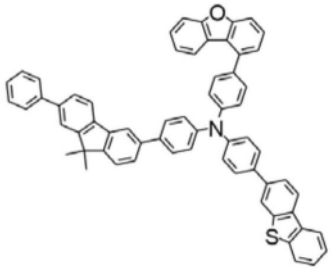
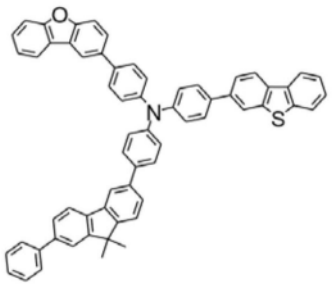
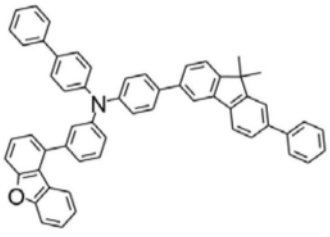
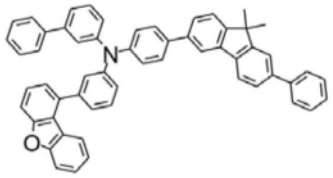
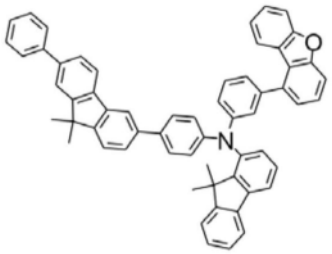
[0160]

		
154 	155 	156 
157 	158 	159 
160 	161 	162 
163	164	165

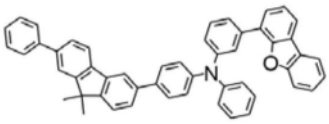
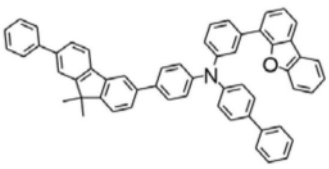
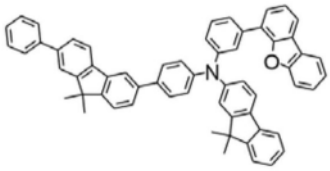
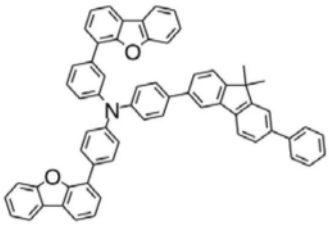
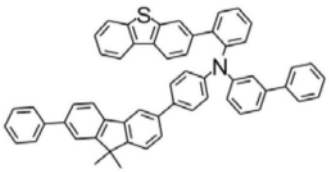
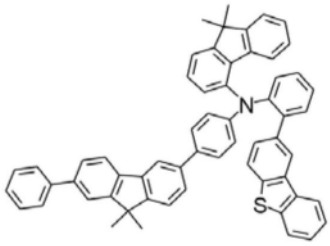
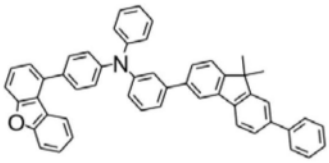
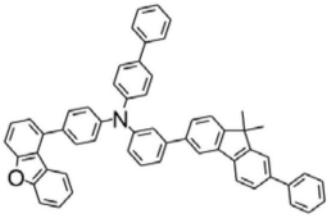
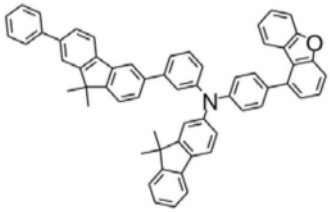
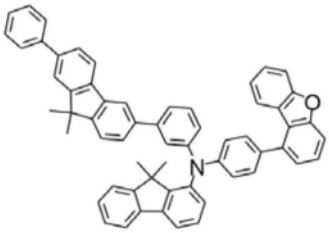
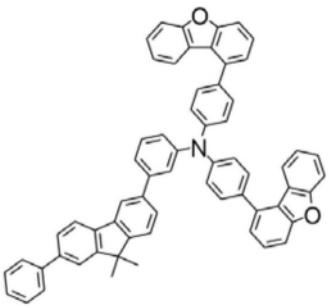
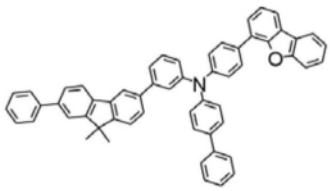
[0161]

		
166 	167 	168 
169 	170 	171 
172 	173 	174 
175	176	177

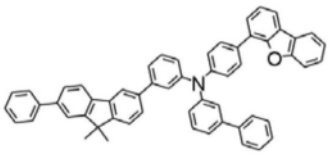
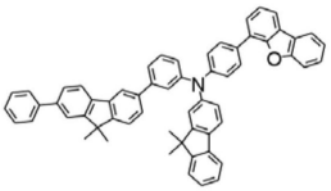
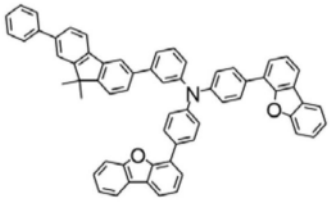
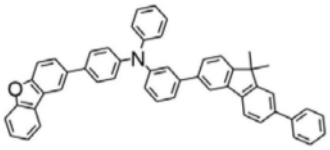
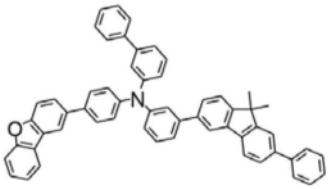
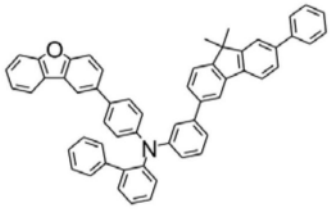
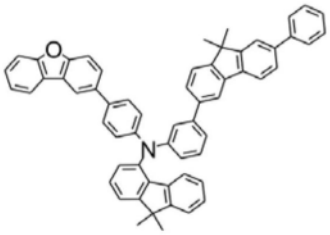
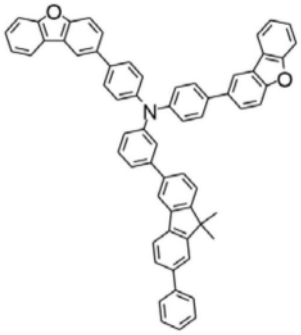
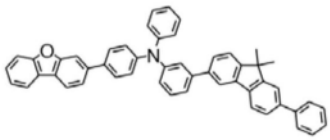
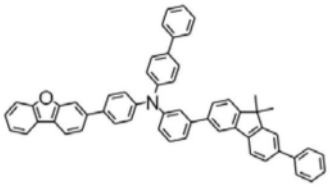
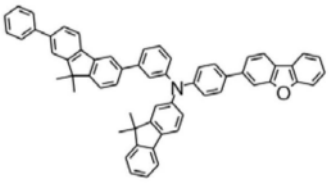
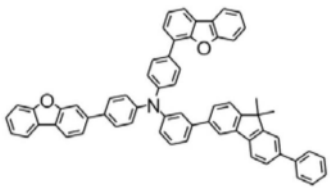
[0162]

		
178 	179 	180 
181 	182 	183 
184 	185 	186 
187	188	189

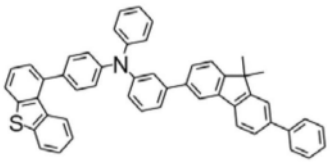
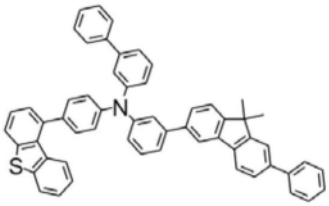
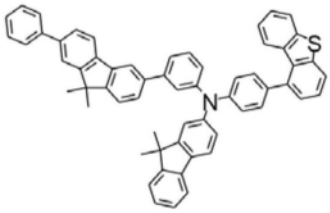
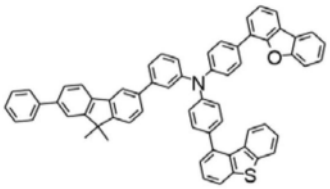
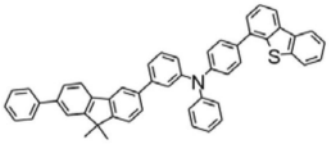
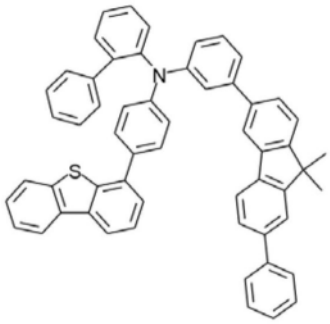
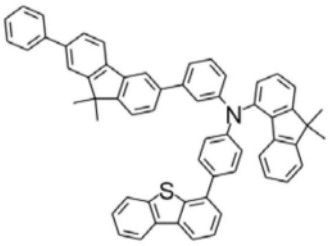
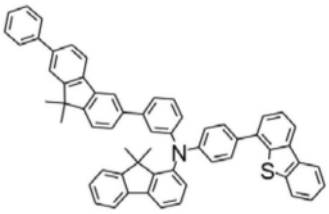
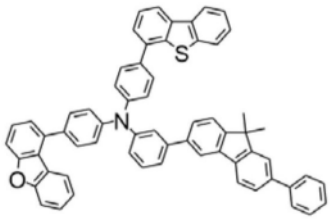
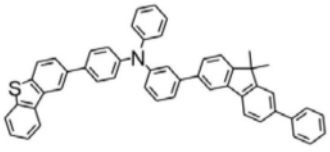
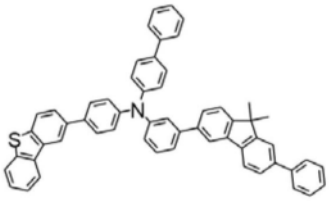
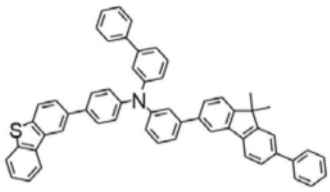
[0163]

		
190 	191 	192 
193 	194 	195 
196 	197 	198 
199	200	201

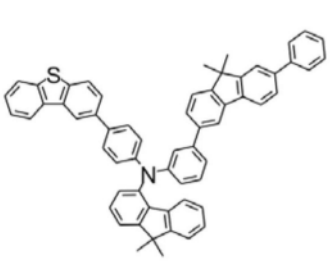
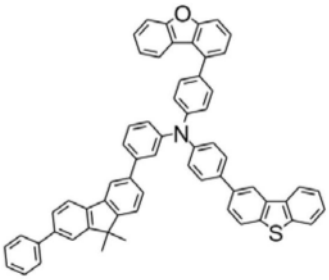
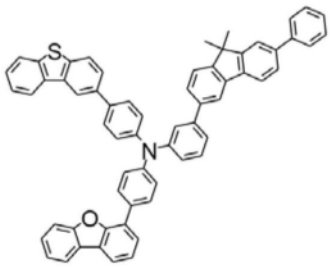
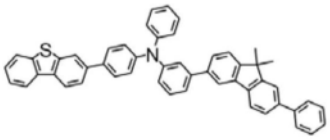
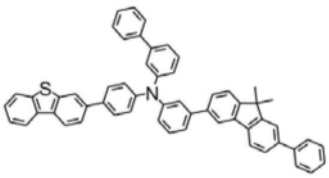
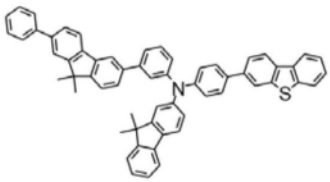
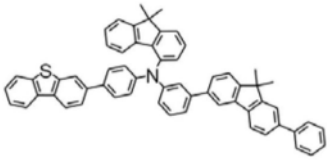
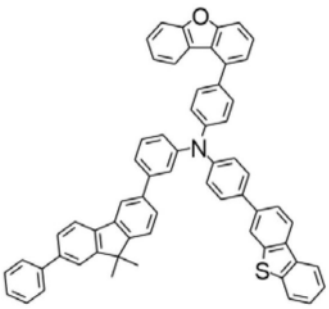
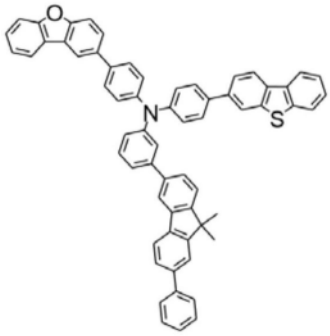
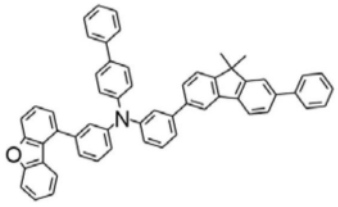
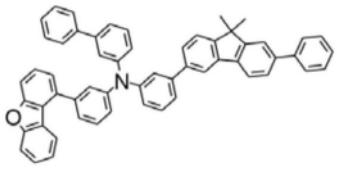
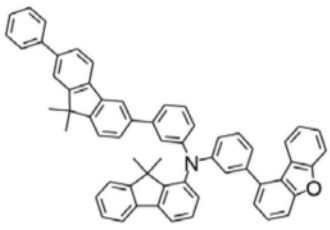
[0164]

		
202 	203 	204 
205 	206 	207 
208 	209 	210 
211	212	213

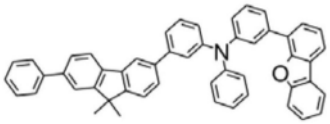
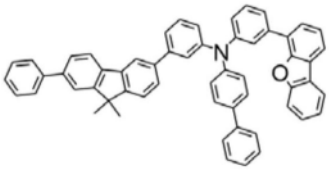
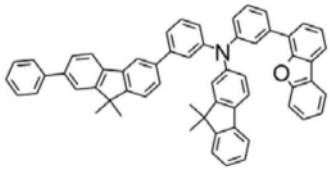
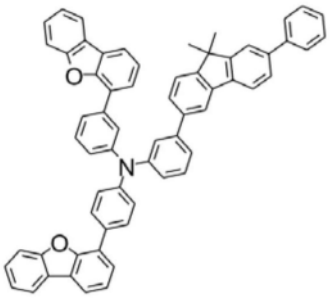
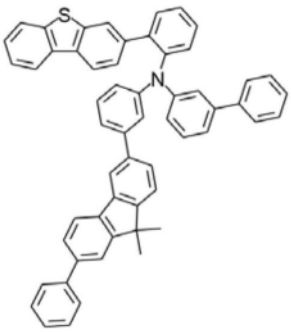
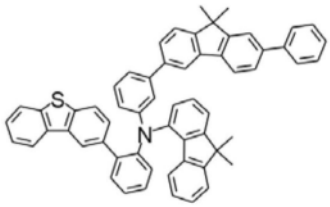
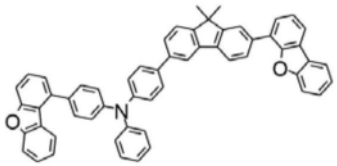
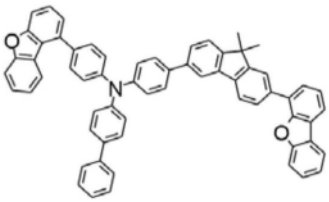
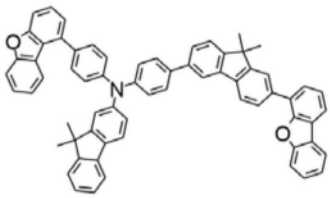
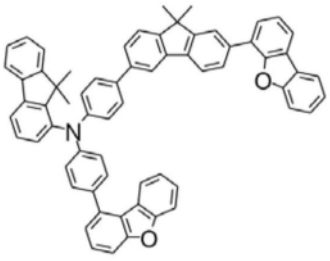
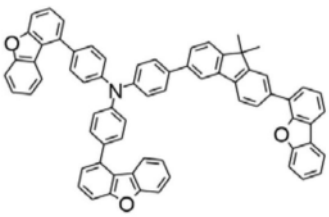
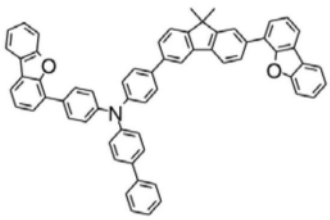
[0165]

		
214 	215 	216 
217 	218 	219 
220 	221 	222 
223	224	225

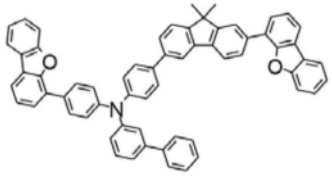
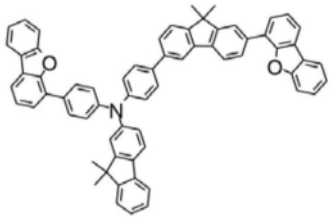
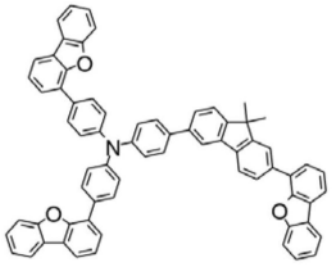
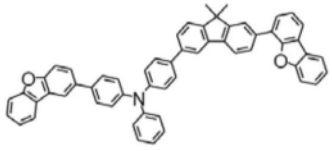
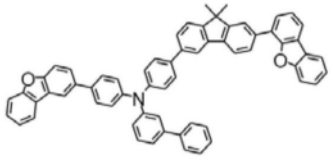
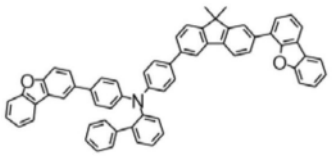
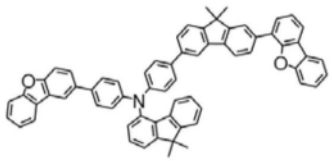
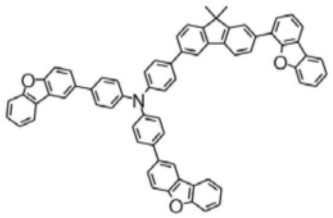
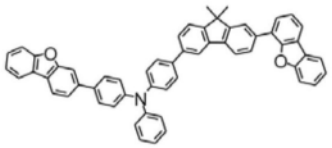
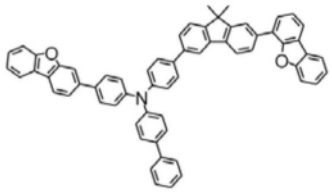
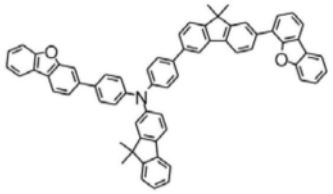
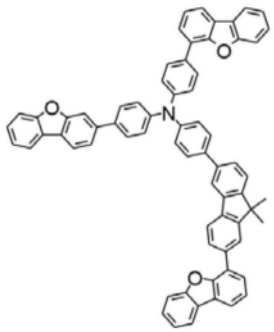
[0166]

		
226 	227 	228 
229 	230 	231 
232 	233 	234 
235	236	237

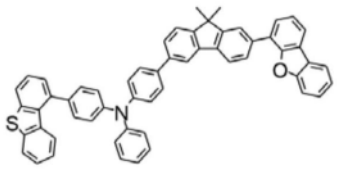
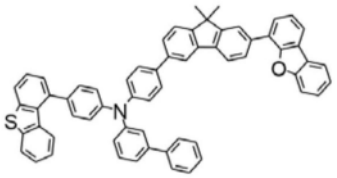
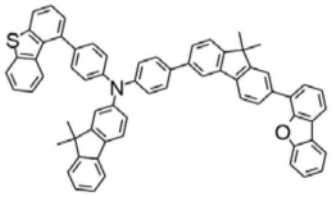
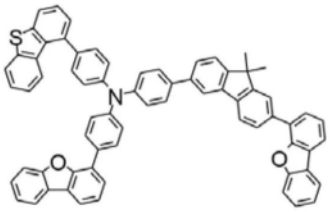
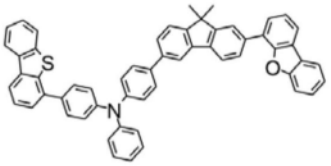
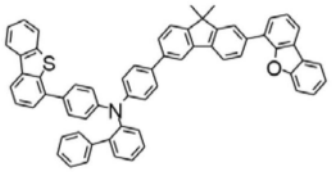
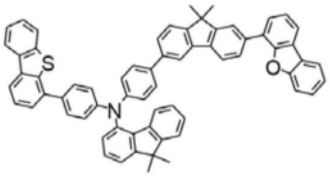
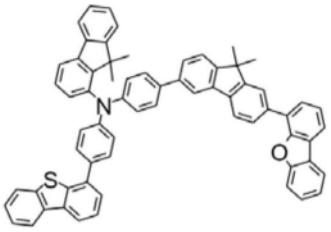
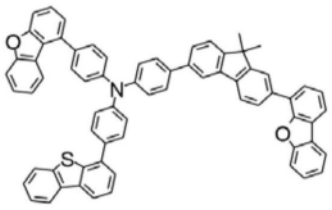
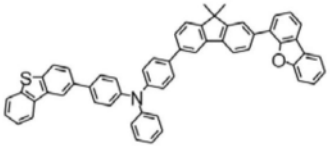
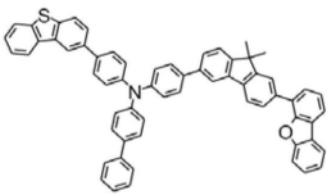
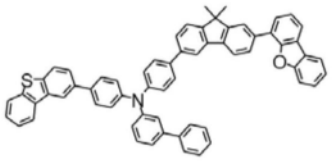
[0167]

		
238 	239 	240 
241 	242 	243 
244 	245 	246 
247	248	249

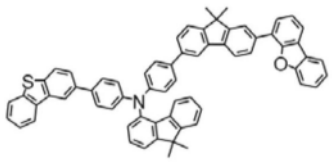
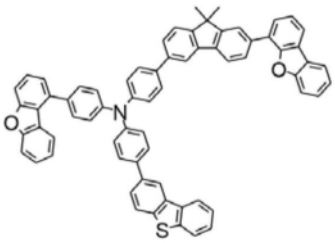
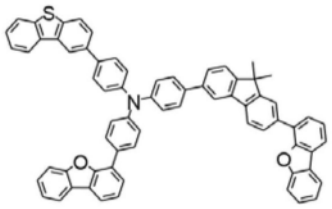
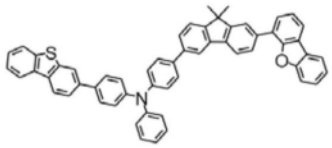
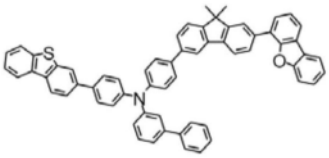
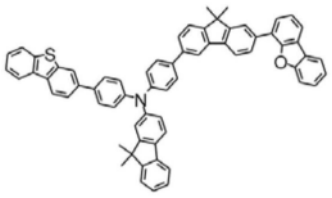
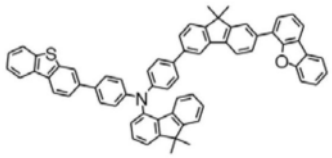
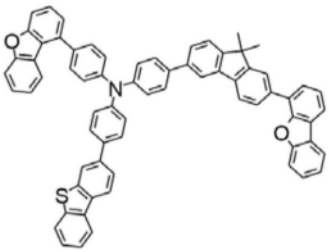
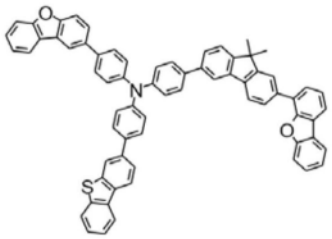
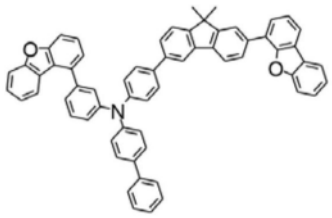
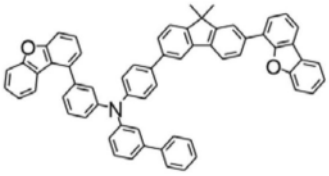
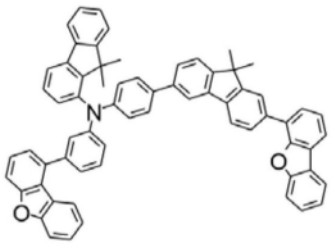
[0168]

		
250 	251 	252 
253 	254 	255 
256 	257 	258 
259	260	261

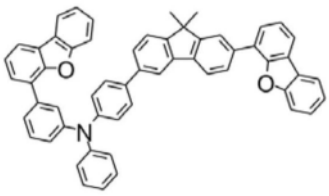
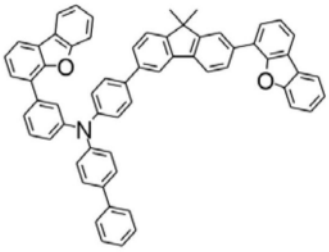
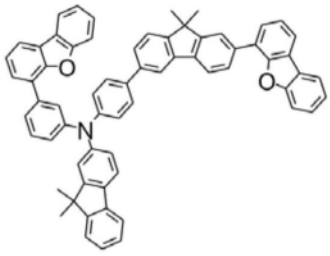
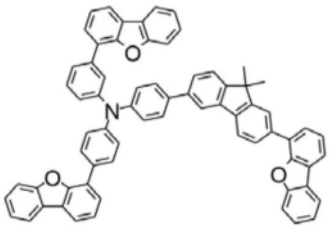
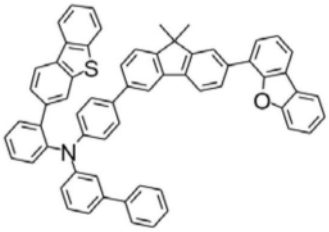
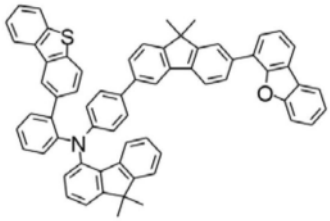
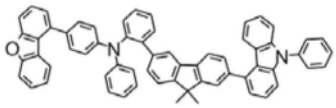
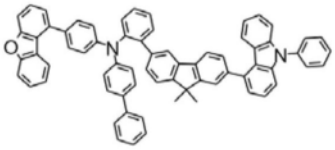
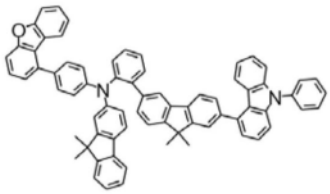
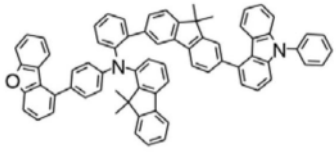
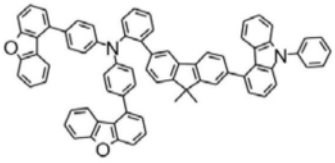
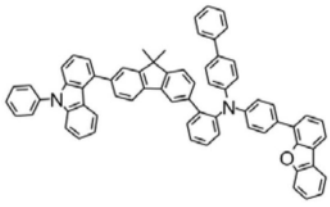
[0169]

		
262 	263 	264 
265 	266 	267 
268 	269 	270 
271	272	273

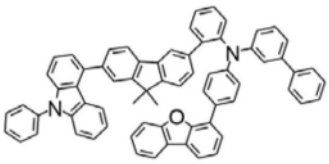
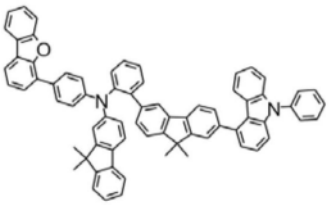
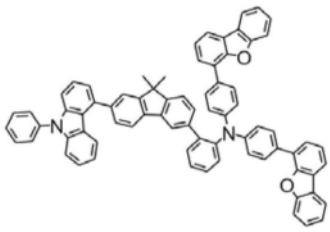
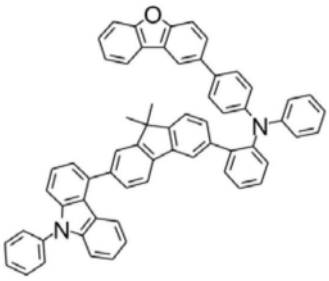
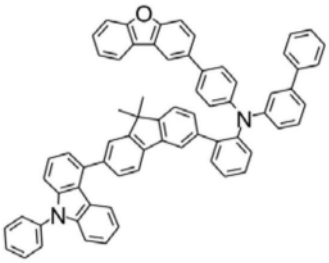
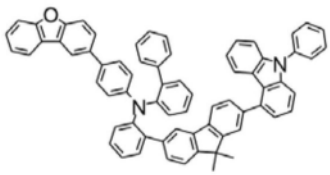
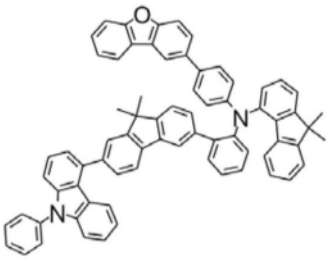
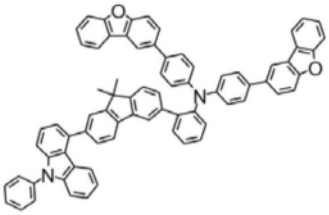
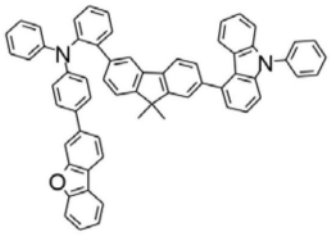
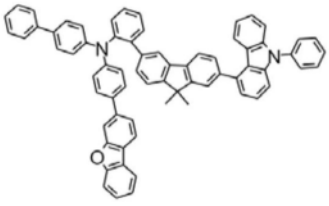
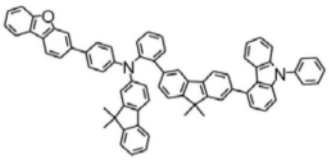
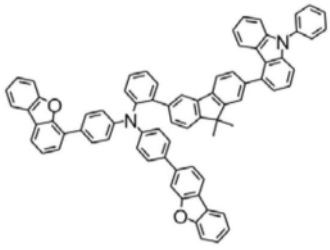
[0170]

		
274 	275 	276 
277 	278 	279 
280 	281 	282 
283	284	285

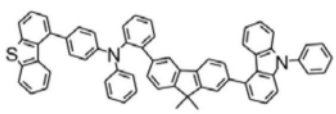
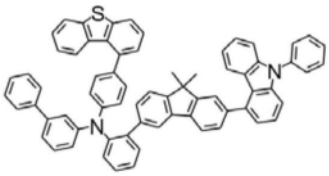
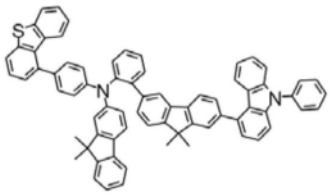
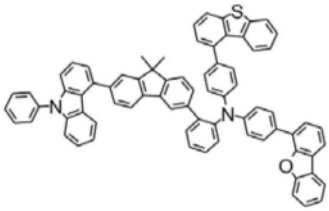
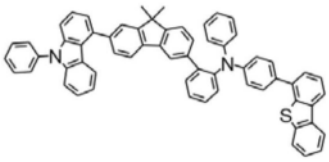
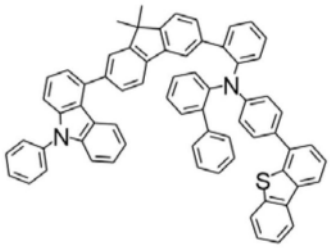
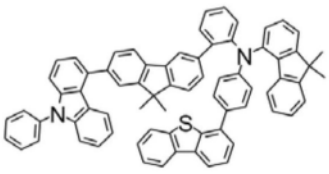
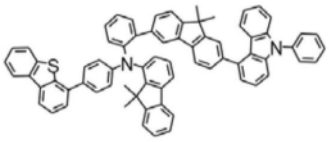
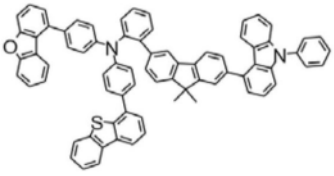
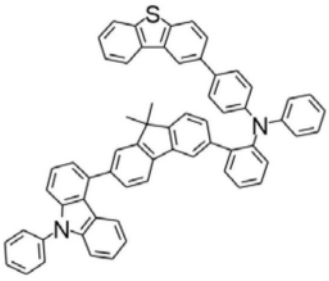
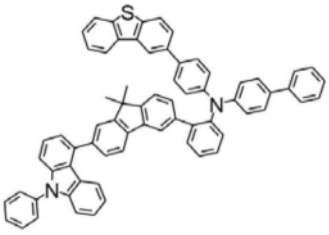
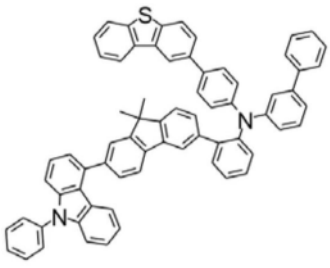
[0171]

		
286 	287 	288 
289 	290 	291 
292 	293 	294 
295	296	297

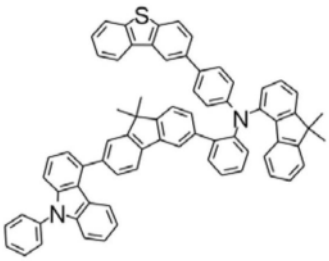
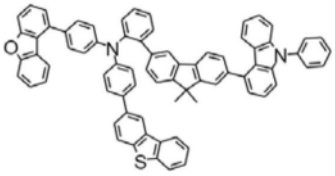
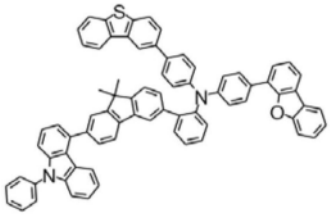
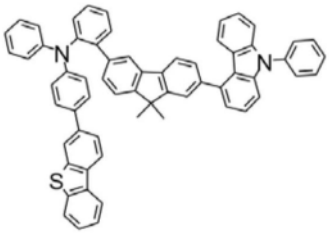
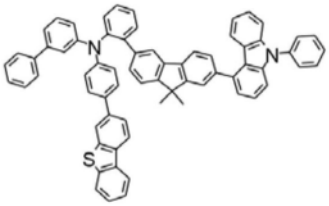
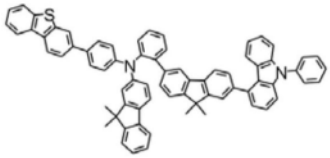
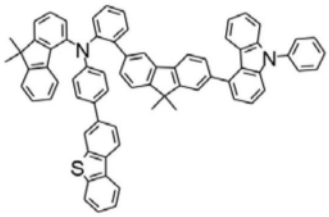
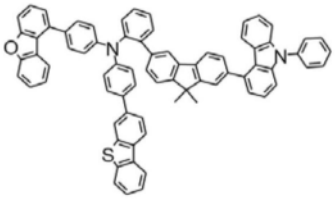
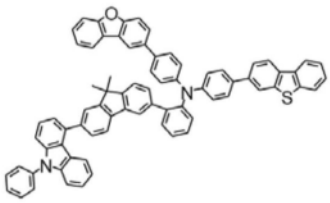
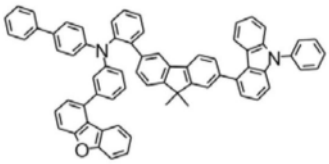
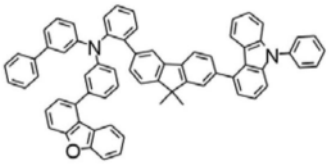
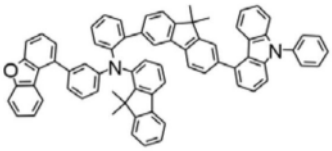
[0172]

		
298 	299 	300 
301 	302 	303 
304 	305 	306 
307	308	309

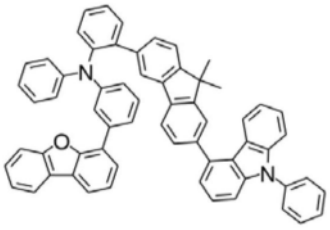
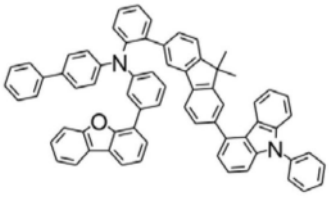
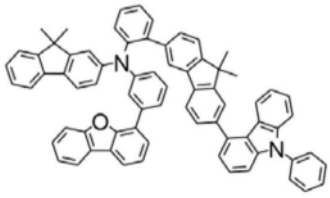
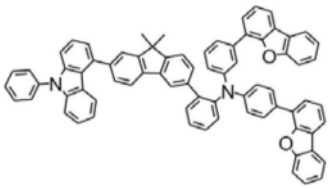
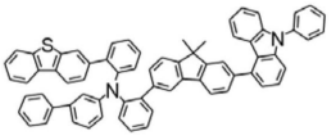
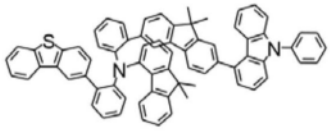
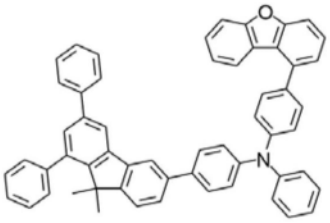
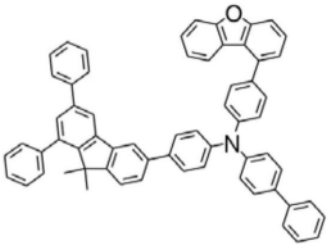
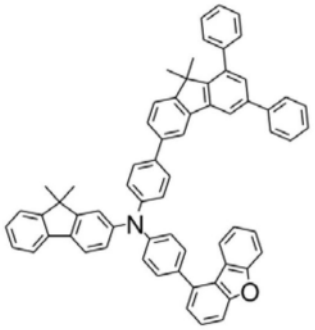
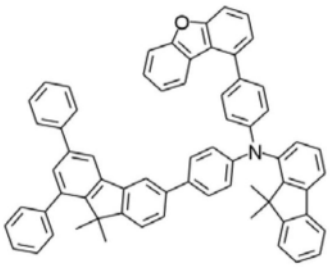
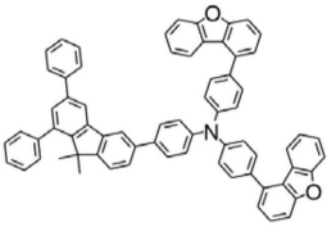
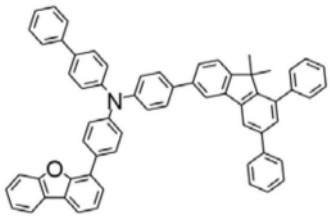
[0173]

		
310 	311 	312 
313 	314 	315 
316 	317 	318 
319	320	321

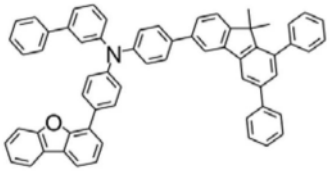
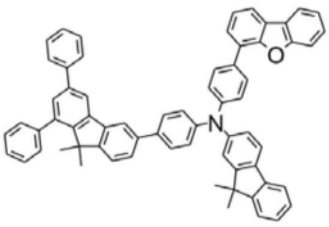
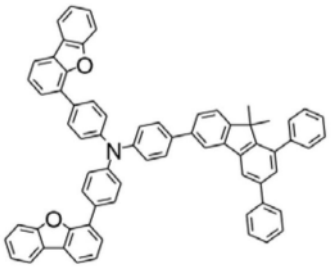
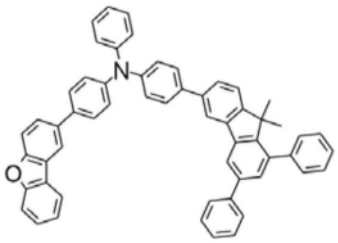
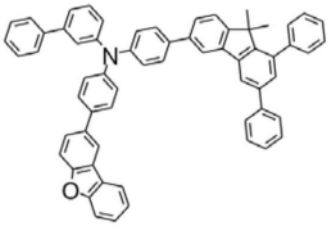
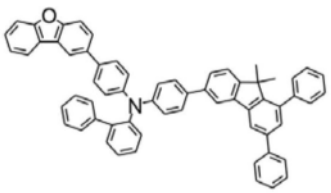
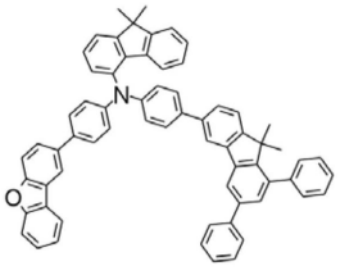
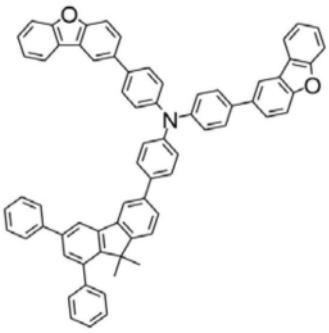
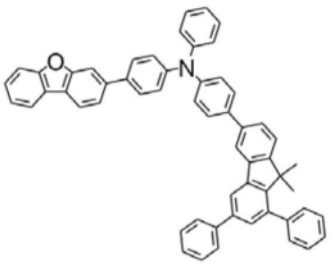
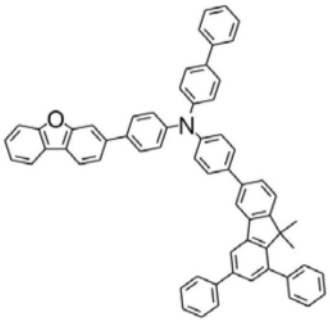
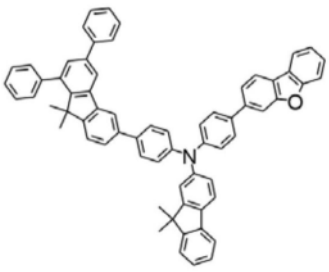
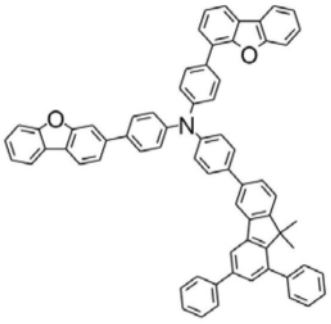
[0174]

		
322 	323 	324 
325 	326 	327 
328 	329 	330 
331	332	333

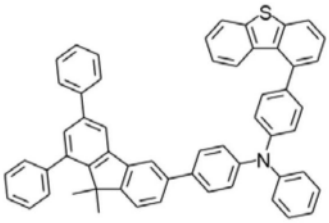
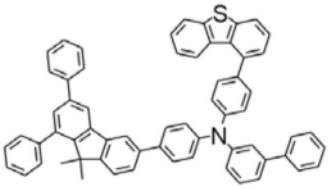
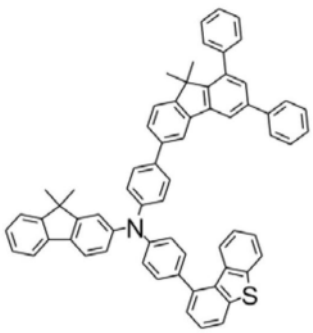
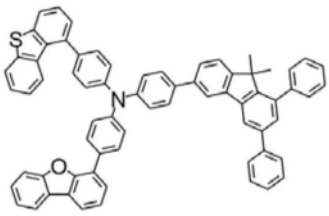
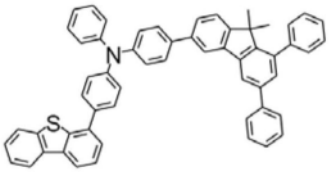
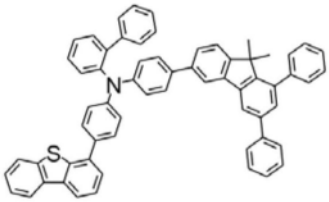
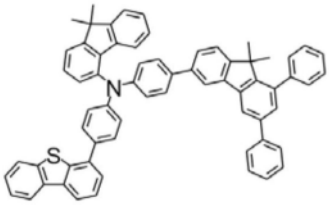
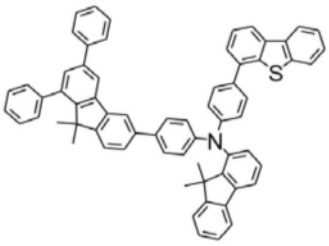
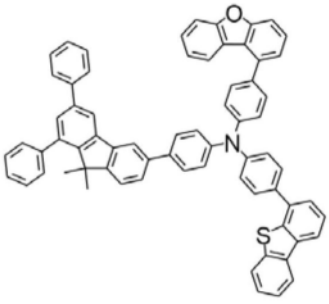
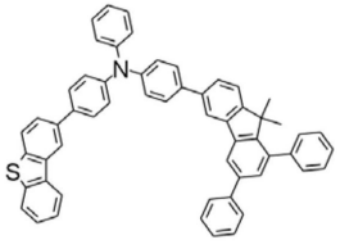
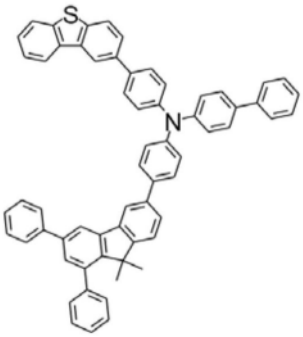
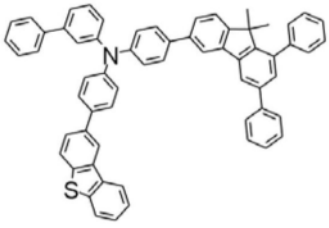
[0175]

		
334 	335 	336 
337 	338 	339 
340 	341 	342 
343	344	345

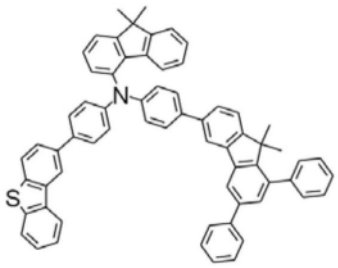
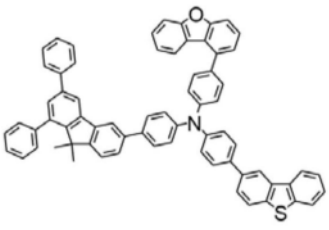
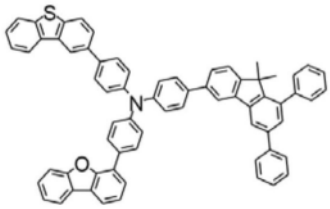
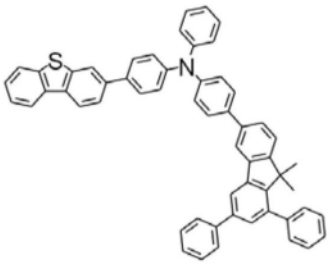
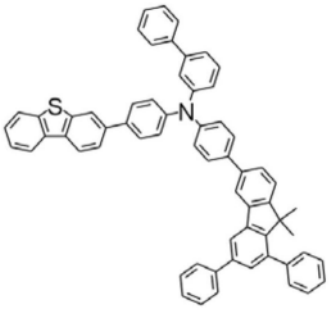
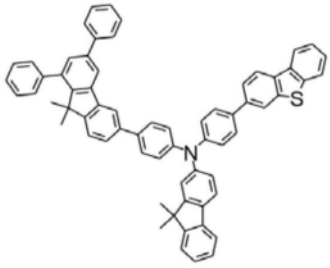
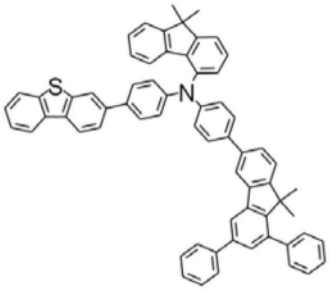
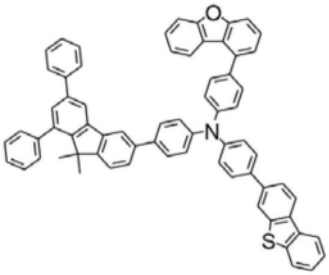
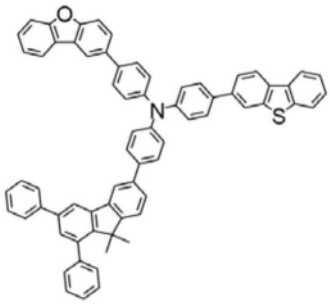
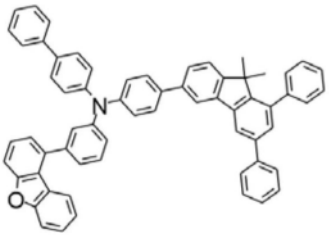
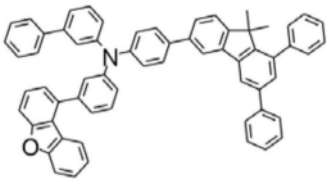
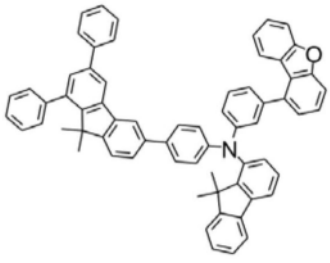
[0176]

		
346 	347 	348 
349 	350 	351 
352 	353 	354 
355	356	357

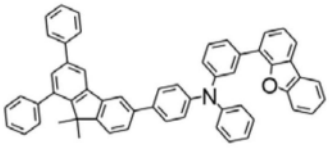
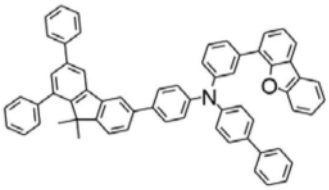
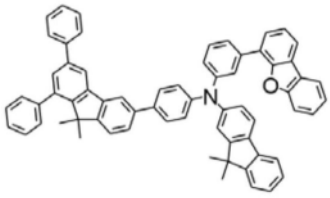
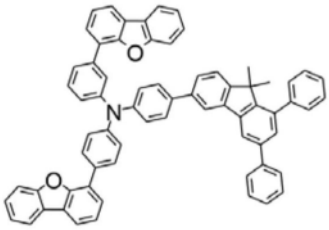
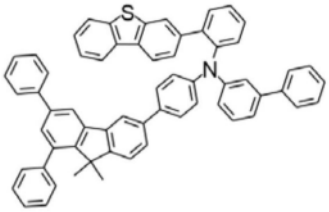
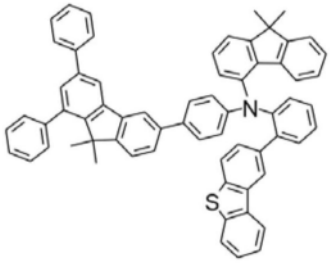
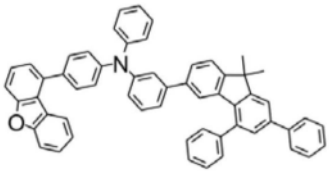
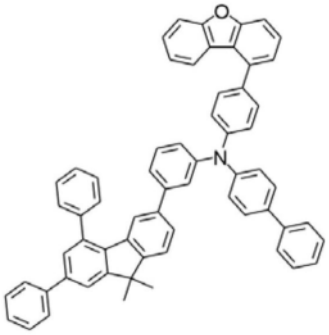
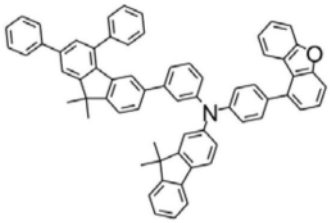
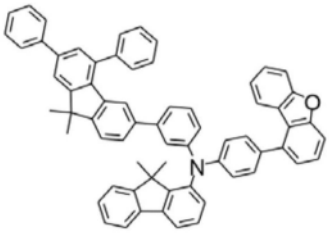
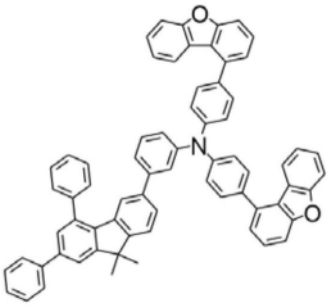
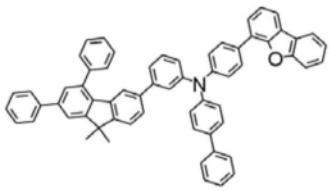
[0177]

		
358 	359 	360 
361 	362 	363 
364 	365 	366 
367	368	369

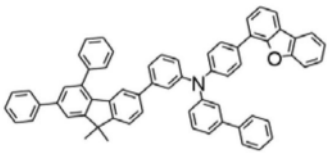
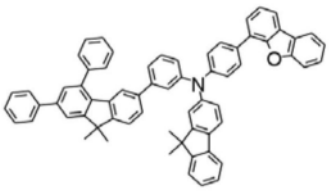
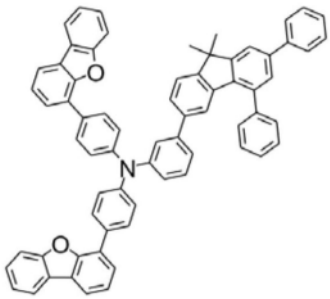
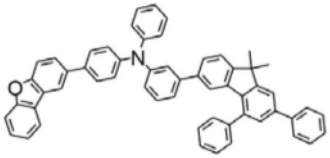
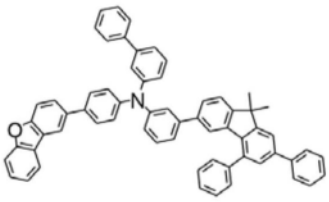
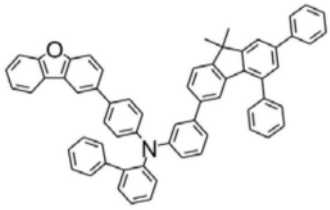
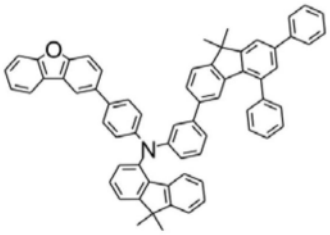
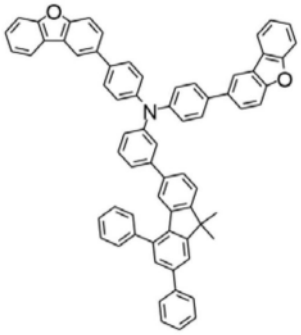
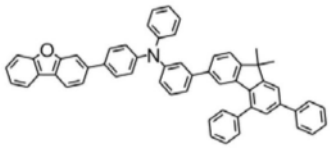
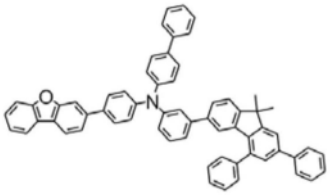
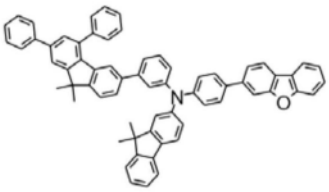
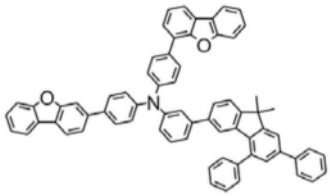
[0178]

		
370 	371 	372 
373 	374 	375 
376 	377 	378 
379	380	381

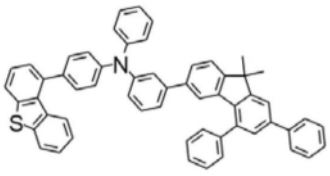
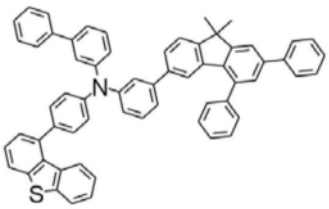
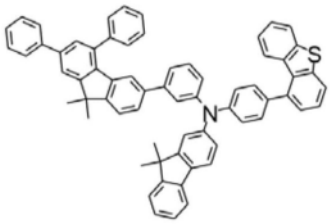
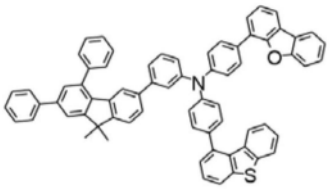
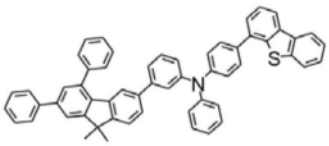
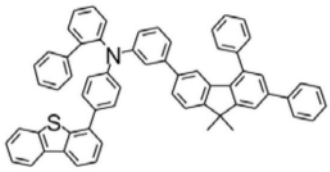
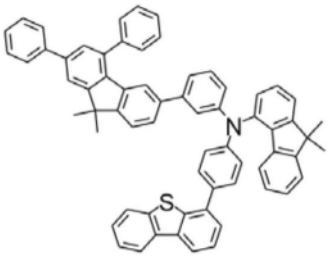
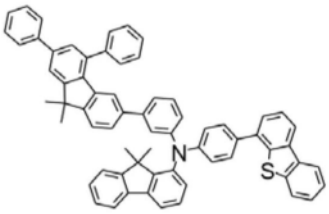
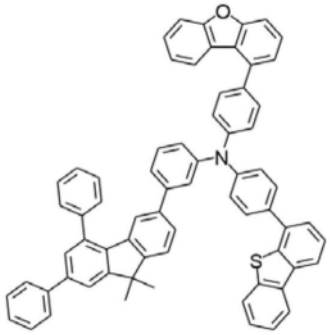
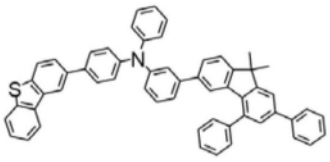
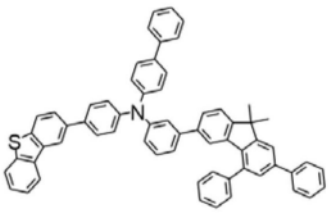
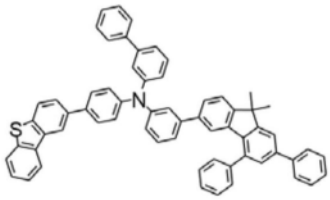
[0179]

		
382 	383 	384 
385 	386 	387 
388 	389 	390 
391	392	393

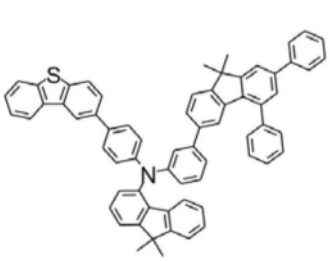
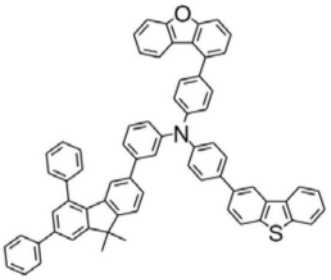
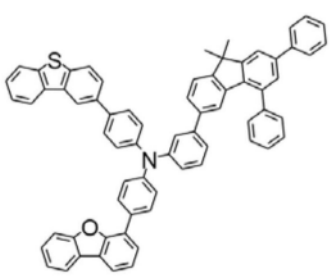
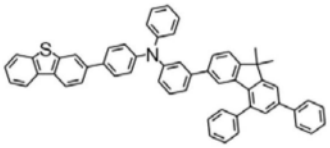
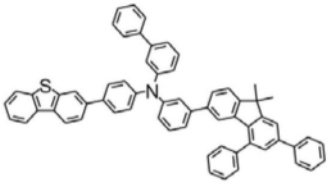
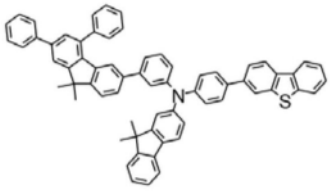
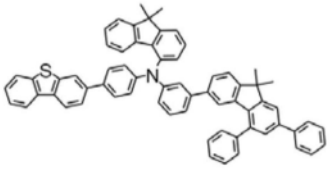
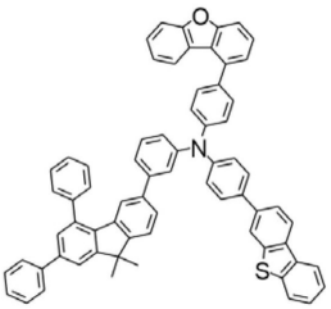
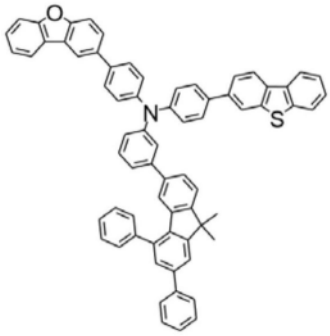
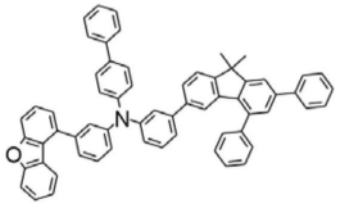
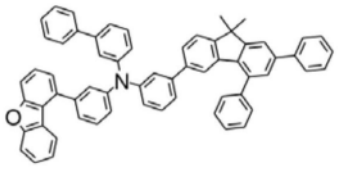
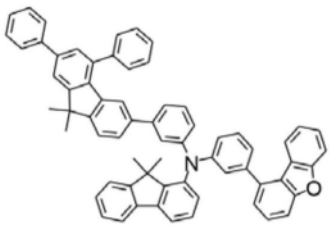
[0180]

		
394 	395 	396 
397 	398 	399 
400 	401 	402 
403	404	405

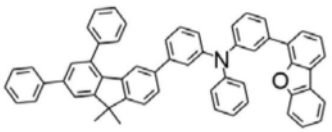
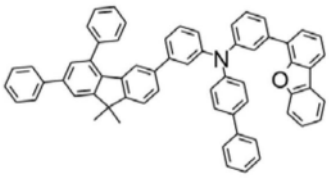
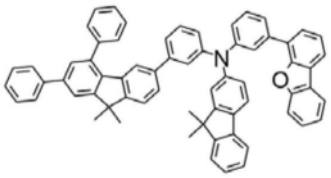
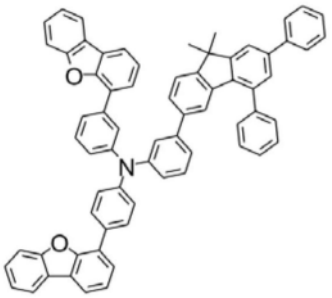
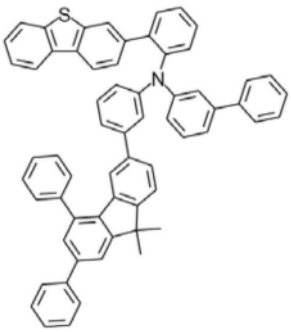
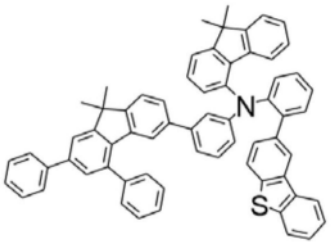
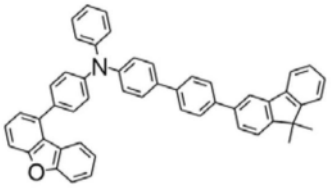
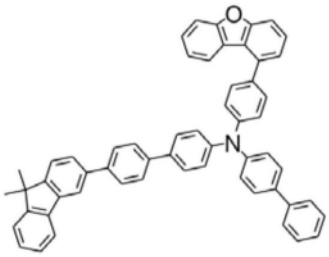
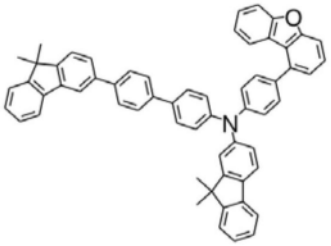
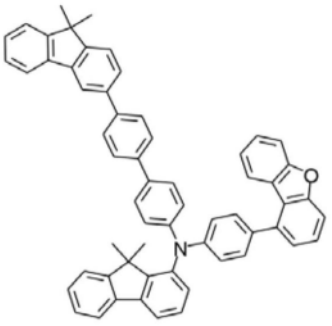
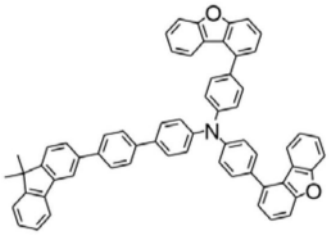
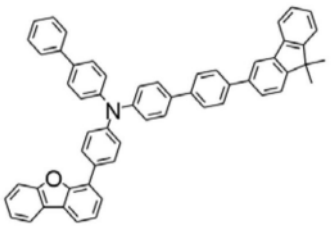
[0181]

		
406 	407 	408 
409 	410 	411 
412 	413 	414 
415	416	417

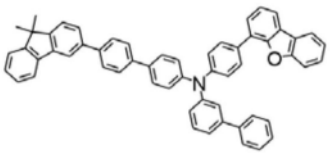
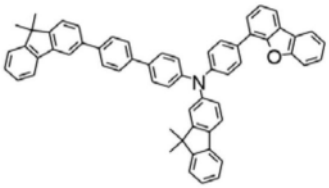
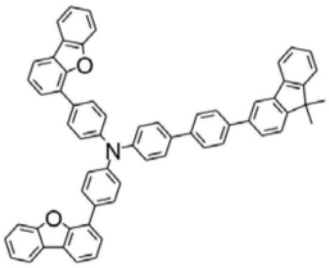
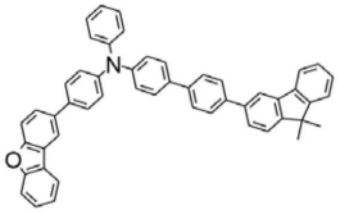
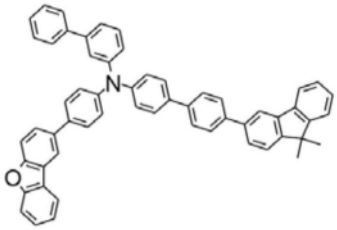
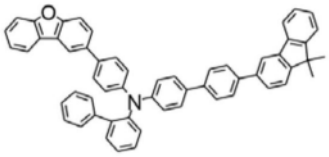
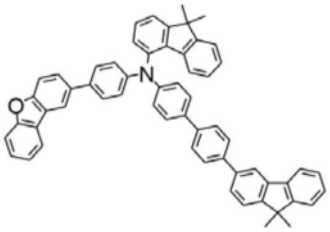
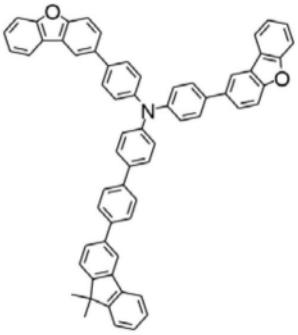
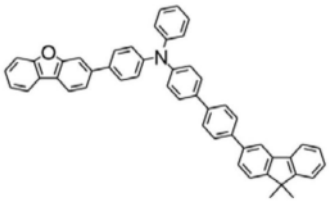
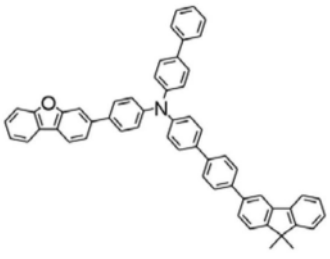
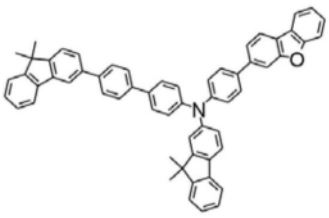
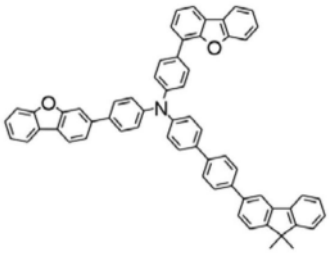
[0182]

		
418 	419 	420 
421 	422 	423 
424 	425 	426 
427	428	429

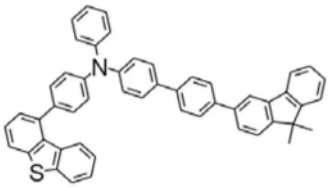
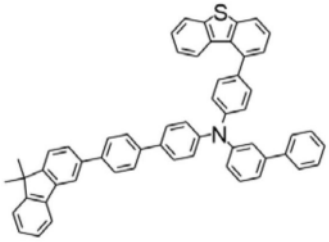
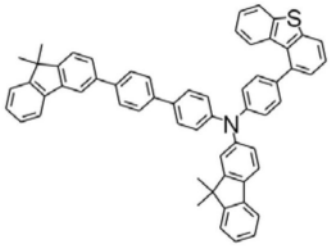
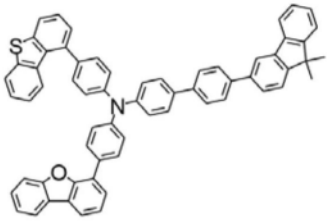
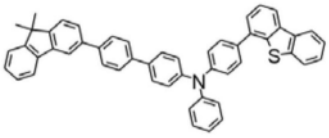
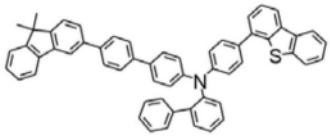
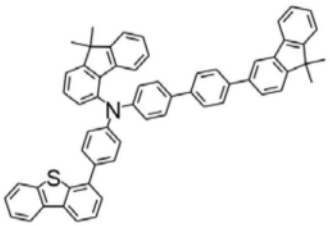
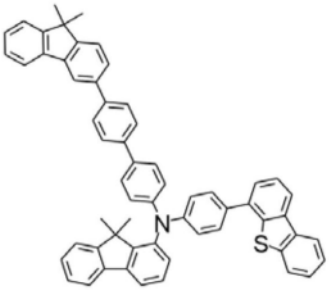
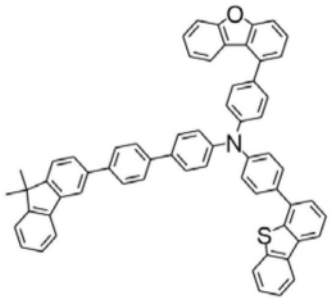
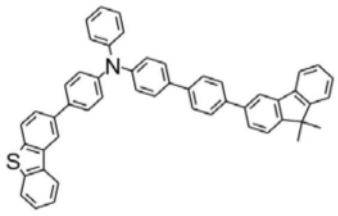
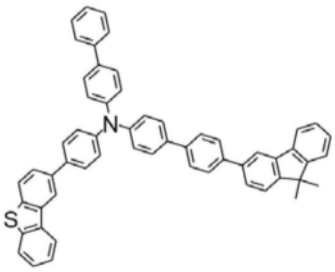
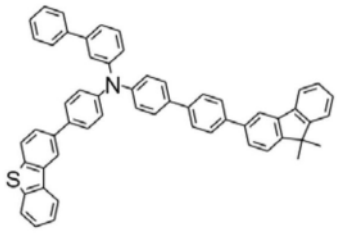
[0183]

		
430 	431 	432 
433 	434 	435 
436 	437 	438 
439	440	441

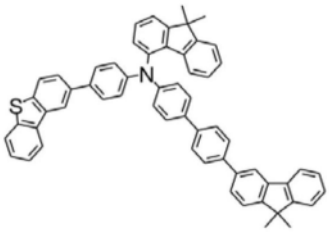
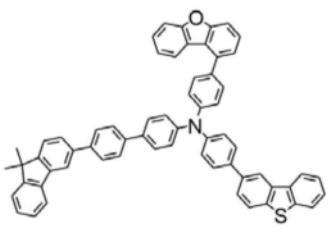
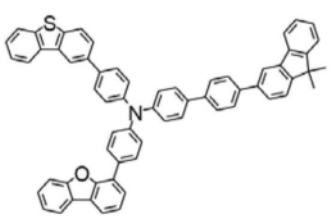
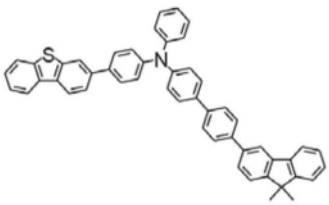
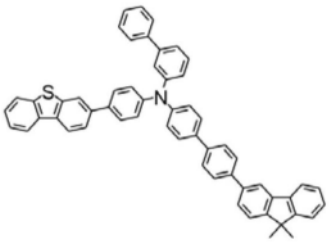
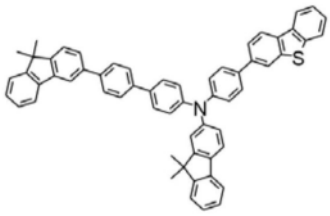
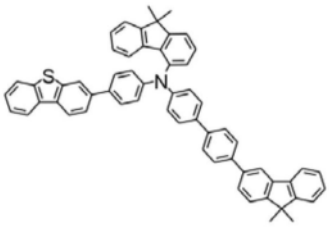
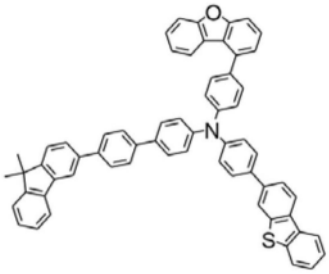
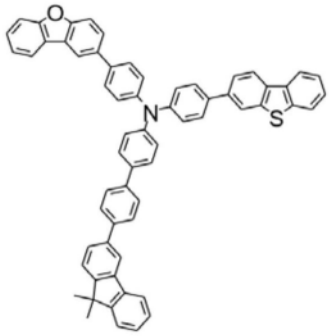
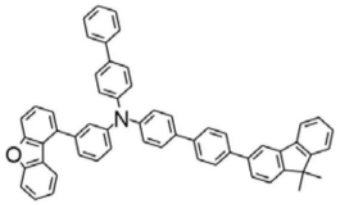
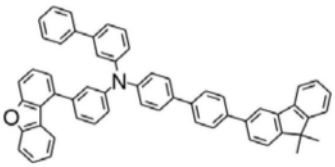
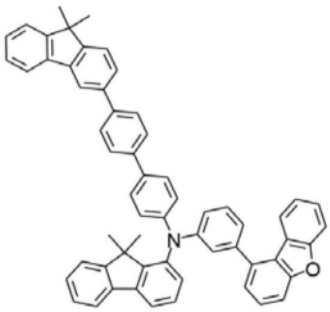
[0184]

		
442 	443 	444 
445 	446 	447 
448 	449 	450 
451	452	453

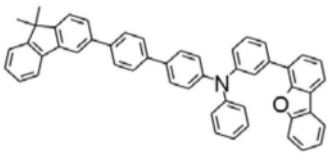
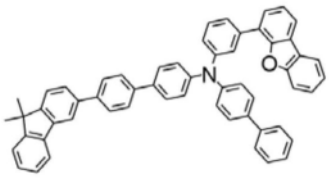
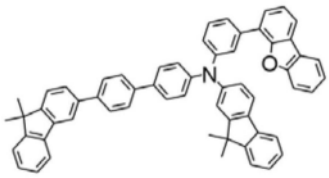
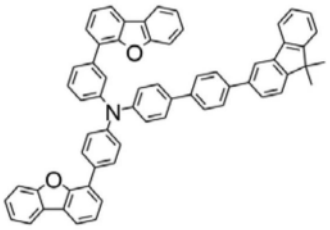
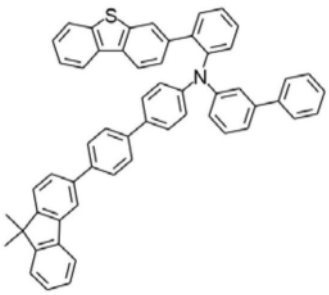
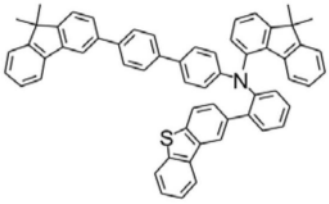
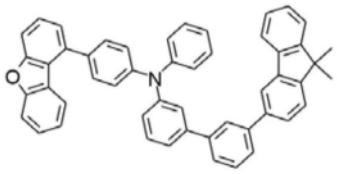
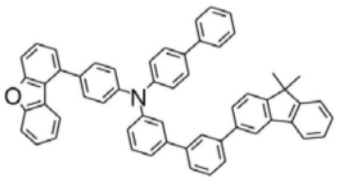
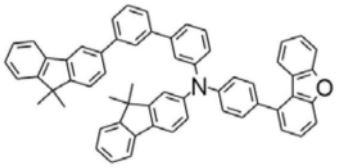
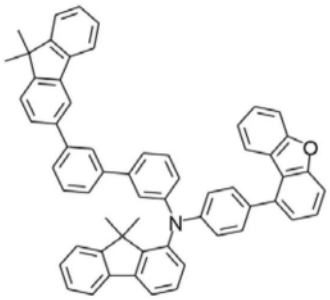
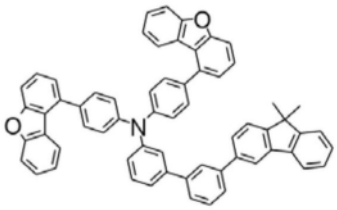
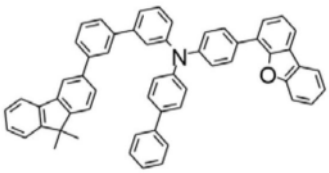
[0185]

		
454 	455 	456 
457 	458 	459 
460 	461 	462 
463	464	465

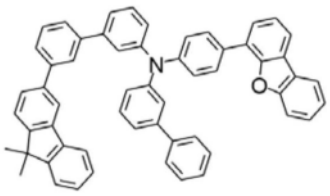
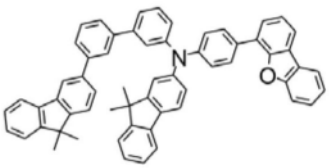
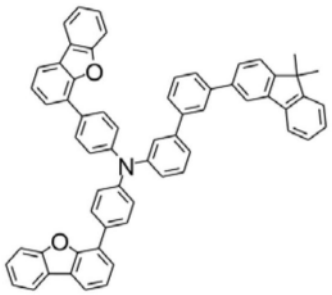
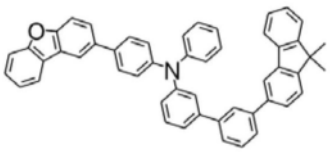
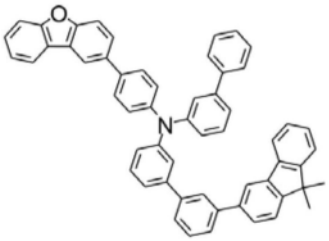
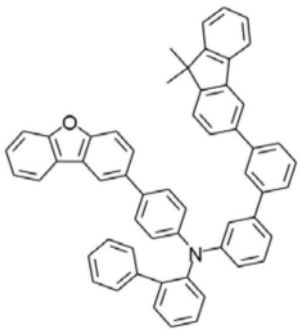
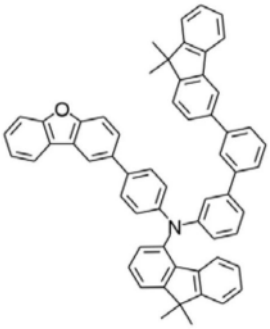
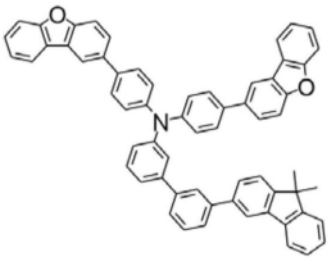
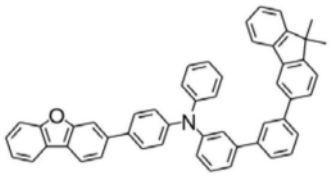
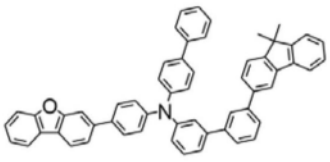
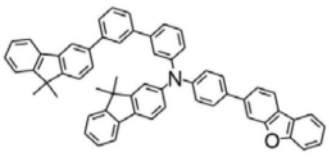
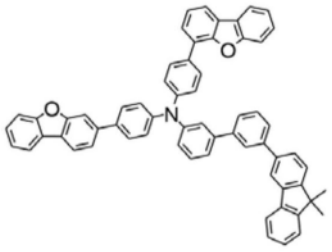
[0186]

		
466 	467 	468 
469 	470 	471 
472 	473 	474 
475	476	477

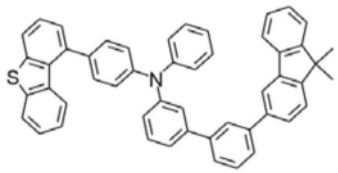
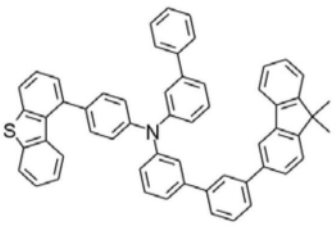
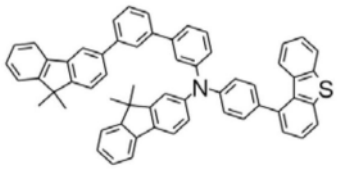
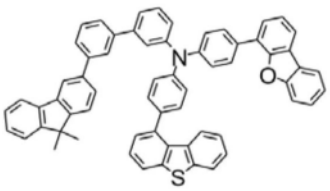
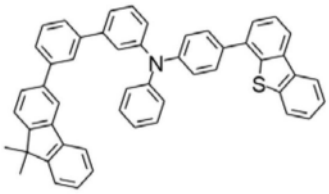
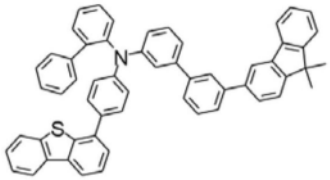
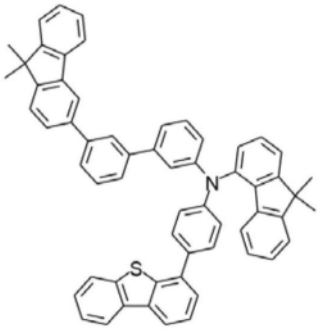
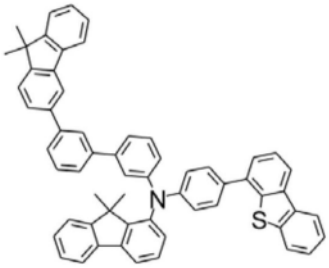
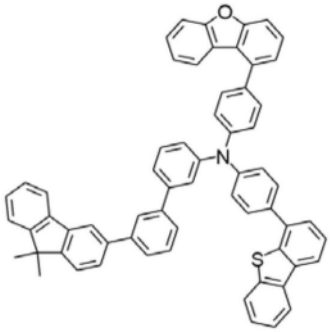
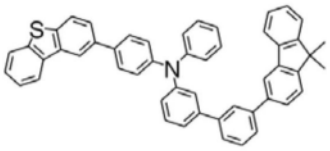
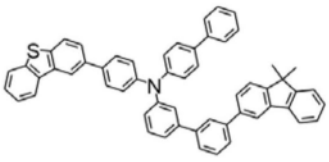
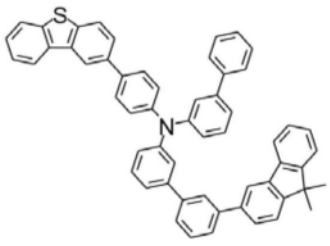
[0187]

		
478 	479 	480 
481 	482 	483 
484 	485 	486 
487	488	489

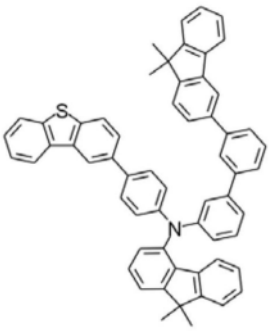
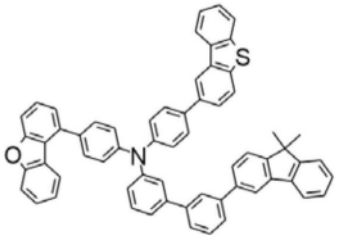
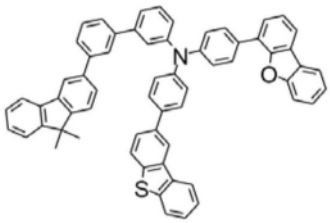
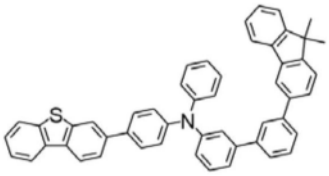
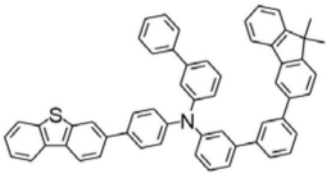
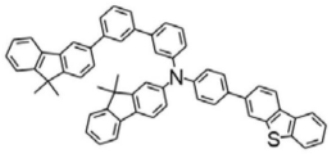
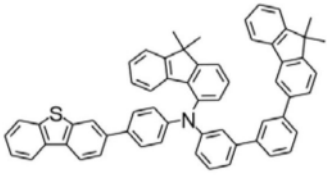
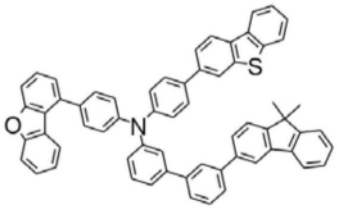
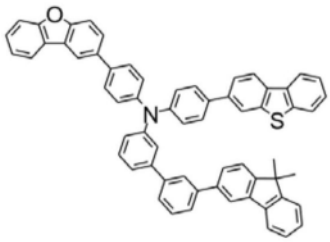
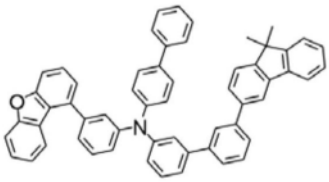
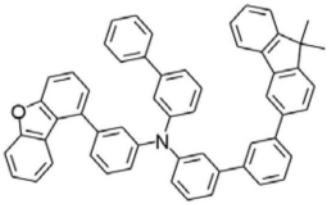
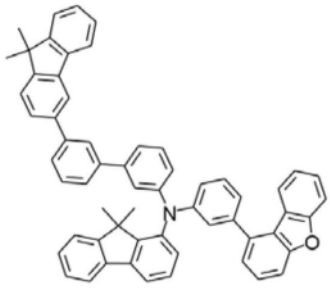
[0188]

		
490 	491 	492 
493 	494 	495 
496 	497 	498 
499	500	501

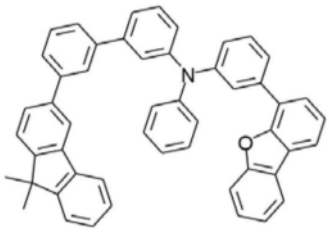
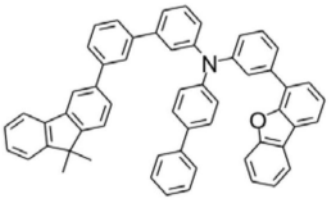
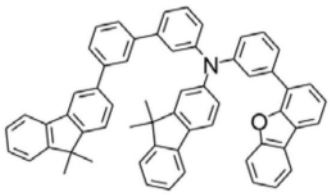
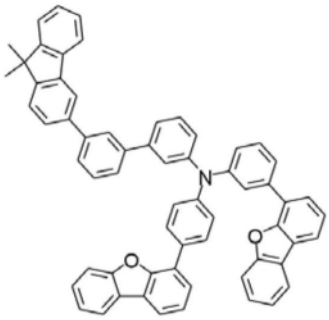
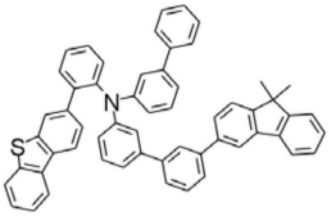
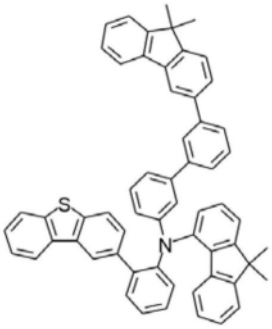
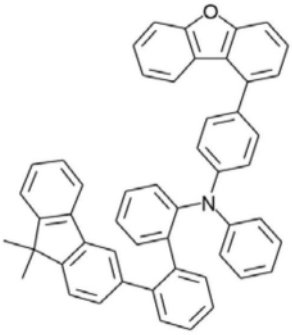
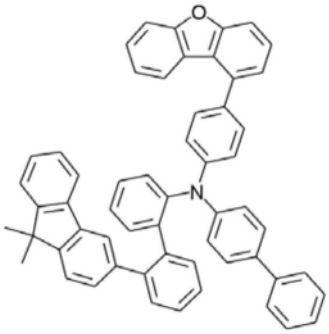
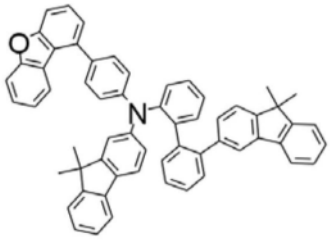
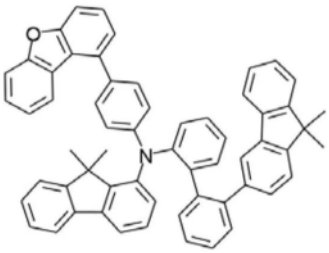
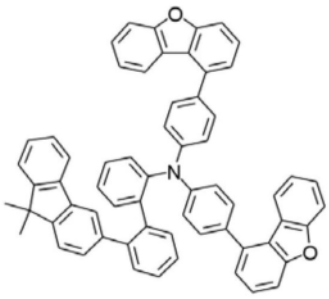
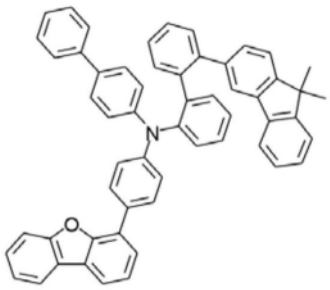
[0189]

		
502 	503 	504 
505 	506 	507 
508 	509 	510 
511	512	513

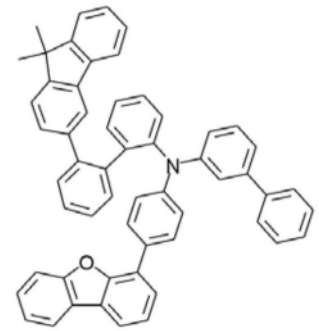
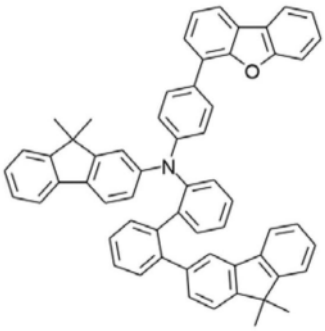
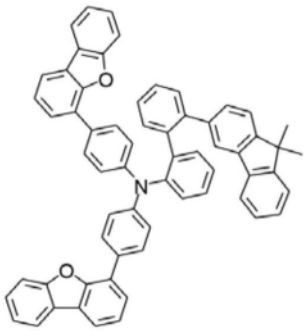
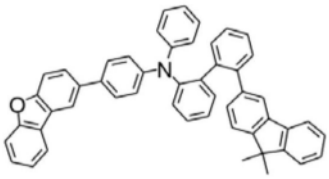
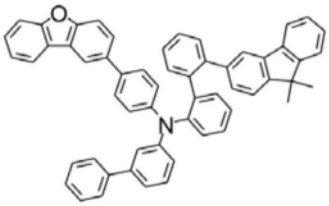
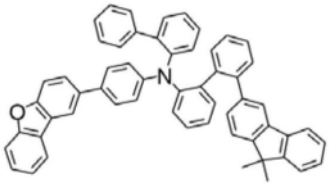
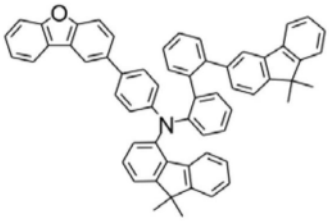
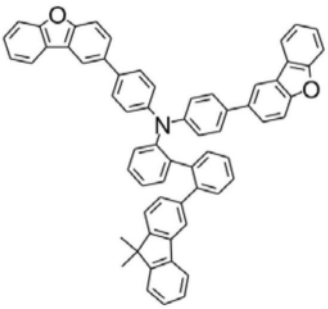
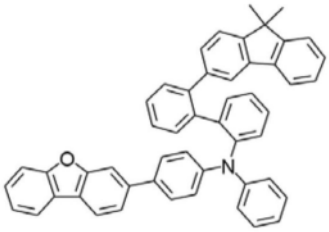
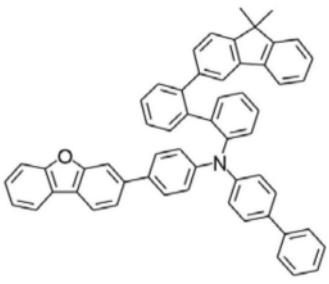
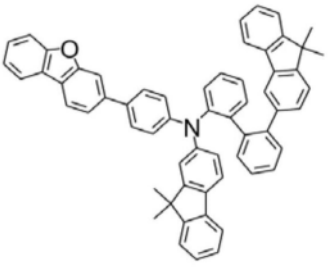
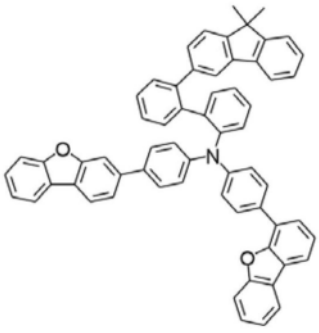
[0190]

		
514 	515 	516 
517 	518 	519 
520 	521 	522 
523	524	525

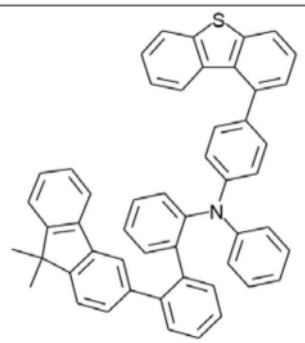
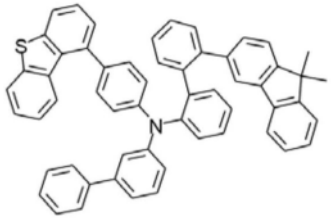
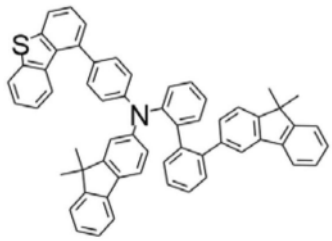
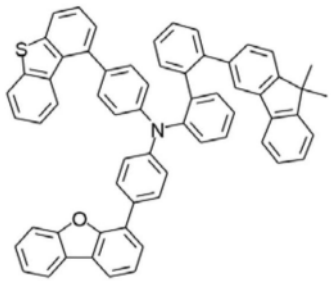
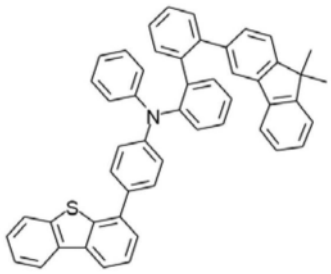
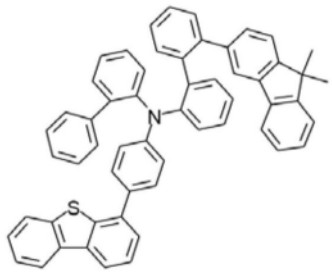
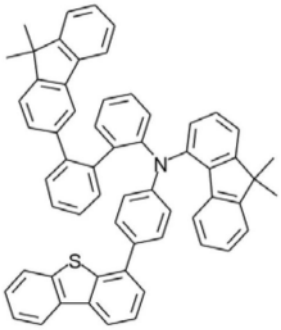
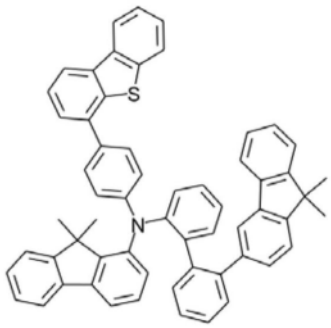
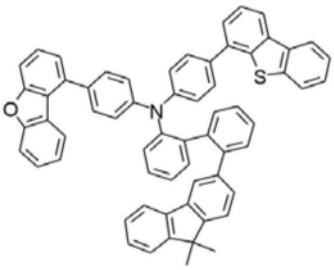
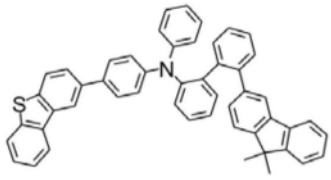
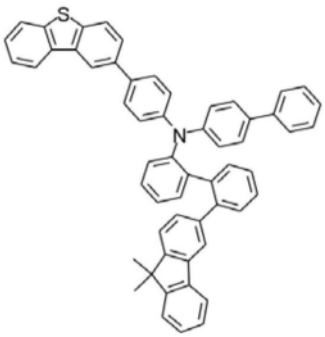
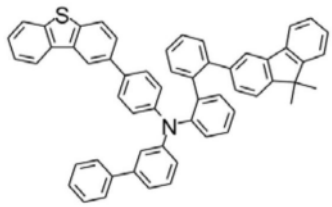
[0191]

		
526 	527 	528 
529 	530 	531 
532 	533 	534 
535	536	537

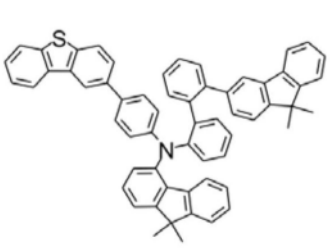
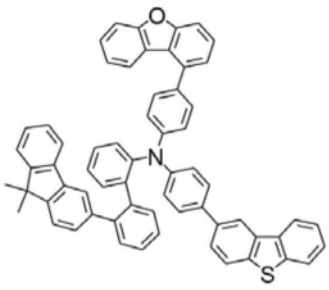
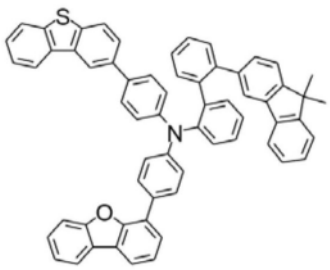
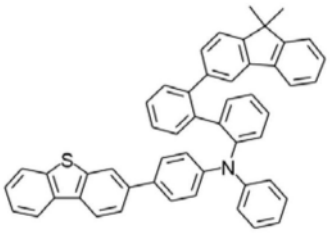
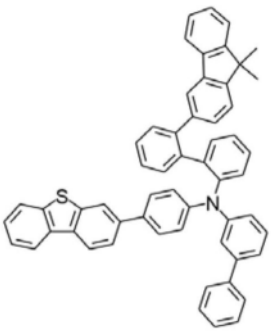
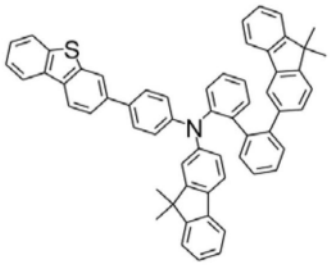
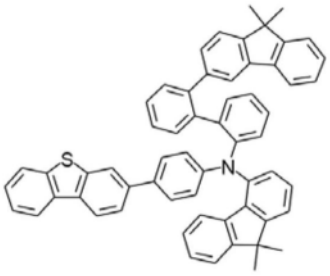
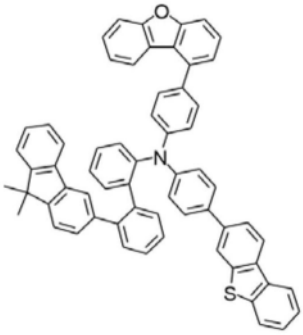
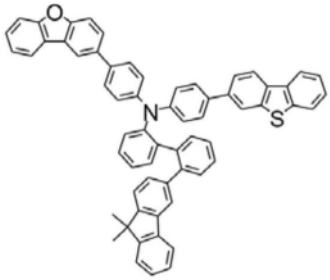
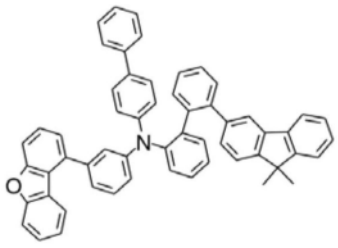
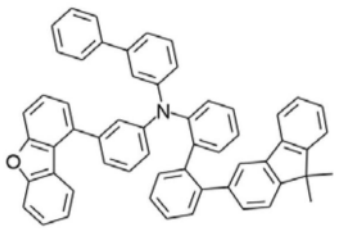
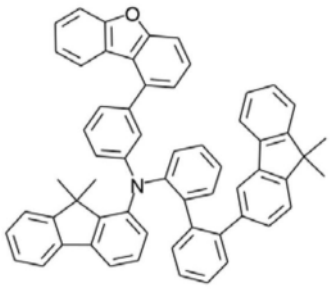
[0192]

		
538 	539 	540 
541 	542 	543 
544 	545 	546 
547	548	549

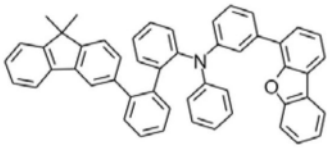
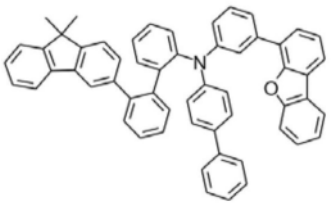
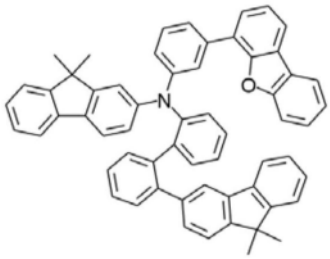
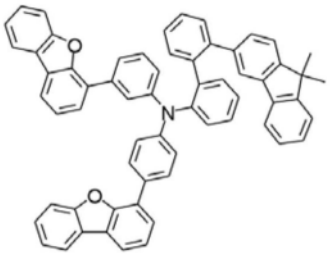
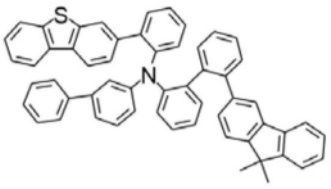
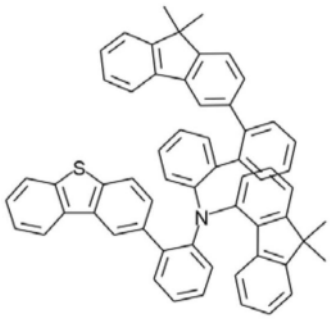
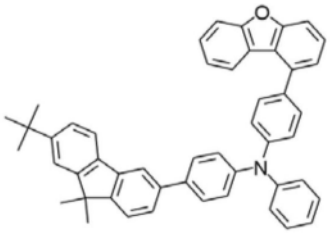
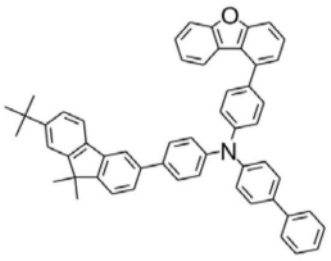
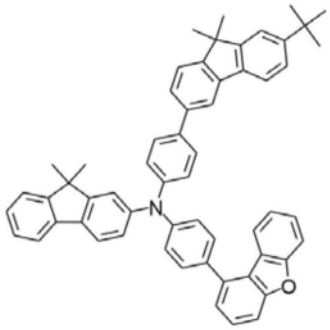
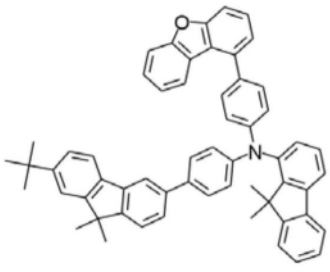
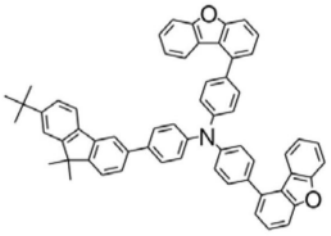
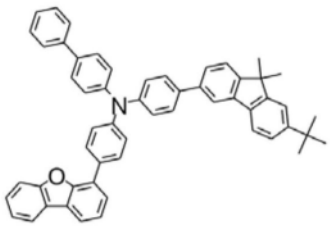
[0193]

		
550 	551 	552 
553 	554 	555 
556 	557 	558 
559	560	561

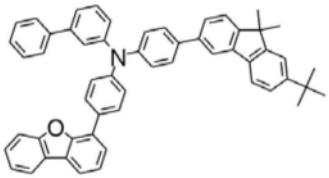
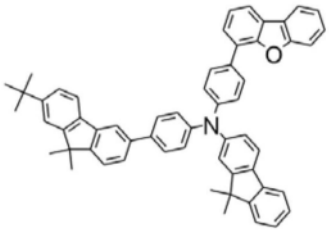
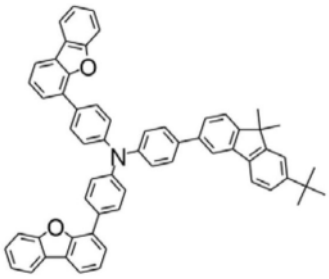
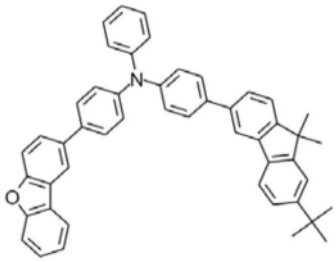
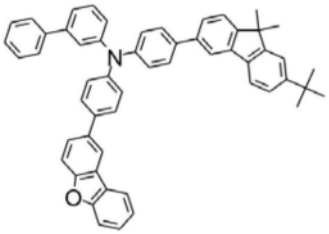
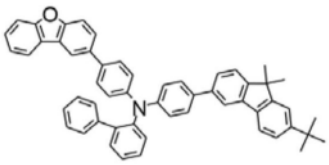
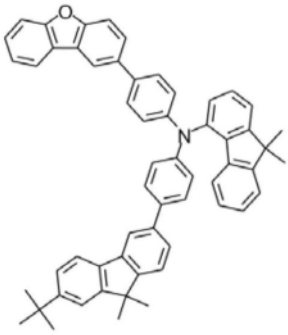
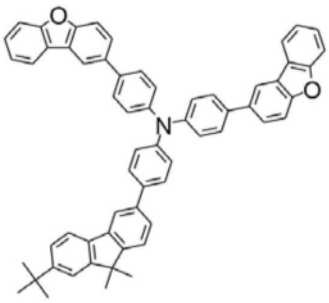
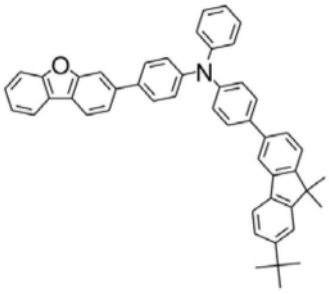
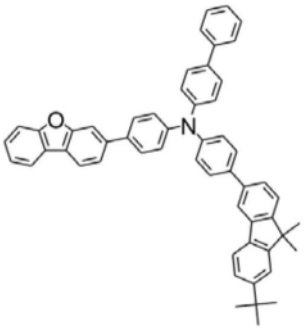
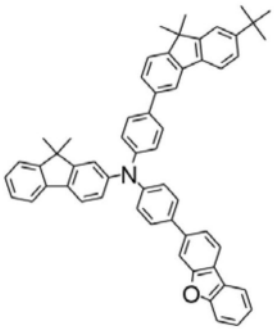
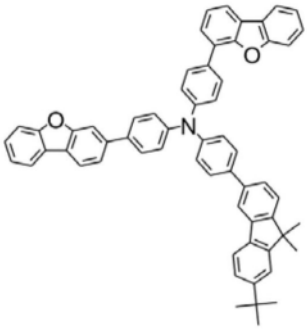
[0194]

		
562 	563 	564 
565 	566 	567 
568 	569 	570 
571	572	573

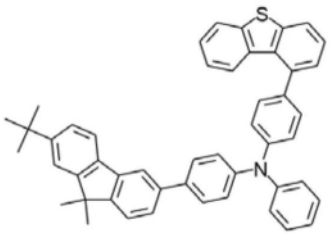
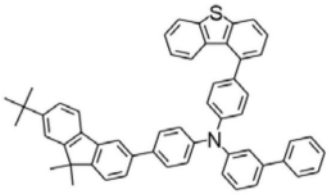
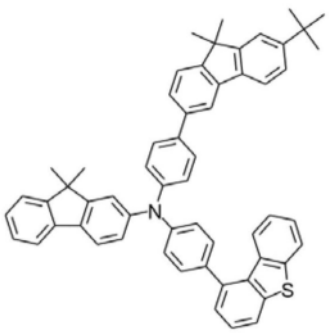
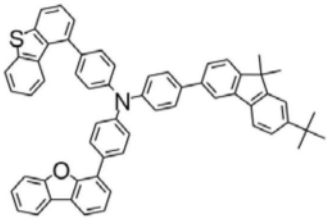
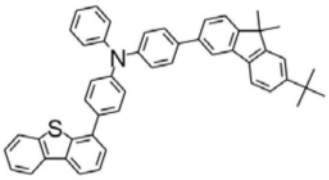
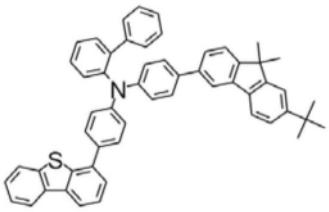
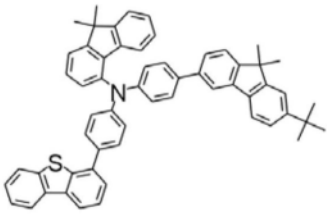
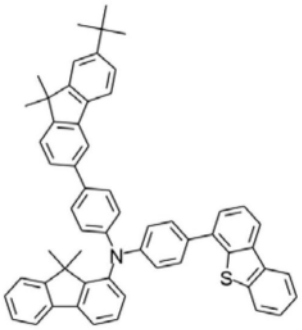
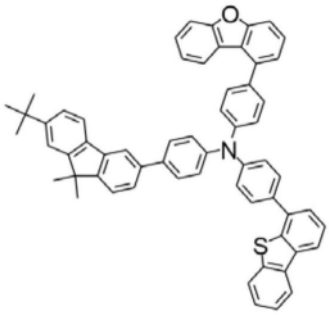
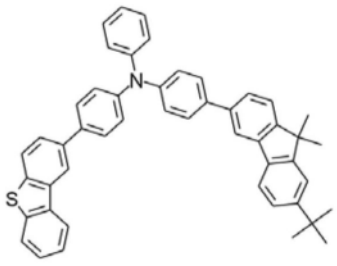
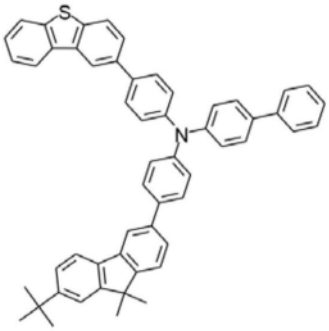
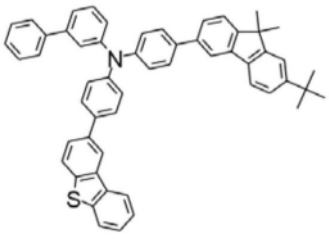
[0195]

		
574 	575 	576 
577 	578 	579 
580 	581 	582 
583	584	585

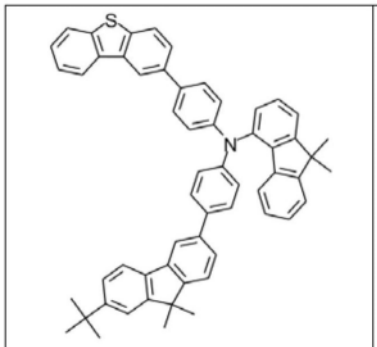
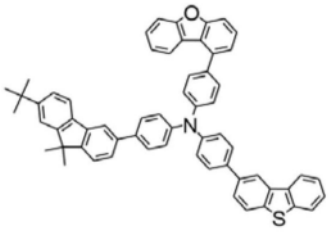
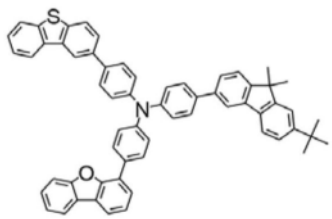
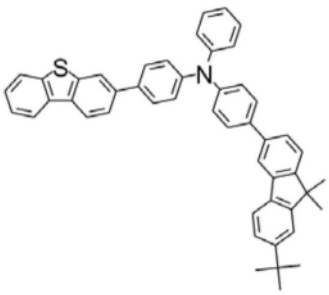
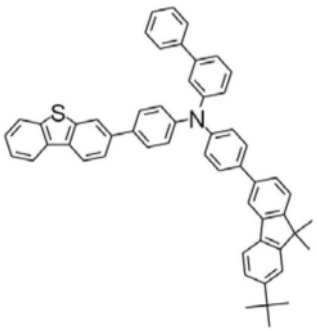
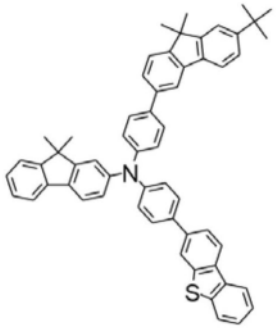
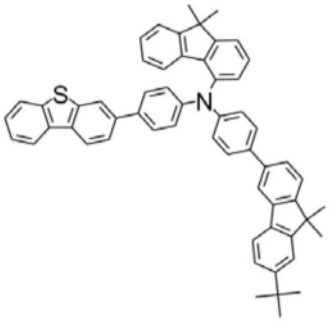
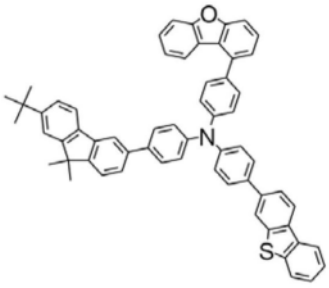
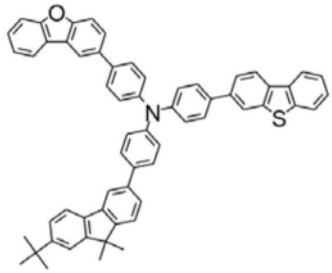
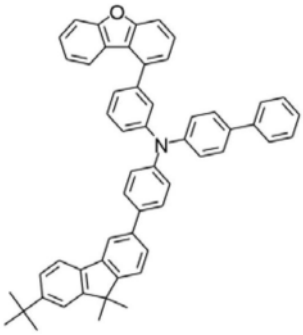
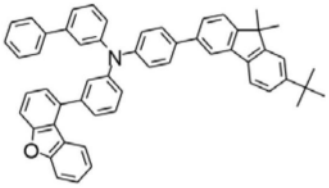
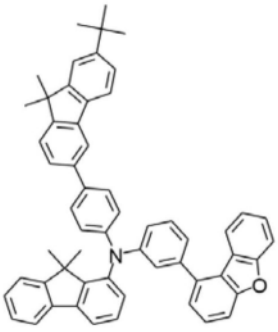
[0196]

		
586 	587 	588 
589 	590 	591 
592 	593 	594 
595	596	597

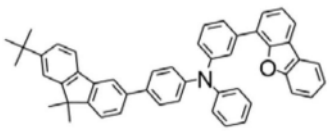
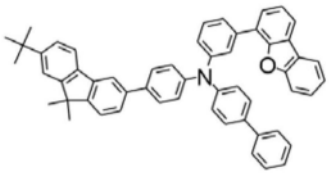
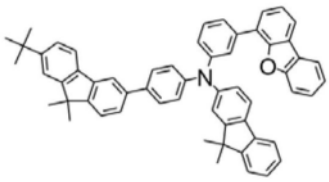
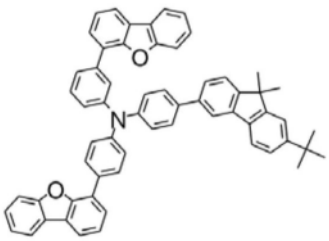
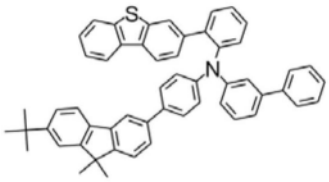
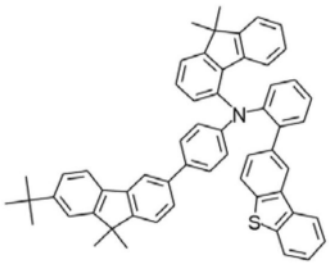
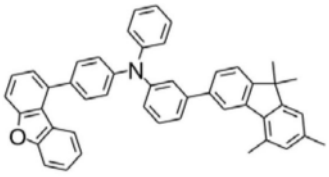
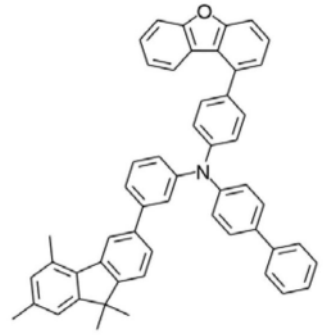
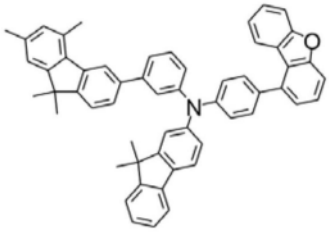
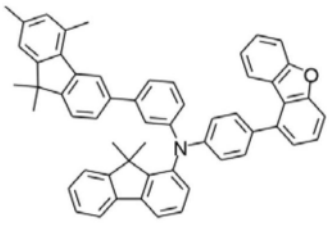
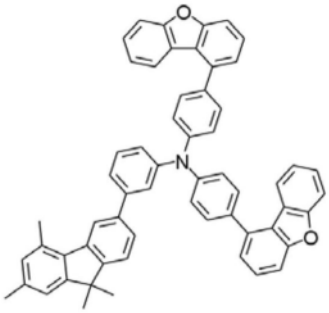
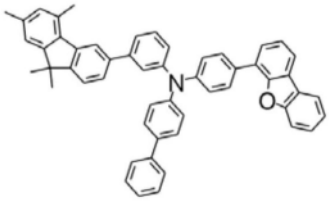
[0197]

		
598 	599 	600 
601 	602 	603 
604 	605 	606 
607	608	609

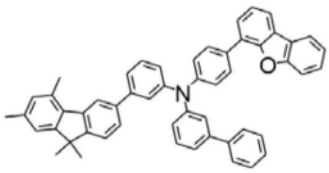
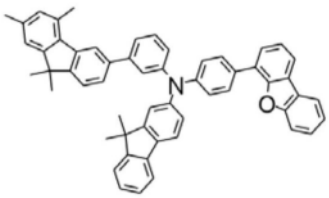
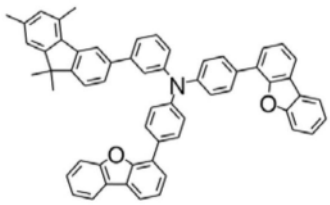
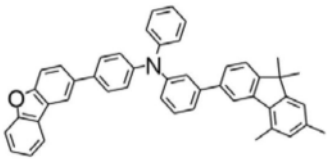
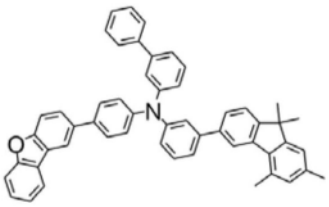
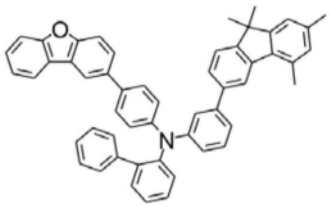
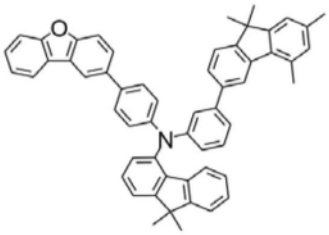
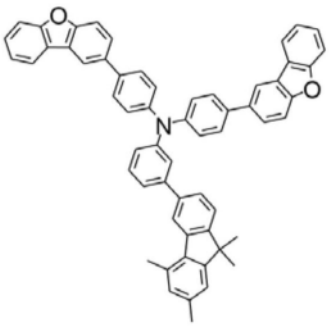
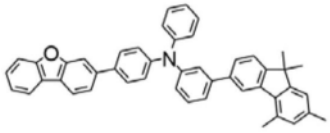
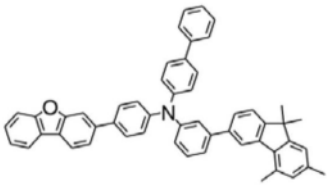
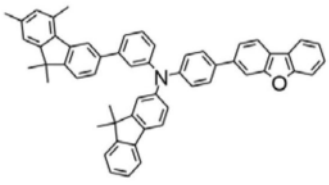
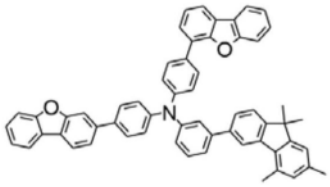
[0198]

		
610 	611 	612 
613 	614 	615 
616 	617 	618 
619	620	621

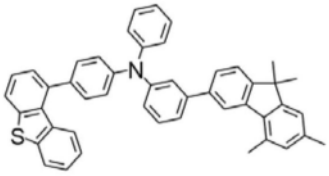
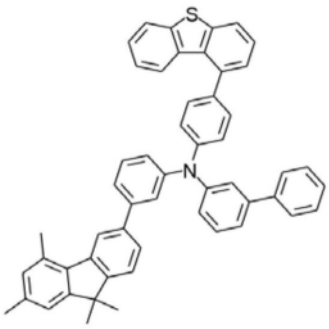
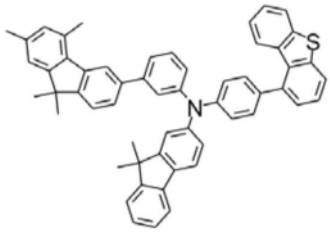
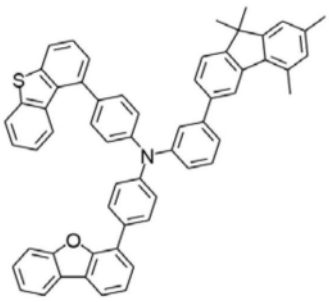
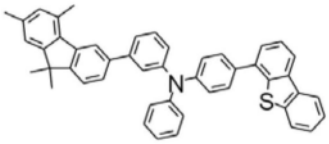
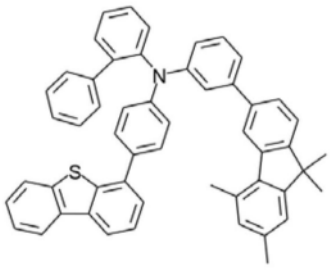
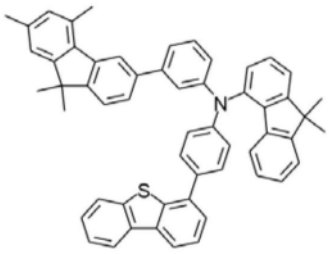
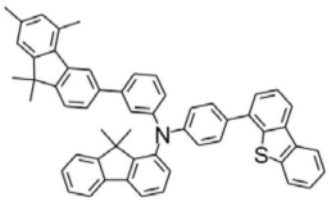
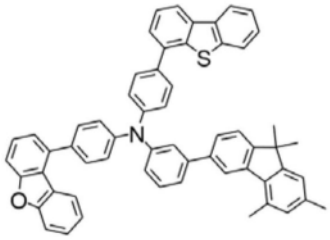
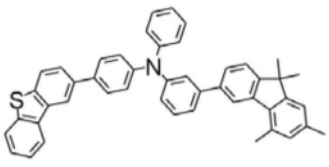
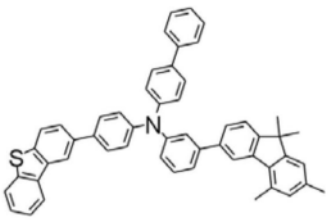
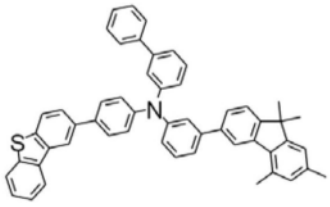
[0199]

		
622 	623 	624 
625 	626 	627 
628 	629 	630 
631	632	633

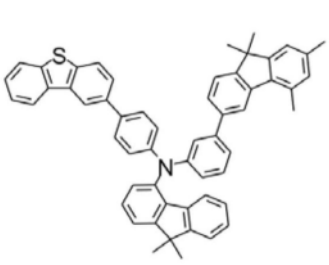
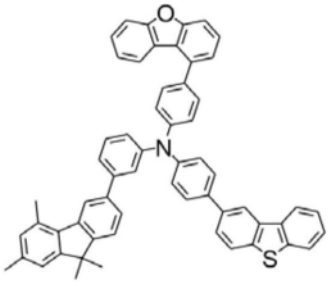
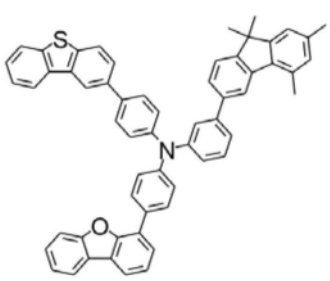
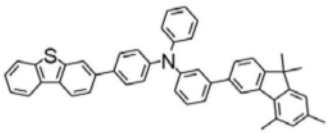
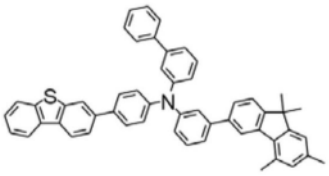
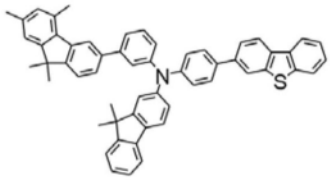
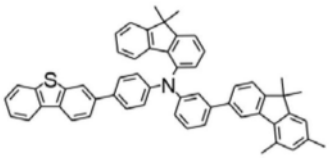
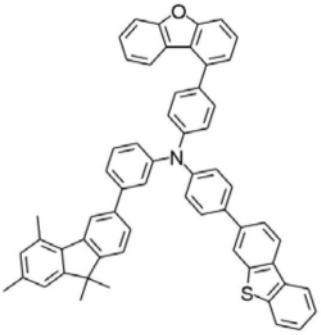
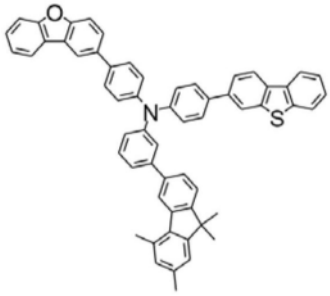
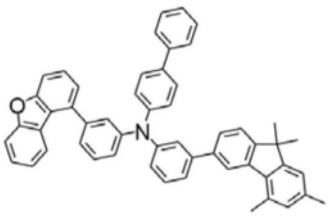
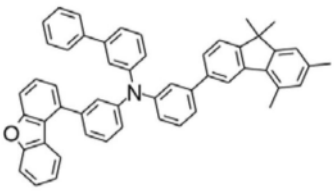
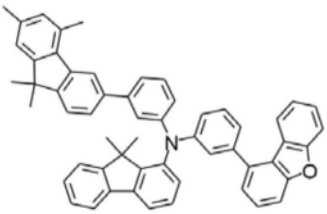
[0200]

		
634 	635 	636 
637 	638 	639 
640 	641 	642 
643	644	645

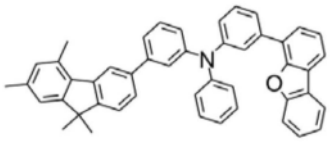
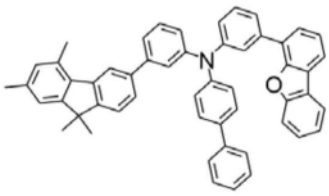
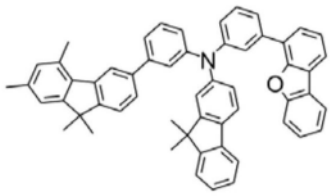
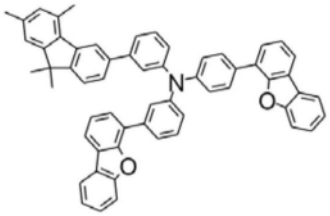
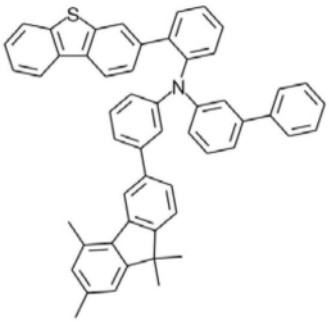
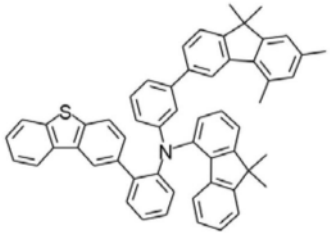
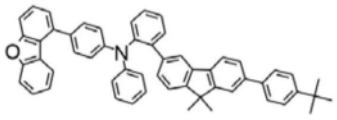
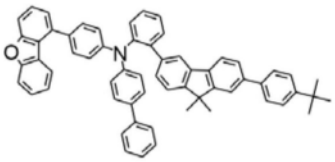
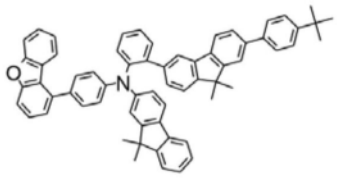
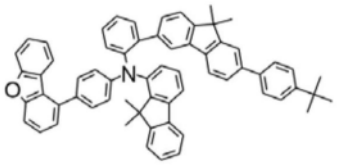
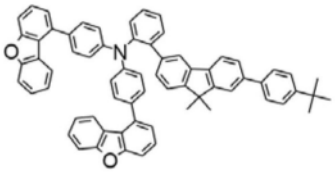
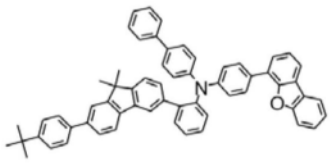
[0201]

		
646 	647 	648 
649 	650 	651 
652 	653 	654 
655	656	657

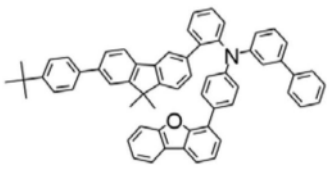
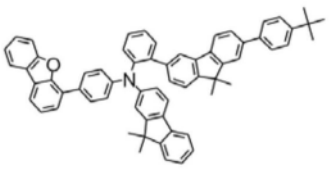
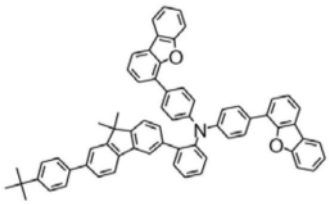
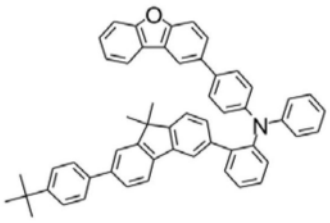
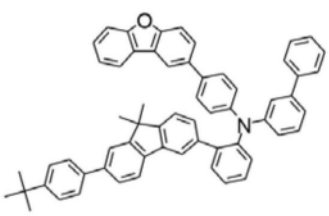
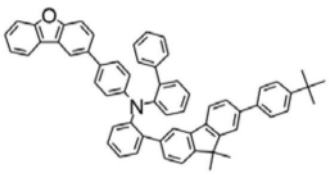
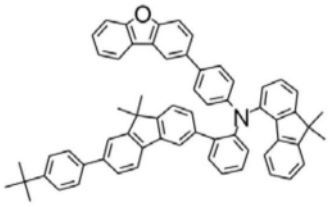
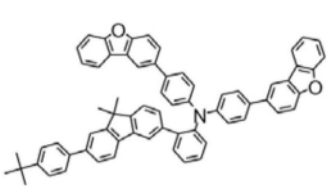
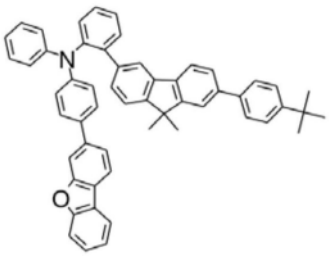
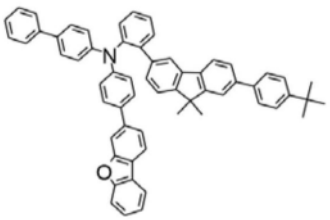
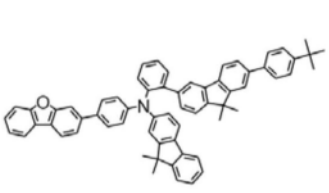
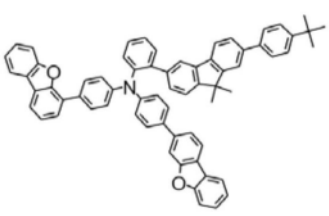
[0202]

		
658 	659 	660 
661 	662 	663 
664 	665 	666 
667	668	669

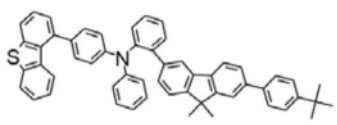
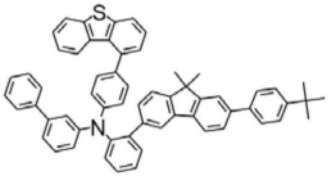
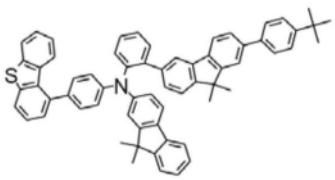
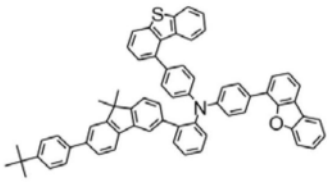
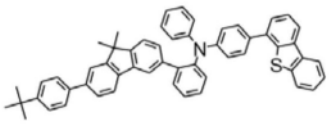
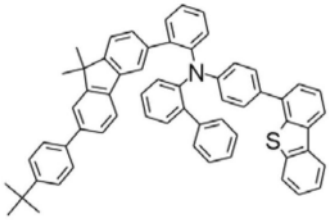
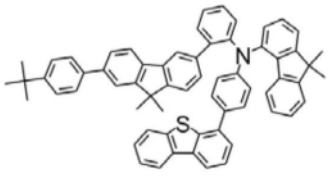
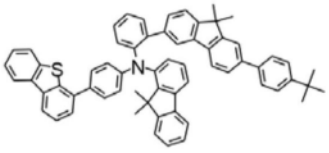
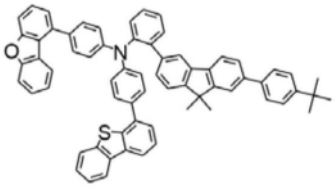
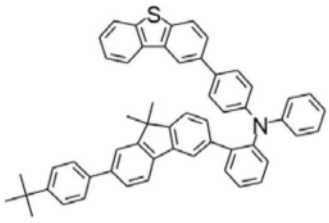
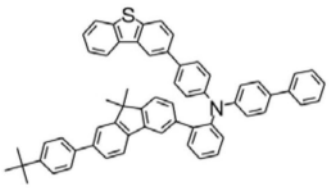
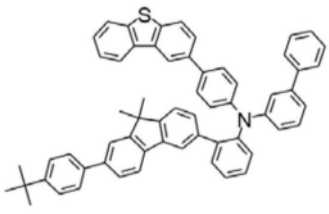
[0203]

		
670 	671 	672 
673 	674 	675 
676 	677 	678 
679	680	681

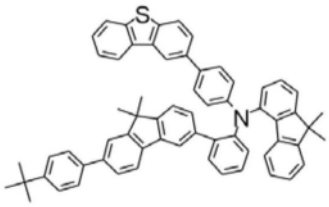
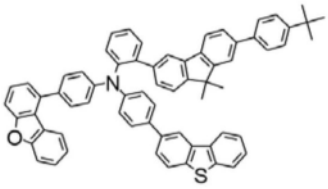
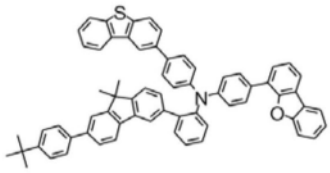
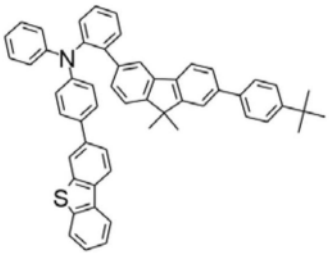
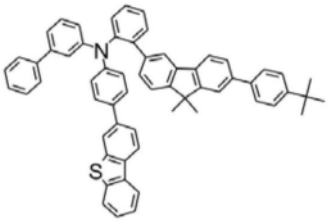
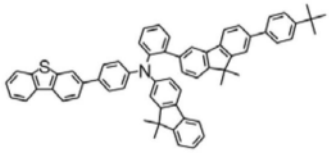
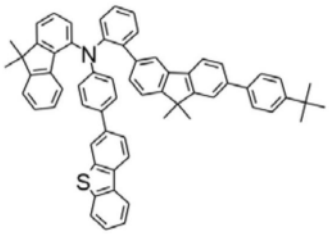
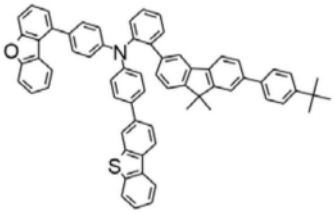
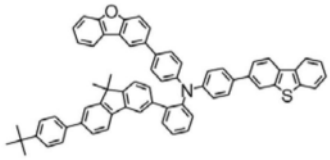
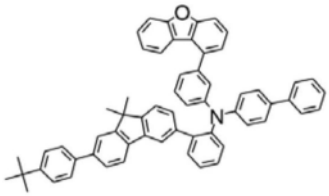
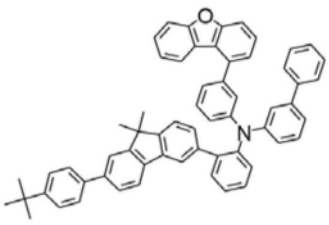
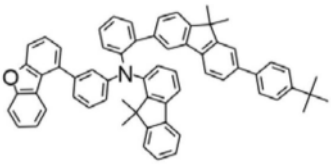
[0204]

		
682 	683 	684 
685 	686 	687 
688 	689 	690 
691	692	693

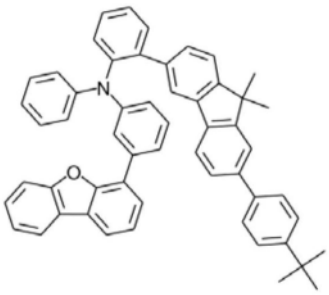
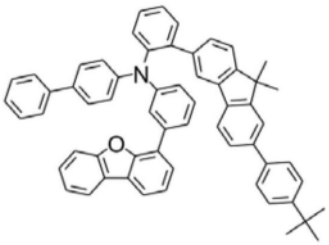
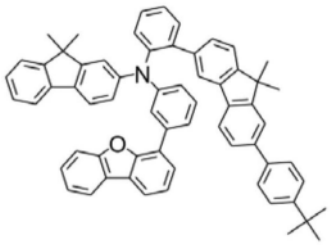
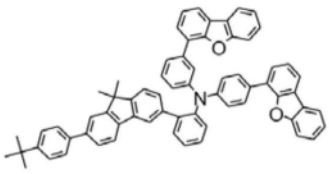
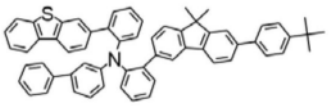
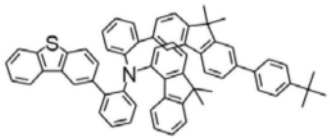
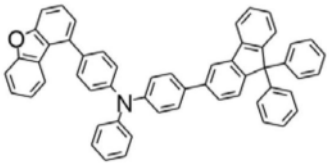
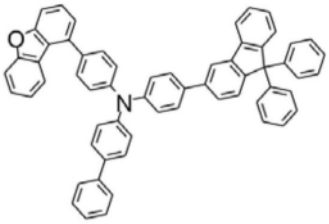
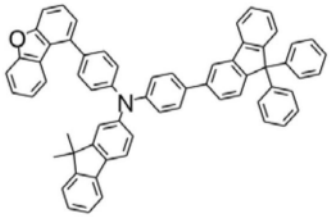
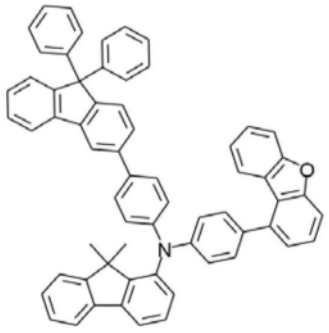
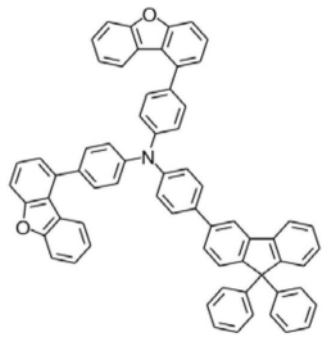
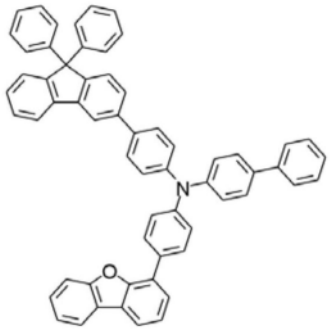
[0205]

		
694 	695 	696 
697 	698 	699 
700 	701 	702 
703	704	705

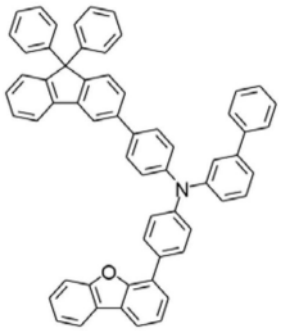
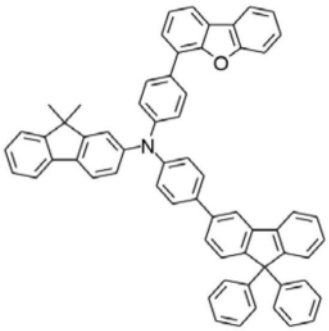
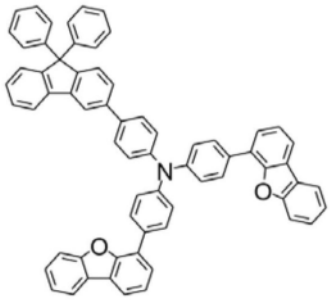
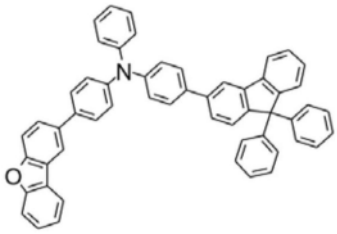
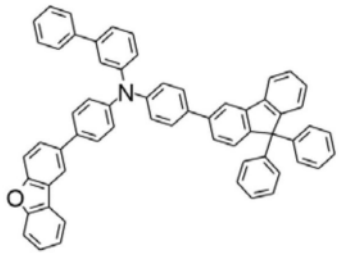
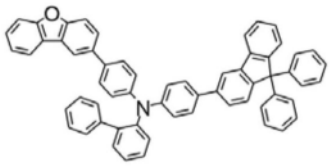
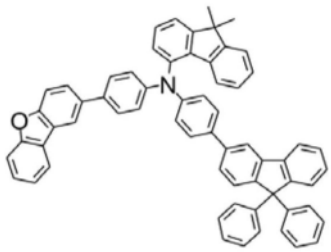
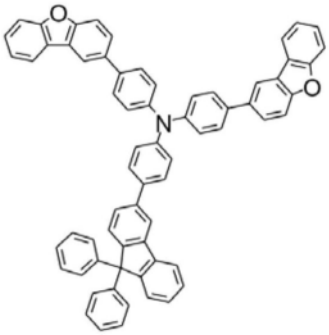
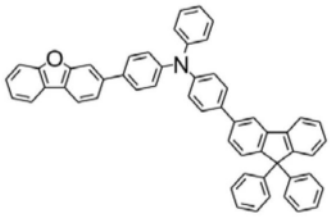
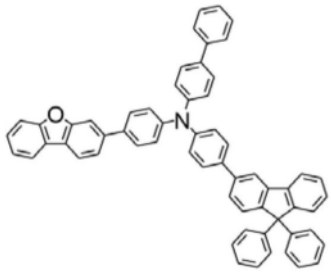
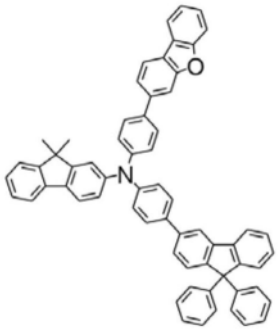
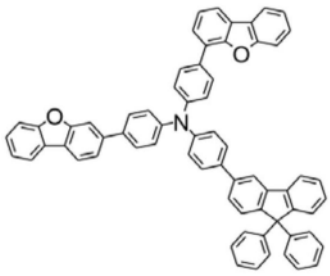
[0206]

		
706 	707 	708 
709 	710 	711 
712 	713 	714 
715	716	717

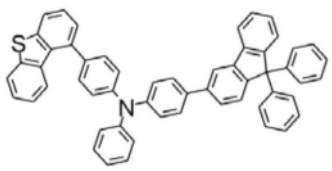
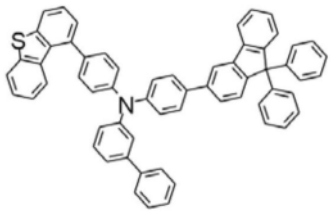
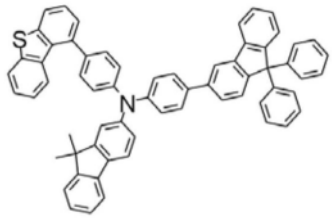
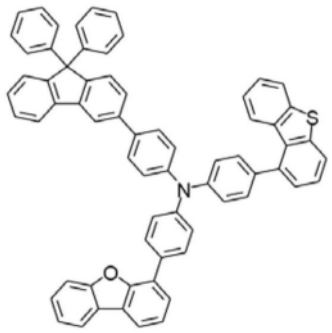
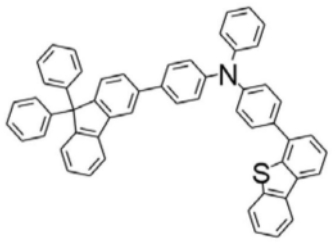
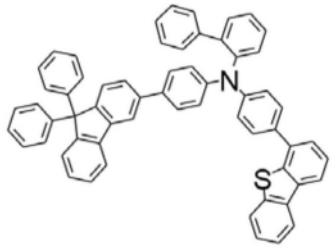
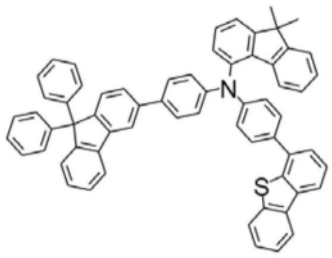
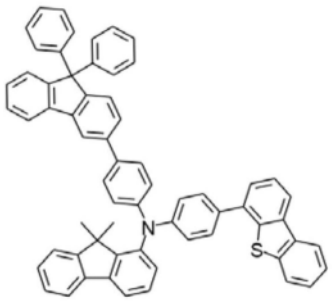
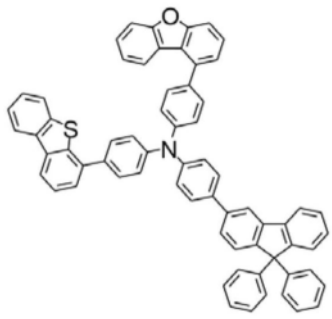
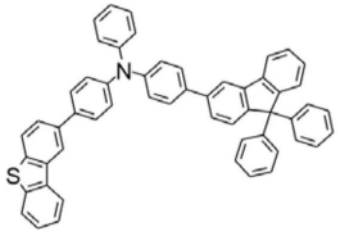
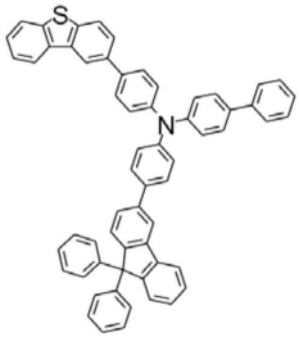
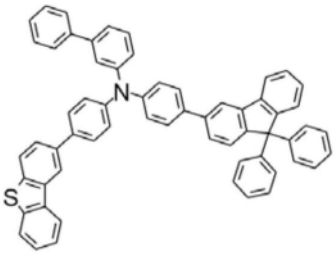
[0207]

		
718 	719 	720 
721 	722 	723 
724 	725 	726 
727	728	729

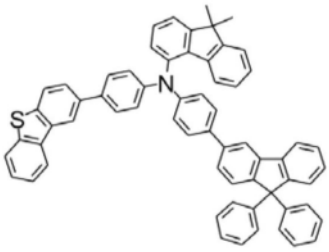
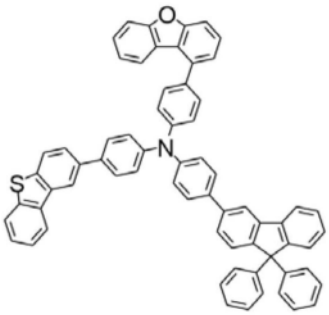
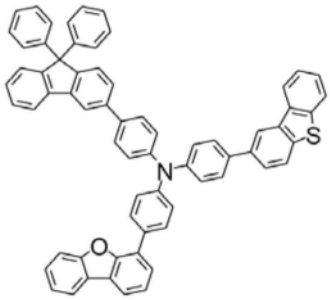
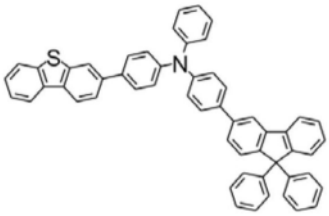
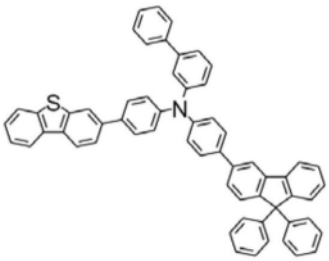
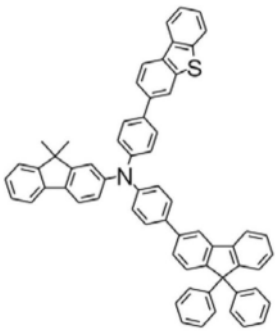
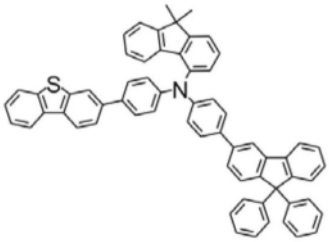
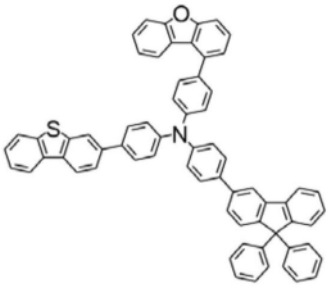
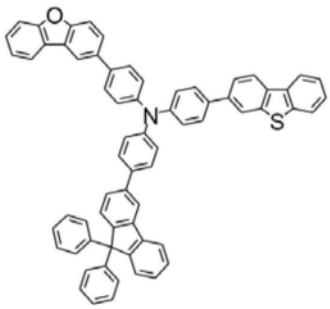
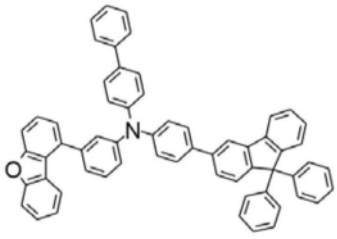
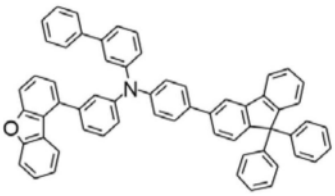
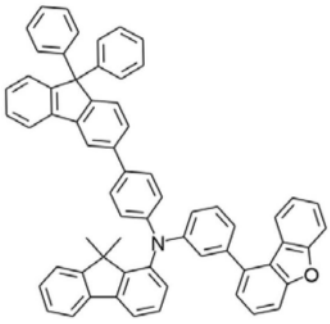
[0208]

		
730 	731 	732 
733 	734 	735 
736 	737 	738 
739	740	741

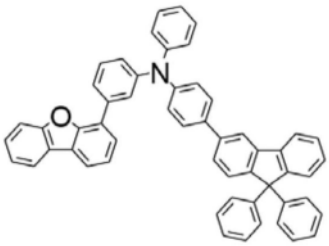
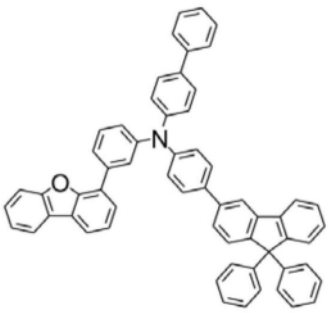
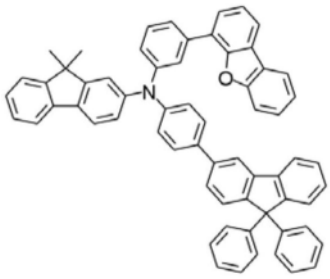
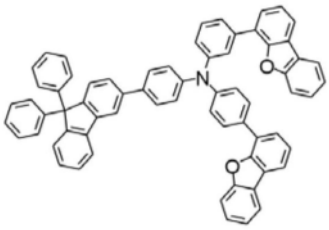
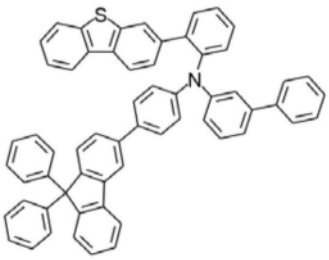
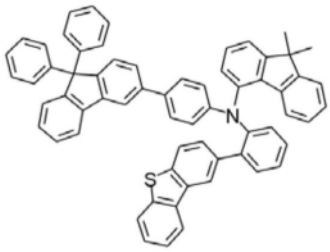
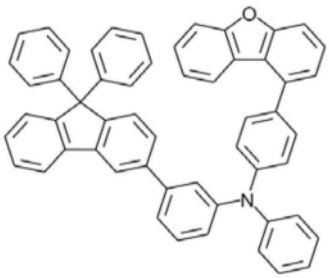
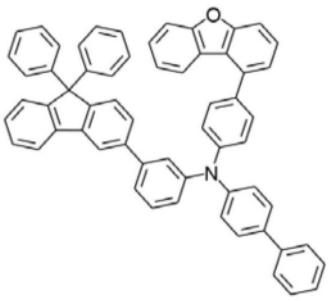
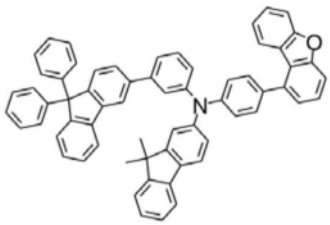
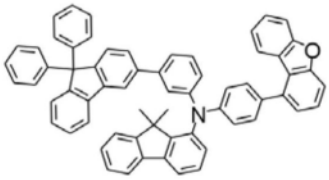
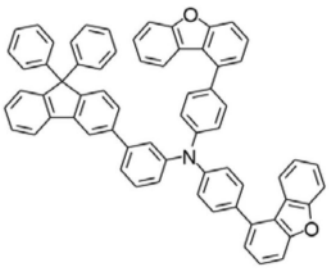
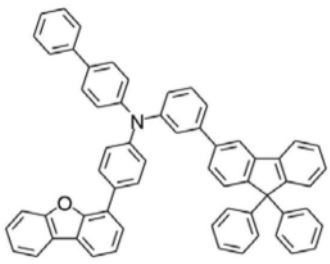
[0209]

		
742 	743 	744 
745 	746 	747 
748 	749 	750 
751	752	753

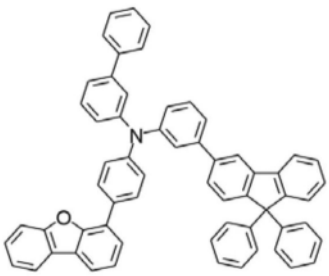
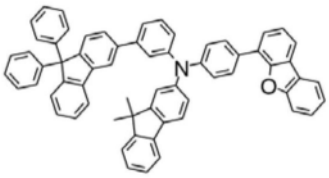
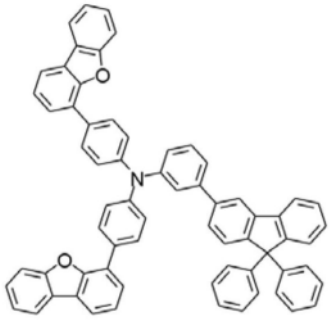
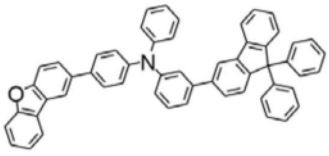
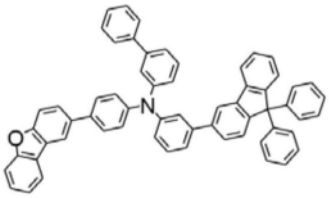
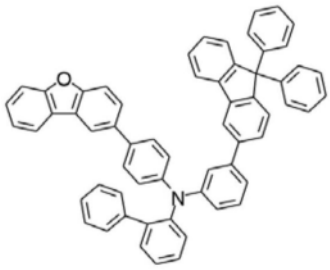
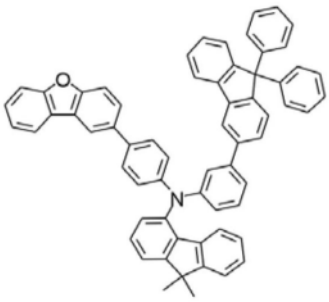
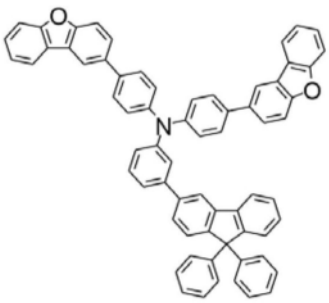
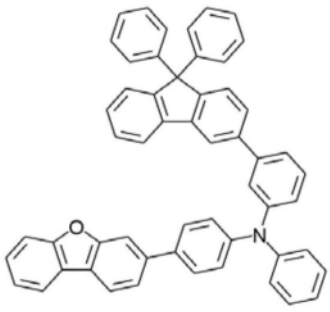
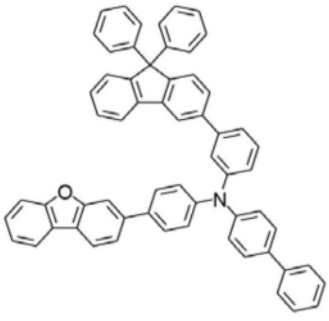
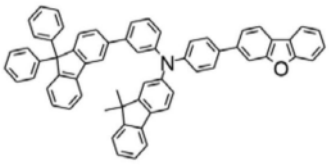
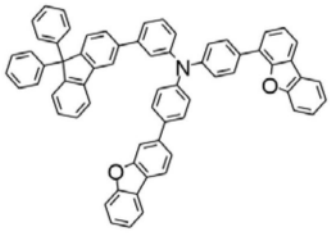
[0210]

		
754 	755 	756 
757 	758 	759 
760 	761 	762 
763	764	765

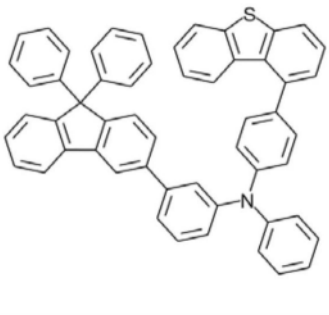
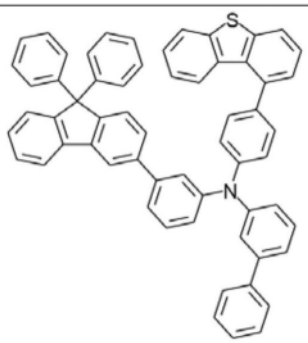
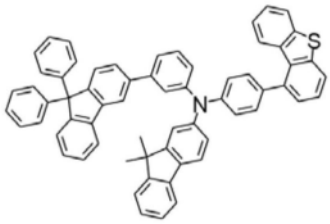
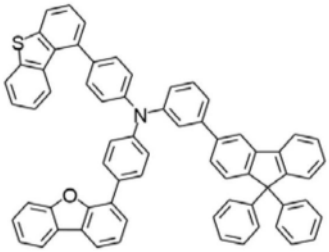
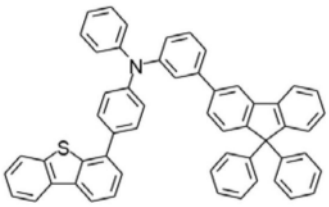
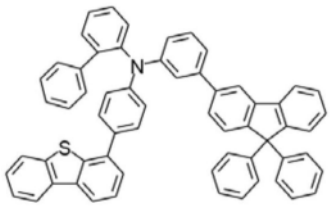
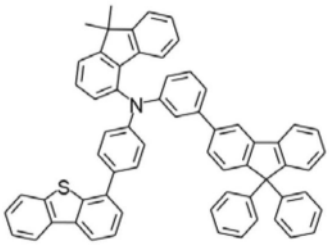
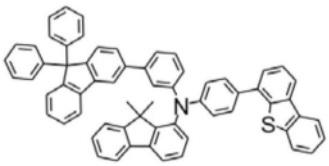
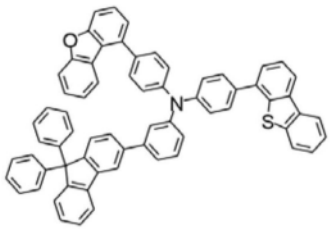
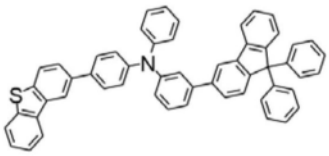
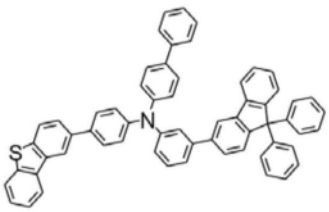
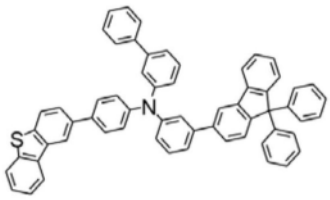
[0211]

		
766 	767 	768 
769 	770 	771 
772 	773 	774 
775	776	777

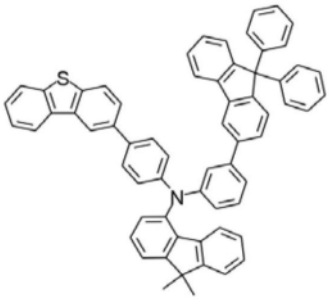
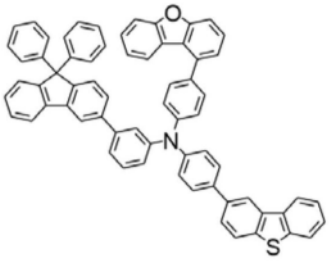
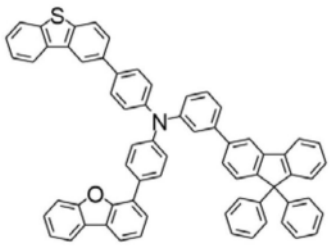
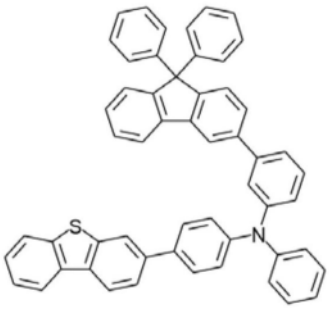
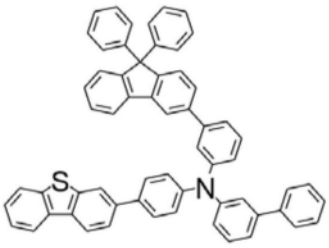
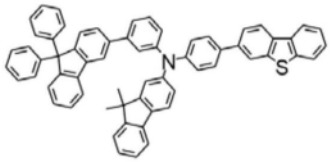
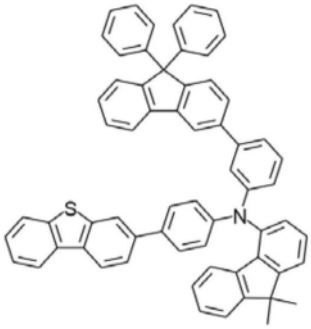
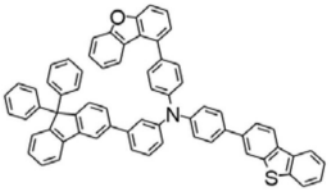
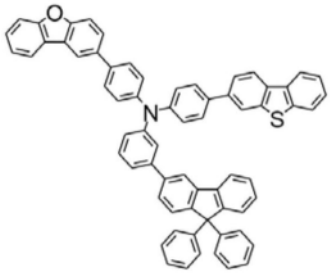
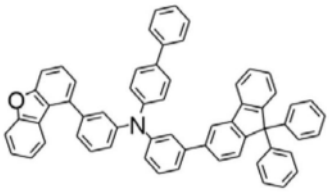
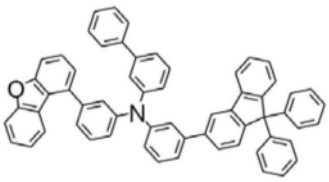
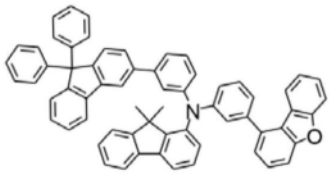
[0212]

		
778 	779 	780 
781 	782 	783 
784 	785 	786 
787	788	789

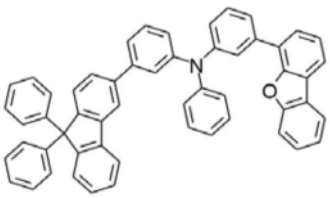
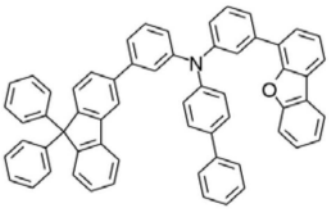
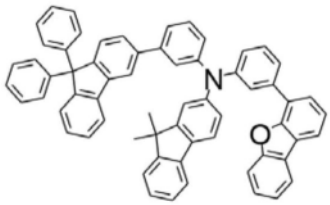
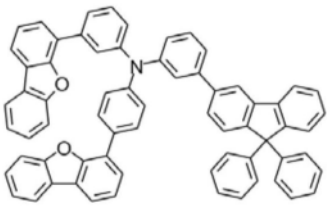
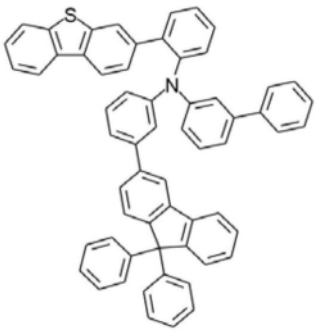
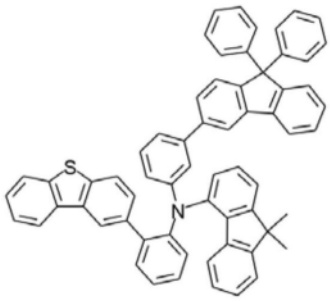
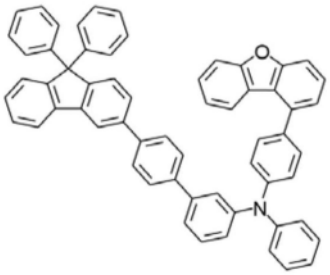
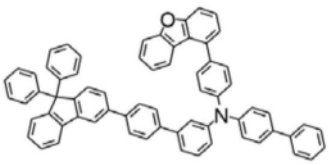
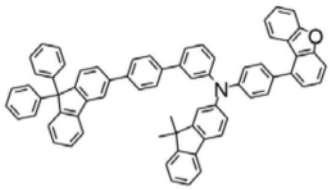
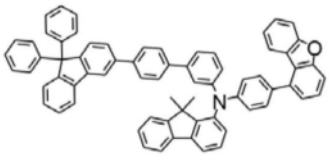
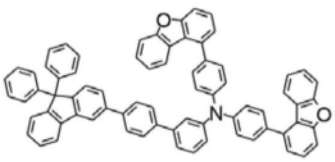
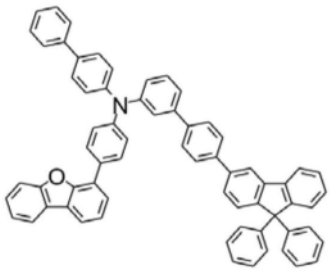
[0213]

		
790 	791 	792 
793 	794 	795 
796 	797 	798 
799	800	801

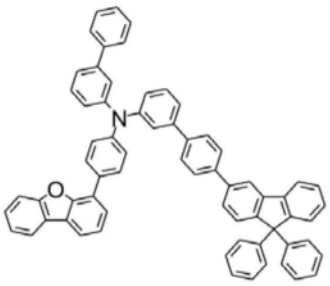
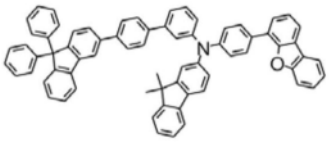
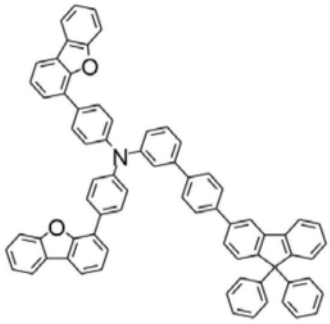
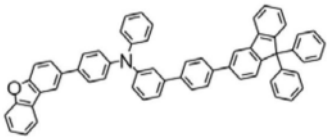
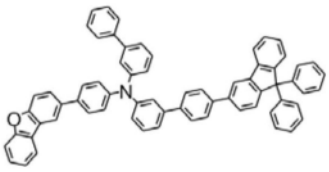
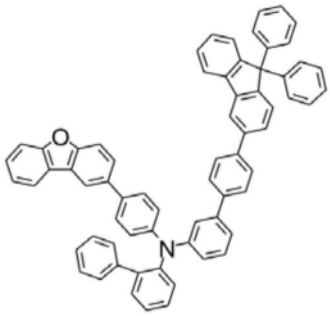
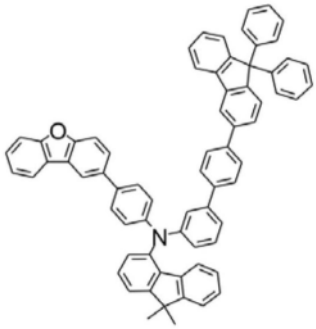
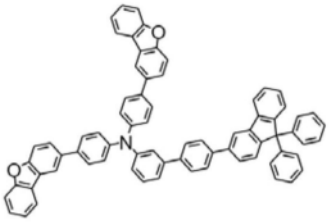
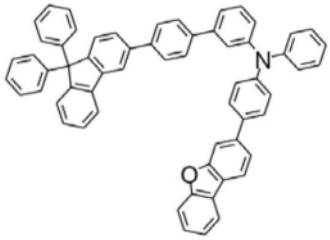
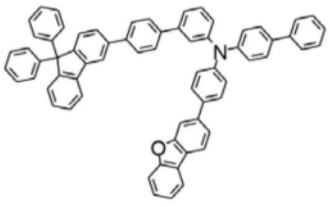
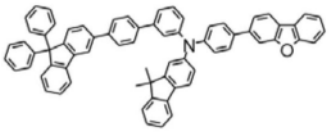
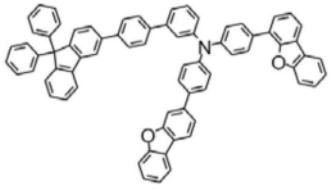
[0214]

		
802 	803 	804 
805 	806 	807 
808 	809 	810 
811	812	813

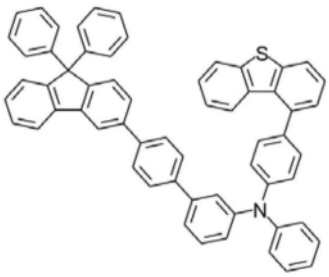
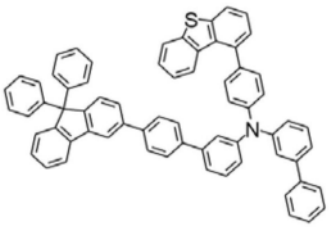
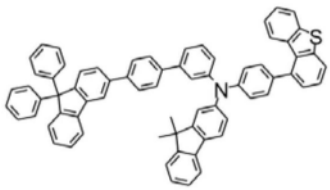
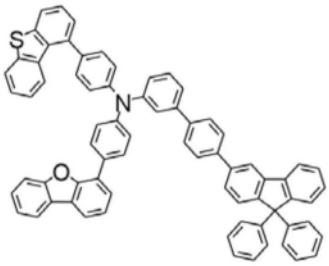
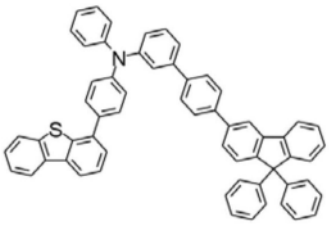
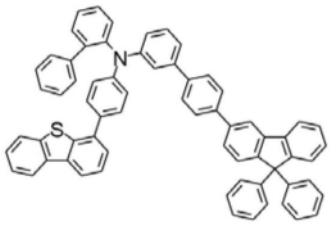
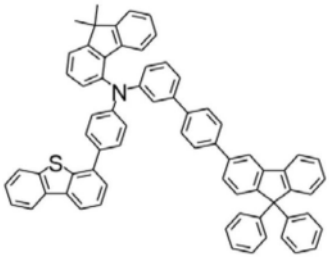
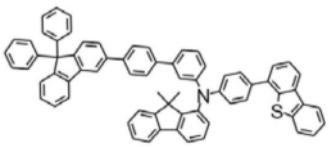
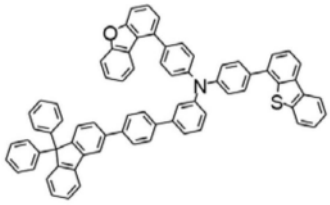
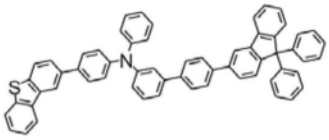
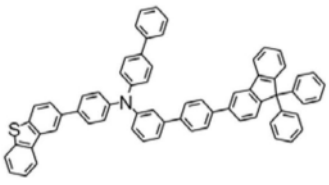
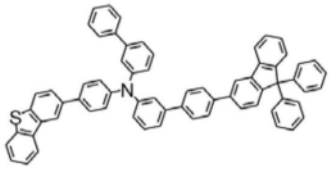
[0215]

		
814 	815 	816 
817 	818 	819 
820 	821 	822 
823	824	825

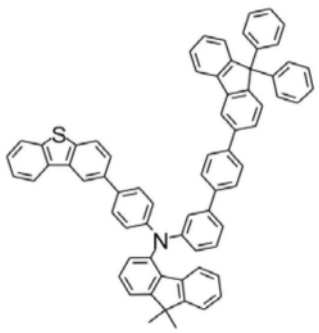
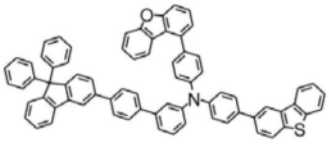
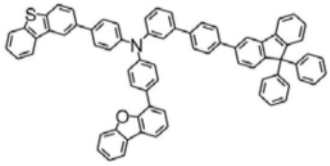
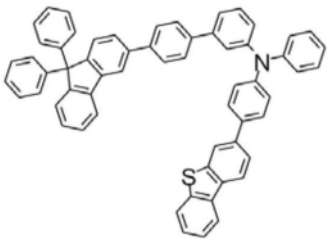
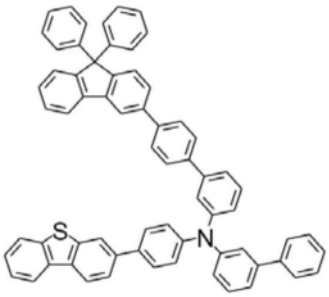
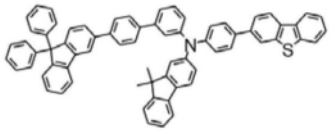
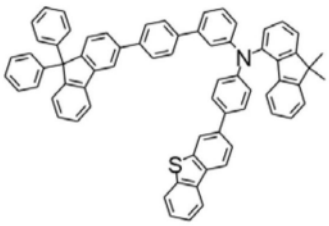
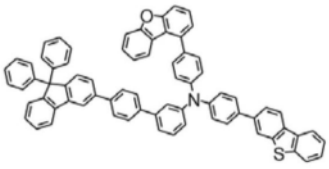
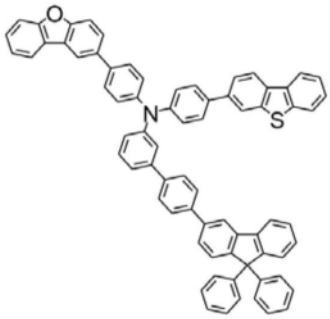
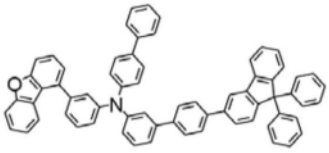
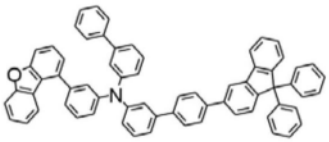
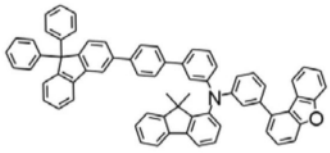
[0216]

		
826 	827 	828 
829 	830 	831 
832 	833 	834 
835	836	837

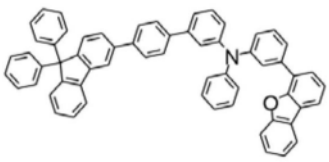
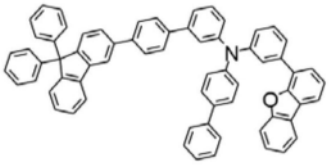
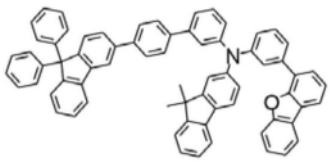
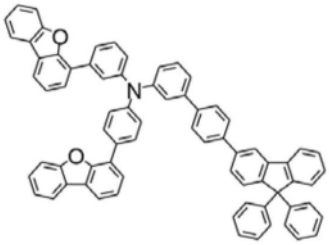
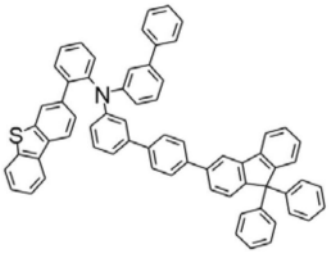
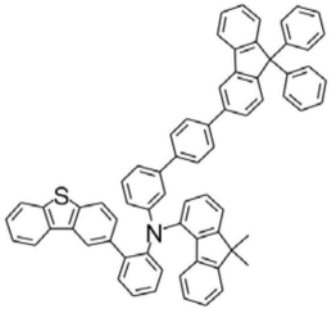
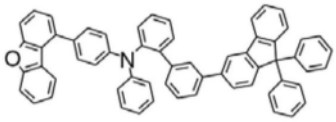
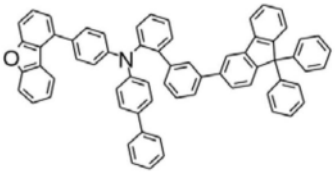
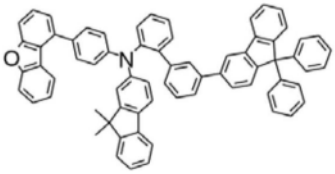
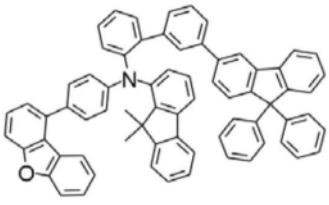
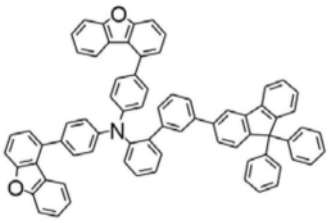
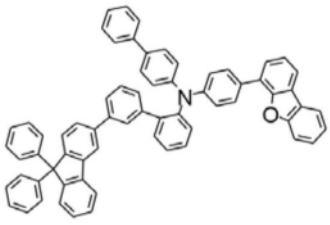
[0217]

		
838 	839 	840 
841 	842 	843 
844 	845 	846 
847	848	849

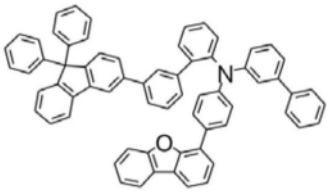
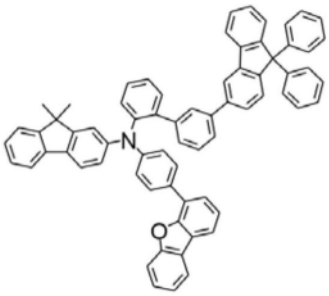
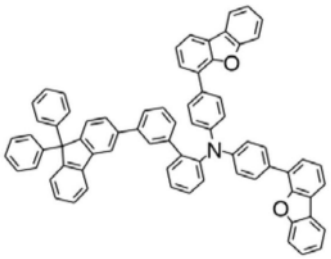
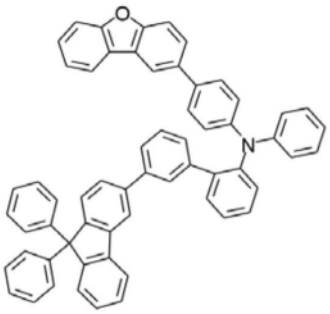
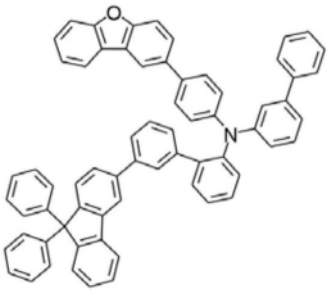
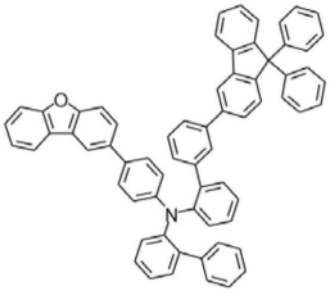
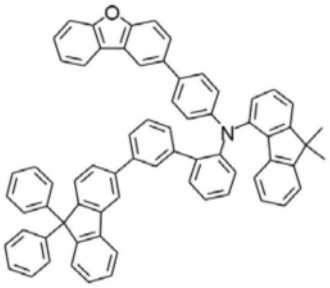
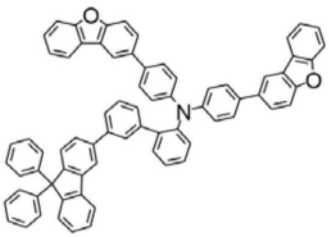
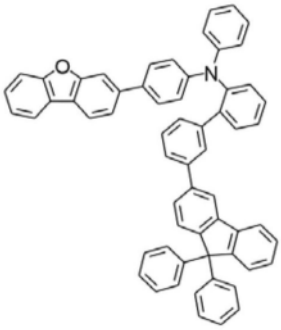
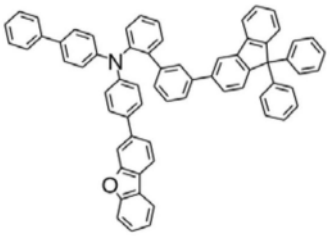
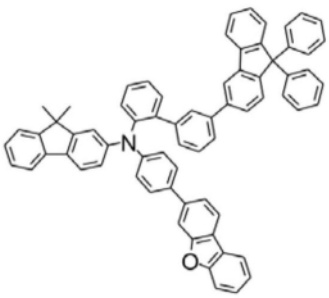
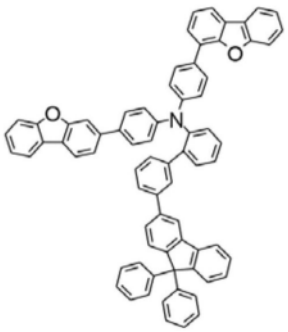
[0218]

		
850 	851 	852 
853 	854 	855 
856 	857 	858 
859	860	861

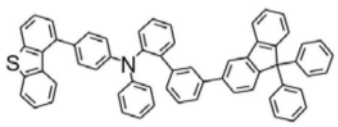
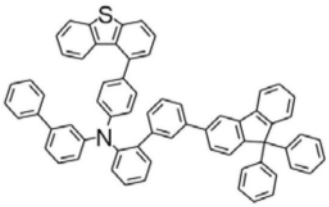
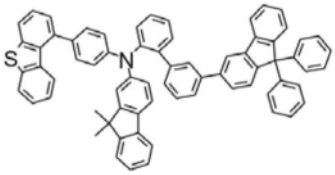
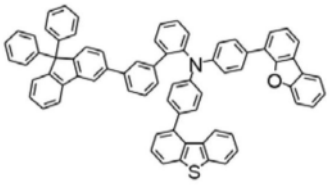
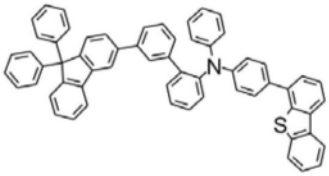
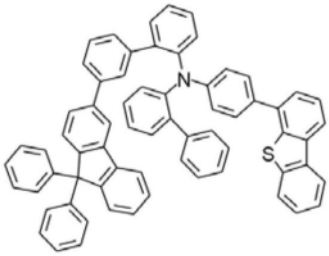
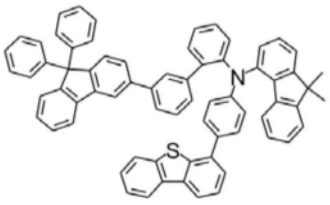
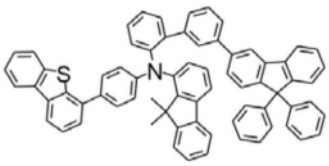
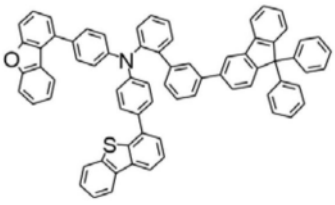
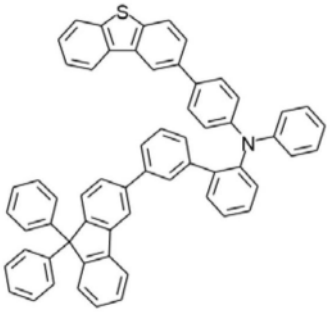
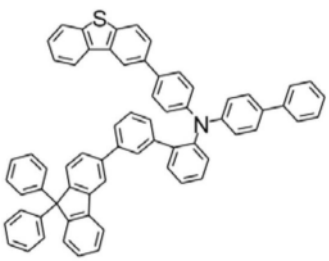
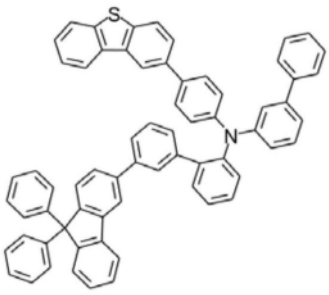
[0219]

		
862 	863 	864 
865 	866 	867 
868 	869 	870 
871	872	873

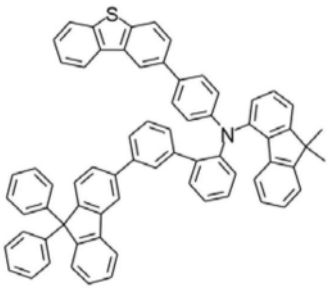
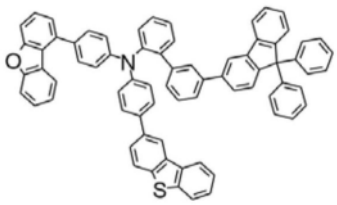
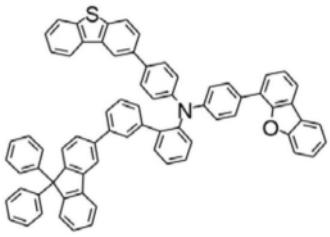
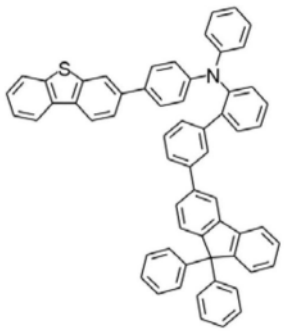
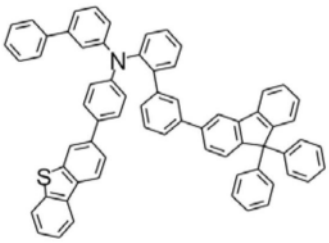
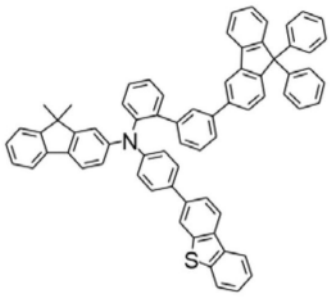
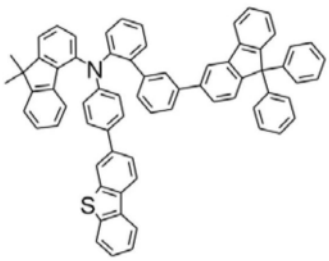
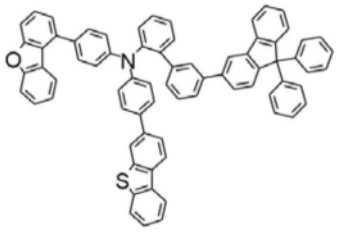
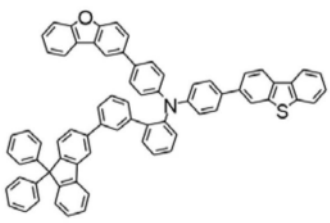
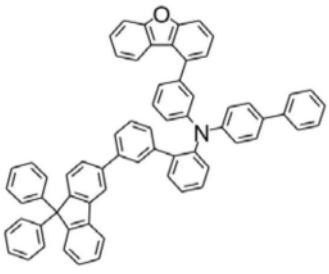
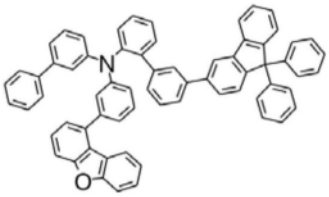
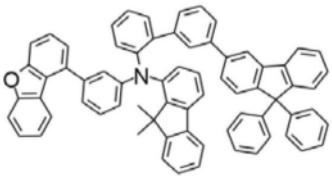
[0220]

		
874 	875 	876 
877 	878 	879 
880 	881 	882 
883	884	885

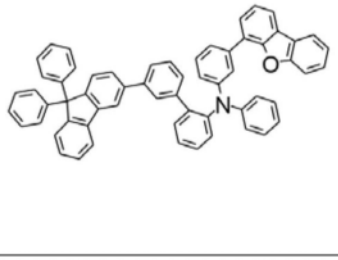
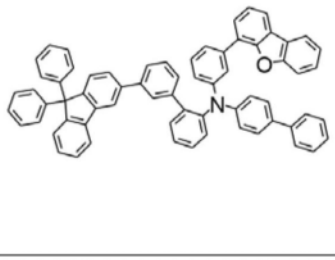
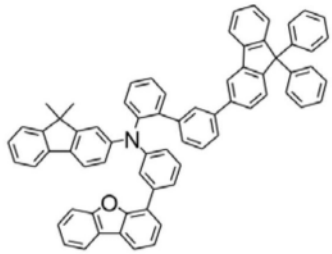
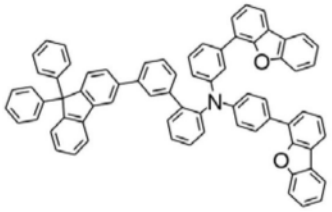
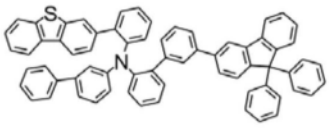
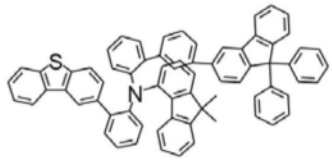
[0221]

		
886 	887 	888 
889 	890 	891 
892 	893 	894 
895	896	897

[0222]

		
898 	899 	900 
901 	902 	903 
904 	905 	906 
907	908	909

[0223]

		
910	911	912
		

[0224] 式(1)的化合物可以通过有机化学中常用的合成方法,如Buchwald偶联反应和Suzuki偶联反应来制备。因此,本发明化合物基本上通过本领域技术人员非常熟悉的方法来合成。首先,借助于Suzuki偶联对芴进行转化。在第二步中,借助于Buchwald反应将第一反应的产物转化为最终产物。

[0225] 根据本申请的化合物的一个优选合成途径如下所示。本领域技术人员将能够在其常规技术知识范围内对该合成途径进行调整。

[0226] 因此,本申请提供了一种借助于Suzuki和Buchwald偶联制备式(1)的化合物的方法。

[0227] 因此,本发明还提供了含有一个或多个式(1)的化合物的低聚物、聚合物或树枝状大分子,其中与所述聚合物、低聚物或树枝状大分子的连接的键可以位于式(1)中被R^1、R^2、R^3、R^4、R^5、R^6、R^7、R^8、R^{11}或R^{12}取代的任何所期望的位置。根据式(1)的化合物的连接,所述化合物是所述低聚物或聚合物侧链的一部分或主链的一部分。在本发明的上下文中,低聚物理解为意指由至少三个单体单元形成的化合物。在本发明的上下文中,聚合物理解为意指由至少十个单体单元形成的化合物。本发明的聚合物、低聚物或树枝状大分子可以是共轭的、部分共轭的或非共轭的。本发明的低聚物或聚合物可以是线性的、支化的或树枝状的。在具有线性连接的结构中,式(1)的单元可以彼此直接连接,或者它们可以经由二价基团,例如经由取代或未取代的烷亚基基团、经由杂原子或经由二价芳族或杂芳族基团彼此连接。在支化和树枝状结构中,例如,三个或更多个式(1)的单元可以经由三价或更高价基团,例如经由三价或更高价芳族或杂芳族基团连接,以产生支化或树枝状低聚物或聚合物。

[0228] 对于低聚物、树枝状大分子和聚合物中式(1)的重复单元,上文针对式(1)的化合物所述的偏好选项同样适用。

[0229] 为了制备所述低聚物或聚合物,使本发明的单体均聚或与其它单体共聚。合适且优选的共聚单体选自芴、螺二芴、对苯亚基、咔唑、噻吩、二氢菲、顺式和反式茚并芴、酮、菲

或这些单元中的两个或更多个。所述聚合物、低聚物和树枝状大分子通常还含有其它单元，例如发光(荧光或磷光)单元，例如乙烯基三芳基胺或磷光金属络合物，和/或电荷传输单元，尤其是基于三芳基胺的那些单元。

[0230] 本发明的聚合物、低聚物和树枝状大分子具有有利的性能，尤其是高寿命、高效率和良好的颜色坐标。

[0231] 本发明的聚合物和低聚物通常通过一种或多种单体类型的聚合来制备，其中至少一种单体导致聚合物中式(1)的重复单元。合适的聚合反应是本领域技术人员已知的，并且在文献中有描述。导致C-C和C-N偶联的特别合适的优选聚合反应如下：

[0232] (A)Suzuki聚合；

[0233] (B)YAMAMOTO聚合；

[0234] (C)STILLE聚合；以及

[0235] (D)HARTWIG-BUCHWALD聚合。

[0236] 如何通过这些方法进行聚合以及接着如何从反应介质中分离聚合物并纯化对本领域技术人员是已知的并详细描述于文献中。

[0237] 为了从液相中加工本发明的化合物，例如通过旋涂或通过印刷方法，需要本发明化合物的制剂。这些制剂可以例如是溶液、分散体或乳液。为此目的，可优选使用两种或更多种溶剂的混合物。合适的优选溶剂例如是甲苯、苯甲醚、邻二甲苯、间二甲苯或对二甲苯、苯甲酸甲酯、均三甲苯、萘满、藜芦醚、THF、甲基-THF、THP、氯苯、二噁烷、苯氧基甲苯(尤其是3-苯氧基甲苯)、(-)-葑酮、1,2,3,5-四甲基苯、1,2,4,5-四甲基苯、1-甲基萘、2-甲基苯并噻唑、2-苯氧基乙醇、2-吡咯烷酮、3-甲基苯甲醚、4-甲基苯甲醚、3,4-二甲基苯甲醚、3,5-二甲基苯甲醚、苯乙酮、α-萜品醇、苯并噻唑、苯甲酸丁酯、异丙苯、环己醇、环己酮、环己基苯、十氢化萘、十二烷基苯、苯甲酸乙酯、茚满、苯甲酸甲酯、NMP、对伞花烃、苯乙醚、1,4-二异丙基苯、二苄醚、二乙二醇丁基甲基醚、三乙二醇丁基甲基醚、二乙二醇二丁基醚、三乙二醇二甲基醚、二乙二醇单丁基醚、三丙二醇二甲基醚、四乙二醇二甲基醚、2-异丙基萘、戊基苯、己基苯、庚基苯、辛基苯、1,1-双(3,4-二甲基苯基)乙烷，或这些溶剂的混合物。

[0238] 因此，本发明还提供了一种制剂，尤其是溶液、分散体或乳液，所述制剂包含至少一种式(1)的化合物或含有至少一个式(1)单元的至少一种聚合物、低聚物或树枝状大分子，以及至少一种溶剂，优选有机溶剂。制备此类溶液的方式是本领域技术人员已知的。

[0239] 式(1)的化合物适合用于电子器件，尤其是有机电致发光器件(OLED)。根据取代，式(1)的化合物可用于不同的功能和层。优选在空穴传输性层和/或电子阻挡层中用作空穴传输性材料和/或在发光层中用作基质材料，更优选与磷光发光体组合使用。

[0240] 因此，本发明还提供了式(1)的化合物在电子器件中的用途。该电子器件优选地选自有机集成电路(OIC)、有机场效应晶体管(OFET)、有机薄膜晶体管(OTFT)、有机发光晶体管(OLET)、有机太阳能电池(OSC)、有机光检测器、有机光感受器、有机场猝熄器件(OFQD)、有机发光电化学电池(OLEC)、有机激光二极管(O-激光器)，以及更优选地，有机发光二极管(OLED)。

[0241] 因此，本发明化合物特别适合用于有机电致发光器件，所述有机电致发光器件还包括OLED、OLEC、OLET、OFQD和O-激光器。

[0242] 本发明还提供了一种包含至少一种式(1)的化合物的电子器件。该电子器件优选

地选自上述器件。

[0243] 特别优选包含阳极、阴极和至少一个发光层的有机电致发光器件，其特征在于所述器件中存在至少一个包含至少一种式(1)的化合物的有机层。优选包含阳极、阴极和至少一个发光层的有机电致发光器件，其特征在于所述器件中选自空穴传输性层和发光层的至少一个有机层包含至少一种式(1)的化合物。

[0244] 空穴传输性层在这里理解为意指布置在阳极与发光层之间的全部层，优选空穴注入层、空穴传输层和电子阻挡层。空穴注入层在这里理解为意指直接邻接阳极的层。空穴传输层在这里理解为意指位于阳极与发光层之间但不直接邻接阳极且优选也不直接邻接发光层的层。电子阻挡层在这里理解为意指位于阳极与发光层之间并直接邻接发光层的层。电子阻挡层优选地具有高能量LUMO，因此防止电子从发光层逸出。

[0245] 除了阴极、阳极和发光层以外，所述电子器件可以包含其它层。这些例如在每种情况下选自一个或多个空穴注入层、空穴传输层、空穴阻挡层、电子传输层、电子注入层、电子阻挡层、激子阻挡层、中间层、电荷产生层和/或有机或无机p/n结。然而，应当指出，这些层中的每一层不必都存在，并且层的选择总是取决于所用化合物，尤其还取决于所述器件是荧光还是磷光电致发光器件。

[0246] 电子器件中的层的顺序优选地如下：

[0247] -阳极-

[0248] -空穴注入层-

[0249] -空穴传输层-

[0250] -任选地其它空穴传输层-

[0251] -发光层-

[0252] -任选地空穴阻挡层-

[0253] -电子传输层-

[0254] -电子注入层-

[0255] -阴极-。

[0256] 同时，应当再次指出，并非全部提到的层都需要存在，和/或可另外存在其它层。

[0257] 本发明的有机电致发光器件可以含有两个或更多个发光层。更优选地，这些发光层总共具有多个在380nm与750nm之间的发光峰值，使得总体结果是白色发光；换言之，在发光层中使用可以发荧光或发磷光以及发蓝光、绿光、黄光、橙光或红光的多种发光化合物。尤其优选三层体系，即具有三个发光层的体系，其中所述三层中的一层在每种情况下显示蓝色发光，所述三层中的一层在每种情况下显示绿色发光，并且所述三层中的一层在每种情况下显示橙色或红色发光。本发明化合物在这里优选存在于空穴传输性层或发光层中。应当注意，为了产生白光，单独使用在宽波长范围内发光的发光体化合物而不是多种颜色发光的发光体化合物，也可以是合适的。

[0258] 优选使用式(1)的化合物作为空穴传输材料。发光层在这里可以是荧光发光层，或者它可以是磷光发光层。发光层优选为蓝色荧光层或绿色磷光层。特别优选使用本发明化合物在电子阻挡层中作为空穴传导电子阻挡材料。

[0259] 当含有式(1)的化合物的器件含有磷光发光层时，优选该层含有两种或更多种、优选恰好两种不同的基质材料(混合基质体系)。下面更详细描述混合基质体系的优选实施方

式。

[0260] 如果在空穴传输层、空穴注入层或电子阻挡层中使用式(1)的化合物作为空穴传输材料，则所述化合物可以作为纯材料，即在空穴传输层中以100％的比例使用，或者它可以与一种或多种其它化合物组合使用。

[0261] 在一个优选实施方式中，包含式(1)的化合物的空穴传输性层或电子阻挡层另外包含一种或多种其它空穴传输性化合物。这些其它空穴性传输化合物优选地选自三芳基胺化合物，更优选地选自单三芳基胺化合物。它们最优选地选自下文进一步规定的空穴传输材料的优选实施方式。在所描述的优选实施方式中，式(1)的化合物和一种或多种其它空穴传输性化合物优选地各自以至少10％的比例，更优选地各自以至少20％的比例存在。

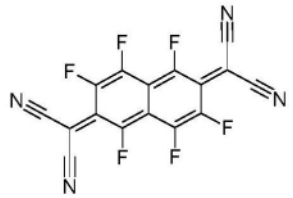
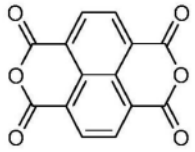
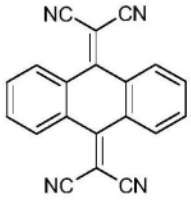
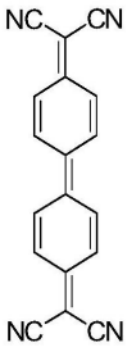
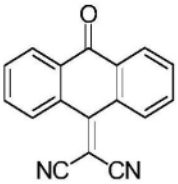
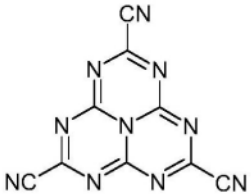
[0262] 在一个优选实施方式中，包含式(1)的化合物的空穴传输性层或电子阻挡层另外包含一种或多种p型掺杂剂。根据本发明使用的p型掺杂剂优选地是能够氧化混合物中的一种或多种其它化合物的那些有机电子受体化合物。

[0263] 特别优选作为p型掺杂剂的是醌二甲烷化合物、氮杂茚并芴二酮、氮杂菪、氮杂联三苯叉、I_2、金属卤化物(优选过渡金属卤化物)、金属氧化物(优选包含至少一种过渡金属或第3主族金属的金属氧化物)，以及过渡金属络合物(优选具有含有至少一个氧原子作为结合位点的配体的Cu、Co、Ni、Pd和Pt的络合物)。还优选过渡金属氧化物作为掺杂剂，优选铼、钼和钨的氧化物，更优选Re_2O_7、MoO_3、WO_3和ReO_3。又另外优选是以(III)氧化态的铋的络合物，更特别地是具有缺电子配体、更特别地是羧酸酯配体的铋(III)络合物。

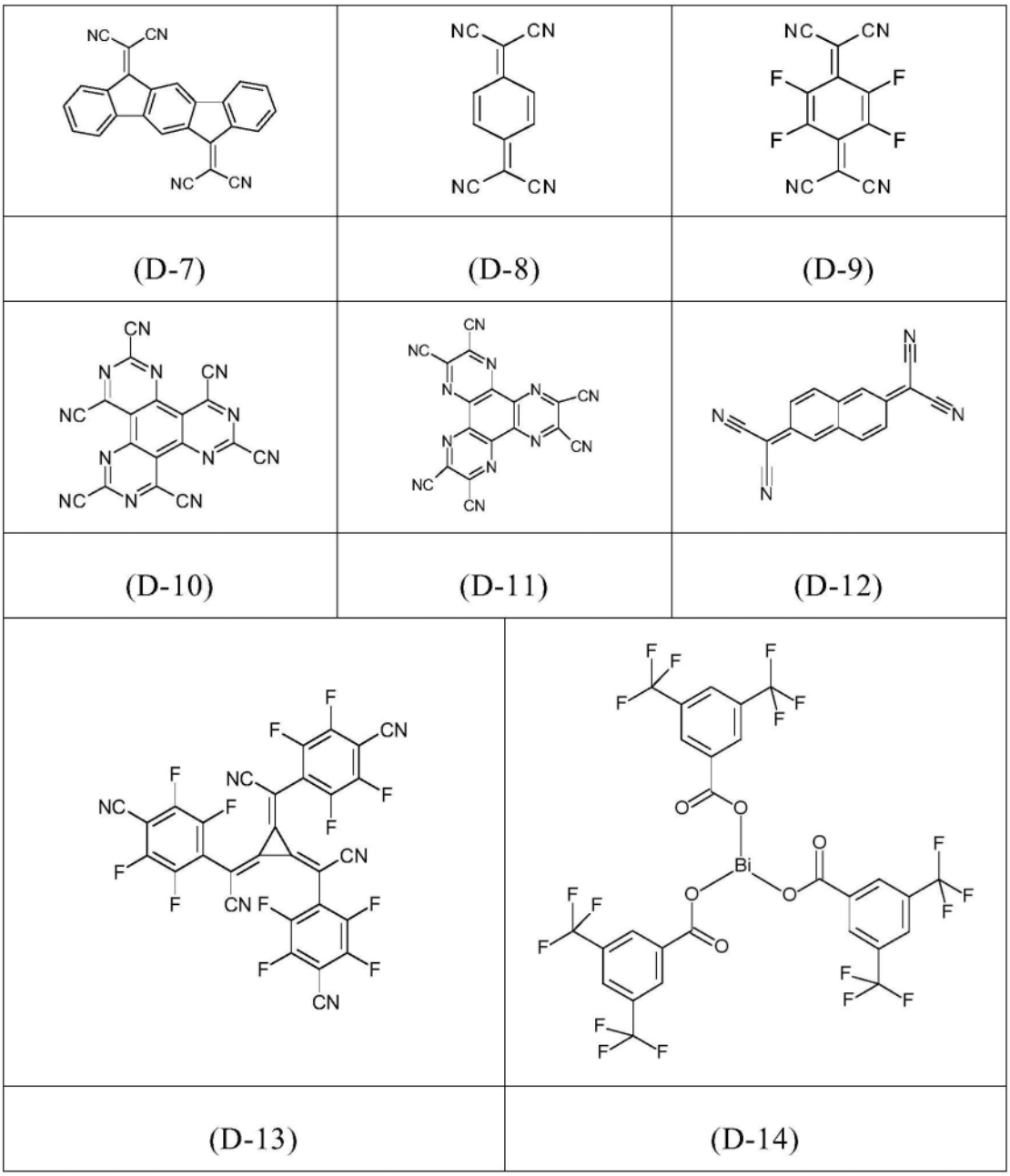
[0264] p型掺杂剂优选地在p型掺杂层中基本上均匀分布。这可以通过例如p型掺杂剂和空穴传输材料基质的共蒸发来实现。p型掺杂剂优选地以1％至10％的比例存在于p型掺杂层中。

[0265] 尤其优选p型掺杂剂是以下化合物：

[0266]

		
(D-1)	(D-2)	(D-3)
		
(D-4)	(D-5)	(D-6)

[0267]



[0268] 在一个优选实施方式中，符合以下实施方式之一的空穴注入层存在于器件中：a)它含有三芳基胺和p型掺杂剂；或b)它含有单个缺电子材料(电子受体)。在实施方式a)的一个优选实施方式中，三芳基胺是单三芳基胺，尤其是下文进一步提及的优选三芳基胺衍生物之一。在实施方式b)的一个优选实施方式中，所述缺电子材料是如在US2007/0092755中所述的六氮杂联三苯叉衍生物。

[0269] 式(1)的化合物可以存在于器件的空穴注入层、空穴传输层和/或电子阻挡层中。当化合物存在于空穴注入层或空穴传输层中时，它优选地是p型掺杂的，意指它以与如上所述的p型掺杂剂混合的形式处于所述层中。

[0270] 更优选地，式(1)的化合物存在于电子阻挡层中。在这种情况下，它优选地不是p型掺杂的。更优选地，在这种情况下，它优选呈单一化合物的形式处于没有添加其它化合物的层中。

[0271] 优选在器件的电子阻挡层中使用式(1)的化合物,其中所述器件具有绿色发光。所述器件在那种情况下优选地含有至少一个发出绿光的荧光或磷光发光体,优选绿色发光的磷光发光体。

[0272] 在一个替代优选实施方式中,式(1)的化合物在发光层中用作基质材料与一种或多种发光化合物(优选磷光发光化合物)组合。磷光发光化合物在这里优选地选自红色磷光和绿色磷光化合物。

[0273] 在这种情况下,在发光层中基质材料的比例在50.0体积%与99.9体积%之间,优选地在80.0体积%与99.5体积%之间,更优选地在85.0体积%与97.0体积%之间。

[0274] 相应地,发光化合物的比例在0.1体积%与50.0体积%之间,优选地在0.5体积%与20.0体积%之间,更优选地在3.0体积%与15.0体积%之间。

[0275] 有机电致发光器件的发光层还可以含有包含多种基质材料(混合基质体系)和/或多种发光化合物的体系。同样在这种情况下,所述发光化合物通常是在体系中具有较小比例的那些化合物,而基质材料是在体系中具有较大比例的那些化合物。然而,在个别情况下,体系中单个基质材料的比例可以小于单个发光化合物的比例。

[0276] 优选地,式(1)的化合物优选用作磷光发光体的混合基质体系的组分。所述混合基质体系优选包含两种或三种不同的基质材料,更优选两种不同的基质材料。优选地,在这种情况下,所述两种材料中的一种是具有空穴传输性质的材料,另一种材料是具有电子传输性质的材料。另外优选所述材料中的一种选自具有在HOMO与LUMO之间的大能量差的化合物(宽带隙材料)。混合基质体系中的式(1)的化合物优选地是具有空穴传输性质的基质材料。相应地,当式(1)的化合物在OLED的发光层中用作磷光发光体的基质材料时,发光层中存在具有电子传输性质的第二基质化合物。所述两种不同的基质材料可以以1:50至1:1、优选1:20至1:1、更优选1:10至1:1、最优选1:4至1:1的比例存在。

[0277] 然而,混合基质组分的所需电子传输和空穴传输性质也可以主要或完全组合在单个混合基质组分中,在这种情况下,其它混合基质组分满足其它功能。

[0278] 本发明的式(1)的化合物还可以以固态混合物的形式与其它材料一起使用,以便从来源进行蒸汽沉积,以用于生产有机电子器件的层。所述其它组分优选为空穴传输材料、电子阻挡材料或基质材料。此类固态混合物也称为预混体系。

[0279] 因此,本申请还涉及包含式(1)的化合物和至少一种其它空穴传输材料、电子阻挡材料或基质材料的固态混合物。

[0280] 本申请还涉及一种通过蒸发包含式(1)的化合物和至少一种其它空穴传输材料、电子阻挡材料或基质材料的固态混合物来生产有机电子器件的层的方法。

[0281] 本申请还提供了包含一种或多种式(1)的化合物以及选自空穴传输材料、空穴注入材料、p型掺杂剂、电子阻挡材料、基质材料、发光体和电子传输材料的至少一种其它材料的混合物或组合物。所用材料是本领域技术人员众所周知的,原则上都可以用于此目的。尤其适合于此目的的是本申请其它部分已经提到的材料。所述发光体可以是荧光或磷光发光体,优选磷光发光体。基质材料通常包括空穴传导和电子传导基质材料,还有双极性基质材料和所谓的宽带隙材料,即那些用作基质材料且具有优选不低于3.0eV的宽带隙(即,HOMO-LUMO间隔)的材料。

[0282] 优选在器件的上述层中使用以下材料类别:

[0283] 磷光发光体：

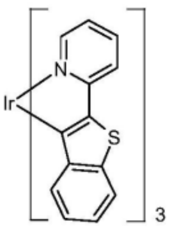
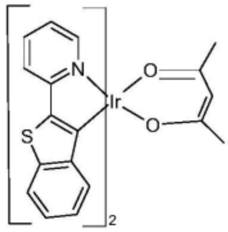
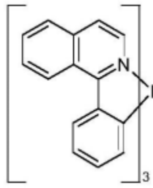
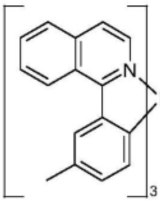
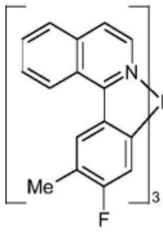
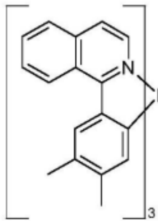
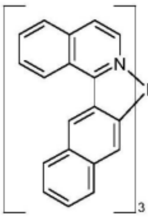
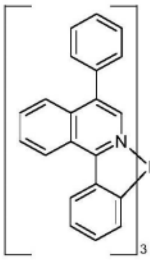
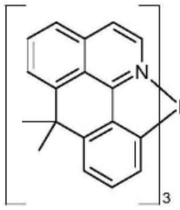
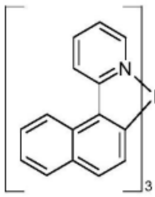
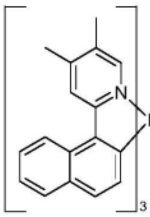
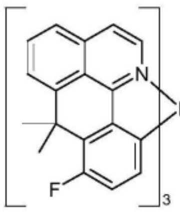
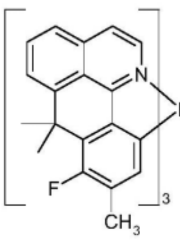
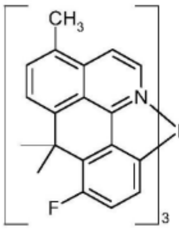
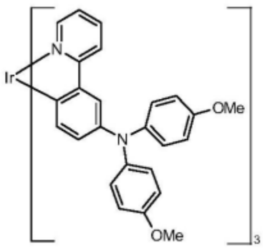
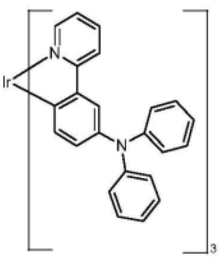
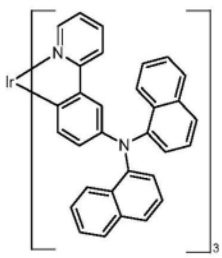
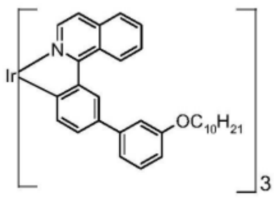
[0284] 术语“磷光发光体”通常涵盖这样的化合物，其中通过自旋禁阻跃迁，例如从激发三重态或具有更高自旋量子数的状态(例如五重态)跃迁来实现发光。

[0285] 合适的磷光发光体尤其是如下的化合物：其在适当激发时发光，优选在可见区发光，而且还含有至少一个原子序数大于20、优选大于38且小于84、更优选大于56且小于80的原子。优选使用含有铜、钼、钨、铼、钌、锇、铑、铱、钯、铂、银、金或铕的化合物，尤其是含有铱、铂或铜的化合物作为磷光发光体。

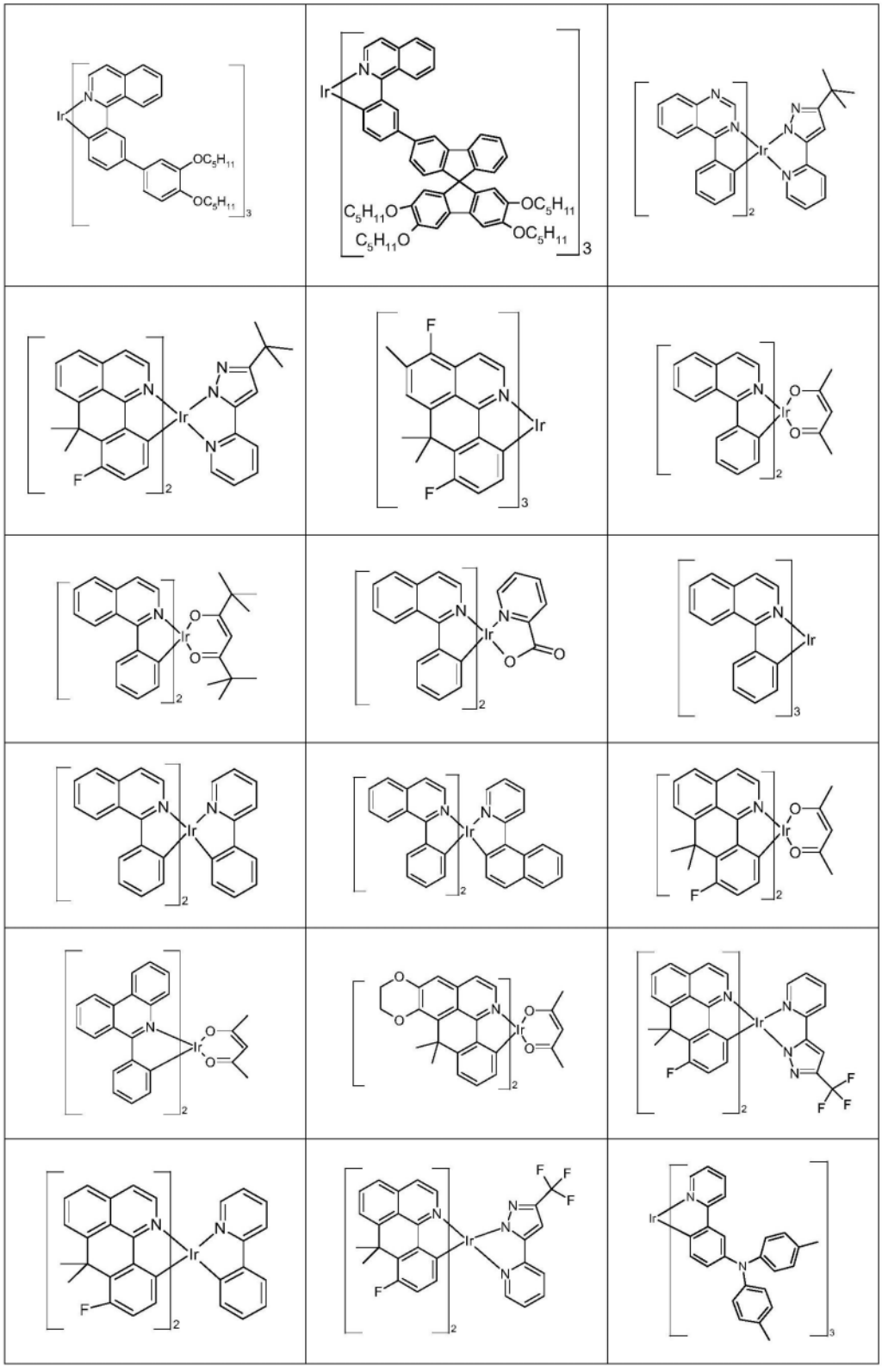
[0286] 在本发明的上下文中，所有发光的铱、铂或铜络合物都被视为磷光化合物。

[0287] 一般来说，根据现有技术的以及如有机电致发光器件领域的技术人员已知的用于磷光OLED的所有磷光络合物都适合用于本发明的器件。下表示出了合适的磷光发光体的其它实例：

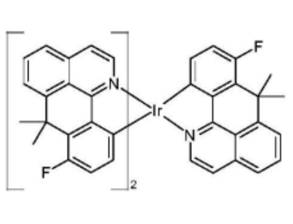
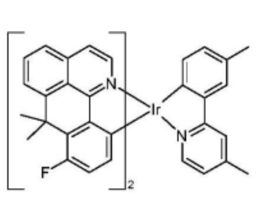
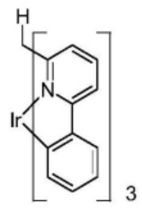
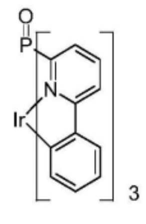
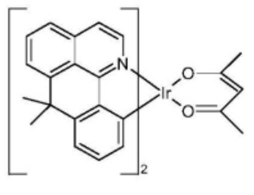
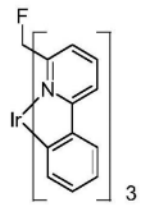
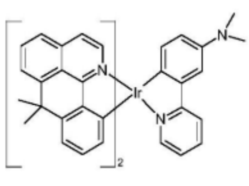
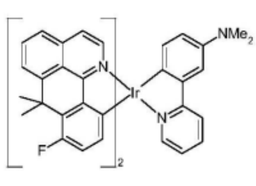
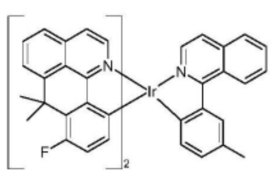
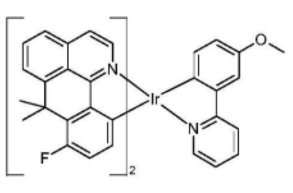
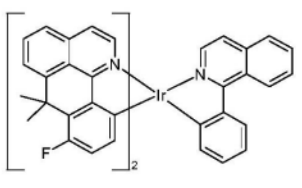
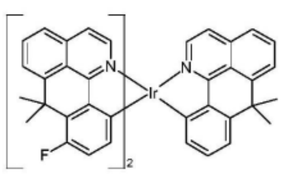
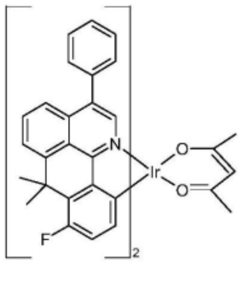
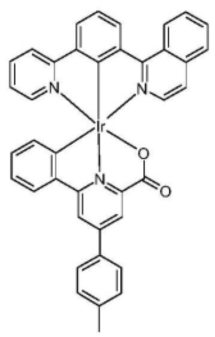
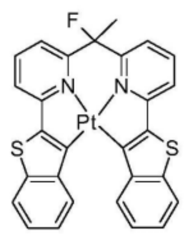
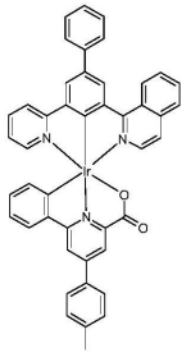
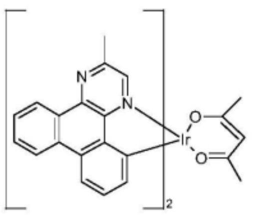
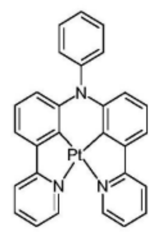
[0288]

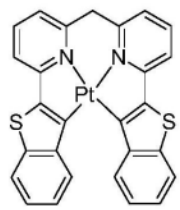
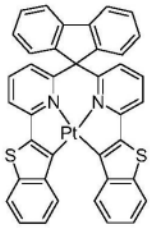
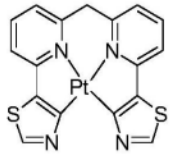
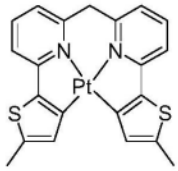
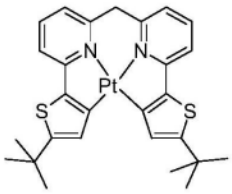
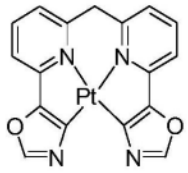
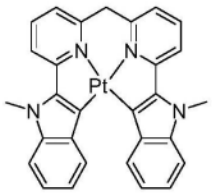
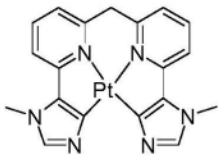
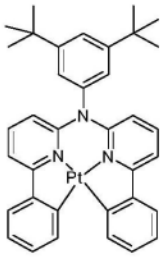
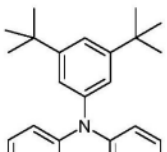
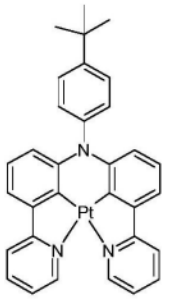
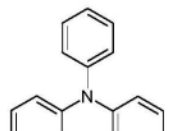
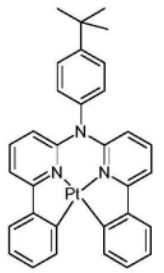
[0289]



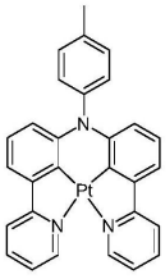
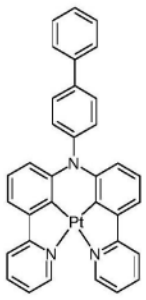
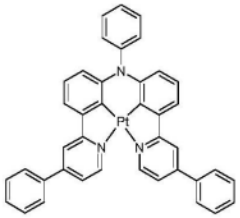
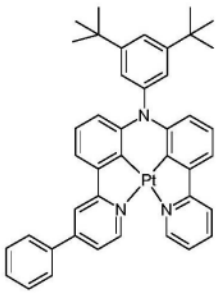
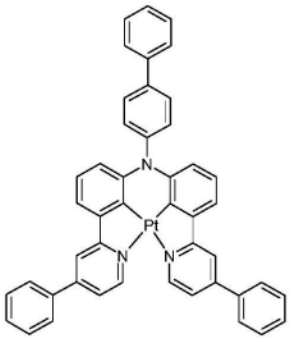
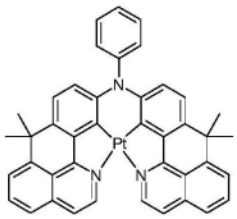
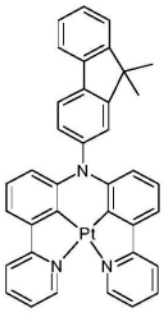
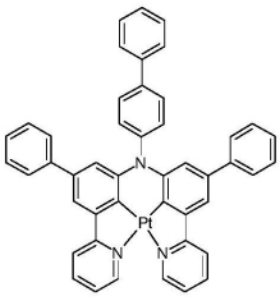
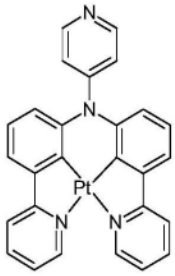
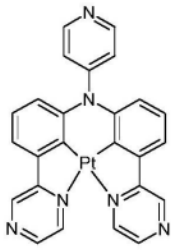
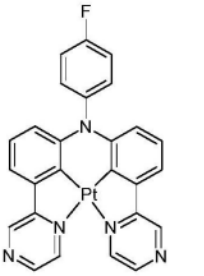
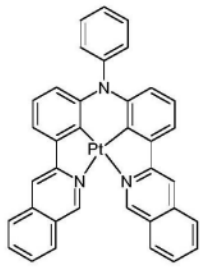
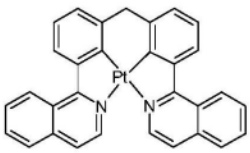
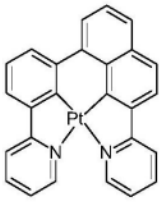
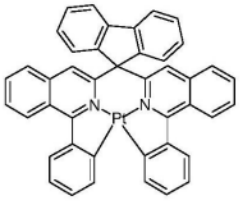
[0290]

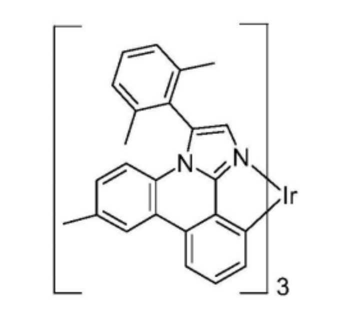
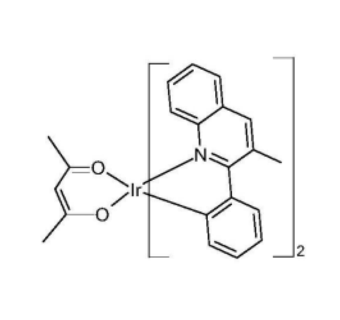
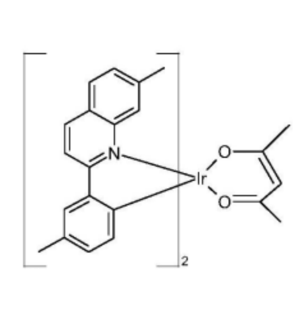
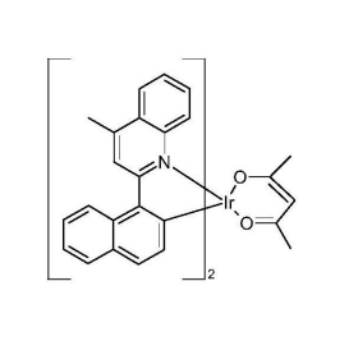
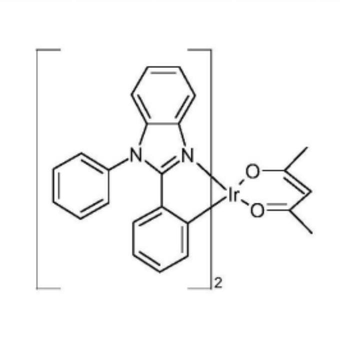
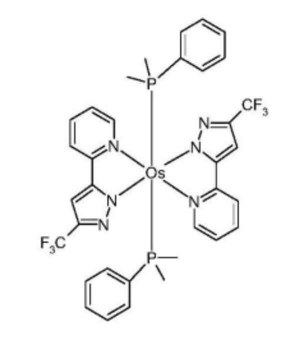
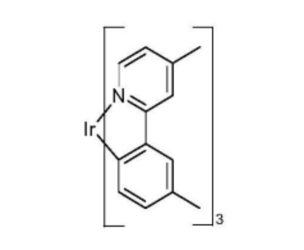
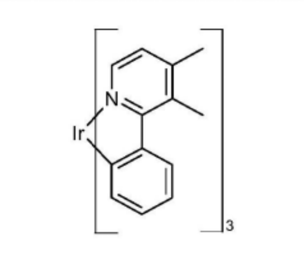
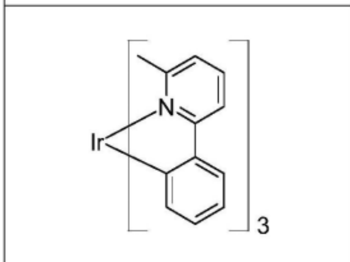
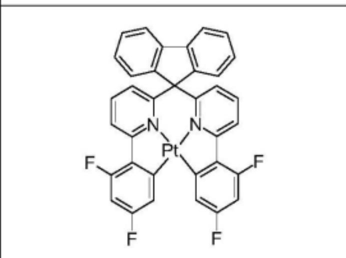
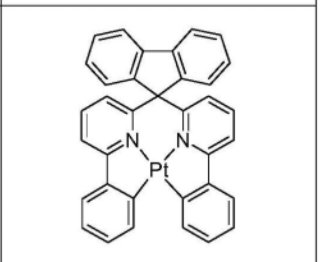
[0291]

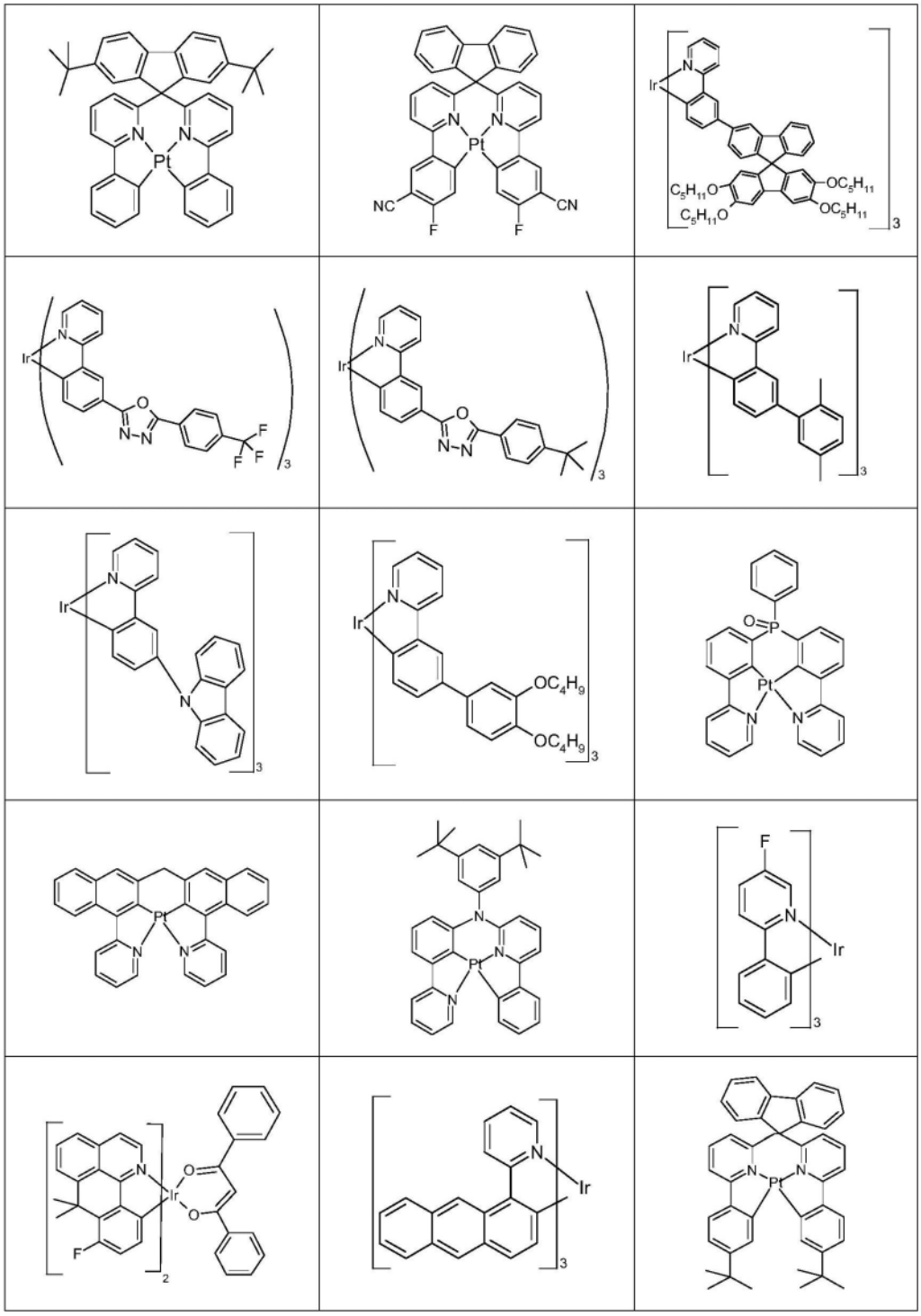
[0292]

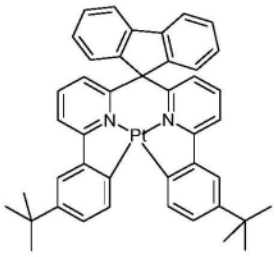
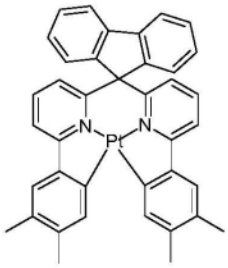
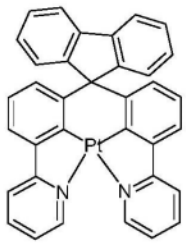
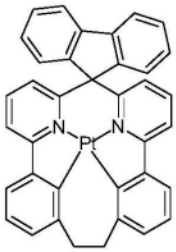
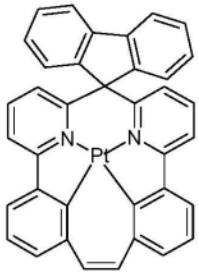
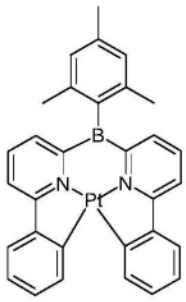
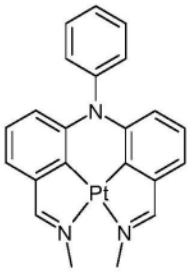
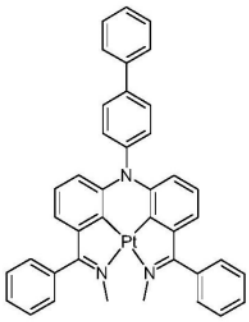
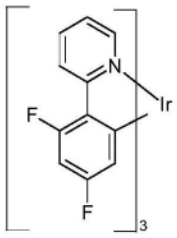
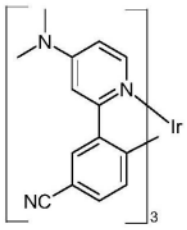
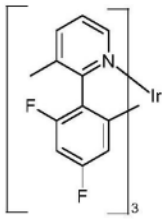
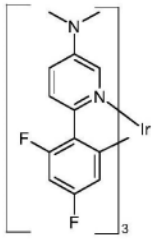
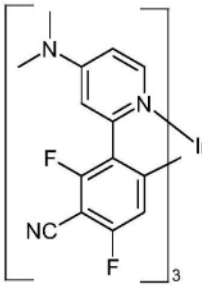
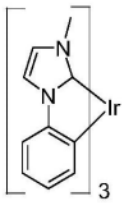
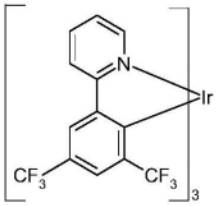
[0293]

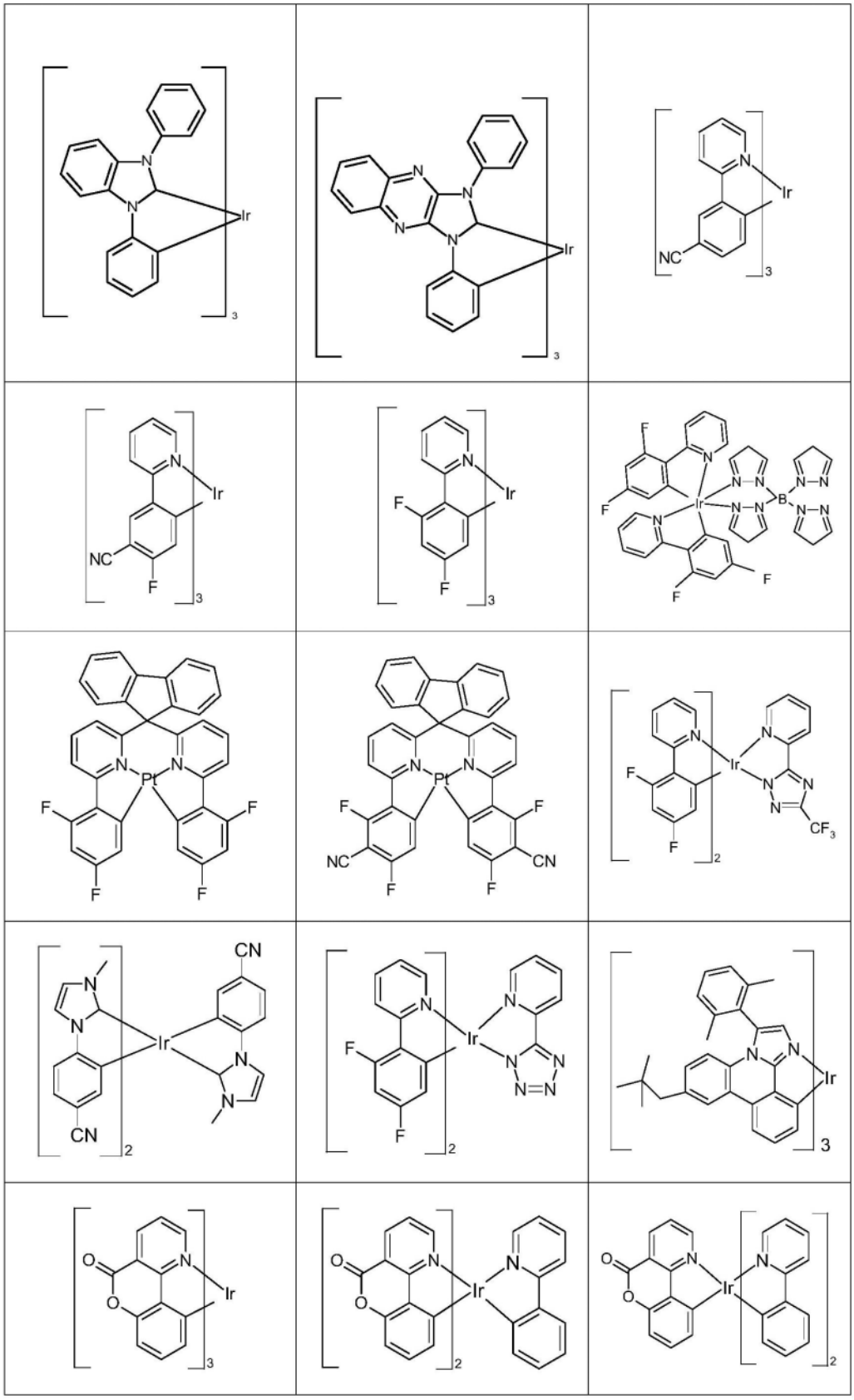
[0294]



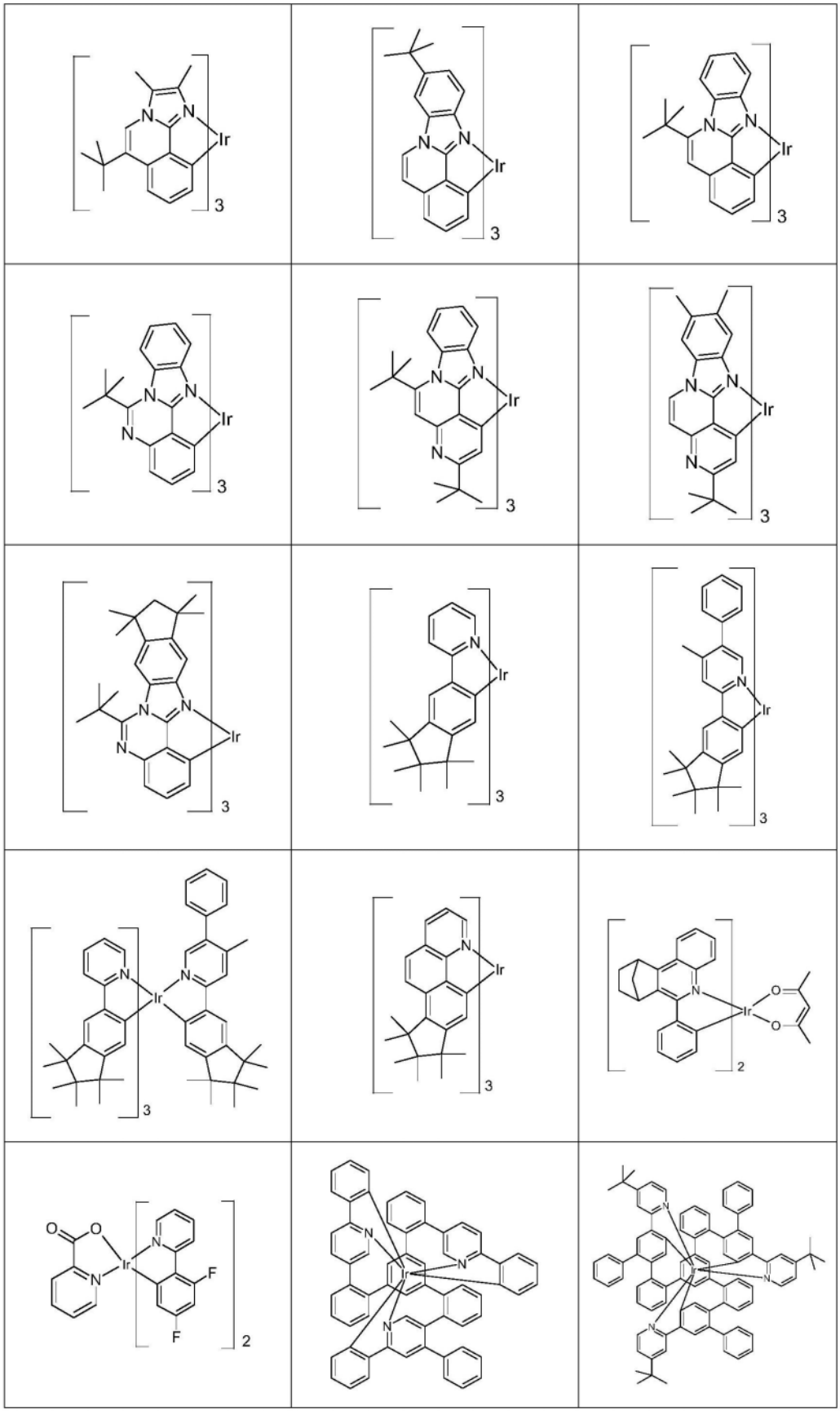
[0295]

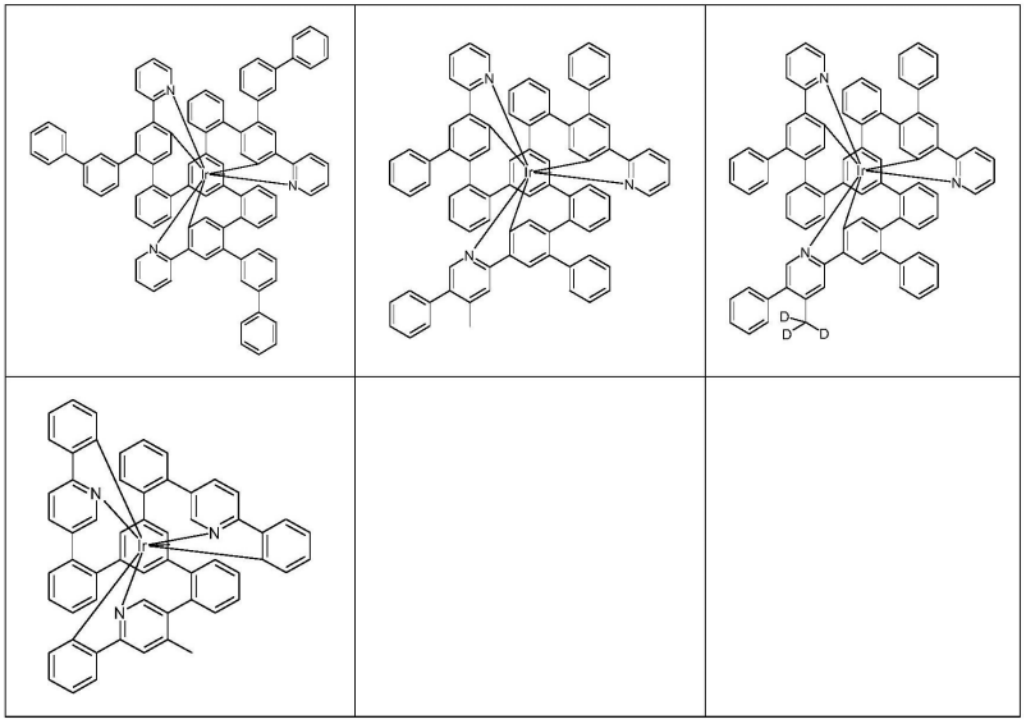
[0296]



[0297]



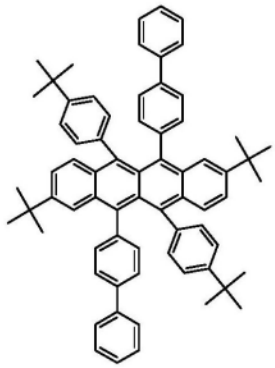
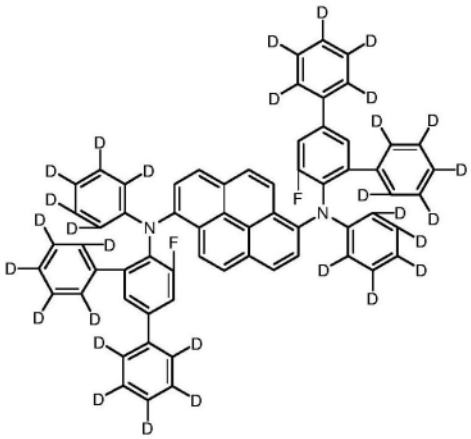
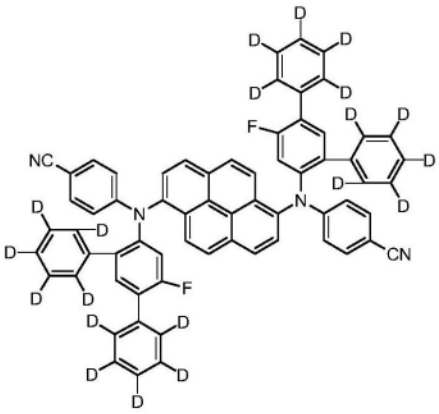
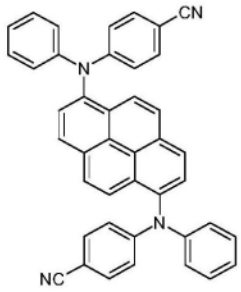
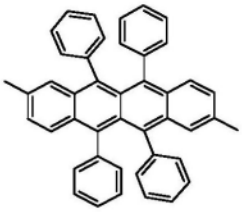
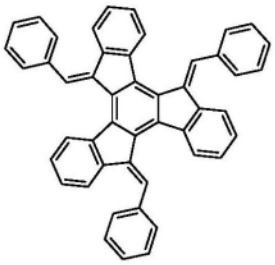
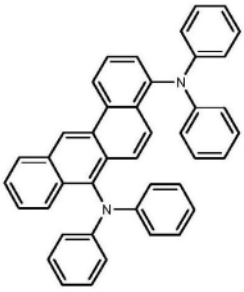
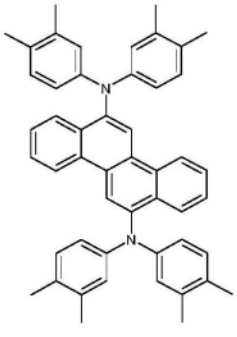
[0298]



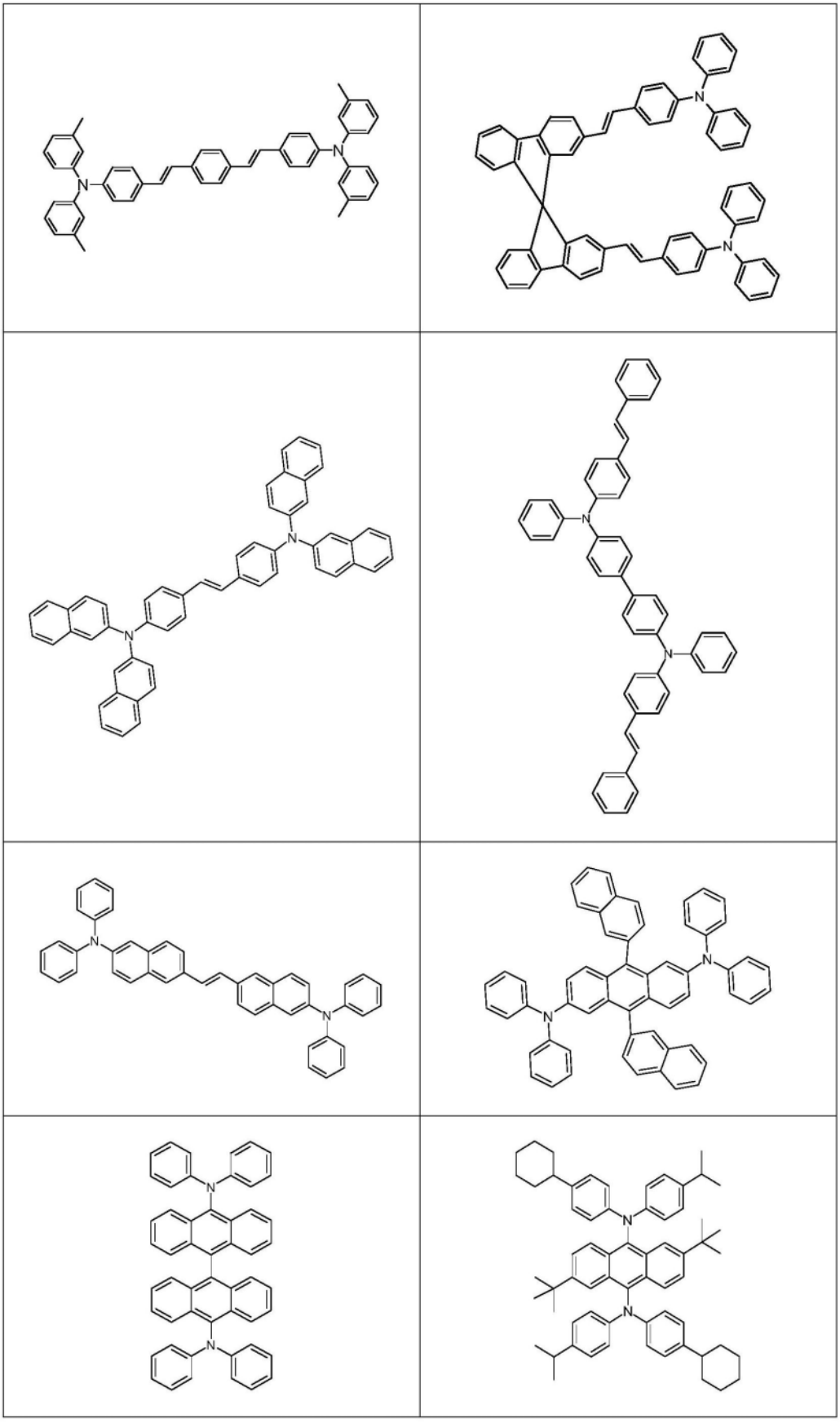
[0299] 荧光发光体：

[0300] 优选的荧光发光化合物选自芳基胺的类别。在本发明的上下文中，芳基胺或芳族胺理解为意指含有三个直接与氮键合的取代或未取代的芳族或杂芳族环系的化合物。优选地，这些芳族或杂芳族环系中的至少一个是稠合环系，更优选具有至少14个芳族环原子的稠合环系。这些的优选实例是芳族蒽胺、芳族蒽二胺、芳族芘胺、芳族芘二胺、芳族苣胺或芳族苣二胺。芳族蒽胺理解为意指其中二芳基氨基基团优选在9位上与蒽基团直接键合的化合物。芳族蒽二胺理解为意指其中两个二芳基氨基基团优选在9,10位上与蒽基团直接键合的化合物。芳族芘胺、芘二胺、苣胺和苣二胺的定义与此类似，其中二芳基氨基基团优选在1位或1,6位上与芘键合。其它优选发光化合物是茚并芴胺或茚并芴二胺、苯并茚并芴胺或苯并茚并芴二胺和二苯并茚并芴胺或二苯并茚并芴二胺以及具有稠合芳基基团的茚并芴衍生物。同样优选芘芳基胺。同样优选苯并茚并芴胺、苯并芴胺、扩展的苯并茚并芴、吩噁嗪以及与呋喃单元或与噻吩单元连接的芴衍生物。下表描绘了荧光发光体的实例：

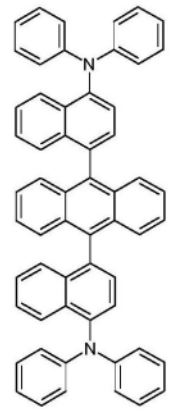
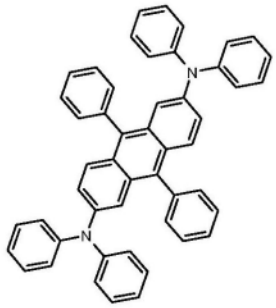
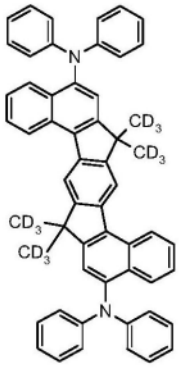
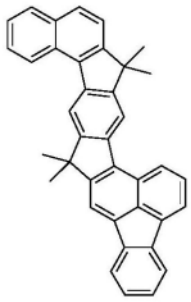
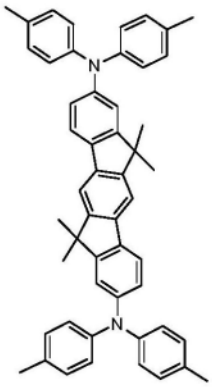
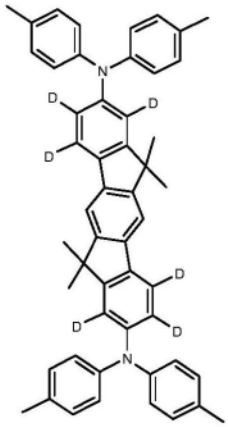
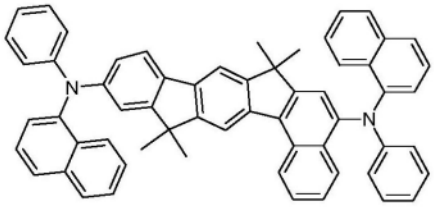
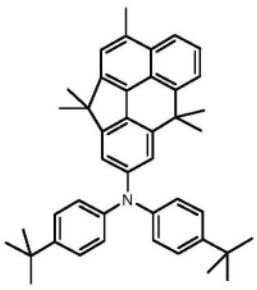
[0301]

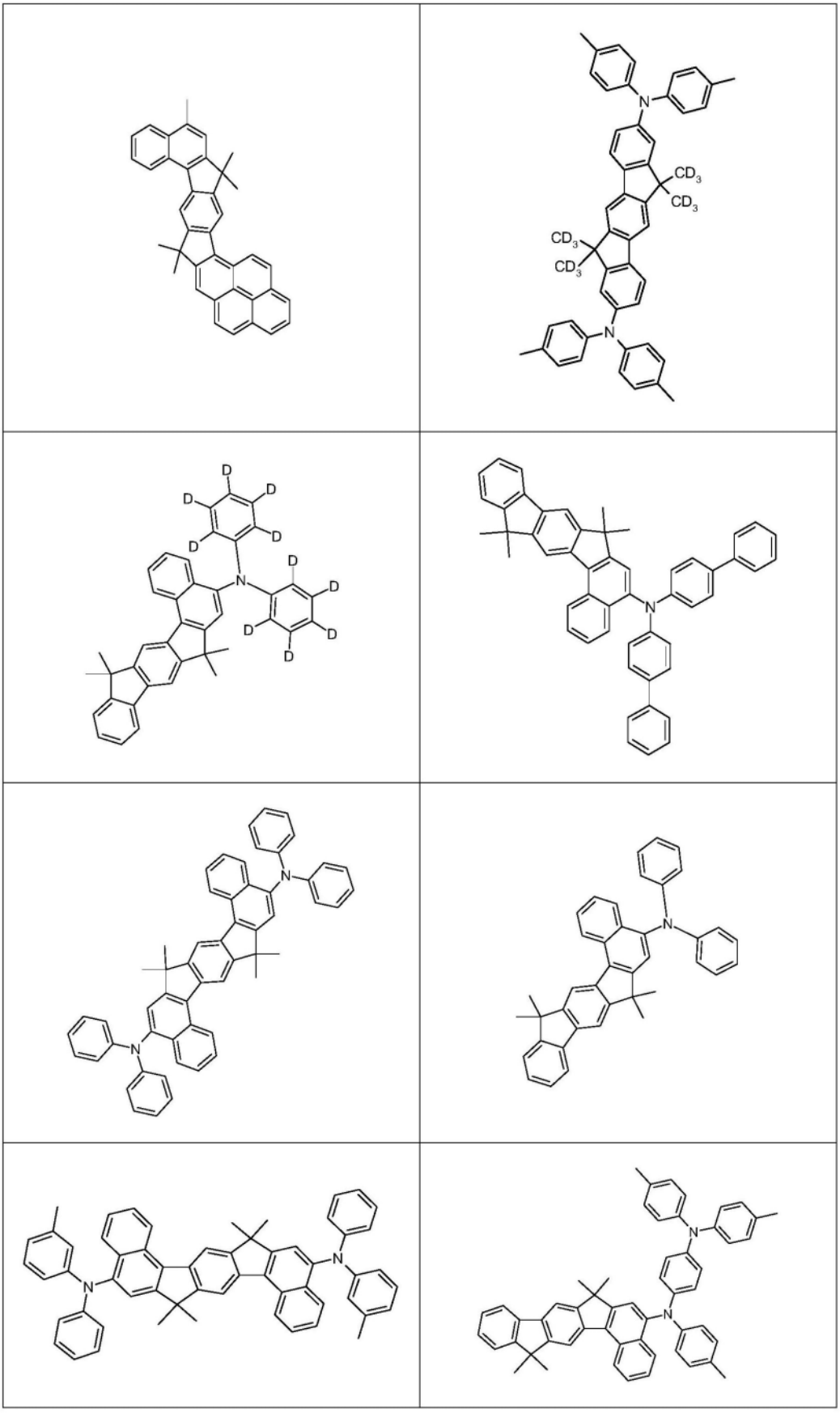
[0302]



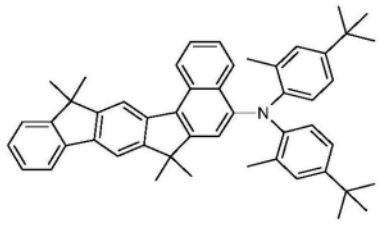
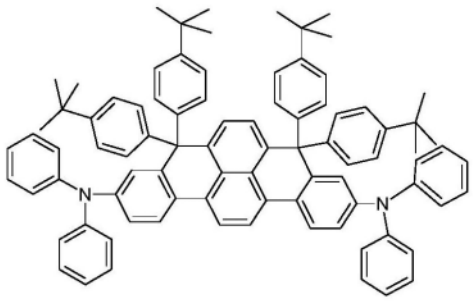
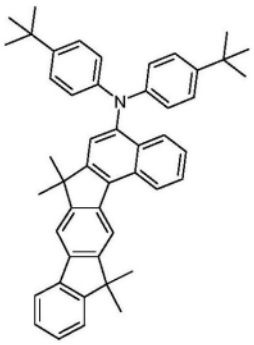
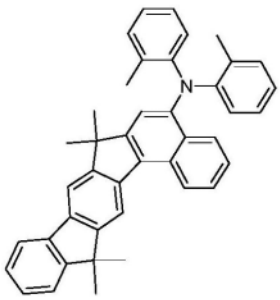
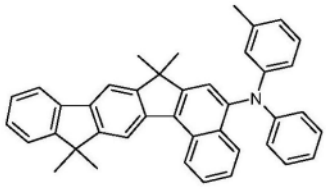
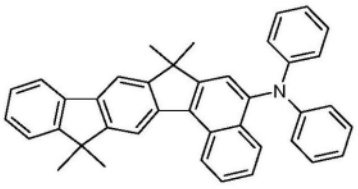
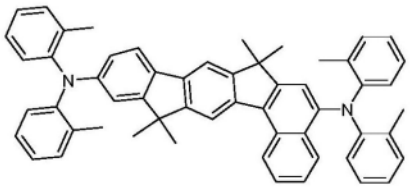
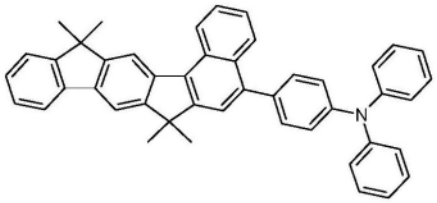
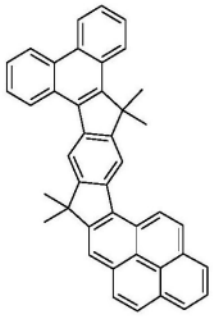
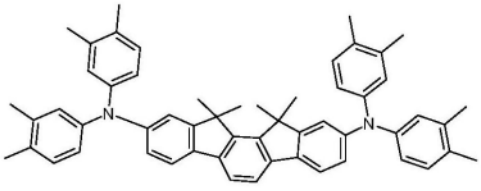
[0303]

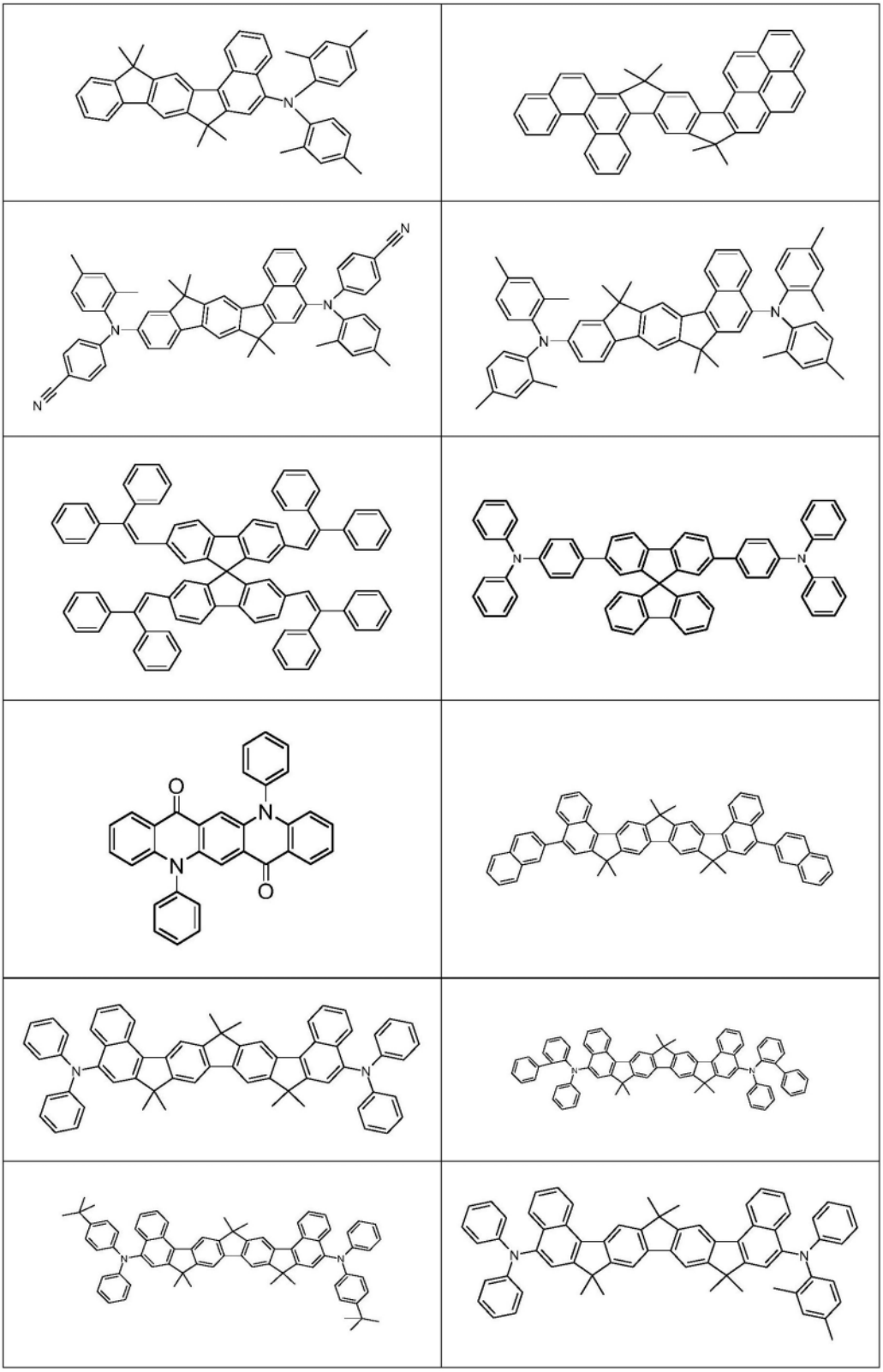
[0304]



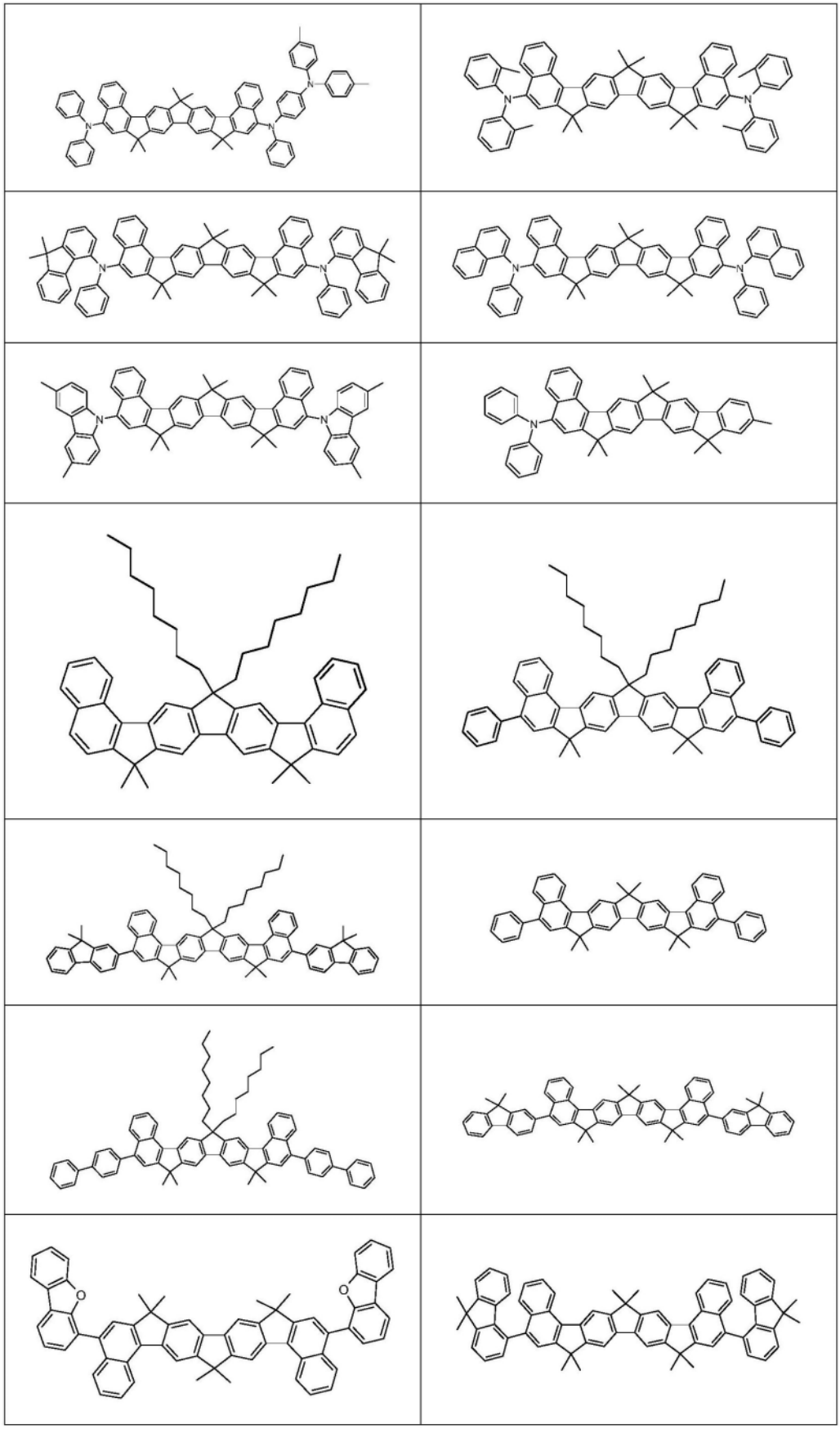
[0305]

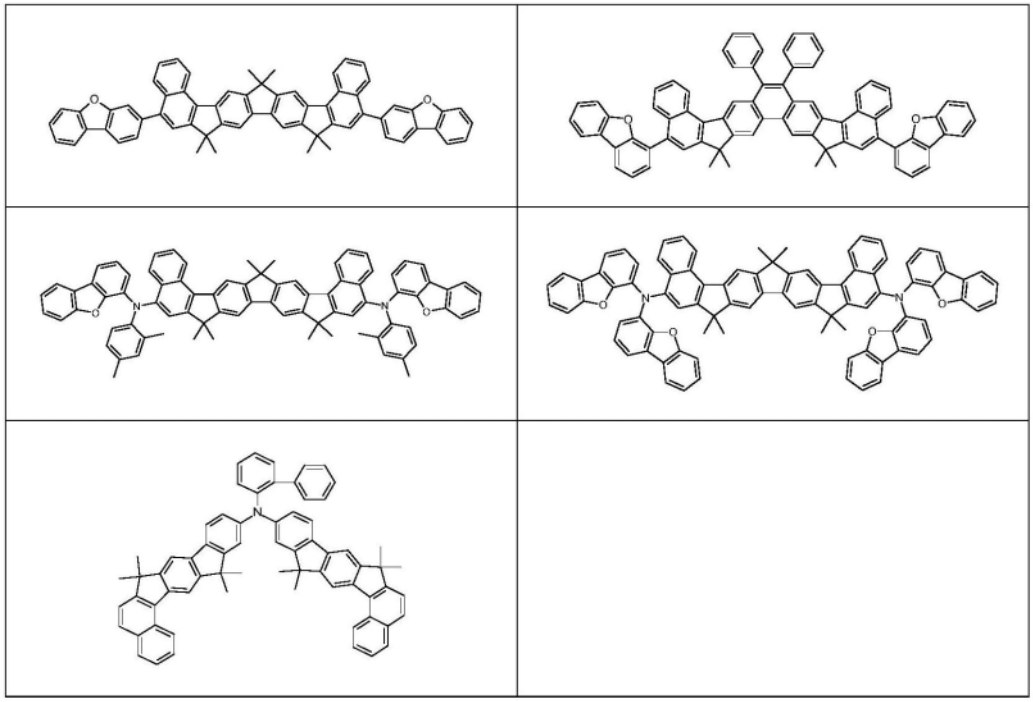
[0306]



[0307]



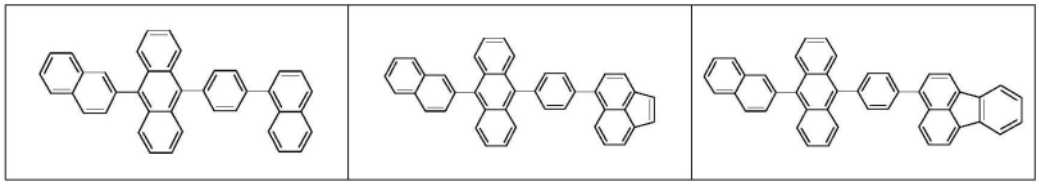
[0308]



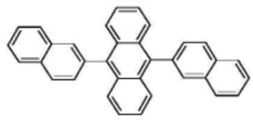
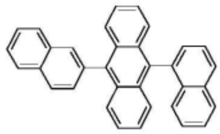
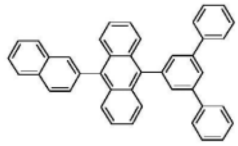
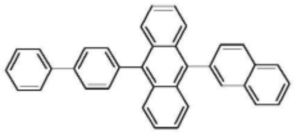
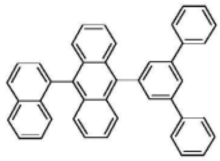
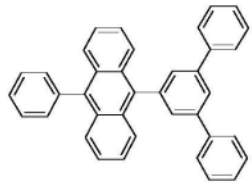
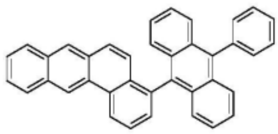
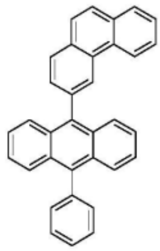
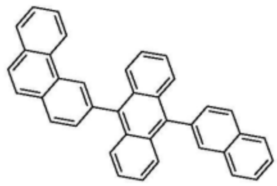
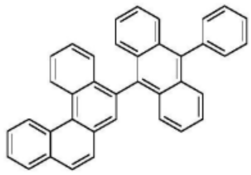
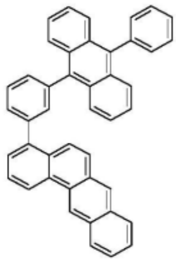
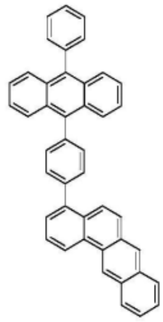
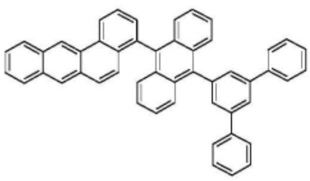
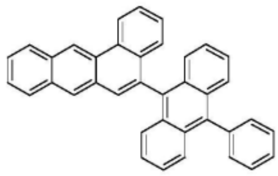
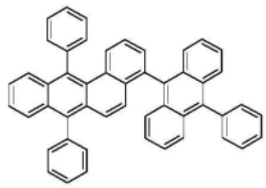
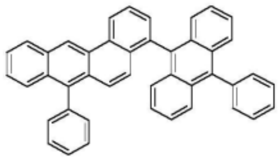
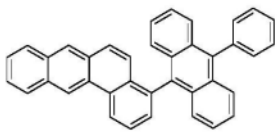
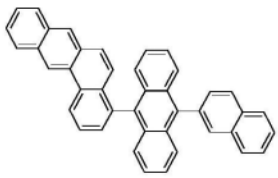
[0309] 用于荧光发光体的基质材料：

[0310] 用于荧光发光体的优选基质材料选自以下类别：低聚芳亚基(例如2,2',7,7'-四苯基螺二芴)，尤其是含有稠合芳族基团的低聚芳亚基、低聚芳亚基乙烯亚基、多足金属络合物、空穴传导化合物、电子传导化合物，尤其是酮、氧化膦和亚砜；阻转异构体、硼酸衍生物或苯并蒽。特别优选的基质材料选自以下类别：低聚芳亚基，包括萘、蒽、苯并蒽和/或芘或这些化合物的阻转异构体、低聚芳亚基乙烯亚基、酮、氧化膦和亚砜。非常特别优选的基质材料选自以下类别：低聚芳亚基，包括蒽、苯并蒽、苯并菲和/或芘或这些化合物的阻转异构体。在本发明的上下文中，低聚芳亚基应当理解为意指其中至少三个芳基或芳亚基基团彼此键合的化合物。下表描绘了用于荧光发光体的优选基质材料：

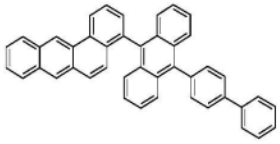
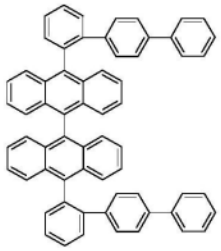
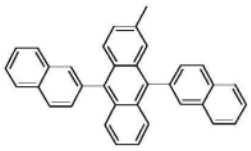
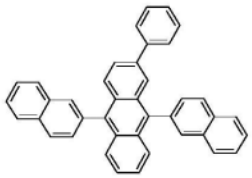
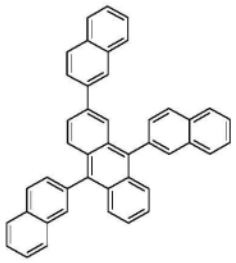
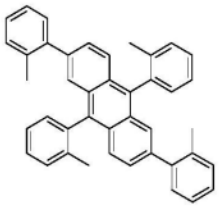
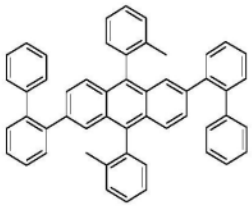
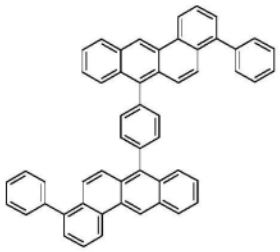
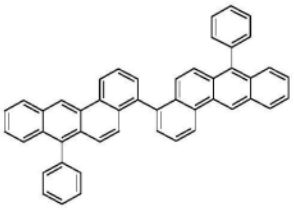
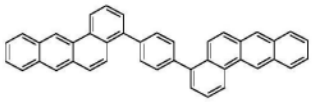
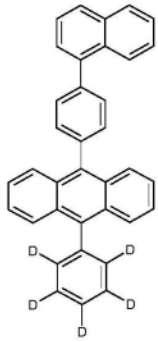
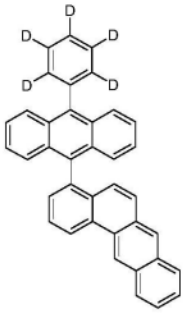
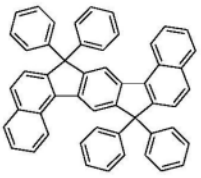
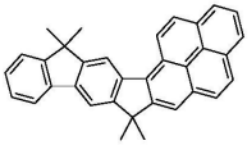
[0311]



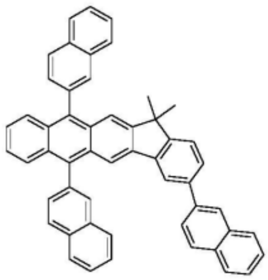
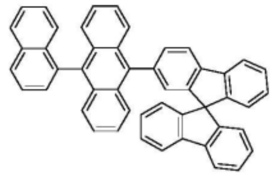
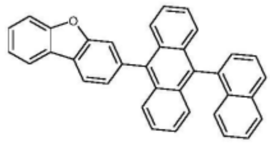
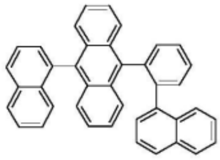
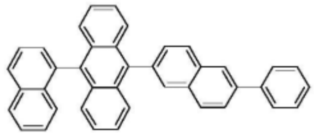
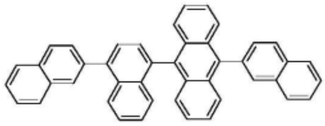
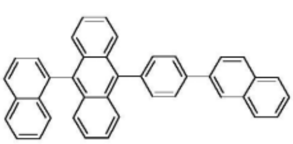
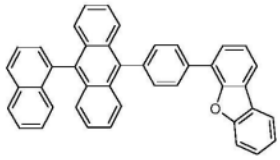
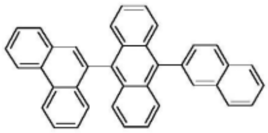
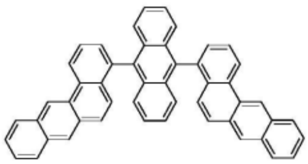
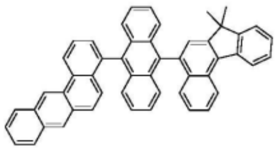
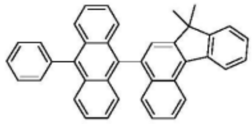
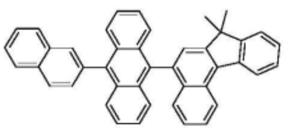
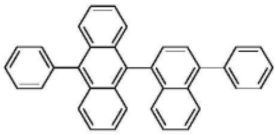
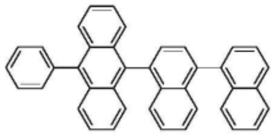
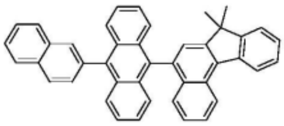
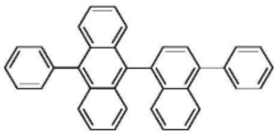
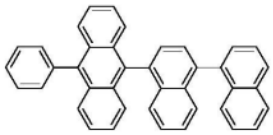
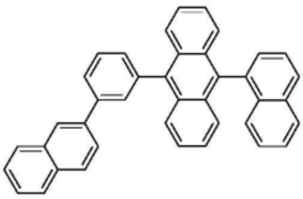
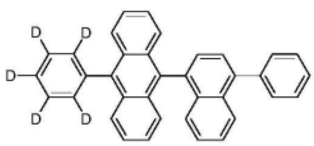
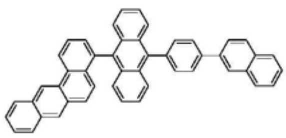
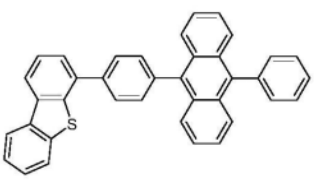
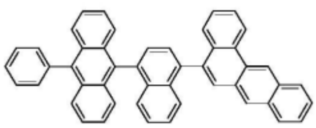
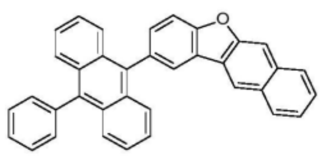
[0312]

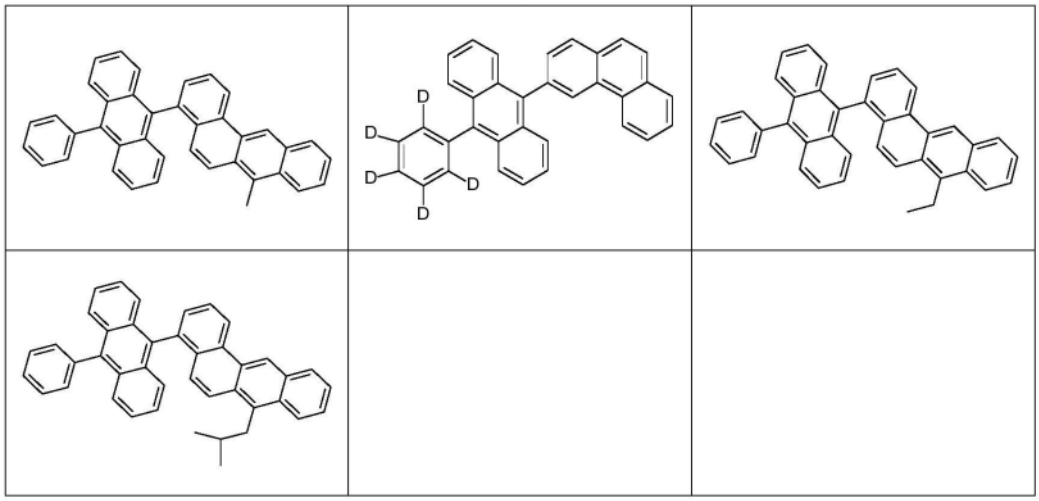
[0313]

[0314]

[0315]



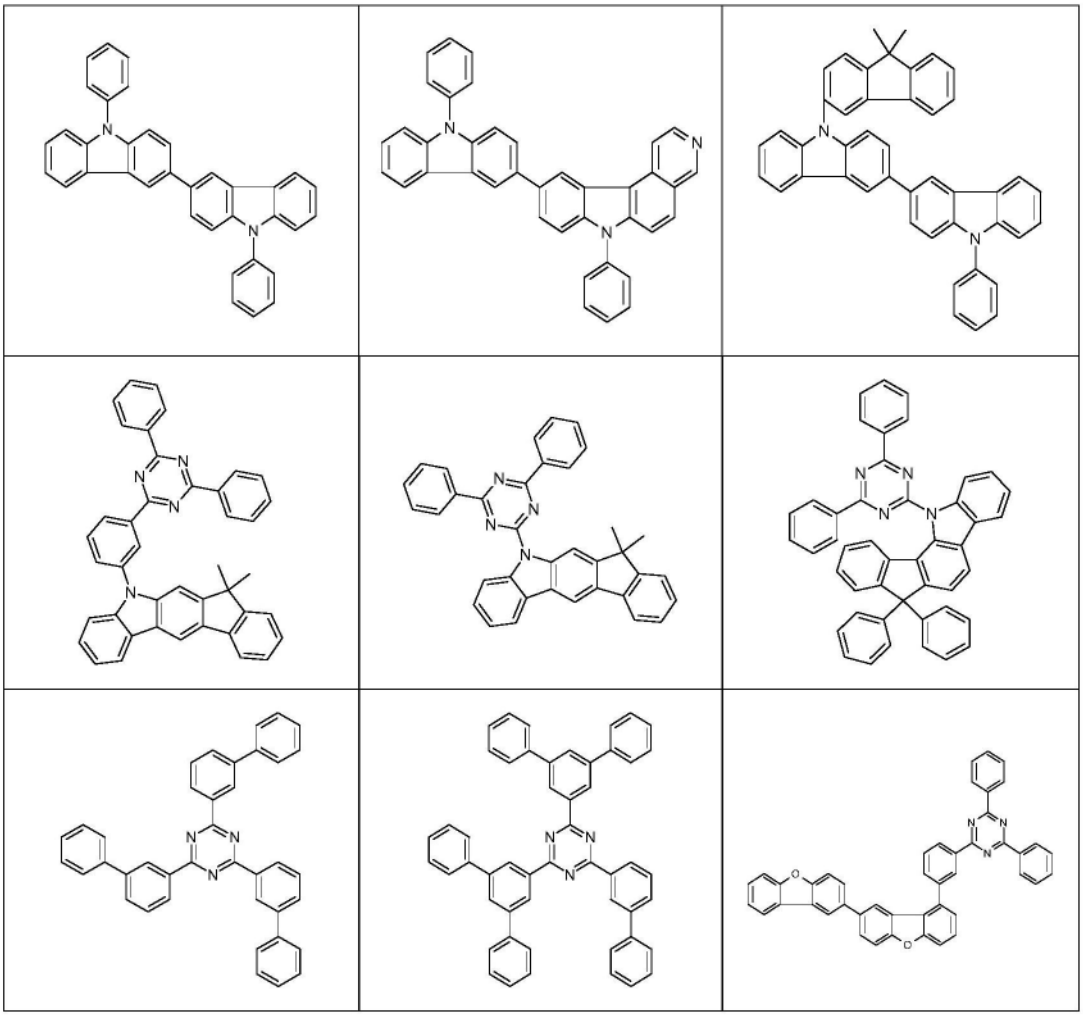
[0316] 用于磷光发光体的基质材料：

[0317] 用于磷光发光体的优选基质材料是芳族酮、芳族氧化膦或芳族亚砜或芳族砜、三芳基胺、咔唑衍生物，例如CBP(N,N-双咔唑基联苯)、吲哚并咔唑衍生物、茚并咔唑衍生物、氮杂咔唑衍生物、双极性基质材料、硅烷、硼氮杂环戊熳或硼酸酯、三嗪衍生物、锌络合物、硅二氮杂环戊熳或硅四氮杂环戊熳衍生物、磷二氮杂环戊熳衍生物、桥连咔唑衍生物、联三苯叉衍生物或内酰胺、以及式(1)的化合物。

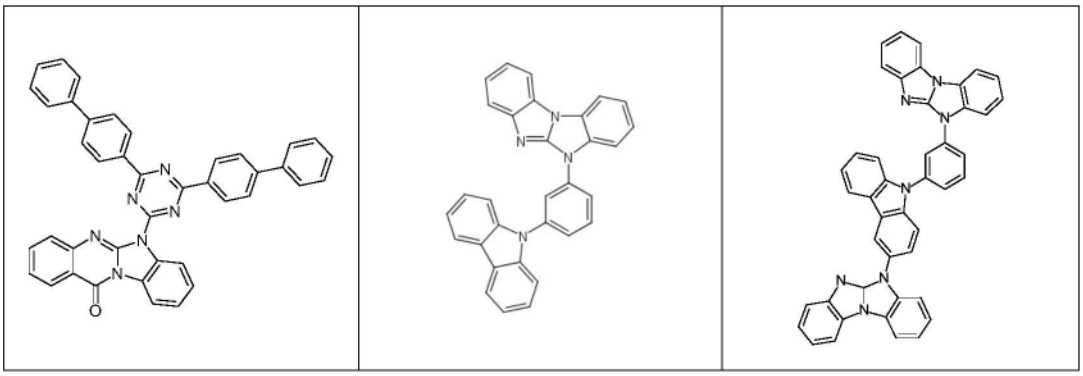
[0318] 用于磷光发光化合物的合适的基质材料有酮、氧化膦、亚砜和砜，例如根据WO 2004/013080、WO 2004/093207、WO 2006/005627或WO 2010/006680的；如在WO 2005/039246、US 2005/0069729、JP 2004/288381、EP 1205527、WO 2008/086851或US 2009/0134784中公开的三芳基胺、咔唑衍生物，例如CBP(N,N-双咔唑基联苯)、m-CBP或咔唑衍生物；桥连咔唑衍生物，例如根据US 2009/0136779、WO 2010/050778、WO 2011/042107或WO 2011/088877的；双咔唑衍生物、吲哚并咔唑衍生物，例如根据WO 2007/063754或WO 2008/056746的；茚并咔唑衍生物，例如根据WO 2010/136109或WO 2011/000455的；氮杂咔唑，例如根据EP 1617710、EP 1617711、EP 1731584、JP 2005/347160的；双极性基质材料，例如根据WO 2007/137725的；硅烷，例如根据WO 2005/111172的；硼氮杂环戊熳或硼酸酯，例如根据WO 2006/117052的；硅二氮杂环戊熳衍生物，例如根据WO 2010/054729的；磷二氮杂环戊熳衍生物，例如根据WO 2010/054730的；三嗪衍生物，例如根据WO 2010/015306、WO 2007/063754或WO 2008/056746的；锌络合物，例如根据EP 652273或WO 2009/062578的；二苯并呋喃衍生物，例如根据WO 2009/148015的；二苯并噻吩衍生物或联三苯叉衍生物或咪唑并咪唑衍生物，例如根据US 2016/0190480、US 2019/0273211或WO 2011/160757的。

[0319] 合适的基质材料的实例是下面所描绘的化合物。

[0320]



[0321]

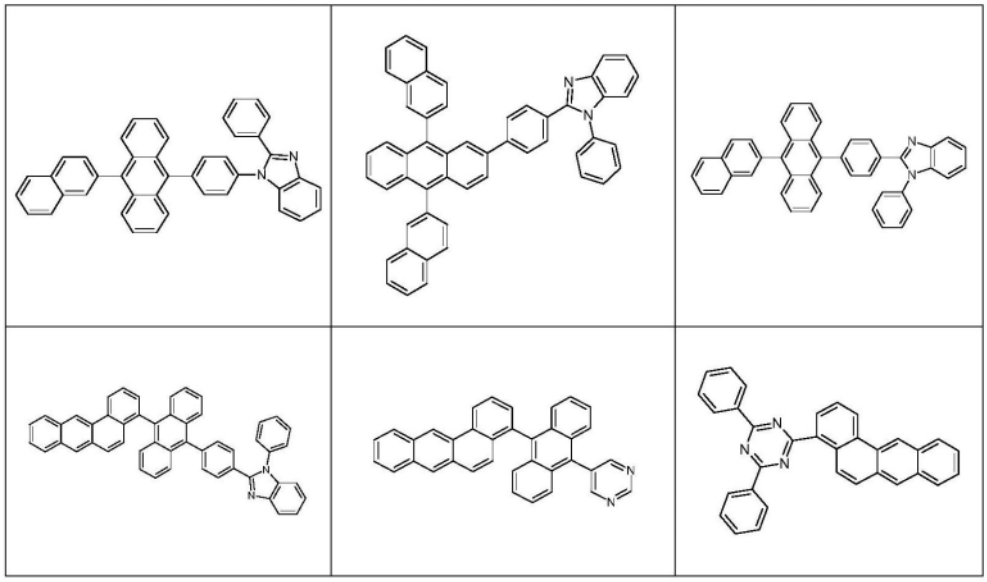


[0322] 电子传输性材料：

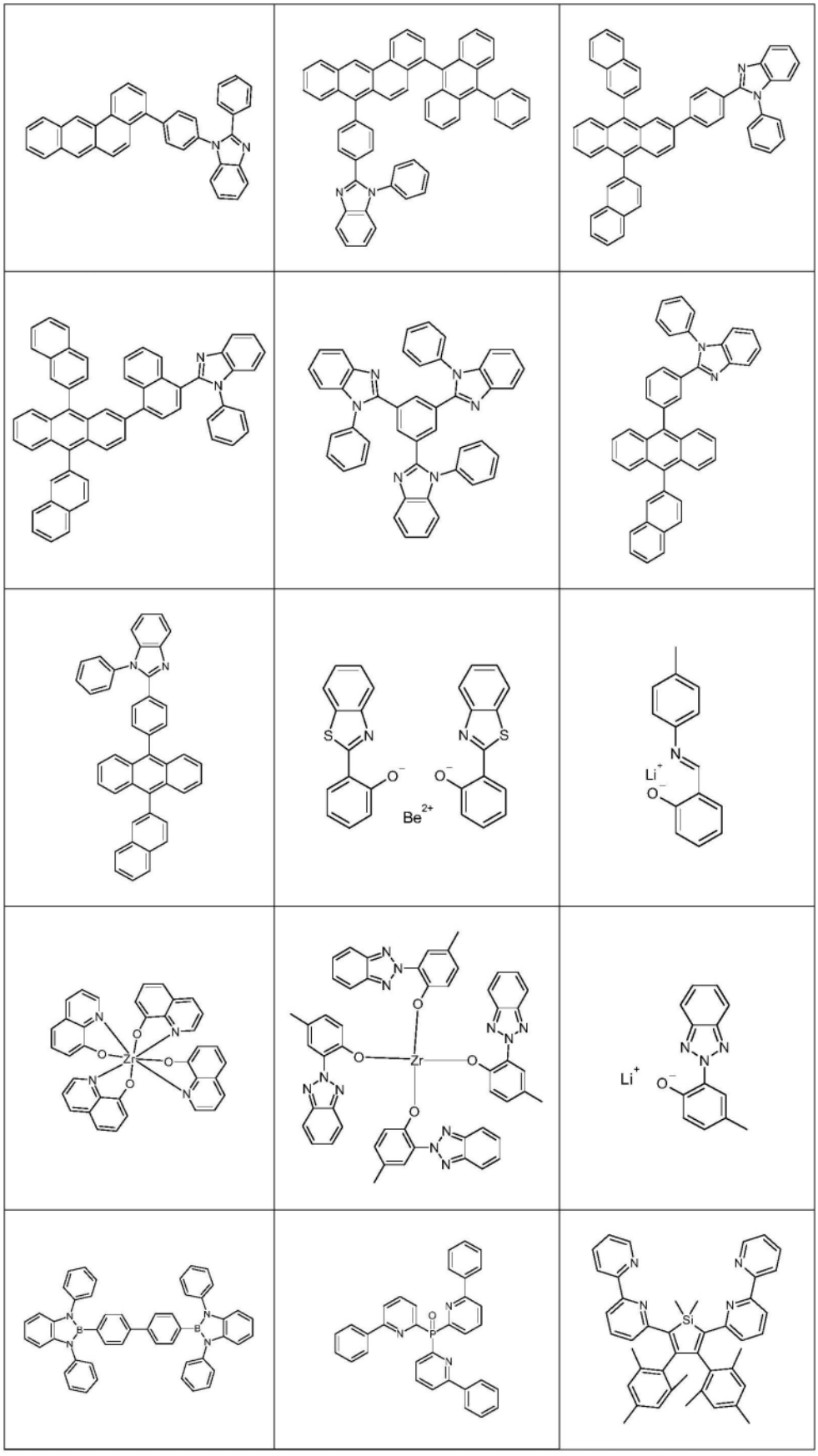
[0323] 合适的电子传输性材料是例如Y.Shirota等人,Chem.Rev.2007,107(4),953-1010中公开的化合物,或根据现有技术在这些层中使用的其它材料。

[0324] 用于电子传输层的材料可以是根据现有技术在电子传输层中用作电子传输材料的任何材料。尤其适合的是铝络合物(例如Alq_3)、锆络合物(例如Zrq_4)、锂络合物(例如LiQ)、苯并咪唑衍生物、三嗪衍生物、嘧啶衍生物、吡啶衍生物、吡嗪衍生物、喹喔啉衍生物、喹啉衍生物、噁二唑衍生物、芳族酮、内酰胺、硼烷、磷二氮杂环戊熳衍生物和氧化膦衍生物。优选电子传输性化合物如下表所示：

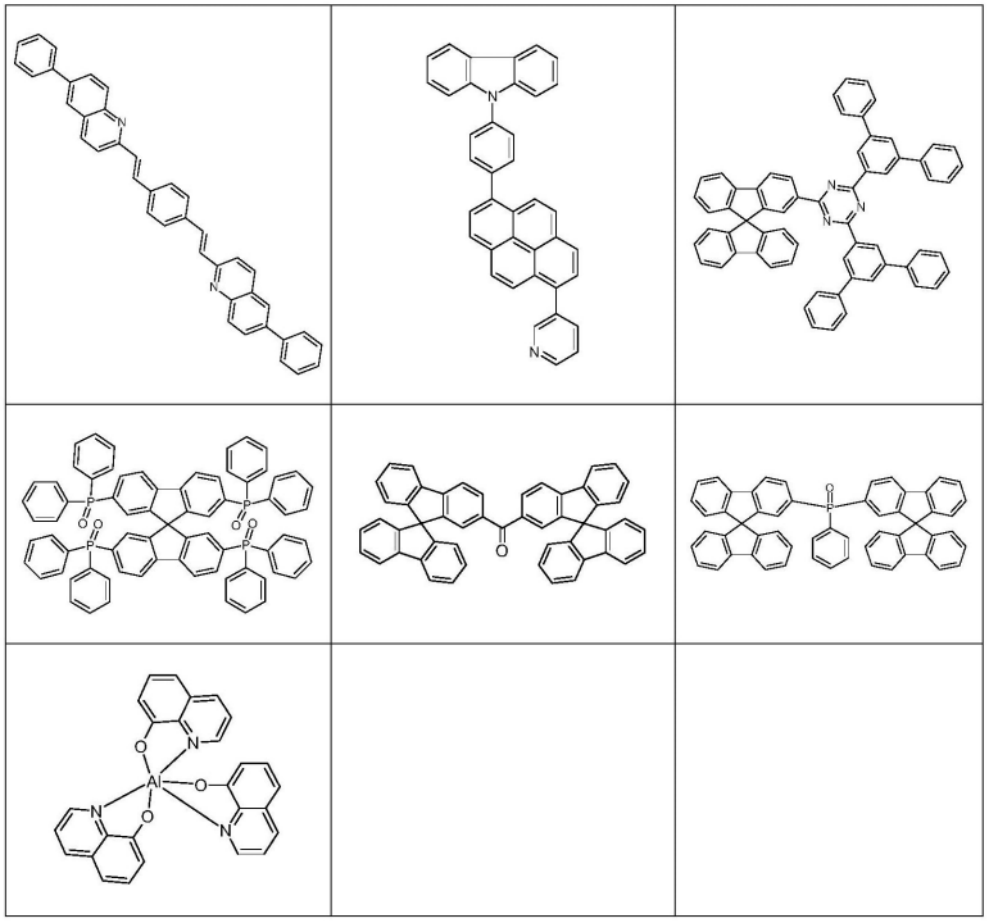
[0325]



[0326]



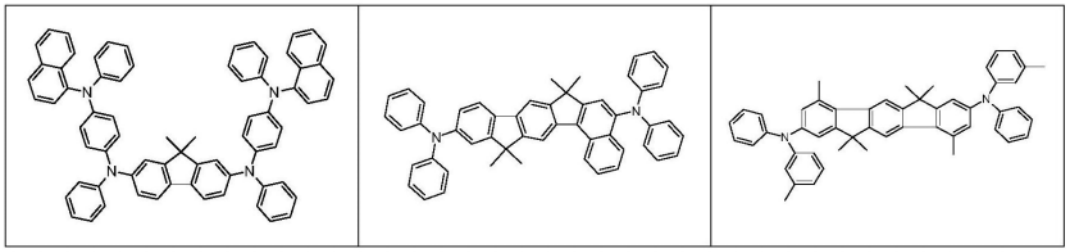
[0327]



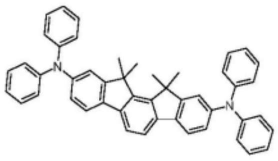
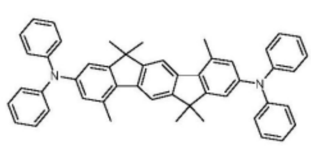
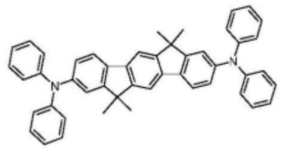
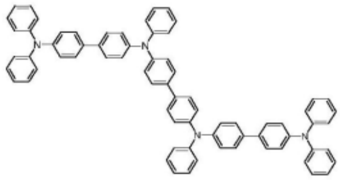
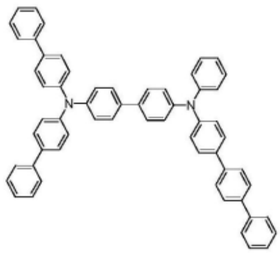
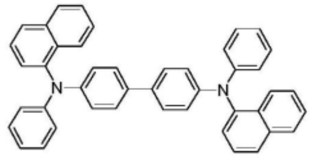
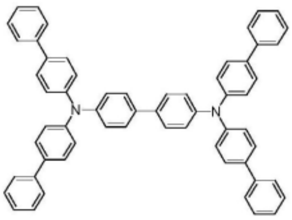
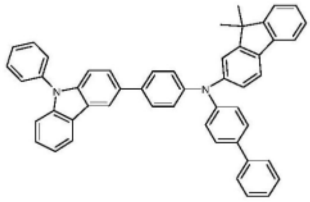
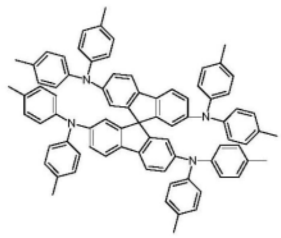
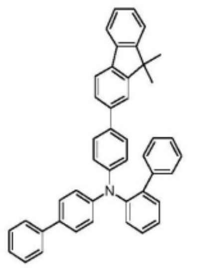
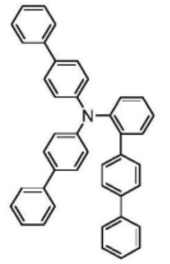
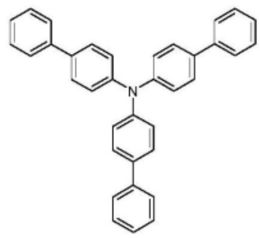
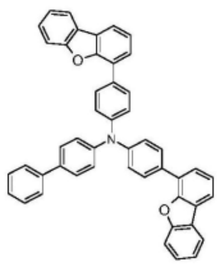
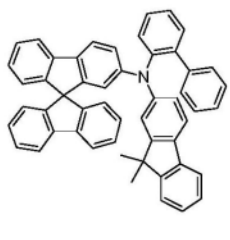
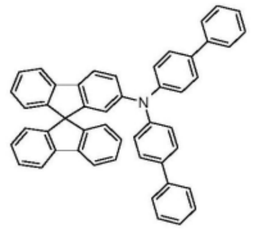
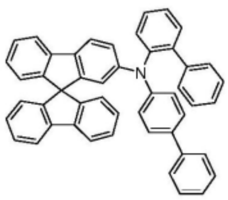
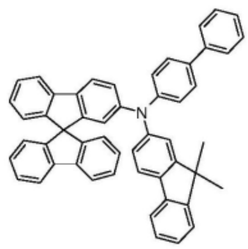
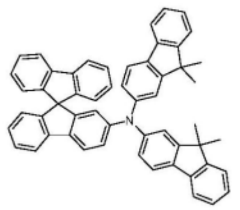
[0328] 空穴传输性材料：

[0329] 除式(1)的化合物以外，优选用于本发明的OLED的空穴传输性层中的其它化合物是茚并芴胺衍生物、胺衍生物、六氮杂联三苯叉衍生物、具有稠合芳族体系的胺衍生物、单苯并茚并芴胺、二苯并茚并芴胺、螺二芴胺、芴胺、螺二苯并吡喃胺、二氢吖啶衍生物、螺二苯并呋喃和螺二苯并噻吩、菲二芳基胺、螺三苯并托酚酮、具有间苯二胺基团的螺二芴、螺二吖啶、呫吨二芳基胺和具有二芳基氨基基团的9,10-二氢蒽螺化合物。下表示出了优选空穴传输性化合物：

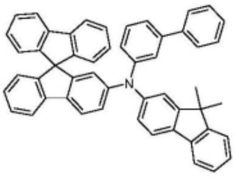
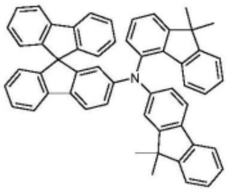
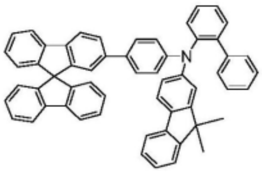
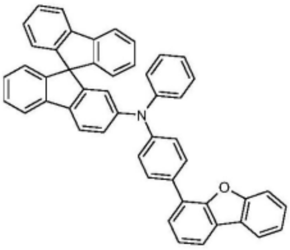
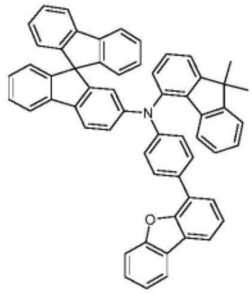
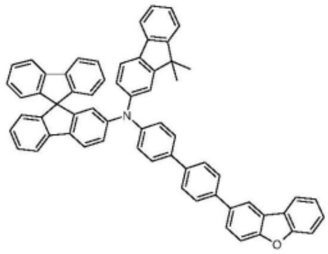
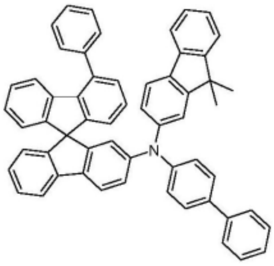
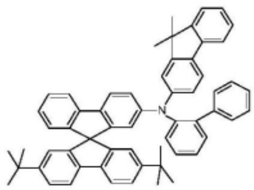
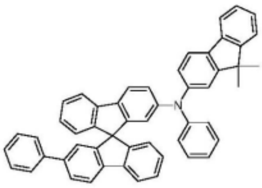
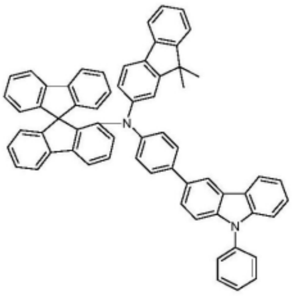
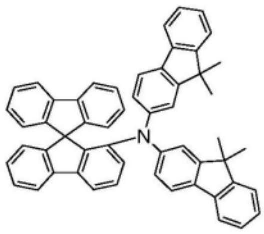
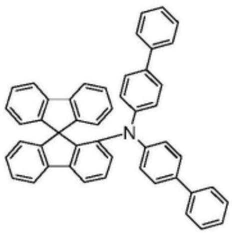
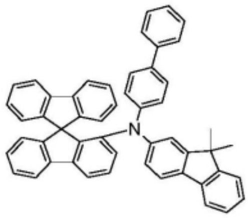
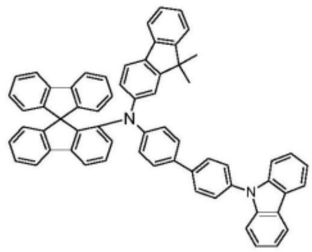
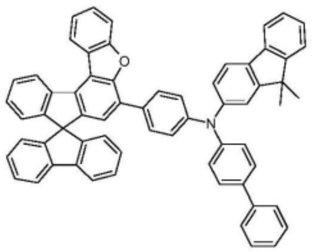
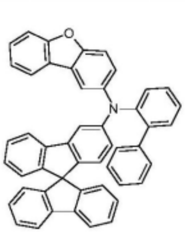
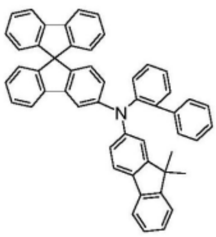
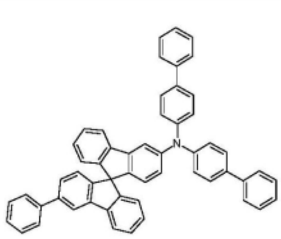
[0330]



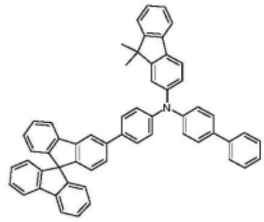
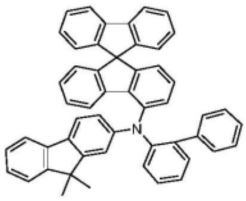
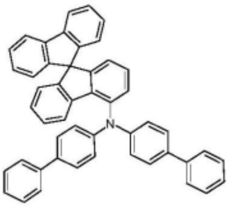
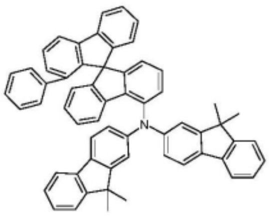
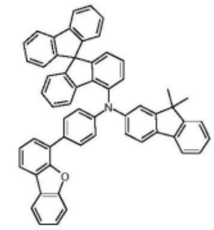
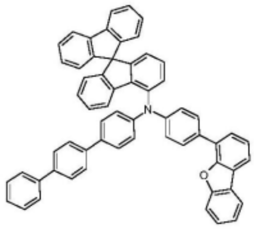
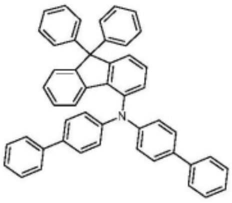
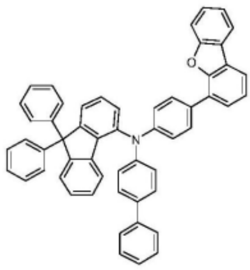
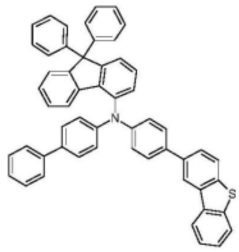
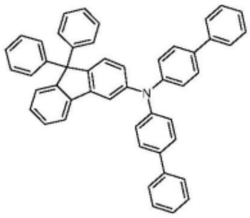
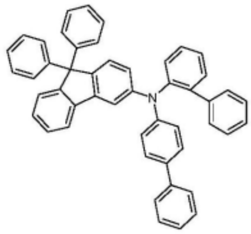
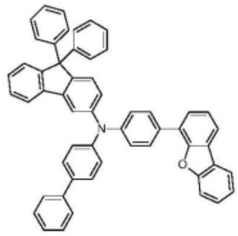
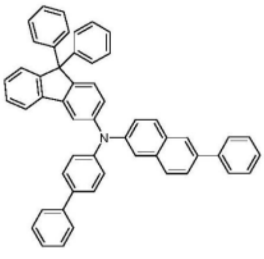
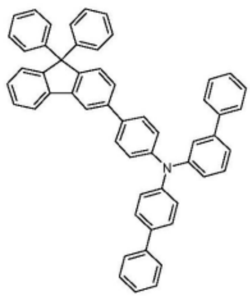
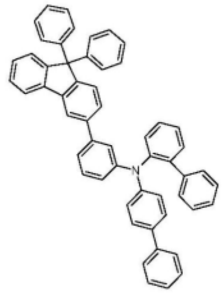
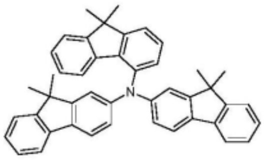
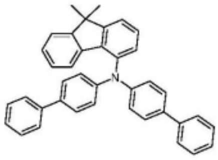
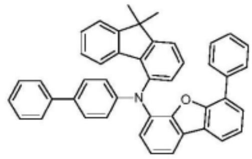
[0331]

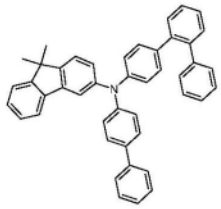
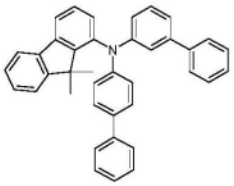
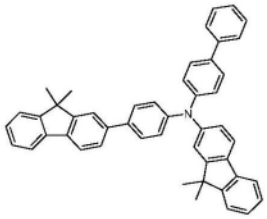
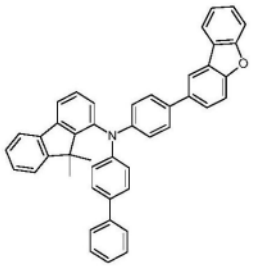
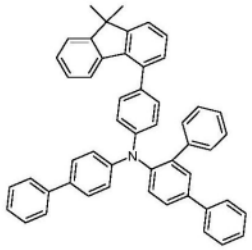
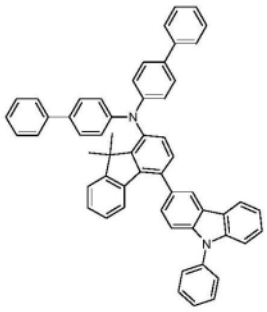
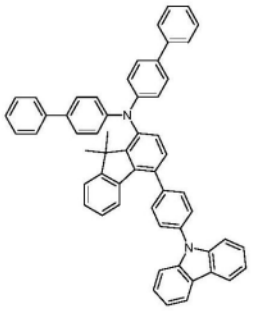
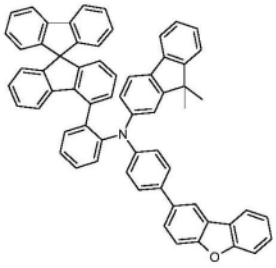
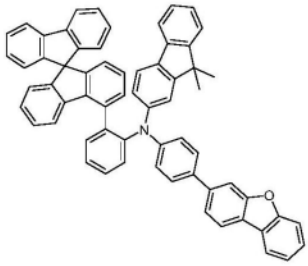
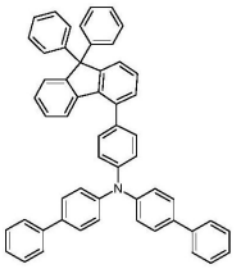
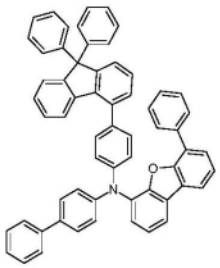
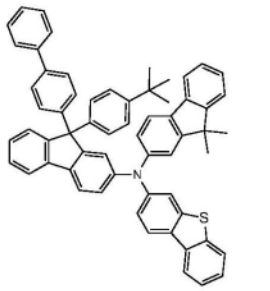
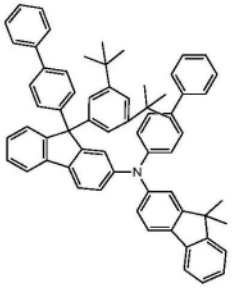
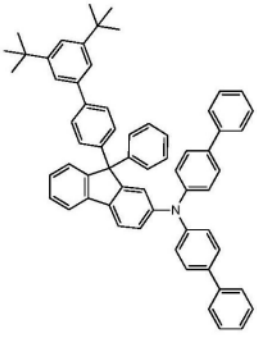
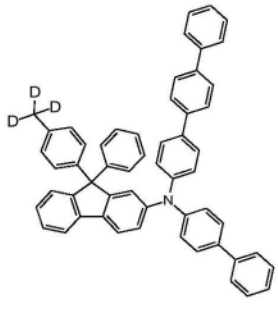
[0332]

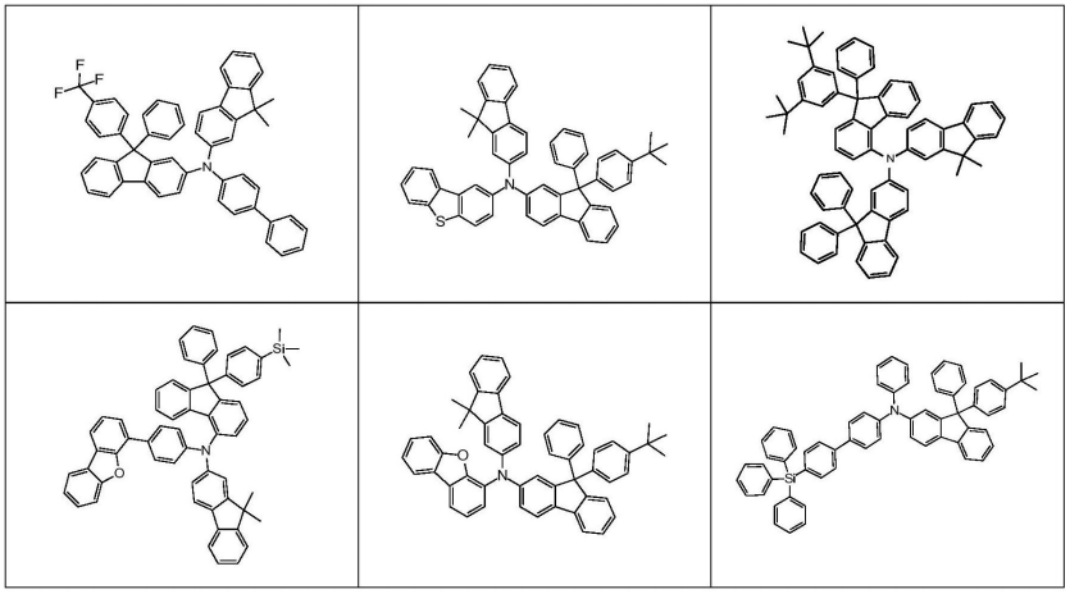
[0333]

[0334]

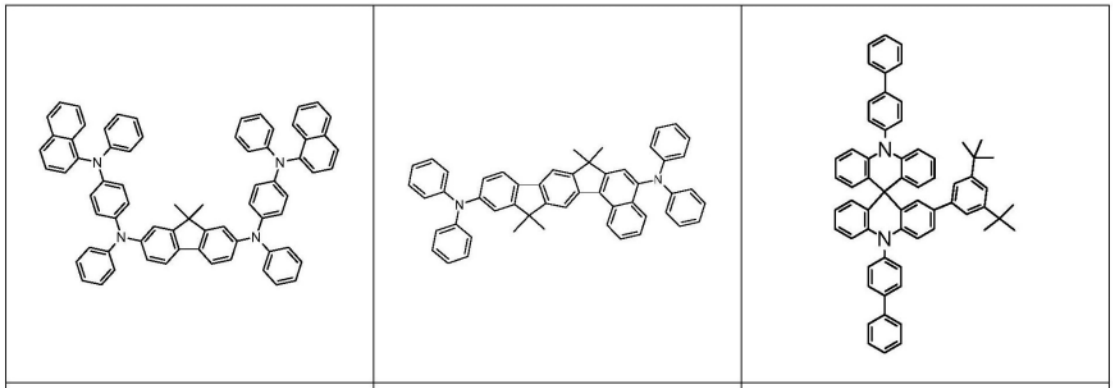
		
		
		
		
		

[0335]



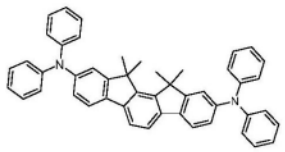
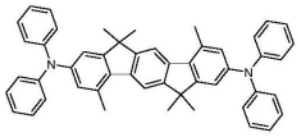
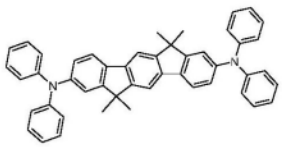
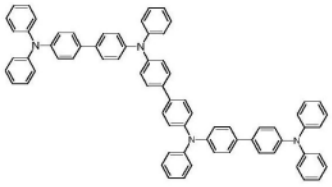
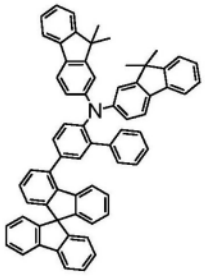
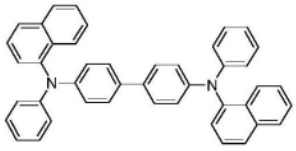
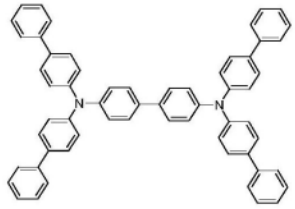
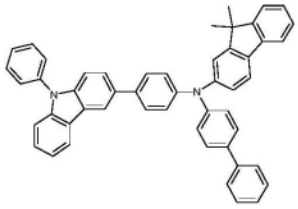
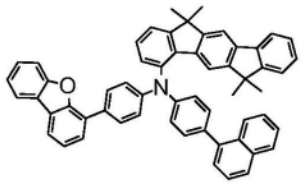
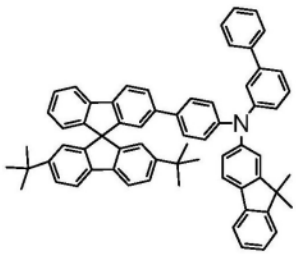
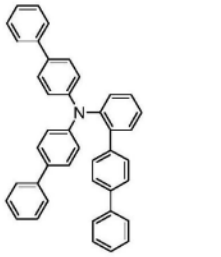
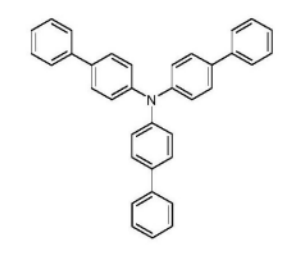
[0336] 以下化合物HT-1至HT-68适合在具有空穴传输性功能的层中使用，尤其在空穴注入层、空穴传输层和/或电子阻挡层中，或在发光层中作为基质材料使用，尤其是在包含一个或多个磷光发光体的发光层中作为基质材料使用，最优选在空穴注入层、空穴传输层和/或电子阻挡层中使用。所述化合物可以与本发明化合物组合在一个层中或在单独的层中使用，因为所述化合物本身已经具有非常好的空穴注入性能以及空穴传输性和电子阻挡性质，并且可以显著改进有机电致发光器件的性能数据(例如效率、寿命和电压)。

[0337]

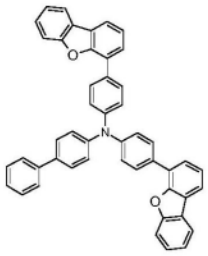
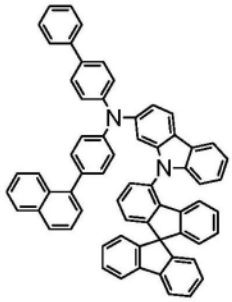
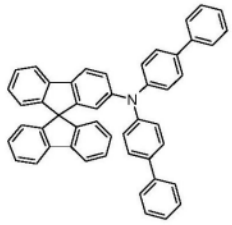
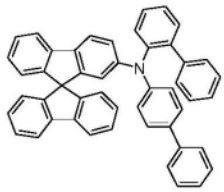
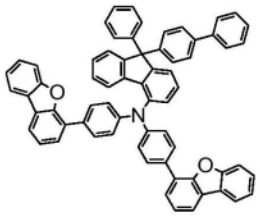
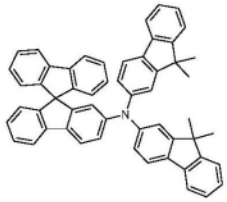
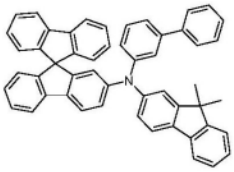
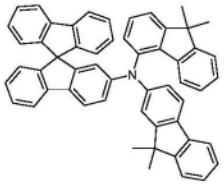
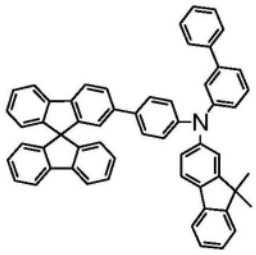
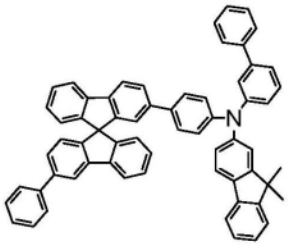
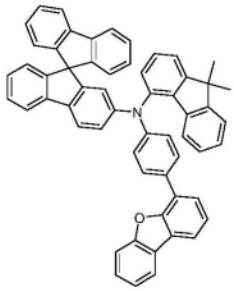
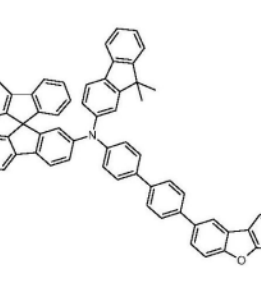


HT-1	HT-2	HT-3

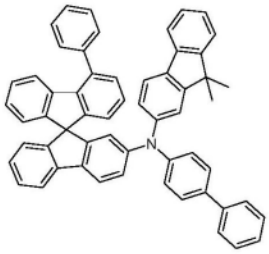
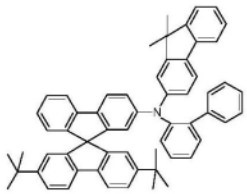
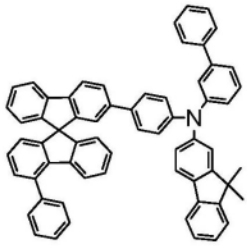
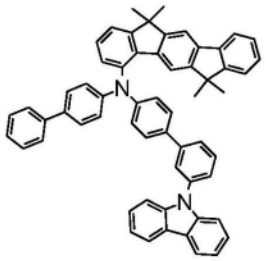
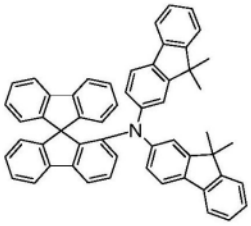
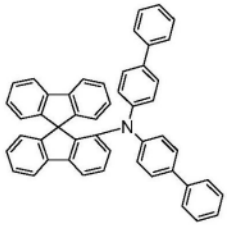
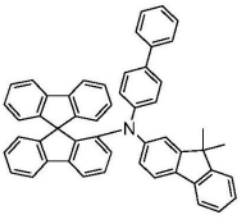
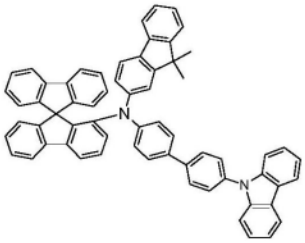
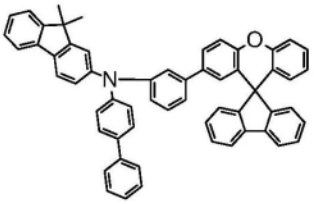
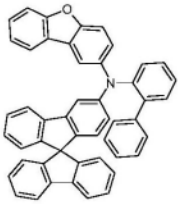
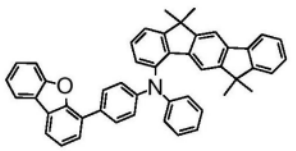
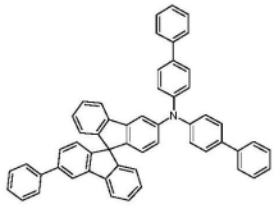
[0338]

		
HT-4	HT-5	HT-6
		
HT-7	HT-8	HT-9
		
HT-10	HT-11	HT-12
		
HT-13	HT-14	HT-15

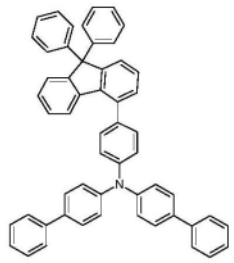
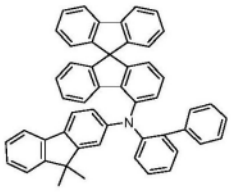
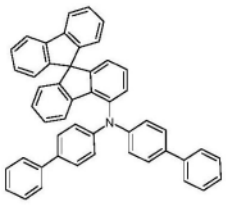
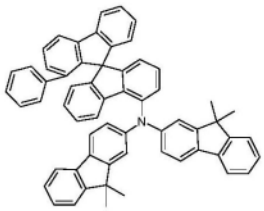
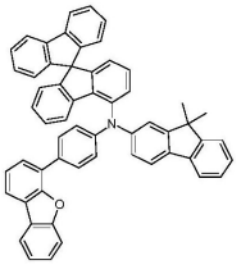
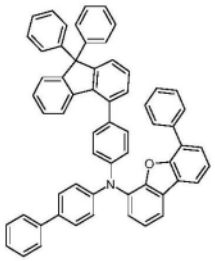
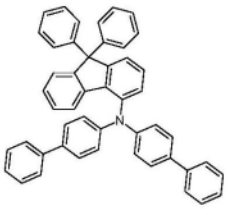
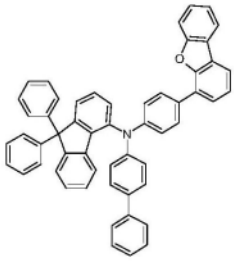
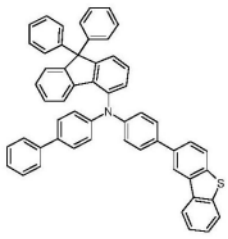
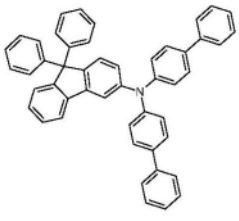
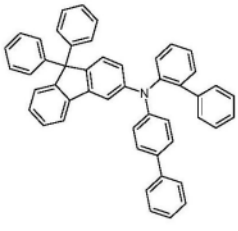
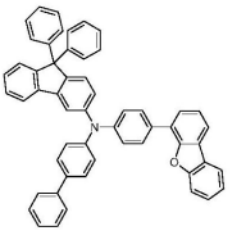
[0339]

		
HT-16	HT-17	HT-18
		
HT-19	HT-20	HT-21
		
HT-22	HT-23	HT-24
		
HT-25	HT-26	HT-27

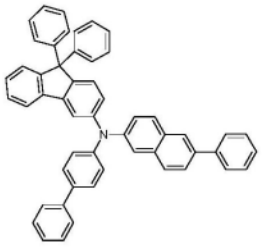
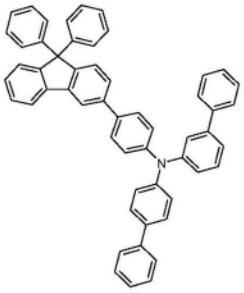
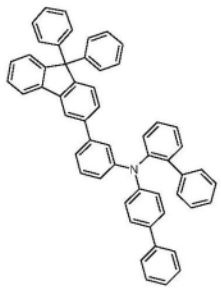
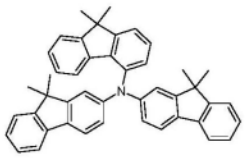
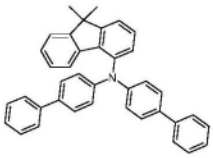
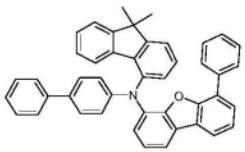
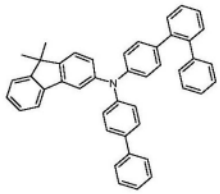
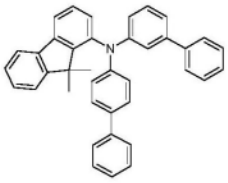
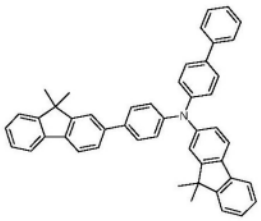
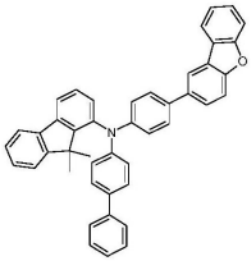
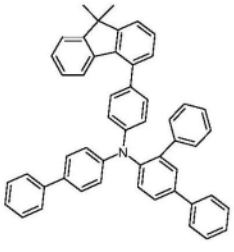
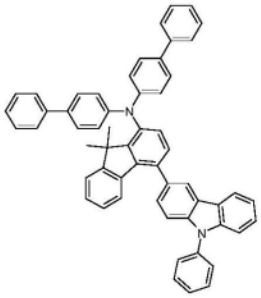
[0340]

		
HT-28	HT-29	HT-30
		
HT-31	HT-32	HT-33
		
HT-34	HT-35	HT-36
		
HT-37	HT-38	HT-39

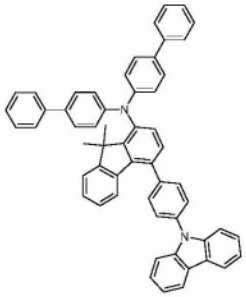
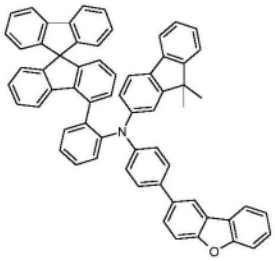
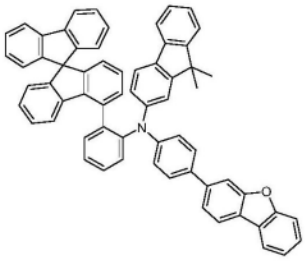
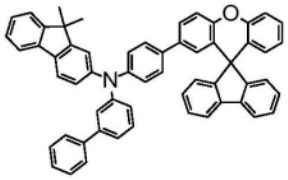
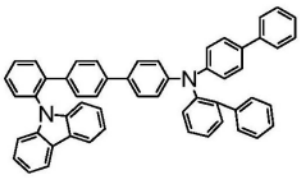
[0341]

		
HT-40	HT-41	HT-42
		
HT-43	HT-44	HT-45
		
HT-46	HT-47	HT-48
		
HT-49	HT-50	HT-51

[0342]

		
HT-52	HT-53	HT-54
		
HT-55	HT-56	HT-57
		
HT-58	HT-59	HT-60
		
HT-61	HT-62	HT-63

[0343]

		
HT-64	HT-65	HT-66
		
HT-67	HT-68	

[0344] 因此，化合物HT-1至HT-68对于任何设计和组成的OLED中而不仅仅是根据本申请的OLED中的上述用途通常具有优异的适用性。用于产生这些化合物的方法以及与这些化合物的用途相关的其它相关公开内容在以下出版物中公开：WO 2021/074106、WO 2018/069167、WO 2020/127145、WO 2019/048443、WO 2012/034627、WO2019/020654、WO 2014/079527、WO 2013/120577和WO 2015/158411。所述化合物在OLED中显示出良好的性能数据，尤其是良好的寿命和良好的效率。

[0345] 阴极：

[0346] 所述电子器件的优选阴极是具有低逸出功的金属、包含各种金属的金属合金或多层结构，所述各种金属例如碱土金属、碱金属、主族金属或镧系元素(例如Ca、Ba、Mg、Al、In、Mg、Yb、Sm等)。此外合适的是包含碱金属或碱土金属和银的合金，例如包含镁和银的合金。在多层结构的情况下，除了所提到的金属以外，还可使用具有相对较高的逸出功的其它金属，例如Ag或Al，在这种情况下，一般使用例如金属的组合，如Ca/Ag、Mg/Ag或Ba/Ag。还可优选将具有高介电常数的材料的薄中间层引入金属阴极与有机半导体之间。就此目的而言有用的材料的实例是碱金属氟化物或碱土金属氟化物，但也可以是相应的氧化物或碳酸盐(例如LiF、Li_2O、BaF_2、MgO、NaF、CsF、Cs_2CO_3等)。就此目的而言还可使用喹啉锂(LiQ)。此层的层厚度优选地在0.5和5nm之间。

[0347] 阳极：

[0348] 优选的阳极是具有高逸出功的材料。优选地，所述阳极具有相对于真空大于4.5eV的逸出功。首先，具有高氧化还原电位的金属适合用于此目的，例如Ag、Pt或Au。其次，金属/金属氧化物电极(例如Al/Ni/NiO_x、Al/PtO_x)也可是优选的。对于一些应用，所述电极中的至少一个必须是透明或部分透明的，以使得能够照射有机材料(有机太阳能电池)或发光(OLED、O-激光器)。在此优选的阳极材料是导电混合金属氧化物。特别优选氧化锡铟(ITO)或氧化铟锌(IZO)。此外优选导电掺杂型有机材料，尤其是导电掺杂聚合物。另外，所述阳极

还可以由两个或更多个层组成，例如ITO内层和金属氧化物外层，所述金属氧化物优选氧化钨、氧化钼或氧化钒。

[0349] 在一个优选实施方式中，所述电子器件的特征在于，通过升华工艺施加一个或多个层。在这种情况下，在低于10^{-5}毫巴、优选低于10^{-6}毫巴的初始压力下，通过在真空升华系统中的气相沉积来施加材料。然而，在这种情况下，初始压力也可以甚至更低，例如低于10^{-7}毫巴。

[0350] 同样优选这样的一种电子器件，其特征在于通过OVPD(有机气相沉积)方法或借助于载气升华来施加一个或多个层。在这种情况下，在10^{-5}毫巴与1巴之间的压力下施加材料。这种方法的一个特例是OVJP(有机蒸气喷印)方法，其中材料是通过喷嘴直接施加并因此结构化(例如M.S.Arnold等人，Appl.Phys.Lett.2008,92,053301)。

[0351] 另外优选这样一种电子器件，其特征在于，从溶液，例如通过旋涂，或通过任何印刷方法，例如丝网印刷、柔版印刷、喷嘴印刷或平板印刷产生一个或多个层，但更优选LITI(光引发热成像、热转印)或喷墨印刷来产生一个或多个层。为此目的，需要式(1)的可溶性化合物。可以通过对化合物进行合适的取代实现高溶解度。

[0352] 还优选通过从溶液施加一个或多个层以及通过升华法施加一个或多个层来制造本发明的电子器件。

[0353] 在施加层之后，根据用途，将所述器件结构化，设置接触连接并最终密封，以便消除水和空气的破坏作用。

[0354] 根据本发明，包含一种或多种式(1)的化合物的电子器件可以用于显示器、在照明应用中作为光源以及在医疗和/或美容应用中作为光源。

[0355] 本发明的化合物和本发明的有机电致发光器件较现有技术具有以下优点：

[0356] 1.本发明化合物非常适合用于有机电子器件的电子阻挡层(EBL)。为此目的，包含本发明化合物的器件具有非常良好的寿命。此外，此类器件的效率和工作电压处在非常良好的水平。当电子器件具有绿色发光，即所述器件由于荧光或磷光发光，优选磷光发光而发出绿光时，实现了特别良好的性能数据。

[0357] 2.本发明化合物非常适合用于电子器件中，例如有机电致发光器件中的空穴传输层或空穴注入层，尤其是由于其高空穴迁移率。

[0358] 3.本发明化合物具有相对较低的升华温度、高热稳定性以及高氧化稳定性和高玻璃化转变温度，这有利于可加工性，例如从溶液或从气相加工，还有利于用于电子器件。根据它们的性能数据和其它物理性质，所述化合物非常适合商业使用、商业生产和大规模生产。

[0359] 4.本发明化合物在电子器件中用作空穴传导基质或者空穴传输或空穴注入材料获得了高效率、低工作电压和长寿命。

[0360] 应当指出，本发明的范围涵盖本发明所述的实施方式的变化。除非明确排除，否则本发明公开的任何特征都可以替换为用于相同目的或者等效或类似目的的替代特征。因此，除非另外说明，否则本发明公开的任何特征都应当被视为通用系列的一个实例或者被视为等效或类似的特征。

[0361] 除非特定特征和/或步骤相互排斥，否则本发明的全部特征都可以以任何方式彼此组合。本发明的优选特征尤其如此。同样，非必要组合的特征可以单独使用(而非组合使

用)。

[0362] 还应当指出,许多特征,尤其是本发明的优选实施方式的那些特征,本身应当被认为是创造性的而非仅作为本发明的一些实施方式。对于这些特征,可以寻求独立保护来补充或替代任何当前要求保护的发明。

[0363] 本发明公开的技术教导可被抽象化并与其它实施例组合。

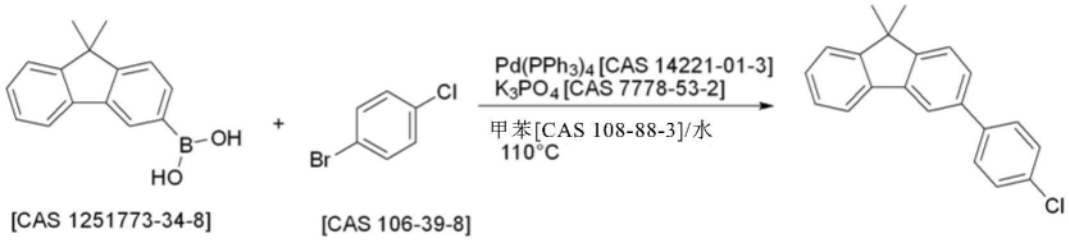
[0364] 以下实施例更详细地说明了本发明,而无意由此限制本发明。

实施例

[0365] A)合成实施例

[0366] 相当普遍地,通过本领域技术人员非常熟悉的方法来合成本发明化合物。首先,借助于Suzuki偶联对芴进行转化。在第二步中,借助于Buchwald反应将第一反应的产物转化为最终产物。

[0367] a)3-(4-氯苯基)-9,9-二甲基-9H-芴

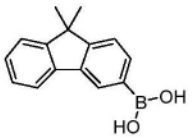
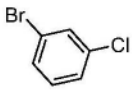
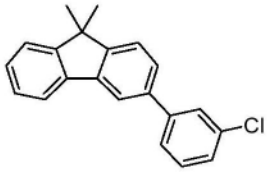
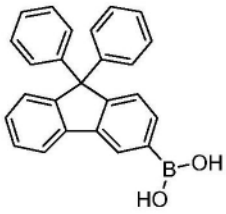
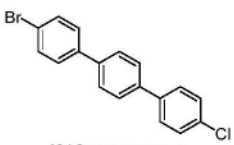
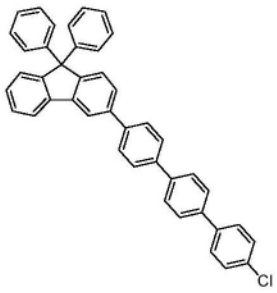
[0368] 

[CAS 1251773-34-8] [CAS 106-39-8]

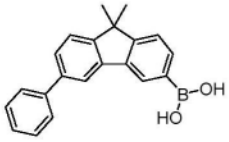
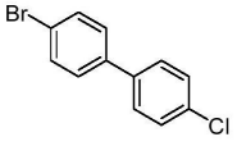
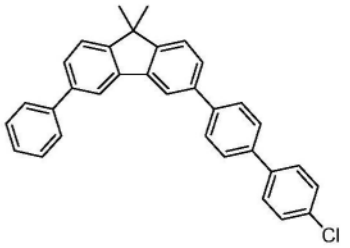
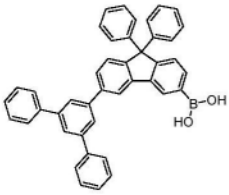
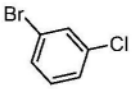
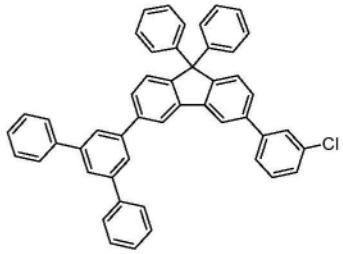
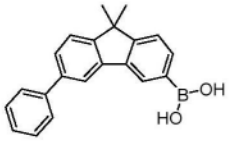
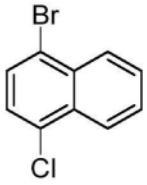
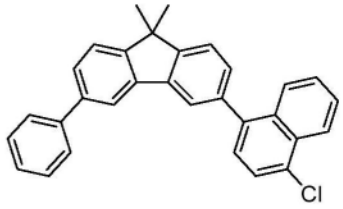
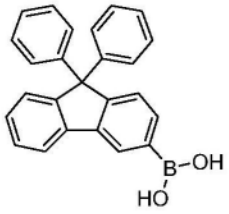
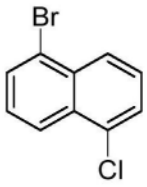
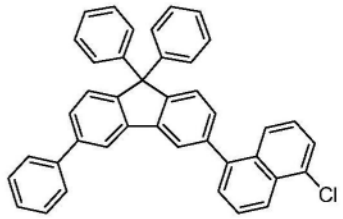
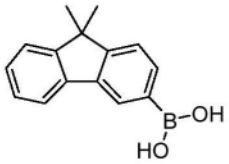
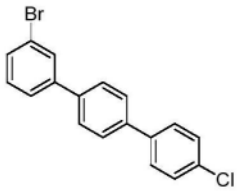
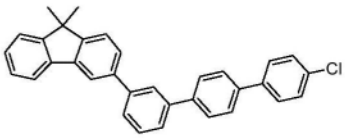
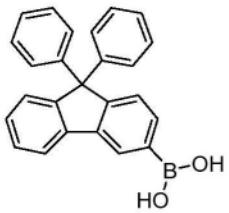
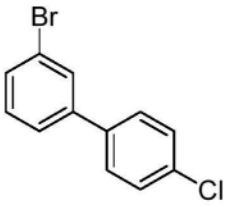
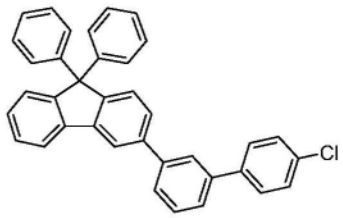
[0369] 将39.5g(166mmol,1.10当量)(9,9-二甲基-9H-芴-3-基)硼酸[CAS1251773-34-8]、30.6g(160mmol,1.00当量)1-溴-4-氯苯[CAS 106-39-8]和102g(480mmol,3.00当量)磷酸钾[CAS 7778-53-2]溶解在2000ml甲苯[CAS 108-88-3]和200ml水中。在氩气流中惰性化45分钟之后,加入3.70g(3.20mmol,2.00摩尔%)四(三苯基膦)钯并将混合物加热至回流持续16小时。冷却至室温之后,分离有机相,用乙酸乙酯萃取水相。用水洗涤所合并的有机相,经Na_2SO_4干燥。在减压下除去溶剂之后,将所获得的固体溶解在二氯甲烷中,通过加入乙醇使其沉淀。重复进行此操作之后,获得40.5g(133mmol,理论值的83%)产物。

[0370] 类似地获得以下化合物:

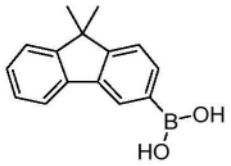
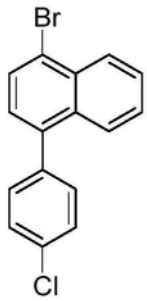
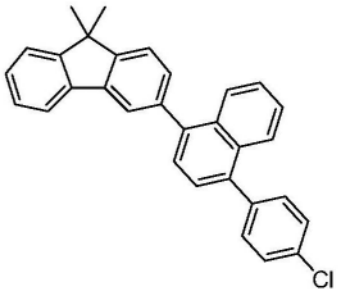
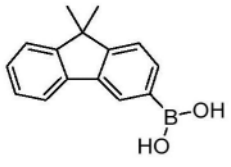
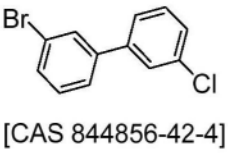
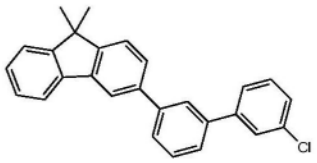
[0371]

编号	反应物 1	反应物 2	产物	产率
1a	 [CAS 1251773-34-8]	 [CAS 108-37-2]		80%
2a	 [CAS 1635401-03-4]	 [CAS 2413379-08-3]		68%

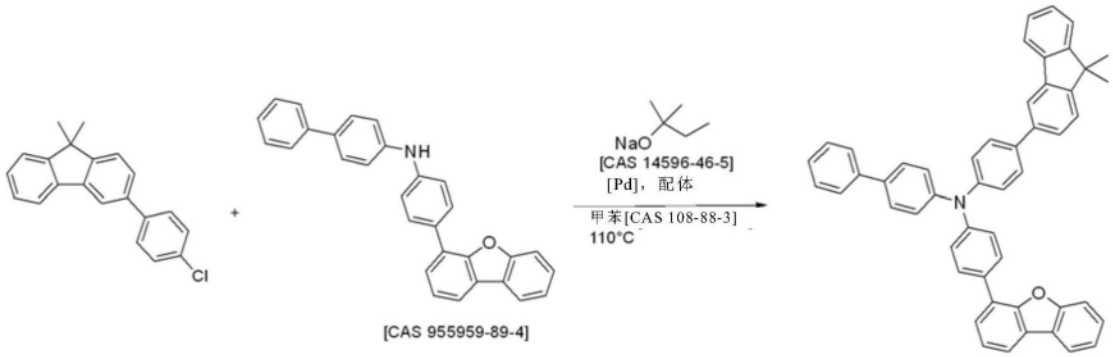
[0372]

3a	 [CAS 1319162-39-4]	 [CAS 23055-77-8]		72%
4a	 [CAS 1319162-42-9]	 [CAS 108-37-2]		55%
5a	 [CAS 1319162-39-4]	 [CAS 53220-82-9]		61%
6a	 [CAS 1635401-03-4]	 [CAS 77332-65-1]		64%
7a	 [CAS 1251773-34-8]	 [CAS 915031-07-1]		70%
8a	 [CAS 1635401-03-4]	 [CAS 164334-69-4]		79%

[0373]

9a	 [CAS 1251773-34-8]	 [CAS 2403429-47-8]		69%
10a	 [CAS 1251773-34-8]	 [CAS 844856-42-4]		71%

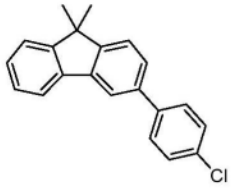
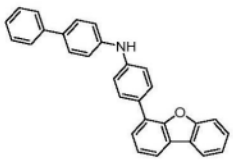
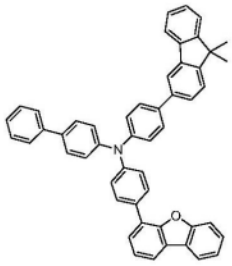
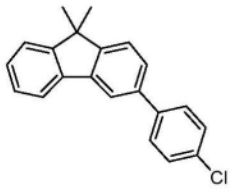
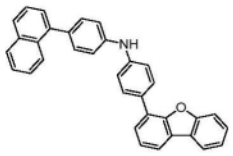
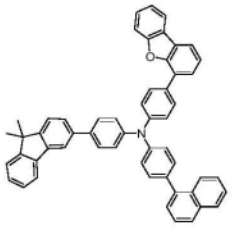
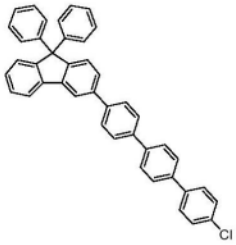
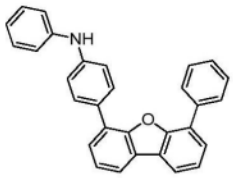
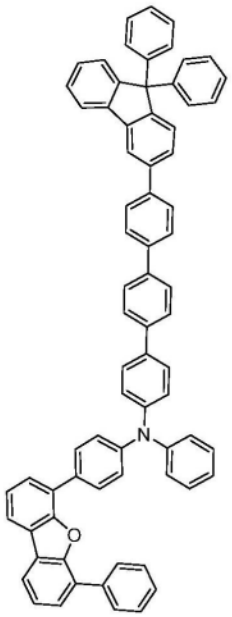
[0374] b)N-[4-(9,9-二甲基-9H-芴-3-基)苯基]-N-(4-{8-氧杂三环[7.4.0.02,7]十三1(9),2(7),3,5,10,12-己烯-6-基}苯基)-[1,1'-联苯]-4-胺

[0375] 

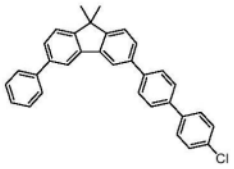
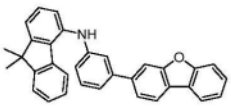
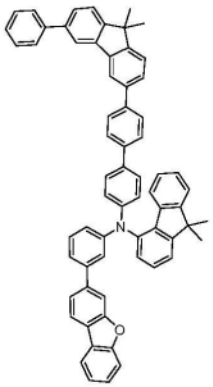
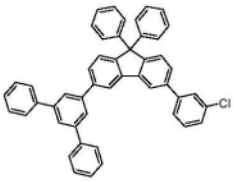
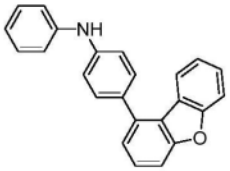
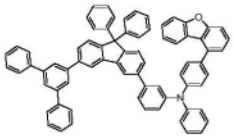
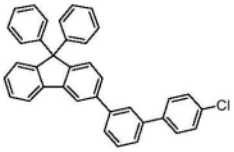
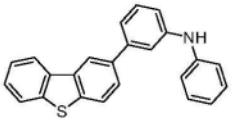
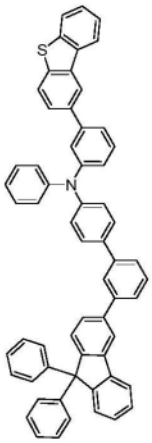
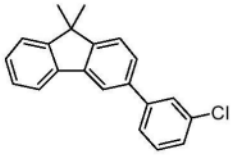
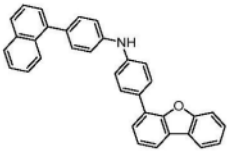
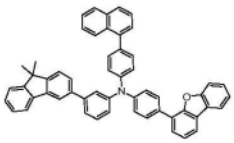
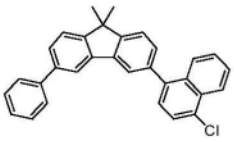
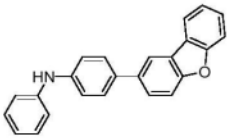
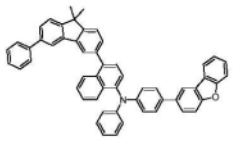
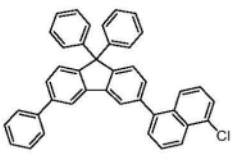
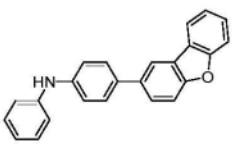
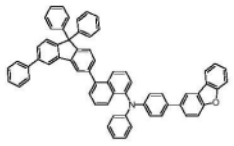
[0376] 将40.0g(131mmol;1.00当量)3-(4-氯苯基)-9,9-二甲基-9H-芴、54.0g(131mmol;1.00当量)N-(4-{8-氧杂三环[7.4.0.0^{2,7}]十三-1(9),2(7),3,5,10,12-己烯-6-基}苯基)-[1,1'-联苯]-4-胺[CAS 955959-89-4]和15.9g(144mmol;1.10当量)叔戊醇钠[CAS 14593-46-5]在2000ml甲苯[CAS 108-88-3]中的初始进料在氩气流中惰性化30分钟。此后,加入1.62mg(3.94mmol;3摩尔%)二环己基-(2',6'-二甲氧基联苯-2-基)膦(SPhos)[CAS 657408-07-6]和886mg(3.94mmol;3摩尔%)醋酸钯[CAS 3375-31-3],将混合物加热至回流持续18小时。完全转化并冷却至室温之后,向反应中加入水。进行相分离和用甲苯[CAS 108-88-3]萃取水相之后,浓缩所合并的有机相并加入庚烷。分离沉淀的固体。借助于Soxhlet萃取、重结晶和真空升华进行纯化,得到所期望的产物(52.0g;77.1mmol;理论值的59%)。

[0377] 类似地获得以下化合物:

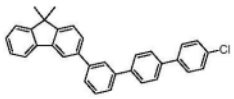
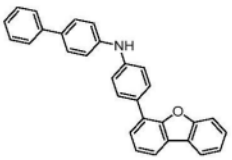
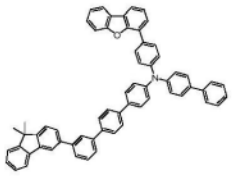
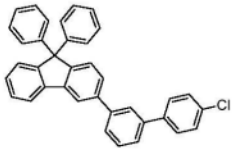
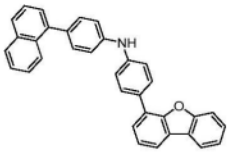
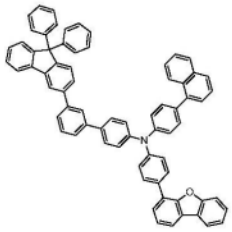
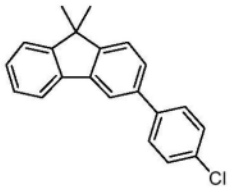
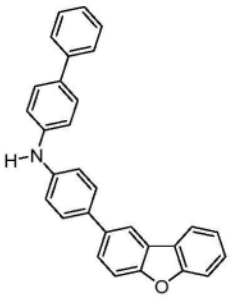
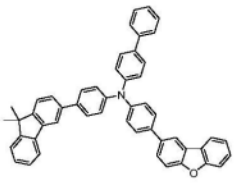
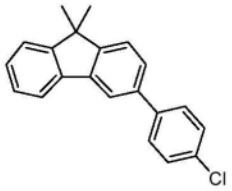
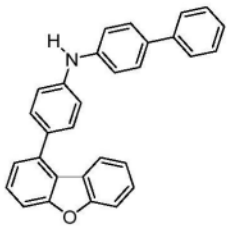
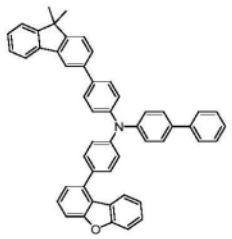
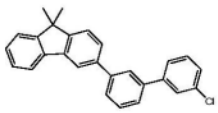
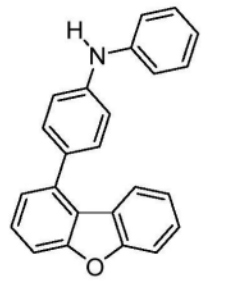
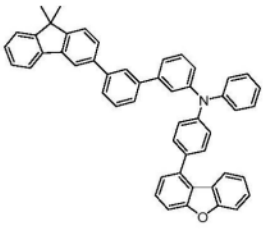
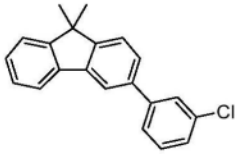
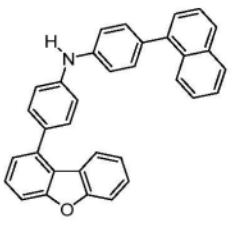
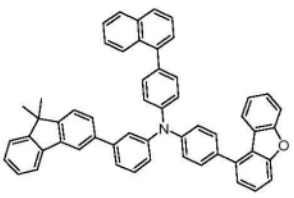
[0378]

编号	反应物 1	反应物 2	产物	产率
1b		 [CAS 955959-89-4]		56%
2b		 [CAS 2097371-73-6]		62%
3b		 [CAS 2376742-43-5]		48%

[0379]

4b		 [CAS 2378356-50-2]		42%
5b		 [CAS 2244106-56-5]		55%
6b		 [CAS 2173402-40-7]		58%
7b		 [CAS 2097371-73-6]		63%
8b		 [CAS 1381976-37-9]		51%
9b		 [CAS 1381976-37-9]		57%

[0380]

10b		 [CAS 955959-89-4]		45%
11b		 [CAS 2097371-73-6]		60%
13b		 [CAS 1547491-60-0]		55%
14b		 [CAS 1922919-50-3]		52%
15b		 [CAS 2244106-56-5]		63%
16b		 [CAS 2244205-92-1]		60%

[0381] 比较化合物FIMA1的合成在WO2014/015935A2中公开(实施例2的化合物2-8)。

[0382] B)器件实施例

[0383] 以下实施例E1至E5(参见表1)提供了本发明的材料在OLED中的用途。

[0384] 对涂覆有50nm厚的结构化ITO(氧化锡铟)的用于实施例E1至E5玻璃板在涂覆之前用氧等离子体预处理,然后用氩等离子体预处理。这些经等离子体处理的玻璃板形成了向其施加OLED的基底。

[0385] OLED基本上具有以下层结构:基底/空穴注入层(HIL)/空穴传输层(HTL)/电子阻挡层(EBL)/发光层(EML)/任选的空穴阻挡层(HBL)/电子传输层(ETL)/任选的电子注入层(EIL),最后是阴极。所述阴极由100nm厚的铝层形成。OLED的确切结构可见于表1。制造OLED所需的材料如表2所示。OLED的数据列在表3中。

[0386] 所有材料都是在真空室中通过热气相沉积施加。在这种情况下,发光层始终是由至少一种基质材料(主体材料)和发光掺杂剂(发光体)组成,所述发光掺杂剂(发光体)通过共蒸发以特定体积比例加入基质材料中。以IC1:IC2:TEG1(59%:29%:12%)这样的形式给出的详细信息在这里意指材料IC1以49%的体积比例存在于层中、IC2以44%的比例存在于层中而TEG1以7%的比例存在于层中。类似地,电子传输层还可以由两种材料的混合物组成。

[0387] 以标准方式对OLED进行表征。为此目的,测定了电致发光光谱、从呈现朗伯发光特性的电流-电压-发光密度特性计算作为发光密度函数的电流效率(SE,以cd/A测量)和外量子效率(EQE,以%测量),还测定了寿命。在1000cd/m^2的发光密度下测定了电致发光光谱,并由此计算CIE 1931x和y颜色坐标。表3中的参数U1000是指在1000cd/m^2发光密度下所需的电压。SE1000和EQE1000分别表示在1000cd/m^2下获得的电流效率和外量子效率。

[0388] 寿命LD定义为在以恒定电流密度j0工作过程中,发光密度从起始发光密度下降到一定比例L1后的时间。表3中的数字L1=80%表示LD列中报告的寿命对应于发光密度下降到其起始值的80%后的时间。

[0389] 本发明化合物EG1、EG2、EG3、EG4用于实施例E2、E3、E4、E5中作为磷光绿色OLED的电子阻挡材料。将结果与比较例E1相比较。表3概括了OLED的性能数据。

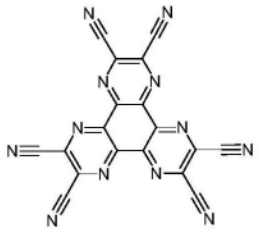
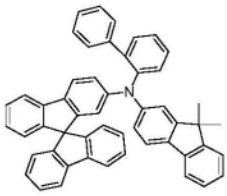
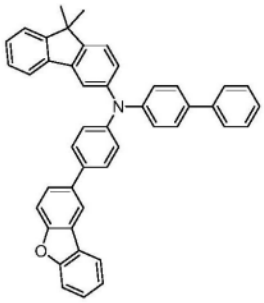
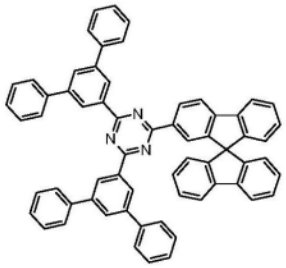
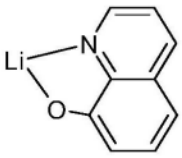
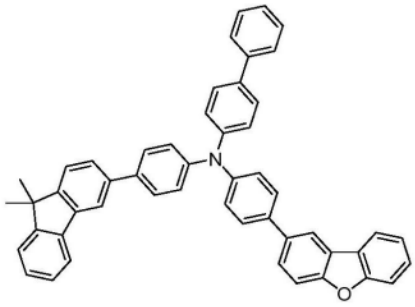
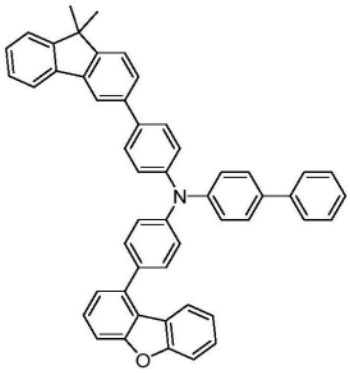
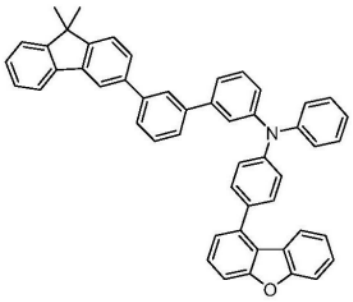
[0390] 表1:OLED的结构

[0391]

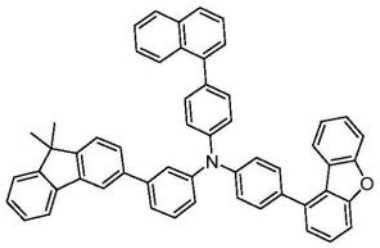
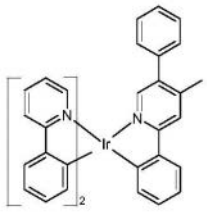
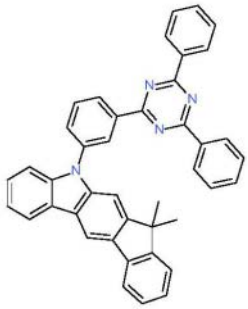
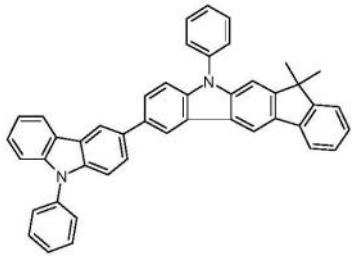
实施例	HIL 厚度	HTL 厚度	EBL 厚度	EML 厚度	HBL 厚度	ETL 厚度	EIL 厚度
E1	HATCN 5nm	SpMA1 230nm	FIMA1 10nm	IC1:IC2:TEG1 (59%:29%:12%) 30nm	ST2 10nm	ST2:LiQ (50%:50%) 30nm	LiQ 1nm
E2	HATCN 5nm	SpMA1 230nm	EG1 10nm	IC1:IC2:TEG1 (59%:29%:12%) 30nm	ST2 10nm	ST2:LiQ (50%:50%) 30nm	LiQ 1nm
E3	HATCN 5nm	SpMA1 230nm	EG2 10nm	IC1:IC2:TEG1 (59%:29%:12%) 30nm	ST2 10nm	ST2:LiQ (50%:50%) 30nm	LiQ 1nm
E4	HATCN 5nm	SpMA1 230nm	EG3 10nm	IC1:IC2:TEG1 (59%:29%:12%) 30nm	ST2 10nm	ST2:LiQ (50%:50%) 30nm	LiQ 1nm
E5	HATCN 5nm	SpMA1 230nm	EG4 10nm	IC1:IC2:TEG1 (59%:29%:12%) 30nm	ST2 10nm	ST2:LiQ (50%:50%) 30nm	LiQ 1nm

[0392] 表2:用于OLED的材料的结构式

[0393]

	
HATCN	SpMA1
	
FIMA1	ST2
	
LiQ	EG1
	
EG2	EG3

[0394]

	
EG4	TEG1
	
IC1	IC2

[0395] 表3:OLED的数据

[0396]

实施例	U1000 (V)	SE1000 (cd/A)	EQE 1000 (%)	1000 cd/m^2 下的 CIE x/y	j_0 (mA/cm^2)	L1 (%)	LD (h)
E1	3.3	69	19.8	0.36/0.61	20	80	310
E2	3.3	71	20.8	0.36/0.62	20	80	328
E3	3.3	77	21.0	0.36/0.62	20	80	316
E4	3.3	80	21.5	0.36/0.62	20	80	298
E5	3.3	81	21.5	0.36/0.62	20	80	305

[0397] 发现含有本发明化合物的OLED具有极好的性能数据;特别地,它们与现有技术相比明显改进了效率。此外,电压和寿命都处于极高水平。