

(19)
(12)

(KR)
(B1)

(51) 。 Int. Cl. 7
H01L 21/76

(45)
(11)
(24)

2003 03 15
10 - 0376237
2003 03 04

(21) 10 - 2000 - 0061878
(22) 2000 10 20

(65) 2001 - 0051166
(43) 2001 06 25

(30) 1999 - 321329 1999 11 11 (JP)

(73) 가 가 2 2 3

(72) 2 2-3 가 가

(74)

:

(54)

STI 가 .
(4) (1) (1)
(2) (3) (1)
(6) 가 , (2)
(3) 가 . (6) (2)

5

, , , , ,

| | | | | |
|----|---|---|--|---|
| 1 | | | | . |
| 2 | 1 | | | . |
| 3 | 1 | | | . |
| 4 | 1 | | | . |
| 5 | 1 | | | . |
| 6 | 1 | | | . |
| 7 | 1 | | | . |
| 8 | 1 | | | . |
| 9 | 1 | | | . |
| 10 | 1 | | | . |
| 11 | 1 | | | . |
| 12 | 1 | | | . |
| 13 | 1 | | | . |
| 14 | 1 | | | . |
| 15 | 1 | | | . |
| 16 | 1 | 1 | | . |
| 17 | 1 | 1 | | . |
| 18 | 1 | 1 | | . |
| 19 | 1 | 1 | | . |
| 20 | 1 | 2 | | . |

| | | | |
|----|---|---|---|
| 21 | 1 | 2 | . |
| 22 | 1 | 2 | . |
| 23 | 1 | 2 | . |
| 24 | 2 | | . |
| 25 | 2 | | . |
| 26 | 2 | | . |
| 27 | 2 | | . |
| 28 | 2 | | . |
| 29 | 2 | | . |
| 30 | 2 | | . |
| 31 | 2 | | . |
| 32 | 2 | 1 | . |
| 33 | 2 | 1 | . |
| 34 | 2 | 1 | . |
| 35 | 2 | 1 | . |
| 36 | 2 | 1 | . |
| 37 | 2 | 1 | . |
| 38 | 2 | 1 | . |
| 39 | 2 | 1 | . |
| 40 | 2 | 2 | . |
| 41 | 2 | 3 | . |
| 42 | 3 | | . |
| 43 | 3 | | . |
| 44 | 3 | | . |
| 45 | 3 | | . |

46 4 .
 47 4 .
 48 .
 49 .
 50 .
 51 .
 52 .
 53 .
 54 .
 55 .
 56 .
 57 .
 58 .
 59 .
 60 .

<

1 : ()

2 : ()

3 : ()

4 : ()

6, 30, 80, 90 : ()

7 :

8 : 32

9, 34, 54, 56 :

11, 50, 35, 44, 60, 62 : ()

가 STI 가

가)

가 가 , 가 , 가 가

0.2 μ m LOCOS

(Local Oxidation of Silicon) STI (Shallow Trench Isolation ;)

LOCOS (1) , (2)

LOCOS () LOCOS 가 , (3)

가 가 가 LOCOS 가 , (4)

가 , STI 가

0.1 0.5 μ m 가

가 CMP (Chemical Mechanical Polishing) , STI

가 가 가 LOCOS

STI

MOS (Metal Oxide Semiconductor)

STI 가 (

;) MOSFET (MOS Field Effect Transistor) 가 STI

가 , MOSFET

가

STI

STI (,) (,) STI

ET가 () 가 MOSFET

가

STI

STI 48 58 ST

(101) (102), (103) (104) (

49 가 49 가 (104) (105) (

) (103) 가 (104) (105) (104)

가 (105) (103) (105)

50 (105)가 (104) (101)

(103), (102) (101)

300nm 가 (101)

(106)가 (101) 50 (103)

51 (106) 50nm (107)

가 가

(107) (101) (106) STI (101)

51 (103) (102) (101) 가

(106) (108) (101)

가 (103) [(101) (107) 가]

(107) , MOS

가 가

(103) (102)

(104) (103) 가

, 52가 (107) (106)가 , (109)
 , HDP (High Density Plasma) - CVD(Chemical Vapor Deposition)
 (104) , (104) ()
 103) , (102) , (101) (109) T
 EOS (107) . , ,
 , 53 (104) CMP (Chemical Mechanical Polishing)
 , (109) . (106) (6) ()
 109) .
 , 54 (104) (103) .
 , 55가 (109) 가 , STI
 (120) , (108) , (102) .
 (107) STI , (108) 55 F
 STI (101) . (108)
 56 G (110)가 .
 , 55 57 가 56 58
 가 (101) 10nm 20nm (120)
 800 1100 가 (106) [(101)]
 (densification) , [(101)]
 [(101) , (111) , (112)]
 , (101) , (111) , (112)
 , 57 58 가 .
 58 (110)가 , (112) 가 (110)
 STI (111) (112) 가 ,
 (110)가 57 F (110)가 58 G
 (108) () , (110)가 58
 (101) STI , STI 57 58
 , STI .
 59 가 () STI
 , (110)가 58 (C11). (110)가
 57 (C10) .
 57 (108) ,

(101) 가 (108)

STI 가 , 가 (101) 가 ()

가 가 가 가 100% 가 , (101)

가 , 59가 STI (110)가 가 가

가 가

, 60 STI MOSFET - HP가 (101)

C13 (110) STI 가 가 (110)

가 가 , MOSFET 가

, STI (110) 가 가

MOSFET 가 가

, (101) (106)가 (101)

(106) STI (101) / (MOSFET

가 , (101) STI 가 (101) 가

STI STI

STI (1) (101) STI

(dislocation)가 (2) STI ()가 가 STI

()가 가 , 가 STI , STI

STI 가 STI STI

가 STI
 가 STI
 STI 2 STI
 SiO₂가 SiO₂ 3.7 3.9 STI
 SFET / MOSFET / 가 MO

가 STI 가 STI
 () , MOSFET
 STI STI

9 - 82794 (, 1), 8 - 213382
 (, 2), "Symposium on VLSI Technology, Digest of Technical Papers"(1999) pp. 159 160(
 , 3), 11 - 186378 (, 4) USP 5,447,884(, 5)가

가
 가

가

b) , (a) , (

, (c) , (d)

, (e) , (f)

, (g) , (h) , (g) , (i)

(g) , (j)

, (d)가 (d - 1)

, (e) (e - 1)

, (e - 2) (e - 1)

(j) (j - 1)

N MOSFET

, (e) (e - 1)

, (e - 2) (e - 1)

(j) (j - 1)

P MOSFET

, (a) , (b)

, (c) , (d)

, (e)

, (f) (e)

, (g) (e) , (h)

, (g) (g - 1) (e) (f)

(i) (g - 1) (f)

, (g) (g - 1) (e) (f)
 (i) (g - 1) (f)

, (a) , (b)

, (c) , (d)

, (e) (e) (g) (e)
 , (f) (e) , (h) , (i) (a)

, (d) (d) (d - 1) (d - 1) 가
 (i) (i - 1) (d - 1) (d - 2)

, (a) , (b)

, (c) , (d)

, (e) (e) (g) (e)
 , (f) (e) , (h) (f) , (i)

, (a) , (b)

, (c) , (d)

, (e) (f) (f) (f)
 , (h) (f) , (g) (f) , (i)

[1.]

1 MOSFET (, N MOSFET) 가

1 (70) (1) P⁻ (70) ; 80) STI(STI MOSFET

(70) N (70) N⁺ / (72) N

LDD(Lightly Doped Drain) (73) LDD (73) (72) LDD (73), (74)

P⁻ (74) / (72)

(74) LDD (73) (74) (74)

(13) (14) (14) (70) 1 (72), LDD (73), (74) MOSFET GW

(70) STI(80) (71) / (72) (79) (79) (77) (77)

(78) (14) (77) (77)

X - X STI(80) 1 GW Y - Y

[2. 1]

1 STI () 2 12

2 가 2 (1) (SiO₂) (2) 10nm 20nm (1) ; CVD(; Chemical Vapor Deposition) 가 30nm 50 nm (3) (2) 가 100nm 250nm (Si₃N₄) (4)

3 가 3 가 (4) (5) () (3) 가 (4) (4) (4) (1)

(4) (4) (1)

(1) STI (8) SiO₂ SiO₂/SiON 2 SiO₂/SiON SiO₂/SiON/SiO₂ 3

가 (9) 가 (6) 가

8 (11) (7)가 HDP - CVD 가

500nm 600nm (11) (7) () (11) (4) 가

(11) TEOS, (7) 가

(11) (7) 가

가 (SiON) (11) MOSFET, STI 가

MOSFET / 4 6 MOSFET

TEOS((11) 가 SiOF 3.3 3.5, SiO₂(3.7 3.9) (11) STI () (1) , SiOF SiON SiO₂ 가 가 , SiOF SiO₂ SiON

(11) SiO₂, TEOS, SiON SiOF SiOF가

, SiOF fluorosilicate glass(FSG), hydrogen silsesquioxane(HSQ), fluorinated polysilicon, poly - phenylquinoxaline polymer, fluoro - polyimide, amorphous fluoro carbon(a - C:F), methyl - poly - siloxane(MPS), poly arylene ether(PAE) porous SiO₂ 2.0 3.5 (11)

9가 (4) CMP(Chemical Mechanical Polishing) (11)

6a, 6b) (4) (3) () (4) (9) (3) (3) (4) (4) (6a ; 6)

(4) 가 (3) (6a) (4) ()가 (9) (6) (8) 가 (110 ; 56)가

(4) , (NH₄OH)
(3) SiON (3)
(9)

(2) 11 (HF) (11) (50) (11) (2)
(11) (51) SiON (9) 가
(51) T2 (51) STI [(7)
]

11 가 , 10nm 20nm (1)
, 1050 1200 가
(50) .1
(1) 가 950 가 (50)
(50)
, STI (1)
가 () (1)
가

가 wet
, STI
(8) SiO₂/SiON 2

(11) 가) 500 1000 (, , , , ,
가 STI 가 STI
(1)

, 12 N MOSFET (1)
, / (13) LDD (73) MOSFET (14) . 1
가

12 (51) ()가 (51) (11
(1) (51) HI) , (110)(56)가 , 1
3 가 (110)가 (C3) ,
(C1). (51) ,
(110)가 (C2)

, 12가 STI (110)가 , -
 (60) , 12가 STI (70)(1)
 GW(1)가 , 가 가 .
 , 5 , dryO₂ , SiON
 (6) , SiON , dryO₂
 (6) . 12가 STI가 ,
 A - A 14 . O₂ , NO ,
 , SiON/Si C4 , , 가
 O₂ SiO₂ NO가 ,
 , NO , O₂ , NO SiON
 O₂가 , O₂ 14 C5가 가
 , 가 (1) , C4가 가
 , C5가 가 , (13) , C4 가
 , STI , C5 가 (13) (70) , C4 가 (13)
 , C5 가 , (1) 가 ,
 , 가 STI , (1) STI
 (51) , 가
 C4, C5 가 가
 C5 가 , 가 가
 가 (1) , 가 C4
 가 .
 , (1) 1% 가
 , STI 가 가 , N MOSFET(NMOSFET) P
 (: 74) 가 , P MOSFET (PMOSFET)
 N (: 74) , NMOSFET
 C4 가 , PMOSFET C5 가 .
 , (13) (70) , (1) STI
 , C4 C5
 ,
 SiON/Si (6) ,
 12 가 , STI (6)
 , NMOSFET (74) , STI (1) 가
 (6) STI , STI 가

(1) STI , 12가 NMOSFE
 T GW , 1 X-X 가 12 A -
 A 15 .

가 가 (1)
 GW가 C7 STI 가 . STI
 C6 , STI STI

STI (1) STI 가
 , / (2)
 STI 가 , SiON (1)
 , STI 가 STI , SiO₂ SiON
 , STI 가 STI 가 STI 가 SiO₂

1 1 N₂가
 STI 가

1 (3) (3) 가 (6) ,
 가 (3) 가 가
 STI (110)가 (3) (7) (4)
 STI 가 STI (3)
 (1)

1 (3) (6) 1

2 , 2 3 가 , 가
 가 STI 가

1 가 ,

(6) , (1)
(3) , (2)
(6) , STI 가
(3) (6) NO 가
(1)

[3. 1 1]

1 . 16 19
(2) (4) 2 (3)
(4) 100nm 250nm (2) 10nm 20nm
16 (3) 3 4 가 .

17 , NO/O₂ , (1)
O O₂ 가 (2) (6) O₂ NO (6) N

18 , (1) 100nm 300nm
(7)가 , 7 11 , 19
12 가 .

1 1 (3) (3)
(51) T2(11) 1 (54)(19) 1 T3 (51)

1 (3) (51) , H1(11)
(3) (3) H1 (54) H2(19)
가 (51) H1 가 STI (1)
STI (1) 가

[4. 1 2]

1 . 20 23 2
1 가 2 (3)

가 , , 4 (4) (2) 100nm 250nm (4) (2) 10nm 20nm
 (1) (1) D1 10nm 100nm (3) 3 4
 , 20

(1) , 21 (2) , NO/O₂ (6) (6) NO
 O₂ 가 , O₂ NO

, 22가 (7)가 (1) 100nm 300nm
 , 12 가 , 7 11 , 23

2 (56) STI (1) (8)
 , 23 (1) , 23
 (1) , STI

, GW(1) , 가 STI
 , 23 2 1 1
 , GW 2
 , 1 1

[5. 2]

2 STI
 ()/ ()/ (SiOF) ()/
 가 STI (110)(56)가
 , 24 31

, 24 가 , 24 (1)
 (1) (2) 가 10nm (30) (2) 2nm 5nm 가 100nm
 250nm (4)

, 25 가 , 25 가 (4)
 , (5)가 가 (5) ()
 (4)

26 (5)가 (4)
 (30), (2) (1)
 (1) (7)가 가

27 (32) (30) (7) , HCl (7) dryO₂ (2) (34) 가 ,
 (30) (30) 가 STI (30) 가
 (30) STI 가 STI (30) STI (30) 가
 30) 가 (30) (35) (SiO₂) (7)가
 (35) , TEOS, SiOF가
 29 (4) , CMP (35)
 , 30 (4) (30)
 31 (35) (60) (35) (2)
 (34) (30) (34) 가 (36)
 , STI (110)(56)가 , HF (36)
 (SiON) (SiO₂)
 12 가 , 가
 SiON/SiO₂ 2 , SiOF()/SiON/SiO₂ 3
 가 SiO₂/Si 가 가

[6. 2 1]

2 32 37
 24 27 가 , 32 가 32
 (4) (38) 10nm 20nm
 (4) (7) (7) 32가 h w
 , h/w , (4) (4) h가 ,
 가 (7) (4) (4) 가 (4)

(38) , (30) (38a) CMP
 (32) (38b) STI가
 , STI
 (38b)
 , 33 (35) , (7)가
 (35) , SiO₂ SiON, TEOS SiOF
 SiOF (Silicon oxyfluoride)가

SiOF , fluorosilicate glass(FSG) hydrogen silsesquioxane (HSQ), fluorinated polysilicon, poly - Phenylquinoxaline polymer, fluoro - polyimide, amorphous fluoro carbon (a - C : F), methy - poly - siloxane (MPS), poly arylene ether(PAE) , 2.9 3.5
 (35)

34 (38a) , CMP (35)
 35 (38a) (38a) (30)
 (30) (38a) , STI
 (110)(56)가 (30)

(110) (38b)
 (38b) 3nm 7nm (38b)
 (38b) 가 STI (1)
 가 3nm ,
 가 (3) , 1100

36 가 36
 (35) (2) (35)
 (62) (34) 가

(34) (30) (36) (SiO
 N) . SiON SiO₂ (36) , STI (1
 10)(56)가 (30) 가 (1
 34) T4 (1) (1s)
 (1) (34) , STI

1

2 「0026」 (3 2) SiO₂ SiO₂ (3
 3) . SiO₂ (3) (2)
 2 , SiO₂ (38) , CMP 1

(4) 2 2 , 32 , 40 가
 (90) 3 10nm , (33)
 10) (56)가 STI . 33 36 . (1)
 35 , (33a) ,
 nm (33b) 가 7nm 가 . (33) 7
 (90) , (90)
 2 1 ,

[8. 2 3]

(4) 2 3 , 32 , 41 가
 (38) , (80) 3nm 10nm
 TI . 33 36 가 . (110)(56)가 S
 , STI 가 1

[9. 3]

3 STI / / , 가 / ,
) , STI , (2) (1) ,
 MOSFET () 가 가 가 ,

3 가 1 2() ,
 가 . 42 45가 ,
 42가 가 (2) (3)
 (1) (3) , () ,
 (NF₃) (40) .
 가 10keV 50keV , 1 × 10¹⁴ /cm² 5 × 10¹⁵ /cm² .
 (3) () , STI
 , (2) (1) .

43 (3) (4) (40)
 , (40) (4) , (3) .

44가 (4) , (40)
 (3) .

45가 (4) (3) , (40)
 0° 38° . , , 1
 2, 4, 8 (3)
 , (40) . (2) (1)
 , (40) . 45 , (40)

, 43 45 가 (2)/ (3)/ (4) 3
 가 , 가 / 2 ,
 가 . , (40)
 (2) , 가 .

(40) , 가 ,

, MOSFET GW (13) (가), (13) STI가
 (13) 가 , GW (13)
 , 가 , 가
 (13) (40) ,

(40) 가 , 가 , (1)
 , 가 , STI .

, STI 가 (1) ,
 가 , STI , GW가
 , STI GW (1) 가 ,
 ,

3

4 2 , STI , STI/ 1μm
, STI (1) 가 $1 \times 10^{14} / \text{cm}^2$ () ,

, 2 3 STI ,

(3) (8), 3 (2) (1) , (2) 3 (4) (7) (1) ,
, 3 3

[10. 4]

4 가 STI
3 가 () , STI 가
4 가 1 2()
가 46 47

46 (7)가 (44) (4) (4)
0) (44), (44) (4), (3) (43) (40) (4)
() MOSFET) , STI
(1) (2) (1)

47 (40) (13) (49), (48), (14) (40)
(44) 49) (40) 가 , 46 47 가
(40) 가 (40) 가
가 (2), (3) (4) 3 (40)

, 3 가 , 가 4 ,

[11. 1 4]

, 1 4 , , SOI (Silicon On Insulator) , DR AM(Dynamic Random Access Memory), SRAM(Static Random Access Memory), EEPROM (Electrically Erasable Programmable Read Only Memory), 가 .

가

가

가

가

가

가

가

가

가

가

가

가

가

,N

MOSFET

가

가 , 가 , P MOSFET

가 , 가

가 , 가

가 , 가

가 , 가 , 가

가 , 가 , 가

가 , 가

(57)

1.

(a)

(b)

(c)

(d)

(e)

(f)

(g)

(h) (g)

(i) (g)

(j)

2.

(a)

(b)

(c)

(d)

(e)

(f) (e)

(g) (e)

(h)

3.

(a)

(b)

,

(c)

,

(d)

,

,

,

(e)

,

(f)

,

(g)

(f)

,

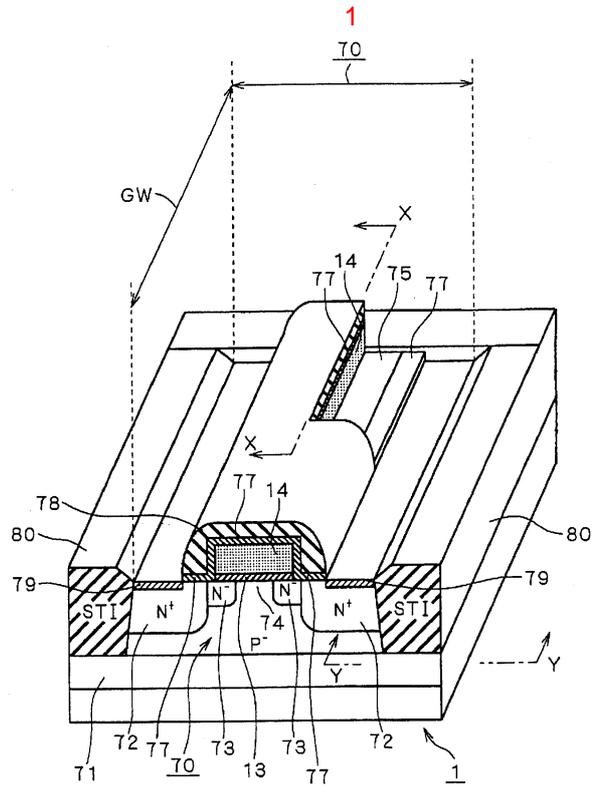
(h)

(f)

,

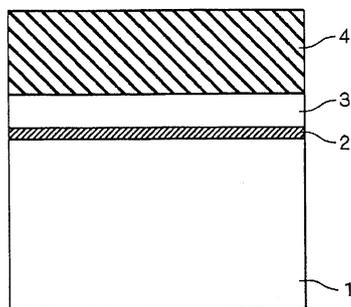
(i)

.



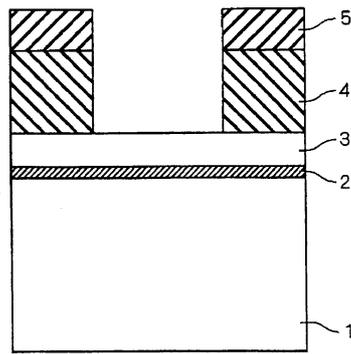
1 : 실리콘 기판(반도체 기판)

2

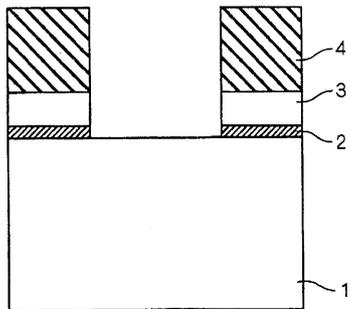


- 2 : 산화 실리콘막(산화 반도체막)
- 3 : 다결정 실리콘막(다결정 반도체막)
- 4 : 절화 실리콘막(절화 반도체막)

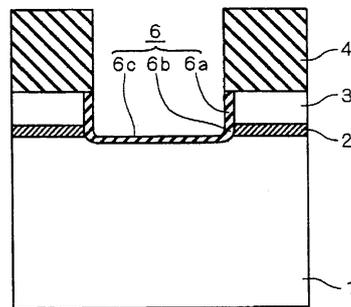
3



4

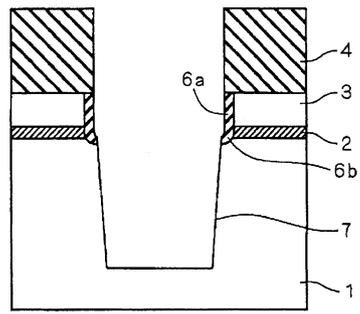


5



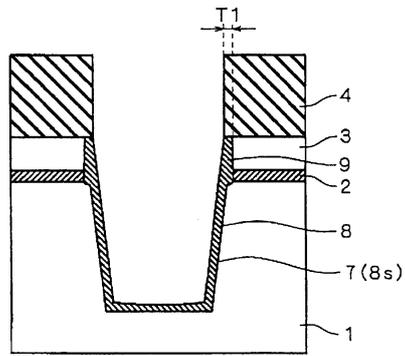
6 : 산화 질화 실리콘막(산화 질화 반도체막)

6



7 : 트렌치

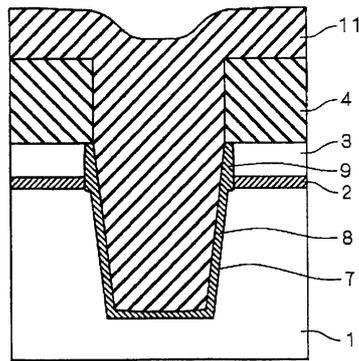
7



8 : 내벽 절연막

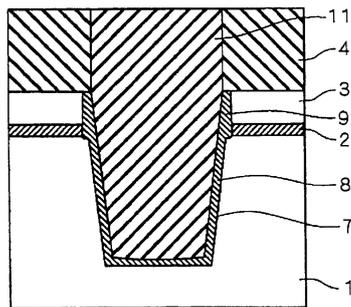
9 : 버즈막

8

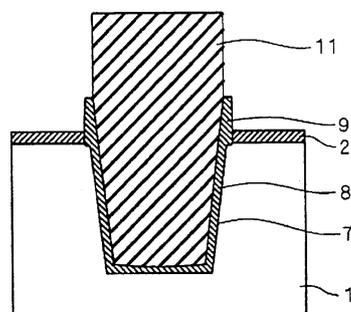


11 : 매립 절연물(절연물)

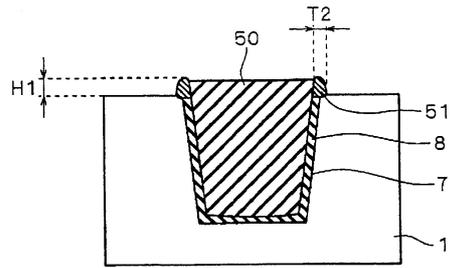
9



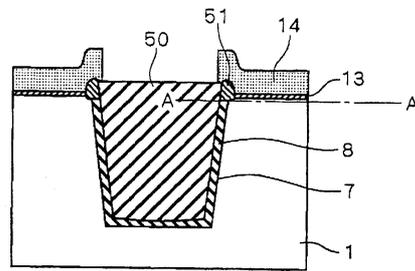
10



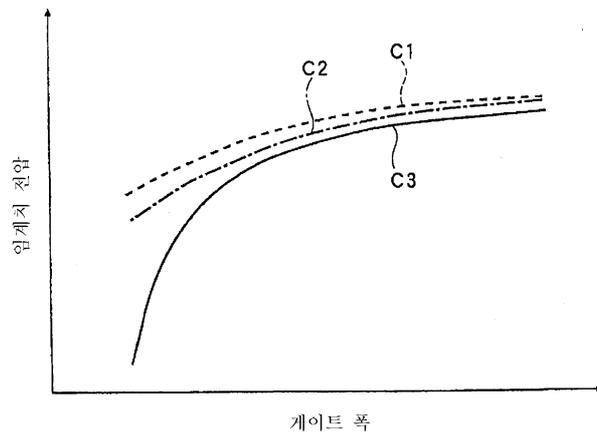
11



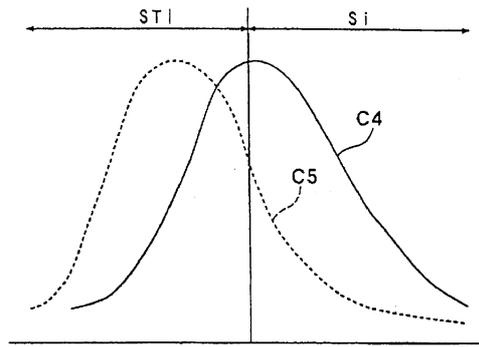
12



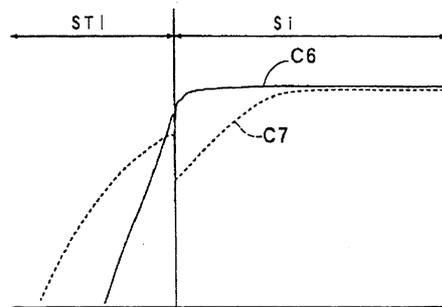
13



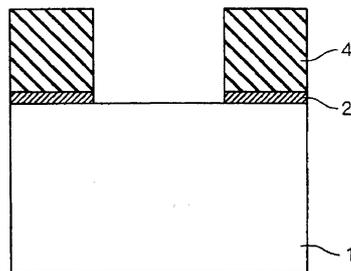
14



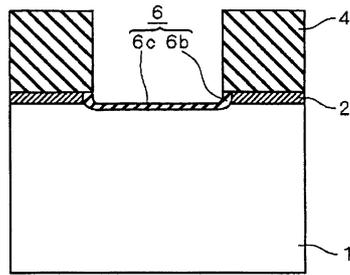
15



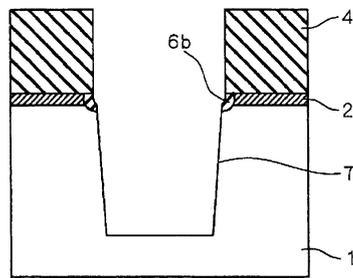
16



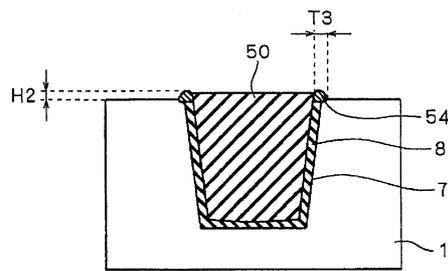
17



18

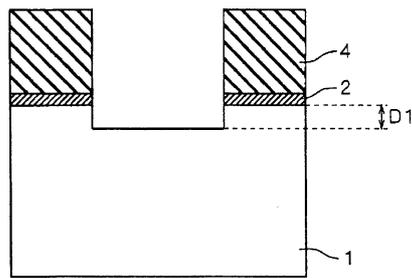


19

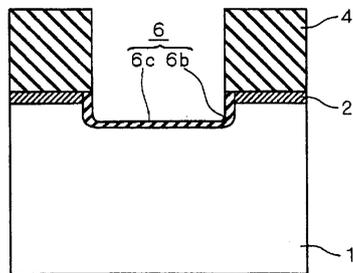


54 : 비즈막

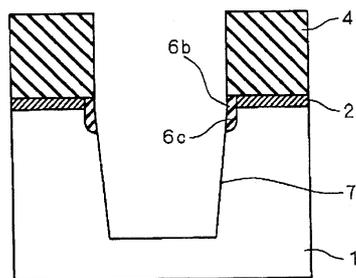
20



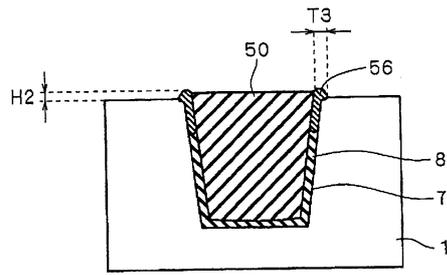
21



22



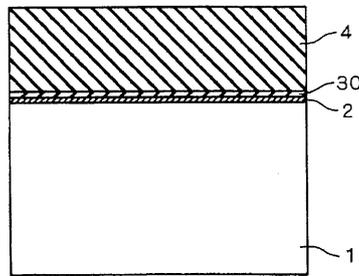
23



50 : 배립 절연물(절연물)

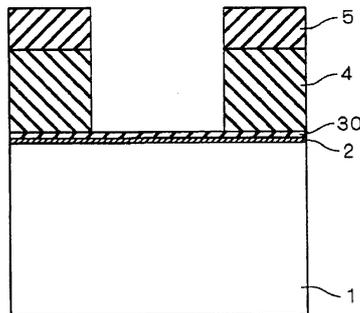
56 : 비즈막

24

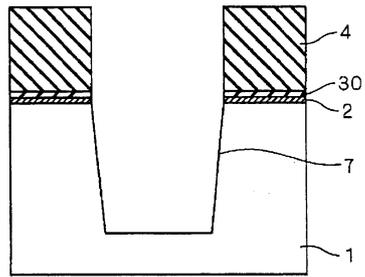


30 : 산화 절화 실리콘막(산화 절화 반도체막)

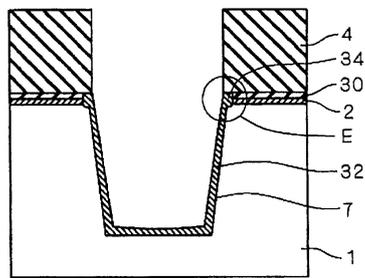
25



26

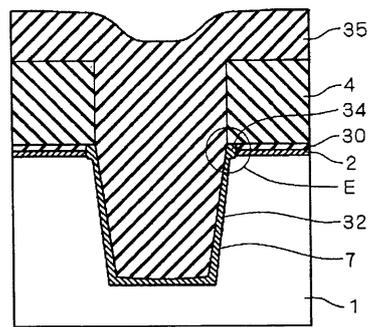


27



32 : 내벽 절연막

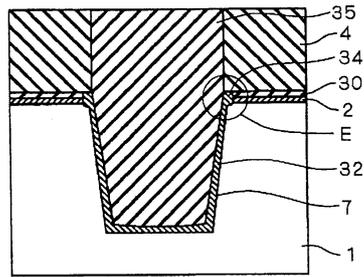
28



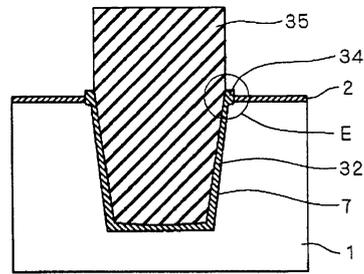
34 : 메즈릭

35 : 메립 절연물(절연물)

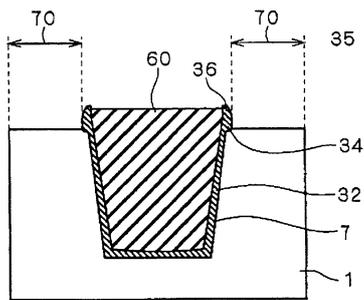
29



30

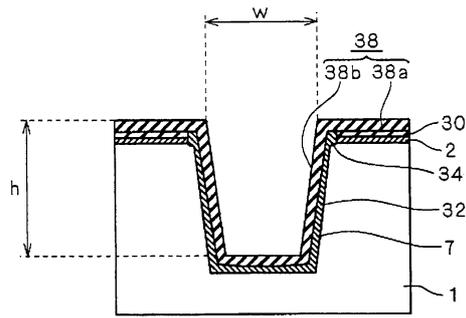


31



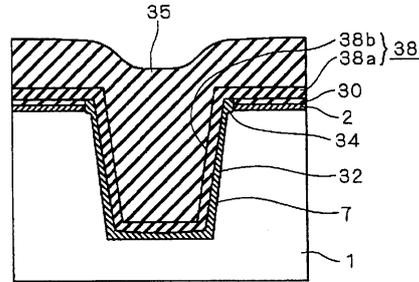
60 : 메립 절연물(절연막)

32

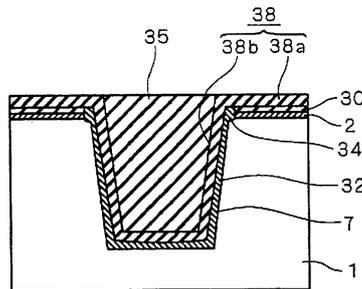


38 : 질화 실리콘막(질화 반도체막)

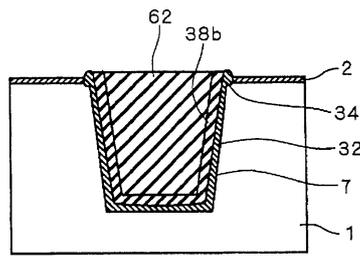
33



34

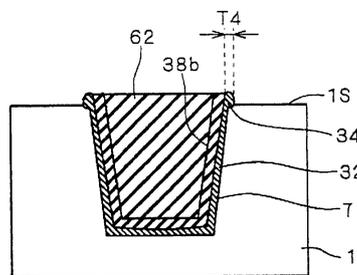


35

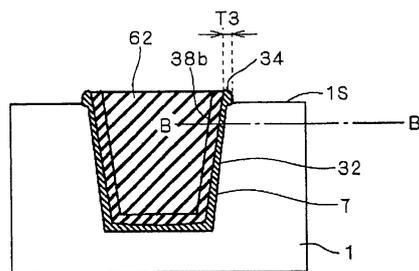


62 : 매립 절연물(절연물)

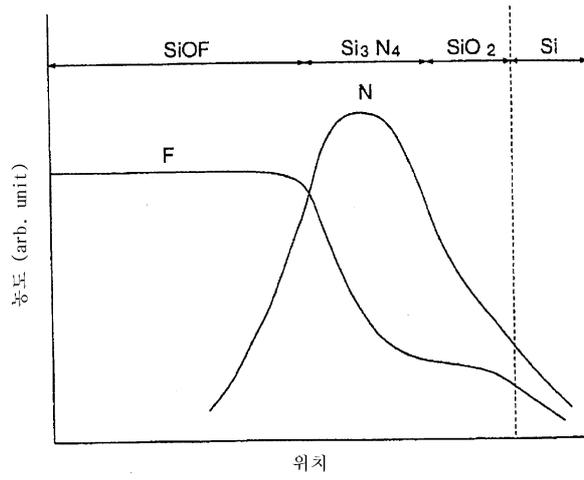
36



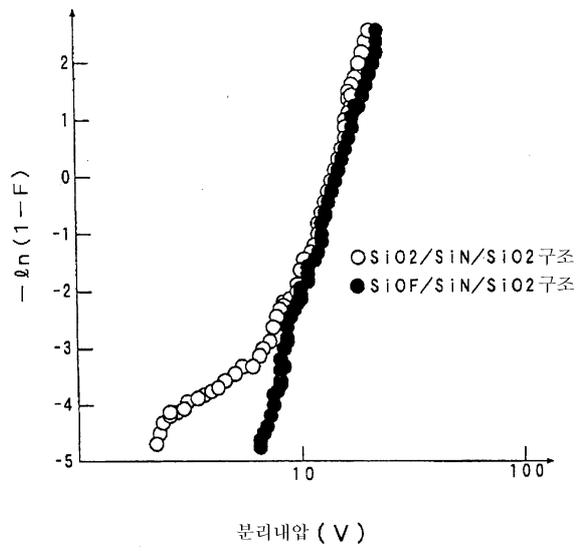
37



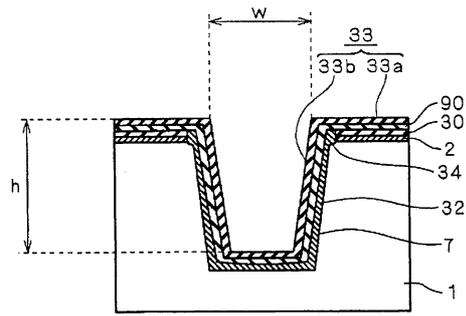
38



39

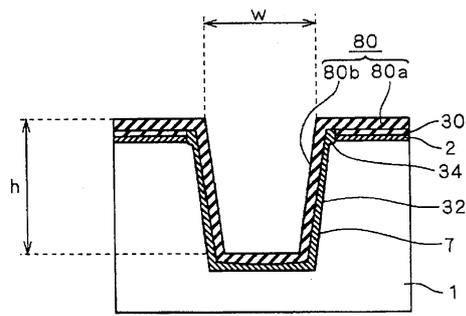


40



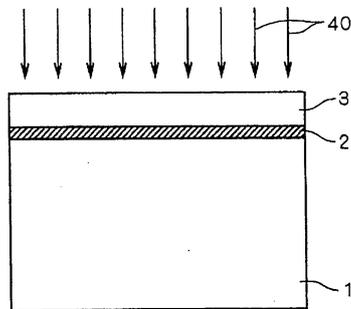
33 : 질화 실리콘막(질화 반도체막)
 90 : 산화 질화 실리콘막(산화 질화 반도체막)

41

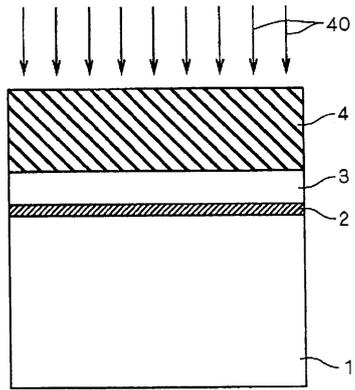


80 : 산화 질화 실리콘막(산화 질화 반도체막)

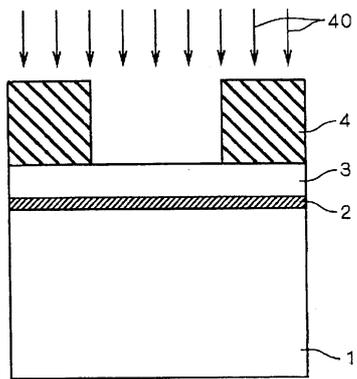
42



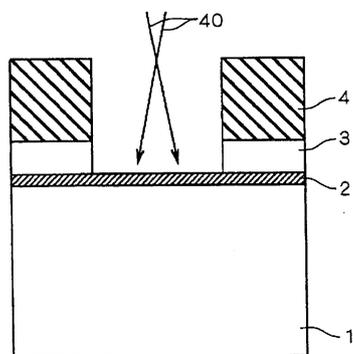
43



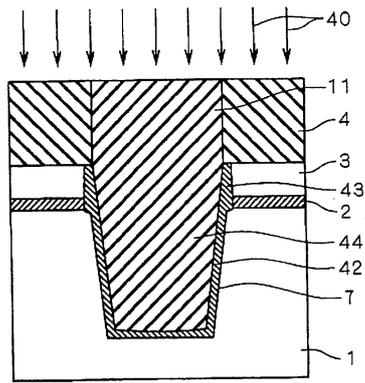
44



45

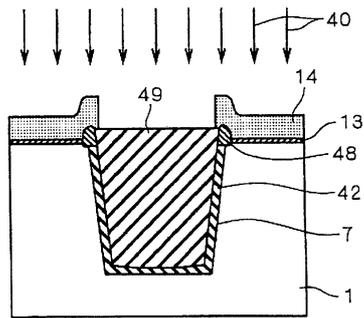


46

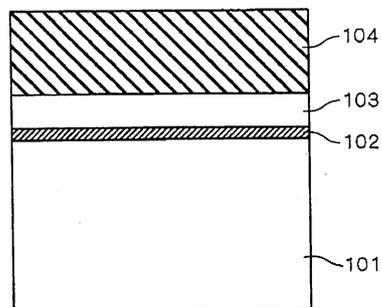


44: 메립 절연물(절연물)

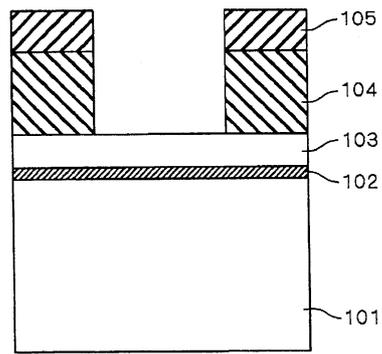
47



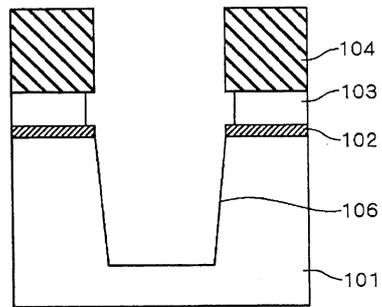
48



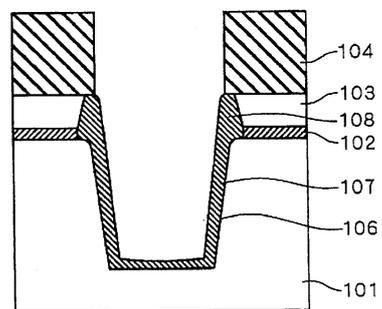
49



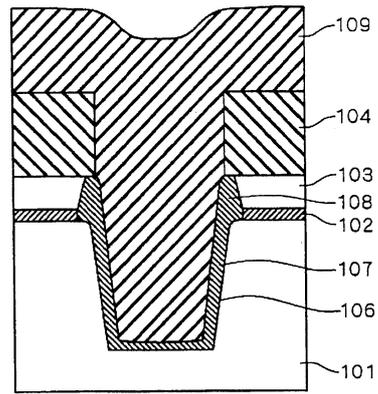
50



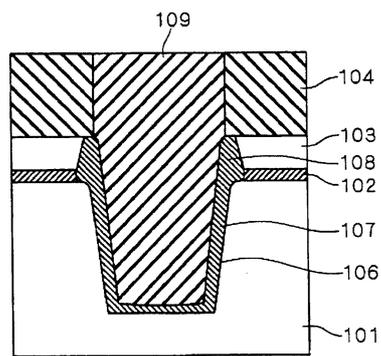
51



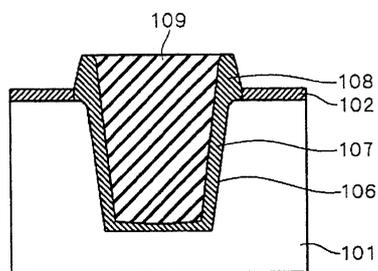
52



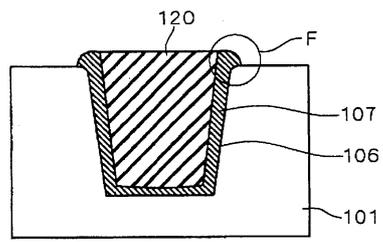
53



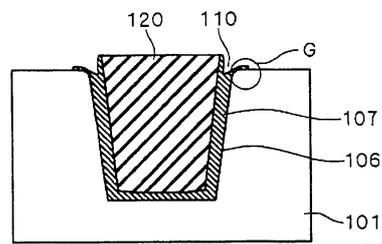
54



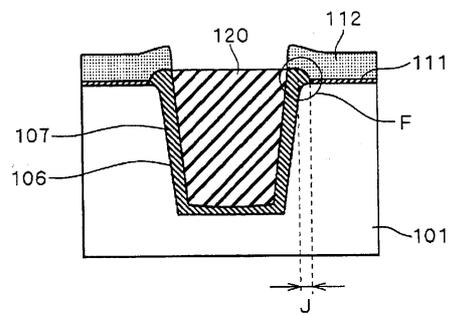
55



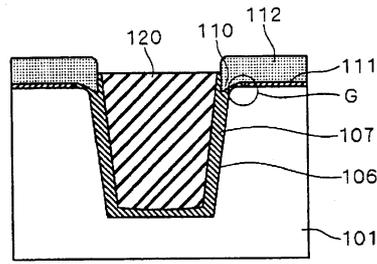
56



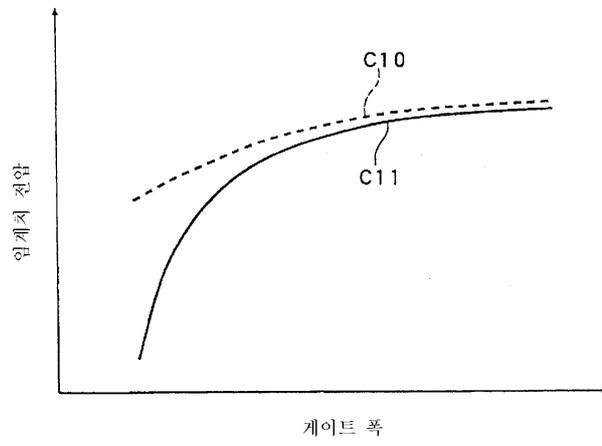
57



58



59



60

