



(51) International Patent Classification:

*B24B 1/00* (2006.01)      *B32B 38/10* (2006.01)  
*B24B 7/30* (2006.01)      *B32B 38/18* (2006.01)

(21) International Application Number:

PCT/US2014/011949

(22) International Filing Date:

17 January 2014 (17.01.2014)

(25) Filing Language:

English

(26) Publication Language:

English

(30) Priority Data:

61/754,826      21 January 2013 (21.01.2013)      US  
61/777,075      12 March 2013 (12.03.2013)      US

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(81) Designated States (*unless otherwise indicated, for every  
kind of national protection available*): AE, AG, AL, AM,  
AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY,  
BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM,

DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT,  
HN, HR, HU, ID, IL, IN, IR, IS, JP, KE, KG, KN, KP, KR,  
KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME,  
MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ,  
OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SA,  
SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM,  
TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM,  
ZW.

(84) Designated States (*unless otherwise indicated, for every  
kind of regional protection available*): ARIPO (BW, GH,  
GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, SZ, TZ,  
UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ,  
TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK,  
EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV,  
MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM,  
TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW,  
KM, ML, MR, NE, SN, TD, TG).

**Declarations under Rule 4.17:**

- *as to applicant's entitlement to apply for and be granted a  
patent (Rule 4.17(ii))*
- *as to the applicant's entitlement to claim the priority of the  
earlier application (Rule 4.17(iii))*

**Published:**

- *with international search report (Art. 21(3))*

(54) Title: REFURBISHED COMPONENT, ELECTRONIC DEVICE INCLUDING THE SAME, AND METHOD OF REFUR-  
BISHING A COMPONENT OF AN ELECTRONIC DEVICE

(57) Abstract: A method of refurbishing a surface of a component for an electronic device, includes: abrading a surface to be refurb-  
ished with an abrasive to remove a coating on the surface and provide an abraded surface; optionally firstly cleaning the abraded  
surface by contacting with a glass cleaner to provide a firstly cleaned surface; optionally secondly cleaning the firstly cleaned surface  
by contacting the firstly cleaned surface with a grease remover to provide a secondly cleaned surface; optionally contacting the  
secondly cleaned surface with an activator to provide an activated surface; and disposing a coating resin on the abraded and option-  
ally activated surface; and curing the coating resin to provide a coated surface to refurbish the surface of the electronic device,  
wherein the coating resin comprises a hydroxyl functional dendritic polymer; optionally an acrylic polyol; and a plurality of metal  
oxide nanoparticles optionally encapsulated in a hydroxyl functional polymer or a hydroxyl functional fluorosurfactant.



REFURBISHED COMPONENT, ELECTRONIC DEVICE INCLUDING THE SAME,  
AND METHOD OF REFURBISHING A COMPONENT OF AN ELECTRONIC DEVICE

BACKGROUND

(1) Field

[0001] This disclosure relates to a refurbished component, an electronic device including the same, and method of refurbishing a component of an electronic device.

(2) Description of the Related Art

[0002] Electronic devices, such as cell phones or touch pads, can get scratched or worn in the course of use. Devices without visible scratches are desirable because they have higher resale value and are cosmetically attractive. Scratched or worn components can be replaced with new components. However, refurbishing is desirable to reduce cost and environmental impact. Thus there remains a need for a method of refurbishing device components to provide a suitable surface finish, including a desirable cosmetic appearance.

SUMMARY

[0003] Disclosed is a method of refurbishing a surface of a component for an electronic device, the method including: abrading a surface to be refurbished with an abrasive to remove a coating on the surface and provide an abraded surface; optionally firstly cleaning the abraded surface by contacting with a glass cleaner to provide a firstly cleaned surface; optionally secondly cleaning the firstly cleaned surface by contacting the firstly cleaned surface with a grease remover to provide a secondly cleaned surface; optionally contacting the secondly cleaned surface with an activator to provide an activated surface; and disposing a coating resin on the abraded and optionally activated surface; and curing the coating resin to provide a coated surface to refurbish the surface of the electronic device, wherein the coating resin comprises: a hydroxyl functional dendritic polymer; optionally an acrylic polyol; and a plurality of metal oxide nanoparticles optionally encapsulated in a hydroxyl functional polymer or a hydroxyl functional fluorosurfactant.

[0004] Also disclosed is a method of refurbishing a surface, the method including: abrading a surface to be refurbished with an abrasive to remove a coating on the surface and provide an abraded surface; optionally firstly cleaning the abraded surface by contacting with a glass cleaner to provide a firstly cleaned surface; optionally secondly cleaning the firstly cleaned surface by contacting the firstly cleaned surface with a grease remover to provide a secondly cleaned surface; optionally contacting the secondly cleaned surface with an

activator to provide an activated surface; and disposing a coating resin on the abraded and optionally activated surface; and curing the coating resin to provide a coated surface to refurbish the surface. wherein the coating resin comprises: a hydroxyl functional dendritic polymer; optionally an acrylic polyol; and a plurality of metal oxide nanoparticles optionally encapsulated in a hydroxyl functional polymer or a hydroxyl functional fluorosurfactant.

[0005] Also disclosed is a method of refurbishing a surface of a component for an electronic device, the method including: abrading a surface to be refurbished with an abrasive to remove a coating on the surface and provide an abraded surface; optionally firstly cleaning the abraded surface by contacting with a glass cleaner to provide a firstly cleaned surface; optionally secondly cleaning the firstly cleaned surface by contacting the firstly cleaned surface with a grease remover to provide a secondly cleaned surface; contacting the secondly cleaned surface with an activator to provide an activated surface; and disposing a coating resin on the abraded and activated surface; and curing the coating resin to provide a coated surface to refurbish the surface of the electronic device, wherein the coating resin comprises a first resin and a second resin, the first resin comprises a clear coat, a hardener, and a reducer, wherein the clear coat comprises a hydroxyl-functional binder selected from a polyurethane, a (meth)acrylic copolymer, a polyester, a polyether, or a combination comprising at least one of the foregoing polymer; the hardener comprises a polyisocyanate crosslinker; and the reducer comprises a solvent; and the second resin comprises a first component and a second component, wherein the first component comprises: hydroxyl functional dendritic polymer; optionally an acrylic polyol; and a plurality of metal oxide nanoparticles optionally encapsulated in a hydroxyl functional polymer or a hydroxyl functional fluorosurfactant; and the second component comprises a cross-linking agent selected from a polyisocyanate, a melamine formaldehyde resin, and a combination comprising at least one of the foregoing compound, and wherein the surface comprises glass.

[0006] Also disclosed is a refurbished component for an electronic device including a surface and a polymerization product of a first resin and a second resin, wherein the first resin comprises a clear coat and a hardener, the clear coat comprises a hydroxyl-functional binder selected from a polyurethane, a (meth)acrylic copolymer, a polyester, a polyether, or a combination comprising at least one of the foregoing polymer; and the hardener comprises a polyisocyanate crosslinker; and wherein the second resin comprises a first component and a second component, the first component comprises: a hydroxyl functional dendritic polymer; optionally an acrylic polyol; and a plurality of metal oxide nanoparticles optionally encapsulated in a hydroxyl functional polymer or a hydroxyl functional fluorosurfactant; and

the second component comprises a cross-linking agent selected from a polyisocyanate, a melamine formaldehyde resin, and a combination comprising at least one of the foregoing compound.

[0007] Also disclosed is a refurbished component for an electronic device including a surface and a polymerization product of a resin having a first component and a second component, wherein the first component comprises: a hydroxyl functional dendritic polymer having a hydroxyl functionality of 40 to 80; a plurality of metal oxide nanoparticles optionally encapsulated in a hydroxyl functional polymer or a hydroxyl functional fluorosurfactant; and a hydroxyl-functional binder selected from a polyurethane, a (meth)acrylic copolymer, a polyester, a polyether, or a combination comprising at least one of the foregoing polymer, wherein the hydroxyl-functional binder has a hydroxyl functionality of 2 to 25; and wherein the second component comprises a cross-linking agent selected from a polyisocyanate, a melamine formaldehyde resin, and a combination comprising at least one of the foregoing compound.

[0008] Also disclosed is a refurbished electronic device, the electronic device including the refurbished component for the electronic device.

#### DETAILED DESCRIPTION

[0009] The invention now will be described more fully hereinafter. This invention may be embodied in many different forms, and should not be construed as limited to the embodiments set forth herein. Rather, these embodiments are provided so that this disclosure will be thorough and complete, and will fully convey the scope of the invention to those skilled in the art. Like reference numerals refer to like elements throughout.

[0010] It will be understood that when an element is referred to as being “on” another element, it can be directly on the other element or intervening elements may be present therebetween. In contrast, when an element is referred to as being “directly on” another element, there are no intervening elements present.

[0011] It will be understood that, although the terms “first,” “second,” “third” etc. may be used herein to describe various elements, components, regions, layers and/or sections, these elements, components, regions, layers and/or sections should not be limited by these terms. These terms are only used to distinguish one element, component, region, layer or section from another element, component, region, layer or section. Thus, “a first element,” “component,” “region,” “layer” or “section” discussed below could be termed a second element, component, region, layer or section without departing from the teachings herein.

[0012] The terminology used herein is for the purpose of describing particular embodiments only and is not intended to be limiting. As used herein, the singular forms “a,” “an,” and “the” are intended to include the plural forms, including “at least one,” unless the content clearly indicates otherwise. “Or” means “and/or.” As used herein, the term “and/or” includes any and all combinations of one or more of the associated listed items. It will be further understood that the terms “comprises” and/or “comprising,” or “includes” and/or “including” when used in this specification, specify the presence of stated features, regions, integers, steps, operations, elements, and/or components, but do not preclude the presence or addition of one or more other features, regions, integers, steps, operations, elements, components, and/or groups thereof.

[0013] Spatially relative terms, such as “beneath,” “below,” “lower,” “above,” “upper” and the like, may be used herein for ease of description to describe one element or feature's relationship to another element(s) or feature(s) as illustrated in the figures. It will be understood that the spatially relative terms are intended to encompass different orientations of the device in use or operation in addition to the orientation depicted in the figures. For example, if the device in the figures is turned over, elements described as “below” or “beneath” other elements or features would then be oriented “above” the other elements or features. Thus, the exemplary term “below” can encompass both an orientation of above and below. The device may be otherwise oriented (rotated 90 degrees or at other orientations) and the spatially relative descriptors used herein interpreted accordingly.

[0014] Unless otherwise defined, all terms (including technical and scientific terms) used herein have the same meaning as commonly understood by one of ordinary skill in the art to which this disclosure belongs. It will be further understood that terms, such as those defined in commonly used dictionaries, should be interpreted as having a meaning that is consistent with their meaning in the context of the relevant art and the present disclosure, and will not be interpreted in an idealized or overly formal sense unless expressly so defined herein.

[0015] “Alkoxy” means an alkyl group that is linked via an oxygen (i.e., -O-alkyl). Nonlimiting examples of C1 to C30 alkoxy groups include methoxy groups, ethoxy groups, propoxy groups, isobutyloxy groups, sec-butyloxy groups, pentyloxy groups, iso-amyloxy groups, and hexyloxy groups.

[0016] “Alkyl” means a straight or branched chain saturated aliphatic hydrocarbon having the specified number of carbon atoms, specifically 1 to 12 carbon atoms, more specifically 1 to 6 carbon atoms.

[0017] “Aryl,” means a cyclic moiety in which all ring members are carbon and at least one ring is aromatic, the moiety having the specified number of carbon atoms, specifically 6 to 24 carbon atoms, more specifically 6 to 12 carbon atoms. More than one ring may be present, and any additional rings may be independently aromatic, saturated or partially unsaturated, and may be fused, pendant, spirocyclic or a combination thereof.

[0018] “Halogen” means one of the elements of Group 17 of the periodic table (e.g., fluorine, chlorine, bromine, iodine, and astatine).

[0019] “Carboxyl” means a functional group consisting of a carbonyl and a hydroxyl, which has the formula  $-C(=O)OH$ .

[0020] “NCO functionality” means the average number of isocyanate groups on a molecule.

[0021] “Hydroxyl functionality” means the average number of hydroxyl groups on a molecule.

[0022] Exemplary embodiments are described herein with reference to cross section illustrations that are schematic illustrations of idealized embodiments. As such, variations from the shapes of the illustrations as a result, for example, of manufacturing techniques and/or tolerances, are to be expected. Thus, embodiments described herein should not be construed as limited to the particular shapes of regions as illustrated herein but are to include deviations in shapes that result, for example, from manufacturing. For example, a region illustrated or described as flat may, typically, have rough and/or nonlinear features. Moreover, sharp angles that are illustrated may be rounded. Thus, the regions illustrated in the figures are schematic in nature and their shapes are not intended to illustrate the precise shape of a region and are not intended to limit the scope of the present claims.

[0023] All cited patents, patent applications, and other references are incorporated herein by reference in their entirety. However, if a term in the present application contradicts or conflicts with a term in the incorporated reference, the term from the present application takes precedence over the conflicting term from the incorporated reference.

[0024] There is currently no technology, including buffing, which can remove deep scratches on the glass surfaces of device screens or digitizers. Further, buffing does not result in a cosmetically satisfactory product having a sufficiently scratch-free appearance and suitable luster. Also, modern wireless devices use high hardness glasses and/or coatings which make buffing difficult. In addition, clear coatings do not suitably adhere directly to device screens or digitizers, making it impractical to simply cover scratched surfaces with a clear coating.

**[0025]** After exploring different process and material variables, it has been surprisingly discovered that the scratched, worn and lackluster glass surfaces of device screens or digitizers can be refurbished conveniently in a cost-effective matter to provide a scratch-free and shiny new appearance by using the method disclosed herein. In addition, the refurbished surface can have high scratch resistance, high chemical resistance, long-term weather resistance, and excellent gloss retention. Accordingly, by refurbishing electronic devices using the discovered method, the worn devices can have a cosmetically appealing new look, and also have a surface coating that is effective to provide long term protection to the device surface, thereby preserving the environment, conserving materials, minimizing pollution, and eliminating waste.

**[0026]** Disclosed is a method of refurbishing a surface of a component of an electronic device, e.g., a surface of a wireless device screen or a digitizer, which provides a surface that is free of scratches or defects to the untrained and unaided eye, e.g., an eye of a consumer. The method comprises abrading a surface to be refurbished with an abrasive to remove a coating on the surface and provide an abraded surface; contacting the abraded surface with a coating resin; and curing the coating resin to provide a coated surface to refurbish the surface of the component of the electronic device.

**[0027]** The method may further optionally comprise, after the abrading, optionally firstly cleaning the abraded surface by contacting with a glass cleaner to provide a firstly cleaned surface; optionally secondly cleaning the firstly cleaned surface by contacting the firstly cleaned surface with a grease remover to provide a secondly cleaned surface; and optionally contacting the secondly cleaned surface with an activator to provide an activated surface.

**[0028]** The abrading may comprise abrading with a diamond polishing compound. The diamond polishing compound comprises diamond and a lubricant and/or a vehicle. The diamond may have a mesh of about 600 to about 2000 grit, specifically about 800 to about 1800 grit. A diamond polishing compound comprising 1200 grit diamond is specifically mentioned. In an embodiment the diamond has a maximum particle size of about 1 micrometer ( $\mu\text{m}$ ) to about 15  $\mu\text{m}$ , specifically about 2  $\mu\text{m}$  to about 10  $\mu\text{m}$ . Diamond having a maximum particle size of about 9  $\mu\text{m}$  is specifically mentioned.

**[0029]** The abrading may comprise abrading with aluminum oxide particles having a size of 5 to 80 micrometers, for example, about 5 to about 30 micrometers, about 15 to about 45 micrometers, or about 30 to about 80 micrometers using an abrasive jet machining (“AJM”) system. The AJM system can operate at a pressure of about 0.5 bar to about 100

bar, specifically about 1 bar to 30 bar, more specifically about 3 bar to about 10 bar. The aluminum oxide particles are carried by air or an inert gas such as nitrogen and argon. An exemplary AJM system that may be used is a Microblaster, available from Finishing Associates of Warminster, PA.

**[0030]** The abrading may be sufficient to remove a coating on the surface to be refurbished. In an embodiment, the surface is an oleophilic surface. In another embodiment, the surface is an oleophobic surface. As used herein, "removing a coating" includes the situation where a coating is at least partially removed. While not wanting to be bound by theory, it is understood that complete removal of the coating is desirable in some embodiments in order to provide a refurbished surface having suitable cosmetic properties, for example, a surface which is optically scratch free and has desirable luster.

**[0031]** After the abrading, the abraded surface may be optionally contacted with a glass cleaner to provide a firstly cleaned surface. The glass cleaner may comprise a solvent, a cleaning agent, a surfactant, a wetting agent, or a combination thereof. The glass cleaner may also comprise a fragrance or a dye. In a specific embodiment, the glass cleaner comprises water and acetic acid. In another embodiment, the glass cleaner comprises ammonium hydroxide instead of acetic acid. The glass cleaner can also comprises disodium cocoamphodipropionate, 2-hexoxyethanol, butoxypropanol, butoxyethanol, isopropyl alcohol, propylene glycol, sodium lauryl sulfate, ethoxylated alcohol, sodium C<sub>14-17</sub> sec-alkyl sulfonate, sodium laureth sulfate, lauryl glucoside, alkyl polyglycoside, sodium dodecylbenzene sulfonate, ethanol amine, or a combination thereof.

**[0032]** Also, the abraded surface may be further optionally contacted with a grease remover to provide a secondly cleaned surface. The grease remover may comprise a solvent effective to remove grease. Exemplary solvents includes acetone, an alcohol (e.g., methanol, ethanol, butanol); water; liquid carbon dioxide; an aldehyde (e.g., an acetaldehyde, a propionaldehyde), a formamide (e.g., N, N- dimethylformamide); a ketone (e.g., acetone, methyl ethyl ketone,  $\beta$ -bromoethyl isopropyl ketone); acetonitrile; a sulfoxide (e.g., dimethylsulfoxide, diphenylsulfoxide, ethyl phenyl sulfoxide); a sulfone (e.g., diethyl sulfone, phenyl 7-quinolylsulfone); a thiophene (e.g., thiophene 1-oxide); an acetate (e.g., ethylene glycol diacetate, n-hexyl acetate, 2-ethylhexyl acetate); an amide (e.g., propanamide, benzamide), or a combination thereof. In an embodiment, the grease remover comprises stoddard solvent such as mineral spirits, aliphatic petroleum distillates, white spirits; naphtha; heptane; toluene; or a combination thereof.



[0033] The abraded surface, which may optionally be firstly cleaned and/or secondly cleaned, may be optionally contacted with an activator to provide an activated surface. While not wanting to be bound by theory, it is understood that the activator chemically reacts with the abraded surface to provide a functional group thereon to provide improved bonding properties with a coating layer. The activator may comprise an alcohol, e.g., methanol, ethanol, propanol, isopropanol, butanol, or a combination thereof, and/or a silane compound. In an embodiment, the activator comprises a carboxysilyl compound of the formula  $\text{SiR}_1\text{R}_2\text{R}_3\text{R}_4$  wherein  $\text{R}_1$  is a straight or branched chain substituted with a carboxyl group or a salt thereof, each  $\text{R}_2$ ,  $\text{R}_3$  and  $\text{R}_4$  is independently a C1 to C12 alkoxy group, a C1 to C12 alkyl group, a C6 to C24 aryl group, halogen, or hydroxy. The phrase "straight or branched chain" as used herein means a C1 to C12 hydrocarbon optionally substituted with a heteroatom such as N on its backbone. An exemplary carboxysilyl compound is N-[(3-trimethoxysilyl)propyl]ethylene-diamine triacetic acid trisodium salt. The activator may comprise an activator as disclosed in U.S. Patent No. 8293322, the content of which in its entirety is herein incorporated by reference, e.g., 2-oxo-N-(3-(triethoxysilyl)propyl)azepan-1-carboxamide. The activator may comprise a silica sol comprising a metal salt and a partial hydrolyzate of an alkoxy silane oligomer, wherein the metal salt is a metal organic acid salt or a metal carbonate of one or more of magnesium, calcium, strontium and barium, and wherein the alkoxy silane oligomer is tetraethoxysilane, tetrapropoxysilane, methyltriethoxysilane, dimethylmethoxysilane, phenyltriethoxysilane, chlorotrimethylsilane, vinyltriethoxysilane or aminopropyltriethoxysilane. Such activators are disclosed in European Patent Application EP1304399, the content of which in its entirety is herein incorporated by reference. In an embodiment, the activator may comprise an unsaturated-hydrocarbylamido-alkanesulfonic acid or a salt thereof, e.g., 2-acrylamido-2-methylpropanesulfonic acid or a salt thereof, as disclosed in European Patent EP 1560858, the content of which in its entirety is herein incorporated by reference. The activator may comprise an epoxysilane for example a gamma glycidoxy-propyl-trimethoxy-silane.

[0034] In an embodiment, the activator may also comprise a reaction product of an epoxy silane and an amino silane having at least two amine groups per molecule. The epoxy silane and the amino silane are used in amounts such that the final mole ratio of epoxy silane to amino silane in the reaction mixture is about at least 2:1. Suitable epoxy silanes for use in preparing a reaction product with epoxy silane and amino silane include any compound containing at least one epoxy group and silane group per compound and include, for example, gamma-glycidoxypropyldimethylethoxy silane, gamma-glycidoxypropylmethyldiethoxy

silane, gamma-glycidoxypropyltrimethoxy silane, glycidoxypropyltrimethoxy silane, beta-(3,4-epoxycyclohexyl)ethylmethyltrimethoxy silane, beta-(3,4-epoxycyclohexyl)ethylmethyldimethoxy silane. Specifically mentioned is gamma-glycidoxypropyltrimethoxy silane. Suitable amino silanes include N-(beta-aminoethyl)aminomethyltrimethoxy silane, gamma-aminopropyltriethoxy silane, gamma-aminopropylmethyldiethoxy silane, N-(gamma-aminoethyl)-gamma-aminopropyltriethoxy silane, N-(gamma-aminoethyl)-gamma-methyldimethoxy silane, and trimethoxysilylpropyldiethylene triamine. N-beta-(aminoethyl)-gamma-aminopropyltrimethoxy silane is specifically mentioned. The activator may also comprise a film forming resin. Such activators are disclosed in US Patent No. 5,466,727, the content of which in its entirety is herein incorporated by reference.

**[0035]** The activator may be disposed by any suitable method, e.g., spraying, dipping, roll coating, brush coating, or transfer coating.

**[0036]** A coating resin, i.e., a coating composition comprising a resin or a clear coat, is then disposed on the abraded and optionally activated surface of the component. A wide variety of clear-coat formulations are known and can be used. However, particularly advantageous coating resins comprise a first resin and a second resin that co-cure to provide a coating with exceptional properties, for example fast cure for efficient manufacture, and suitable buffability and hardness.

**[0037]** Thus, in an embodiment, the coating resin comprises a first resin and a second resin. The first and second resin may each independently comprise a blend of a polymer, copolymer, terpolymer, or a combination comprising at least one of the foregoing polymers. The polymer, copolymer, terpolymer, or a combination can be an oligomer, a homopolymer, a copolymer, a block copolymer, an alternating block copolymer, a random polymer, a random copolymer, a random block copolymer, a graft copolymer, a star block copolymer, a dendrimer, or the like, or a combination thereof.

**[0038]** Examples of polymers which may be included in the first and/or the second resin include thermoplastic and thermosetting polymers such as polyacetals, polyolefins, polyacrylics, polyacrylates, polycarbonates, polystyrenes, polyesters, polyamides, polyamideimides, polyarylates, polyarylsulfones, polyethersulfones, polyphenylene sulfides, polyvinyl chlorides, polysulfones, polyimides, polyetherimides, polytetrafluoroethylenes, polyetherketones, polyether etherketones, polyether ketone ketones, polybenzoxazoles, polyphthalides, polyacetals, polyanhydrides, polyvinyl ethers, polyvinyl thioethers, polyvinyl alcohols, polyvinyl ketones, polyvinyl halides, polyvinyl nitriles, polyvinyl esters,

polysulfonates, polysulfides, polythioesters, polysulfones, polysulfonamides, polyureas, polyphosphazenes, polysilazanes, polyethylene terephthalate, polybutylene terephthalate, polyurethane, ethylene propylene diene rubber (EPR), polytetrafluoroethylene, fluorinated ethylene propylene, perfluoroalkoxyethylene, polychlorotrifluoroethylene, polyvinylidene fluoride, or the like, or a combination thereof.

**[0039]** The first and second resins may be a blend comprising thermoplastic polymers, and may include acrylonitrile-butadiene-styrene/nylon, polycarbonate/acrylonitrile-butadiene-styrene, acrylonitrile butadiene styrene/polyvinyl chloride, polyphenylene ether/polystyrene, polyphenylene ether/nylon, polysulfone/acrylonitrile-butadiene-styrene, polycarbonate/thermoplastic urethane, polycarbonate/polyethylene terephthalate, polycarbonate/polybutylene terephthalate, thermoplastic elastomer alloys, nylon/elastomers, polyester/elastomers, polyethylene terephthalate/polybutylene terephthalate, acetal/elastomer, styrene-maleicanhydride/acrylonitrile-butadiene-styrene, polyether etherketone/polyethersulfone, polyether etherketone/polyetherimide polyethylene/nylon, polyethylene/polyacetal, or the like, or a combination thereof.

**[0040]** In an embodiment, the first and second resin may each independently comprise a polyacetal, polyacrylic, polycarbonate, polystyrene, polyester, polyamide, polyamideimide, polyarylate, polyarylsulfone, polyethersulfone, polyphenylene sulfide, polyvinyl chloride, polysulfone, polyimide, polyetherimide, polytetrafluoroethylene, polyetherketone, polyether etherketone, polyether ketone ketone, polybenzoxazole, polyoxadiazole, polybenzothiazinophenothiazine, polybenzothiazole, polypyrazinoquinoxaline, polypyromellitimide, polyquinoxaline, polybenzimidazole, polyoxindole, polyoxoisindoline, polydioxoisindoline, polytriazine, polypyridazine, polypiperazine, polypyridine, polypiperidine, polytriazole, polypyrazole, polypyrrolidine, polycarborane, polyoxabicyclononane, polydibenzofuran, polyphthalide, polyacetal, polyanhydride, polyvinyl ether, polyvinyl thioether, polyvinyl alcohol, polyvinyl ketone, polyvinyl halide, polyvinyl nitrile, polyvinyl ester, polysulfonate, polysulfide, polythioester, polysulfone, polysulfonamide, polyurea, polyphosphazene, polysilazane, or a combination thereof.

**[0041]** The first and second resins are curable resins, for example polyacrylics, polyacrylates, epoxies, phenolics, and polyurethane precursors, in particular polyurethane prepolymers. Such resins are often used in combination with hardeners, for example polyisocyanate or polyurethane prepolymers containing isocyanate groups. The prepolymers

can then be reacted with monomers, oligomers, or polymers containing active hydrogen groups, for example hydroxyl and amino groups. These oligomers or polymers can be polyesters, polyacrylics, or polyacrylates. Curing agents can further be included, for example short-chain diamines and glycols such 1,4-butanediol. If needed, catalysts can be included to promote the reaction between the isocyanate groups and the hydroxyl or amino groups.

**[0042]** In an embodiment, the first resin comprises a clear coat, a hardener, and optionally a reducer. A content of the clear coat may be about 0.1 to about 6 parts, specifically about 1 part to about 4 parts, based on a total content of the first resin. A content of the hardener may be about 0.1 to about 2 parts, specifically about 0.2 part to about 1.5 parts, based on a total content of the first resin. The reducer, when present, acts to adjust the working viscosity of the composition. A content of the reducer may be about 0.0 to about 1 part, specifically about 0.01 part to about 0.5 part, based on a total content of the clear coat, the hardener, and the reducer, if present.

**[0043]** The clear coat comprises a hydroxyl-functional binder. The hydroxy-functional binders are oligomeric and/or polymeric compounds with a number average molecular weight ( $M_n$ ) of, e.g., 500 to 500,000 g/mole, specifically of 1100 to 300,000 g/mole and can have a hydroxyl functionality of 2 to 25. The binders with hydroxyl groups are for example the polyurethanes, (meth)acrylic copolymers, polyesters and polyethers, or a combination thereof. Examples of hydroxy-functional polyurethane resins are those, for example, with a number average molecular weight  $M_n$  of 500 to 500 000 g/mol, specifically, of 1100 to 300 000 g/mol, more specifically, of 5000 to 300 000 g/mol, an acid value of 0 to 100 mg KOH/g, specifically of 0 to 80 mg KOH/g, a hydroxyl value of 40 to 400 mg KOH/g, specifically, of 80 to 250 mg KOH/g. The polyurethane resins include such resins which are in modified form, for example, as silicon-modified or (meth)acrylated polyurethane resins. Examples of poly(meth)acrylate resins are for example those with a number average molecular mass  $M_n$  of 1000-20000 g/mol, specifically, of 1100-15000, an acid value of 0-100 mg KOH/g, specifically, of 0-50 and a hydroxyl value of 40-400 mg KOH/g, specifically, of 60-200 mg KOH/g. The poly(meth)acrylate resins can also have been prepared in the presence of different binders, e.g., in the presence of oligomeric or polymeric polyester and/or polyurethane resins. Examples of hydroxy-functional polyester resins are for example hydroxyfunctional polyesters with a number average molecular weight of 500-10,000 g/mol, specifically, of 1100-8000 g/mol, an acid value of 0-150 mg KOH/g, specifically, of 0-50 mg KOH/g and a hydroxyl value of 40-400 mg KOH/g, specifically, of 50-200 g/mol.

[0044] The hardener of the first resin comprises a crosslinker. The crosslinkers are polyisocyanates with free isocyanate groups as cross-linking agents. Examples of polyisocyanates are any number of organic polyisocyanates with aliphatically, cycloaliphatically, araliphatically and/or aromatically bound free isocyanate groups. At 23°C, the polyisocyanates generally have a viscosity of 1 to 6,000 megapascal (“mPas”), advantageously, above 5 and below 3,000 mPas. Specifically mentioned polyisocyanates are polyisocyanates or polyisocyanate mixtures with exclusively aliphatically and/or cycloaliphatically bound isocyanate groups with an average NCO functionality of 1.5 to 5, specifically 2 to 4. Examples of particularly suitable polyisocyanates are what are known as “paint polyisocyanates” based on hexamethylene diisocyanate (HDI), 1-isocyanato-3,3,5-trimethyl-5-isocyanatomethyl-cyclohexane (IPDI), isophorone diisocyanate, 3-isocyanatomethyl-3,5,5-trimethylcyclohexyl isocyanate, and/or bis(isocyanatocyclohexyl)-methane and the derivatives thereof. As used herein, the term “derivatives thereof” with respect to the foregoing isocyanates means isocyanates and polyisocyanates modified by introduction of at least one of urethane, allophanate, urea, biuret, carbodiimide, uretonimine, or isocyanurate residues to the above mentioned diisocyanate, which, following production, are freed from surplus parent diisocyanate, for example by distillation, and having a residue content of less than 0.5% by weight. Triisocyanates, such as, triisocyanatononan can also be used. Sterically hindered polyisocyanates are also suitable. Examples of these are 1,1,6,6-tetramethyl-hexamethylene diisocyanate, 1,5-dibutyl-penta-methyldiisocyanate, p- or m-tetramethylxylylene diisocyanate and the appropriate hydrated homologues. In some embodiments, diisocyanates can be converted by the usual method to higher functional compounds, for example, by trimerization or by reaction with water or polyols, such as, for example, trimethylolpropane or glycerine. The polyisocyanates can also be used in the form of isocyanate-modified resins.

[0045] The reducer can comprise a paint solvent. Examples of suitable solvents include mono- or polyvalent alcohols, for example propanol, butanol, hexanol; glycol ethers or glycol esters, for example diethylene glycol dialkyl ether, dipropylene glycol dialkyl ether, each with C1 to C6 alkyl, ethoxy propanol, butyl glycol; glycols, for example ethylene glycol, propylene glycol, N-methylpyrrolidone and ketones, for example methyl ethyl ketone, acetone, cyclohexanon; aromatic or aliphatic hydrocarbons, for example toluene, xylene or linear or branched aliphatic C6-C12 hydrocarbons. In a specific embodiment, the reducer comprises butyl acetate, propylene glycol monoethyl ether acetate, propylene glycol methyl

ether acetate, 2-methoxy-1-methylethyl acetate, 2-methoxypropyl-1-acetate, acetone, xylene, toluene, or a combination thereof.

[0046] The first resin can also comprise a low molecular reactive component, so-called reactive thinners, which are able to react with the crosslinker.

[0047] The first resin may also contain an additive. Examples of additives include light stabilizers, for example based on benzotriazoles and hindered amine light stabilizer ("HALS") compounds, flow agents based on (meth)acryl-homopolymers or silicone oils, rheology-influencing agents, such as highly dispersed silica or polymeric urea compounds, thickeners, such as cross linked-on polycarboxylic acid or polyurethanes, anti-foaming agents, wetting agents, curing accelerators, for example for the crosslinking reaction of OH-functional binders with the polyisocyanate crosslinkers, for example organic metallic salts, such as dibutyl tin dilaurate, zinc naphthenate and compounds containing tertiary amino groups, such as triethylamine. The selection and the quantity of the additive can be determined by a person of ordinary skill in the art without undue experimentation.

[0048] The second resin can comprise a first component and a second component. The first component comprises a hydroxyl functional dendritic polymer; optionally, an acrylic polyol; and a plurality of metal oxide nanoparticles optionally encapsulated in a hydroxyl functional polymer and/or a hydroxyl functional fluorosurfactant. The first component can comprise a catalyst and a first solvent in which the materials of the first component other than the solvent are either dissolved or dispersed. The first component can optionally comprise a sterically hindered amine light stabilizer; and optionally, a UV absorber. The second component comprises a cross-linking agent, and a second solvent which may be the same as or different from the first solvent.

[0049] The dendritic polymer is a dendritic polyester having a hydroxyl functionality of from about 40 to about 80. The molecular weight of the dendritic polyester can be from about 5,000 to about 10,000. A highly-branched polyester having a hydroxyl functionality of 64 is specifically mentioned.

[0050] In some embodiments, the first component of the second resin can also comprise an acrylic polyol having a hydroxyl functionality of from 2 to 6. Addition of the acrylic polyol tends to reduce the hardness and brittleness of the coating composition.

[0051] Examples of the nanoparticles include, without limitation, aluminum oxide ( $\text{Al}_2\text{O}_3$ ) and/or zinc oxide ( $\text{ZnO}$ ) nanoparticles. Aluminum oxide nanoparticles can have a particle size in the range of about 10 to about 500 nanometers, specifically about 20 to about

60 nanometers. Similarly, the zinc oxide nanoparticles can have a particle size in the range of about 10 to about 500 nm, specifically from about 50 to about 70 nanometers.

[0052] Advantageously, the aluminum and zinc nanoparticles are encapsulated in a polymer. The polymer advantageously exhibits high adhesion to the nanoparticle and can be a hydroxyl functional silicone polyacrylate such as, without limitation, BYK SILCLEAN 3700\*. The encapsulated aluminum oxide and/or zinc oxide nanoparticles increase scratch resistance, improve hydrophobicity, and enhance the self-cleaning surface properties of the coating.

[0053] In an embodiment, the first component of the second resin also contains a hydroxyl functional fluorocarbon, in particular a hydroxyl functional fluorinated methacrylate polymer such as, without limitation, ZONYL 8857A\* fluorosurfactant from DuPont.

[0054] Optionally, a hindered amine light stabilizer (HALS) can be included in the first component of the second resin. HALS are known to those skilled in the art as efficient stabilizers against light-induced degradation of polymers. A presently preferred HALS is TINUVIN 292\*.

[0055] A UV absorber can also optionally be included in the first component of the second resin, an example, without limitation, of which is hydroxyphenylbenzotriazole, commercially available as TINUVIN 1130\*.

[0056] The second component of the second resin comprises a cross-linking agent polyisocyanate, which can react with hydroxyl groups to form urethanes. Another cross-linking agent that may be used is a melamine formaldehyde resin, which can react with hydroxyl groups to form acetals.

[0057] The polyisocyanate cross-linking agent having an average isocyanate functionality of from 1.5 to 5. It can be the same or different from the crosslinker in the hardener of the first resin described herein. A specifically mentioned polyisocyanate is DESMODUR N-3300\*. A dibutyltin catalyst can be used to speed the cure time.

[0058] A content of each of the first component and the second component of the second resin may independently be about 0.5 to about 1.5 parts, specifically about 0.7 to about 1.4 parts, based a total content of the first component and the second component.

[0059] The second resin is disclosed in US Patent No. 8,206,827, the content of which in its entirety is herein incorporated by reference.

[0060] It has been found that a coating using the first resin alone would not provide suitable hardness, and a coating using the second resin alone would not provide suitable buffing properties. Surprisingly, when the coating resin comprises both the first resin and the

second resin, the surface of a component for an electronic device can be properly a suitably refurbished to provide scratch free cosmetically-appealing appearance.

[0061] The coating resin may comprise the first resin in an amount of about 1 to about 99 wt%, specifically about 10 to about 90 wt%, more specifically about 20 to about 80 wt%, based on a total weight of the coating resin. The coating resin may comprise the second resin in an amount of about 1 to about 99 wt%, specifically about 10 to about 90 wt%, more specifically about 20 to about 80 wt%, based on a total weight of the coating resin. An embodiment comprising equal parts of the first and second resin is specifically mentioned.

[0062] The coating resin is described herein in detail as comprising a first resin and a second resin, wherein the first resin comprises a clear coat, a hardener, and optionally a reducer, and the second resin comprises a first component and a second component. However, it is appreciated that it is also within the scope of the disclosure a coating resin which comprises a first component and a second component, wherein the first component of the coating resin comprises (i) the clear coat of the first resin or the hydroxyl-functional binder of the clear coating in the first resin; and (ii) the first component of the second resin; and wherein the second component of the coating resin comprises the hardener of the first component and/or the second component of the second resin.

[0063] The coating resin can be disposed on the abraded and optionally activated surface by any suitable means, for example, by spraying, brushing, dipping, or brushing, the details of which can be determined by one of skill in the art without undue experimentation. Once deposited, the coating resin can be cured to provide a coated surface to refurbish the surface of the electronic device.

[0064] The curing may include heating the coating resin. The heating may include convection heating, microwave heating, or infra-red heating. The heating may comprise heating at about 30°C to about 80°C, specifically at about 35°C to about 70°C.

[0065] Depending on the curing conditions and the specific formulation of the coating resin, the curing time varies from a few minutes to a few hours. Specifically, the curing time is 5 to 180 minutes.

[0066] The surface to be refurbished can comprise glass or other materials suitable for use in the surface of electronic device components. Advantageously, the surface to be refurbished comprises glass. In an embodiment, the surface comprises an alkali aluminosilicate. Corning Gorilla glass is specifically mentioned.

[0067] Also disclosed is a method of refurbishing a digitizer for an electronic device, the method comprising the foregoing method for refurbishing a surface.



[0068] Also disclosed is a refurbished component for an electronic device, the refurbished component comprising: a polymerization product of a first resin and a second resin, wherein the first resin comprises a clear coat and a hardener, the clear coat comprises a hydroxyl-functional binder selected from a polyurethane, a (meth)acrylic copolymer, a polyester, a polyether, or a combination comprising at least one of the foregoing polymer; and the hardener comprises a polyisocyanate crosslinker; and wherein the second resin comprises a first component and a second component, the first component comprises: a hydroxyl functional dendritic polymer; optionally an acrylic polyol; and a plurality of metal oxide nanoparticles optionally encapsulated in a hydroxyl functional polymer or a hydroxyl functional fluorosurfactant; and the second component comprises a cross-linking agent selected from a polyisocyanate, a melamine ormaldehyde resin, and a combination comprising at least one of the foregoing compound.

[0069] In an embodiment, the polymerization product is directly disposed on the surface of the component for an electronic device. In another embodiment, the refurbished component may further comprise an activation layer disposed between the polymerization product and the component surface of the electronic device. The electronic device may be a wireless device. The component may be a screen, a digitizer, a front case, or a rear case, for example.

[0070] Also disclosed is refurbished electronic device, the electronic device comprising a component comprising: a substrate; and a polymerization product of a first resin and a second resin directly on the substrate, wherein the first resin and the second resin are as disclosed herein.

[0071] The disclosed embodiment is further described by way of the following Examples. The Examples are illustrative and shall not limit the scope of this disclosure.

## EXAMPLES

### Example 1.

[0072] A digitizer of an Apple iPhone was provided. The surface of the digitizer was abraded using a 1200 mesh diamond polishing compound (Rio Grande\* 201494). The abraded digitizer was then firstly cleaned using a glass cleaner (Windex\*), secondly cleaned using a degreaser (Klean Strip\* Prep-All\*), and dry wiped to remove residual degreaser.

[0073] The cleaned surface was then treated with an activator (Glassprimer GP083).

[0074] The activated surface was then sprayed with a coating resin prepared by combining equal parts of a first resin and a second resin. The first resin was prepared by

mixing 1 part hardener (Spies Hecker Permasolid\* 3220), 0.1 part reducer (Spies Hecker Permacron\* 3363), and 3 parts clearcoat (Spies Hecker Permasolid\* 8600). The second resin was prepared using 1 part of a clear (Nanovere VX-RC 2K) and 1 part activator (Nanovere).

[0075] The coating resin was allowed to cure at room temperature to provide a refurbished surface.

Example 2.

[0076] The surface of a digitizer was abraded, cleaned, and activated following the same procedure of Example 1.

[0077] The activated surface was then sprayed with a coating resin prepared by combining 1 part by volume of a first resin and 8 parts by volume of a second resin. The first resin was prepared by mixing 4 parts by volume of a clear coat (PPG Concept DCU 2021 clear), 1 part by volume of a hardener (PPG DCX hardner), and 1 part by volume of a reducer (PPG 870 reducer). The second resin was prepared using 1 part by volume of a clear coat (Nanovere VX-RC 2K) and 1 part by volume of an activator (Nanovere).

[0078] The coating resin was allowed to cure at room temperature to provide a refurbished surface. The refurbished surface was evaluated by contacting with a finger nail and a copper penny. No scratches were observed after contacting with the finger nail and the copper penny.

Comparative Example 1.

[0079] Example 1 was repeated except that the activated surface was sprayed with a coating resin containing only the first resin. Contacting with a finger nail showed that the coating was scratched by the finger nail, and thus is too soft and susceptible to scratches.

Comparative Example 2.

[0080] Example 1 was repeated except that the activated surface was sprayed with a coating resin containing only the second resin. It was observed the coating was too hard and not buffable.

Comparative Examples 3 to 6.

[0081] Example 1 was repeated except that the surface of the digitizer was abraded with a Scotch Brite<sup>TM</sup> abrasive pad, 200A sand paper, a grease bar, and a Na<sub>2</sub>CO<sub>3</sub> blast, respectively instead of the 1200 mesh diamond polishing compound. It was observed that the coating was uneven and did not provide cosmetically appealing appearance.

[0082] In an embodiment, a method of refurbishing a surface of a component for an electronic device, comprises: abrading a surface to be refurbished with an abrasive to remove a coating on the surface and provide an abraded surface; optionally firstly cleaning the

abraded surface by contacting with a glass cleaner to provide a firstly cleaned surface; optionally secondly cleaning the firstly cleaned surface by contacting the firstly cleaned surface with a grease remover to provide a secondly cleaned surface; optionally contacting the secondly cleaned surface with an activator to provide an activated surface; and disposing a coating resin on the abraded and optionally activated surface; and curing the coating resin to provide a coated surface to refurbish the surface of the electronic device, wherein the coating resin comprises a hydroxyl functional dendritic polymer; optionally an acrylic polyol; and a plurality of metal oxide nanoparticles optionally encapsulated in a hydroxyl functional polymer or a hydroxyl functional fluorosurfactant. The coating resin can comprise a first resin and a second resin, wherein the second resin comprises a first component comprising the hydroxyl functional dendritic polymer, the optional acrylic polyol and the plurality of metal oxide nanoparticles; and the first resin comprises a clear coat and a hardener, wherein the clear coat comprises a hydroxyl-functional binder selected from a polyurethane, a (meth)acrylic copolymer, a polyester, a polyether, or a combination comprising at least one of the foregoing polymer; and the hardener comprises a polyisocyanate crosslinker.

**[0083]** In various embodiments, (i) the abrading comprises abrading with a diamond polishing compound; (ii) the diamond polishing compound comprises diamond having a mesh of 600 to 2000 grit; (iii) the diamond polishing compound comprises 1200 mesh diamond; (iv) the diamond polishing compound comprises diamond having a maximum particle size of 1 micrometer to 15 micrometers; (v) the diamond polishing compound comprises diamond having a maximum particle size of 1 micrometer to 10 micrometers; and/or (vi) the abrading comprises abrading with aluminum oxide having a particle size of 5 to 80 micrometers using an abrasive jet machining system.

**[0084]** In various embodiments, (i) the coating is an oleophilic coating; (ii) the glass cleaner comprises water and acetic acid; (iii) the grease remover comprises acetone, an alcohol; liquid carbon dioxide; an aldehyde; a formamide; a ketone; acetonitrile; a sulfoxide; a sulfone; a thiophene; an acetate; an amide; or a combination thereof; (iv) the grease remover comprises mineral spirits, aliphatic petroleum distillates, white spirits, naphtha, heptane, toluene or a combination thereof; (v) the activator comprises a silane; (vi) the activator comprises a reaction product of an epoxy silane and an amino silane having at least two amino groups; (vii) the activator comprises a carboxysilyl compound of the formula  $\text{SiR}_1\text{R}_2\text{R}_3\text{R}_4$  wherein  $\text{R}_1$  is a straight or branched chain substituted with a carboxyl group or a salt thereof, each  $\text{R}_2$ ,  $\text{R}_3$  and  $\text{R}_4$  is independently a C1 to C12 alkoxy group, a C1 to C12 alkyl group, a C6 to C24 aryl group, halogen, or hydroxyl; (viii) the activator comprises N-[(3-

trimethoxysilyl)propyl]ethylene-diamine triacetic acid trisodium salt; (ix) the activator comprises 2-oxo-*N*-(3-(triethoxysilyl)propyl)azepane-1-carboxamide; (x) the activator comprises a silica sol comprising a metal salt and a partial hydrolyzate of an alkoxy silane oligomer, wherein the metal salt is a metal organic acid salt or a metal carbonate of one or more of magnesium, calcium, strontium and barium, and wherein the alkoxy silane oligomer is tetraethoxysilane, tetrapropoxysilane, methyltriethoxysilane, dimethylmethoxysilane, phenyltriethoxysilane, chlorotrimethylsilane, vinyltriethoxysilane or aminopropyltriethoxysilane; (xi) the activator comprises an unsaturated-hydrocarbylamido-alkanesulfonic acid or a salt thereof; and/or (xii) the contacting comprises spraying, dipping, roll coating, brush coating, or transfer coating.

**[0085]** In another embodiment, a refurbished component for an electronic device comprises a surface, and a polymerization product of a first resin and a second resin disposed on the surface,

wherein the first resin comprises a clear coat and a hardener, the clear coat comprises a hydroxyl-functional binder selected from a polyurethane, a (meth)acrylic copolymer, a polyester, a polyether, or a combination comprising at least one of the foregoing polymer; and the hardener comprises a polyisocyanate crosslinker; and wherein the second resin comprises a first component and a second component, the first component comprises: a hydroxyl functional dendritic polymer; optionally an acrylic polyol; and a plurality of metal oxide nanoparticles optionally encapsulated in a hydroxyl functional polymer or a hydroxyl functional fluorosurfactant; and the second component comprises a cross-linking agent selected from a polyisocyanate, a melamine formaldehyde resin, and a combination comprising at least one of the foregoing compound.

**[0086]** In yet another embodiment, a refurbished component for an electronic device comprises a surface and a polymerization product of a resin having a first component and a second component disposed on the surface, wherein the first component comprises: a hydroxyl functional dendritic polymer having a hydroxyl functionality of 40 to 80; a plurality of metal oxide nanoparticles optionally encapsulated in a hydroxyl functional polymer or a hydroxyl functional fluorosurfactant; and a hydroxyl-functional binder selected from a polyurethane, a (meth)acrylic copolymer, a polyester, a polyether, or a combination comprising at least one of the foregoing polymer, wherein the hydroxyl-functional binder has a hydroxyl functionality of 2 to 25; and wherein the second component comprises a cross-linking agent selected from a polyisocyanate, a melamine formaldehyde resin, and a combination comprising at least one of the foregoing compound.

[0087] In various embodiments, (i) the hydroxyl functional dendritic polymer has a hydroxyl functionality of 40 to 80; (ii) the hydroxyl functional dendritic polymer is a branched polyester having a hydroxyl functionality of 64; (iii) the acrylic polyol has a hydroxyl functionality of 2 to 6; (iv) the plurality of encapsulated metal oxide nanoparticles is selected from encapsulated aluminum oxide nanoparticles, encapsulated zinc oxide nanoparticles or a combination comprising at least one of the foregoing particles; (v) the hydroxyl functional polymer is a hydroxyl functional silicone polyacrylate; (vi) the hydroxyl functional fluorosurfactant is a hydroxyl functional fluorinated methacrylate polymer; (vii) the hydroxyl-functional binder has an acid value of 0 to 100 mg KOH/g, and a hydroxyl value of 40 to 400 mg KOH/g; (viii) the polyisocyanate crosslinker has an average NCO functionality of 1.5 to 5; (ix) the polyisocyanate crosslinker is selected from hexamethylene diisocyanate, isophorone diisocyanate, 3-isocyanatomethyl-3,5,5-trimethylcyclohexyl isocyanate, 1-isocyanato-3,3,5-trimethyl-5-isocyanatomethyl-cyclohexane, bis(isocyanatocyclohexyl)-methane, a derivative of one of the foregoing, or a combination thereof; (x) the first resin further comprises a reducer comprising butyl acetate, propylene glycol monoethyl ether acetate, propylene glycol methyl ether acetate, 2-methoxy-1-methylethyl acetate, 2-methoxypropyl-1-acetate, acetone, xylene, toluene, a combination comprising at least one of the foregoing; (xi) the polymerization product is disposed directly on the surface; (xii) the refurbished component further comprises an activation layer disposed between the surface and the polymerization product; (xiii) the electronic device is a wireless device; and/or (xiv) the component is a screen, a digitizer, a front case, or a rear case.

[0088] While the invention has been described with reference to an exemplary embodiment, it will be understood by those skilled in the art that various changes may be made and equivalents may be substituted for elements thereof without departing from the scope of the invention. In addition, many modifications may be made to adapt a particular situation or material to the teachings of the invention without departing from the essential scope thereof. Therefore, it is intended that the invention not be limited to the particular embodiment disclosed as the best mode contemplated for carrying out this invention, but that the invention will include all embodiments falling within the scope of the appended claims.

## WHAT IS CLAIMED IS:

1. A method of refurbishing a surface of a component for an electronic device, the method comprising:
  - abrading a surface to be refurbished with an abrasive to remove a coating on the surface and provide an abraded surface;
  - optionally firstly cleaning the abraded surface by contacting with a glass cleaner to provide a firstly cleaned surface;
  - optionally secondly cleaning the firstly cleaned surface by contacting the firstly cleaned surface with a grease remover to provide a secondly cleaned surface;
  - optionally contacting the secondly cleaned surface with an activator to provide an activated surface; and
  - disposing a coating resin on the abraded and optionally activated surface; and
  - curing the coating resin to provide a coated surface to refurbish the surface of the electronic device,wherein the coating resin comprises
  - a hydroxyl functional dendritic polymer;
  - optionally an acrylic polyol; and
  - a plurality of metal oxide nanoparticles optionally encapsulated in a hydroxyl functional polymer or a hydroxyl functional fluorosurfactant.
2. The method of claim 1, wherein the abrading comprises abrading with a diamond polishing compound.
3. The method of claim 1 or claim 2, wherein the diamond polishing compound comprises diamond having a mesh of 600 to 2000 grit.
4. The method of claim 2 or claim 3, wherein the diamond polishing compound comprises 1200 mesh diamond.
5. The method of any one of claims 2 to 4, wherein the diamond polishing compound comprises diamond having a maximum particle size of 1 micrometer to 15 micrometers.
6. The method of any one of claims 2 to 5, wherein the diamond polishing compound comprises diamond having a maximum particle size of 1 micrometer to 10 micrometers.
7. The method of claim 1, wherein the abrading comprises abrading with aluminum oxide having a particle size of 5 to 80 micrometers using an abrasive jet machining system.

8. The method of any one of claims 1 to 7, wherein the coating is an oleophilic coating.
9. The method of any one of claims 1 to 8, wherein the glass cleaner comprises water and acetic acid.
10. The method of any one of claims 1 to 9, wherein the grease remover comprises acetone, an alcohol; liquid carbon dioxide; an aldehyde; a formamide; a ketone; acetonitrile; a sulfoxide; a sulfone; a thiophene; an acetate; an amide; or a combination thereof.
11. The method of any one of claims 1 to 9, wherein the grease remover comprises mineral spirits, aliphatic petroleum distillates, white spirits, naphtha, heptane, toluene, or a combination thereof.
12. The method of any one of claims 1 to 11, wherein the activator comprises a silane.
13. The method of any one of claims 1 to 11, wherein the activator comprises a reaction product of an epoxy silane and an amino silane having at least two amino groups.
14. The method of any one of claims 1 to 11, wherein the activator comprises a carboxysilyl compound of the formula  $\text{SiR}_1\text{R}_2\text{R}_3\text{R}_4$  wherein  $\text{R}_1$  is a straight or branched chain substituted with a carboxyl group or a salt thereof, each  $\text{R}_2$ ,  $\text{R}_3$  and  $\text{R}_4$  is independently a C1 to C12 alkoxy group, a C1 to C12 alkyl group, a C6 to C24 aryl group, halogen, or hydroxy.
15. The method of any one of claims 1 to 11, wherein the activator comprises N-[(3-trimethoxysilyl)propyl]ethylene-diamine triacetic acid trisodium salt.
16. The method of any one of claims 1 to 11, wherein the activator comprises 2-oxo-N-(3-(triethoxysilyl)propyl)azepane-1-carboxamide.
17. The method of any one of claims 1 to 11, wherein the activator comprises a silica sol comprising a metal salt and a partial hydrolyzate of an alkoxy silane oligomer, wherein the metal salt is a metal organic acid salt or a metal carbonate of one or more of magnesium, calcium, strontium and barium, and wherein the alkoxy silane oligomer is tetraethoxysilane, tetrapropoxysilane, methyltriethoxysilane, dimethylmethoxysilane, phenyltriethoxysilane, chlorotrimethylsilane, vinyltriethoxysilane or aminopropyltriethoxysilane.
18. The method of any one of claims 1 to 11, wherein the activator comprises an unsaturated-hydrocarbylamido-alkanesulfonic acid or a salt thereof.
19. The method of any one of claims 1 to 18, wherein the contacting comprises spraying, dipping, roll coating, brush coating, or transfer coating.

20. The method of any one of claims claim 1 to 19, wherein the coating resin comprises a first resin and a second resin, wherein the second resin comprises a first component comprising the hydroxyl functional dendritic polymer, the optional acrylic polyol and the plurality of metal oxide nanoparticles.

21. The method of claim 20, wherein the first resin comprises a clear coat and a hardener,

wherein the clear coat comprises a hydroxyl-functional binder selected from a polyurethane, a (meth)acrylic copolymer, a polyester, a polyether, or a combination comprising at least one of the foregoing polymer; and

the hardener comprises a polyisocyanate crosslinker.

22. The method of claim 21, wherein the polyurethane has a number average molecular weight  $M_n$  of 500 to 500,000 g/mol, an acid value of 0 to 100 mg KOH/g, and a hydroxyl value of 40 to 400 mg KOH/g.

23. The method of claim 21 or 22, wherein the polyurethane comprises silicon-modified or (meth)acrylated polyurethane resins.

24. The method of claim 21, wherein the poly(meth)acrylate resin has a number average molecular mass  $M_n$  of 1000 to 20,000 g/mol, an acid value of 0 to 100 mg KOH/g, and a hydroxyl value of 40 to 400 mg KOH/g.

25. The method of claim 21, wherein the polyester has a number average molecular weight of 500 to 10,000 g/mol, an acid value of 0 to 150 mg KOH/g, and a hydroxyl value of 40 to 400 mg KOH/g.

26. The method of any one of claims 21 to 25, wherein the polyisocyanate crosslinker has an average NCO functionality of 1.5 to 5.

27. The method of any one of claims 21 to 26, wherein the polyisocyanate crosslinker is selected from hexamethylene diisocyanate, isophorone diisocyanate, 3-isocyanatomethyl-3,5,5-trimethylcyclohexyl isocyanate, 1-isocyanato-3,3,5-trimethyl-5-isocyanatomethyl-cyclohexane, bis(isocyanatocyclohexyl)-methane, a derivative of one of the foregoing, or a combination thereof.

28. The method of any one of claims 20 to 27, wherein the first resin further comprises a reducer.

29. The method of claim 28, wherein the reducer comprises butyl acetate, propylene glycol monoethyl ether acetate, propylene glycol methyl ether acetate, 2-methoxy-1-methylethyl acetate, 2-methoxypropyl-1-acetate, acetone, xylene, toluene, a combination comprising at least one of the foregoing.



30. The method of claim 20, wherein the second resin further comprises a second component,

wherein the second component comprises a cross-linking agent selected from a polyisocyanate, a melamine formaldehyde resin, and a combination comprising at least one of the foregoing compound.

31. The method of any one of claims 1 to 30, wherein the hydroxyl functional dendritic polymer has a hydroxyl functionality of 40 to 80.

32. The method of any one of claims 1 to 31, wherein the hydroxyl functional dendritic polymer is a branched polyester having a hydroxyl functionality of 64.

33. The method of any one of claims 1 to 32, wherein the acrylic polyol has a hydroxyl functionality of 2 to 6.

34. The method of any one of claims 1 to 33, wherein the plurality of encapsulated metal oxide nanoparticles is selected from encapsulated aluminum oxide nanoparticles, encapsulated zinc oxide nanoparticles or a combination comprising at least one of the foregoing particles.

35. The method of any one of claims 1 to 34, wherein the hydroxyl functional polymer is a hydroxyl functional silicone polyacrylate.

36. The method of any one of claims 1 to 35, wherein the hydroxyl functional fluorosurfactant is a hydroxyl functional fluorinated methacrylate polymer.

37. The method of any one of claims 1 to 19, wherein the coating resin further comprises

a hydroxyl-functional binder selected from a polyurethane, a (meth)acrylic copolymer, a polyester, a polyether, or a combination comprising at least one of the foregoing polymer, wherein the hydroxyl-functional binder has a hydroxyl functionality of 2 to 25; and

a cross-linking agent selected from a polyisocyanate, a melamine formaldehyde resin, and a combination comprising at least one of the foregoing compound.

38. The method of claim 37, wherein the plurality of encapsulated metal oxide nanoparticles is selected from encapsulated aluminum oxide nanoparticles, encapsulated zinc oxide nanoparticles or a combination comprising at least one of the foregoing particles.

39. The method of claim 37 or claim 38, wherein the hydroxyl functional fluorosurfactant is a hydroxyl functional fluorinated methacrylate polymer.

40. The method of any one of claims 37 to 39, wherein the polyisocyanate crosslinker has an average NCO functionality of 1.5 to 5.

41. The method of any one of claims 37 to 40, wherein the polyisocyanate crosslinker is selected from hexamethylene diisocyanate, isophorone diisocyanate, 3-isocyanatomethyl-3,5,5-trimethylcyclohexyl isocyanate, 1-isocyanato-3,3,5-trimethyl-5-isocyanatomethyl-cyclohexane, bis(isocyanatocyclohexyl)-methane, a derivative of one of the foregoing, or a combination thereof.

42. The method of any one of claims 1 to 41, wherein the surface comprises glass.

43. The method of any one of claims 1 to 42, wherein the component is a screen, a digitizer, a front case, or a back case for a wireless device.

44. A method of refurbishing a surface, the method comprising:  
abrading a surface to be refurbished with an abrasive to remove a coating on the surface and provide an abraded surface;

optionally firstly cleaning the abraded surface by contacting with a glass cleaner to provide a firstly cleaned surface;

optionally secondly cleaning the firstly cleaned surface by contacting the firstly cleaned surface with a grease remover to provide a secondly cleaned surface;

optionally contacting the secondly cleaned surface with an activator to provide an activated surface; and

disposing a coating resin on the abraded and optionally activated surface; and  
curing the coating resin to provide a coated surface to refurbish the surface,

wherein the coating resin comprises:

a hydroxyl functional dendritic polymer;

optionally an acrylic polyol; and

a plurality of metal oxide nanoparticles optionally encapsulated in a hydroxyl functional polymer or a hydroxyl functional fluorosurfactant.

45. A refurbished component for an electronic device comprising a surface, and a polymerization product of a first resin and a second resin disposed on the surface,

wherein the first resin comprises a clear coat and a hardener,

the clear coat comprises a hydroxyl-functional binder selected from a polyurethane, a (meth)acrylic copolymer, a polyester, a polyether, or a combination comprising at least one of the foregoing polymers; and

the hardener comprises a polyisocyanate crosslinker; and

wherein the second resin comprises a first component and a second component,

the first component comprises:

a hydroxyl functional dendritic polymer;

optionally an acrylic polyol; and  
a plurality of metal oxide nanoparticles optionally encapsulated in a hydroxyl functional polymer or a hydroxyl functional fluorosurfactant; and

the second component comprises a cross-linking agent selected from a polyisocyanate, a melamine formaldehyde resin, and a combination comprising at least one of the foregoing compounds.

46. The refurbished component of claim 45, wherein the hydroxyl functional dendritic polymer has a hydroxyl functionality of 40 to 80.

47. The refurbished component of claim 45 or 46, wherein the hydroxyl functional dendritic polymer is a branched polyester having a hydroxyl functionality of 64.

48. The refurbished component of any one of claims 45 to 47, wherein the acrylic polyol has a hydroxyl functionality of 2 to 6.

49. The refurbished component of any one of claims 45 to 48, wherein the plurality of encapsulated metal oxide nanoparticles is selected from encapsulated aluminum oxide nanoparticles, encapsulated zinc oxide nanoparticles or a combination comprising at least one of the foregoing particles.

50. The refurbished component of any one of claims 45 to 49, wherein the hydroxyl functional polymer is a hydroxyl functional silicone polyacrylate.

51. The refurbished component of any one of claims 45 to 50, wherein the hydroxyl functional fluorosurfactant is a hydroxyl functional fluorinated methacrylate polymer.

52. The refurbished component of any one of claims 45 to 51, wherein the hydroxyl-functional binder has an acid value of 0 to 100 mg KOH/g, and a hydroxyl value of 40 to 400 mg KOH/g.

53. The refurbished component of any one of claims 45 to 52, wherein the polyisocyanate crosslinker has an average NCO functionality of 1.5 to 5.

54. The refurbished component of any one of claims 45 to 53, wherein the polyisocyanate crosslinker is selected from hexamethylene diisocyanate, isophorone diisocyanate, 3-isocyanatomethyl-3,5,5-trimethylcyclohexyl isocyanate, 1-isocyanato-3,3,5-trimethyl-5-isocyanatomethyl-cyclohexane, bis(isocyanatocyclohexyl)-methane, a derivative of one of the foregoing, or a combination thereof.

55. The refurbished component of any one of claims 45 to 54, wherein the first resin further comprises a reducer comprising butyl acetate, propylene glycol monoethyl ether acetate, propylene glycol methyl ether acetate, 2-methoxy-1-methylethyl acetate, 2-

methoxypropyl-1-acetate, acetone, xylene, toluene, a combination comprising at least one of the foregoing.

56. The refurbished component of any one of claims 45 to 55, wherein the polymerization product is disposed directly on the surface.

57. The refurbished component of any one of claims 45 to 56, further comprising an activation layer disposed between the surface and the polymerization product.

58. The refurbished component of any one of claims 45 to 57, wherein the electronic device is a wireless device.

59. The refurbished component of any one of claims 45 to 58, wherein the component is a screen, a digitizer, a front case, or a rear case.

60. A refurbished component for an electronic device comprising a surface and a polymerization product of a resin having a first component and a second component disposed on the surface,

wherein the first component comprises:

a hydroxyl functional dendritic polymer having a hydroxyl functionality of 40 to 80;

a plurality of metal oxide nanoparticles optionally encapsulated in a hydroxyl functional polymer or a hydroxyl functional fluorosurfactant; and

a hydroxyl-functional binder selected from a polyurethane, a (meth)acrylic copolymer, a polyester, a polyether, or a combination comprising at least one of the foregoing polymers, wherein the hydroxyl-functional binder has a hydroxyl functionality of 2 to 25; and

wherein the second component comprises a cross-linking agent selected from a polyisocyanate, a melamine formaldehyde resin, and a combination comprising at least one of the foregoing compounds.

61. The refurbished component of claim 60, wherein the plurality of encapsulated metal oxide nanoparticles is selected from encapsulated aluminum oxide nanoparticles, encapsulated zinc oxide nanoparticles or a combination comprising at least one of the foregoing particles.

62. The refurbished component of claim 60 or 61, wherein the hydroxyl functional fluorosurfactant is a hydroxyl functional fluorinated methacrylate polymer.

63. The refurbished component of any one of claims 60 to 62, wherein the polyisocyanate crosslinker has an average NCO functionality of 1.5 to 5.

64. The refurbished component of any one of claims 60 to 63, wherein the polyisocyanate crosslinker is selected from hexamethylene diisocyanate, isophorone diisocyanate, 3-isocyanatomethyl-3,5,5-trimethylcyclohexyl isocyanate, 1-isocyanato-3,3,5-trimethyl-5-isocyanatomethyl-cyclohexane, bis(isocyanatocyclohexyl)-methane, a derivative of one of the foregoing, or a combination thereof.

65. The refurbished component of any one of claims 60 to 64, wherein the polymerization product is directly disposed on the surface.

66. The refurbished component of any one of claims 60 to 65, further comprising an activation layer disposed between the surface and the polymerization product.

67. The refurbished component of any one of claims 60 to 66, wherein the electronic device is a wireless device.

68. The refurbished component of any one of claims 60 to 67, wherein the component is a screen, a digitizer, a front case, or a rear case.

69. A refurbished electronic device comprising the refurbished component of any one of claims 45 to 68.

70. A method of refurbishing a surface of a component for an electronic device, the method comprising:

abrading a surface to be refurbished with an abrasive to remove a coating on the surface and provide an abraded surface;

optionally firstly cleaning the abraded surface by contacting with a glass cleaner to provide a firstly cleaned surface;

optionally secondly cleaning the firstly cleaned surface by contacting the firstly cleaned surface with a grease remover to provide a secondly cleaned surface;

contacting the secondly cleaned surface with an activator to provide an activated surface; and

disposing a coating resin on the abraded and activated surface; and

curing the coating resin to provide a coated surface to refurbish the surface of the electronic device,

wherein the coating resin comprises a first resin and a second resin,

the first resin comprises a clear coat, a hardener, and a reducer,

wherein the clear coat comprises a hydroxyl-functional binder selected from a polyurethane, a (meth)acrylic copolymer, a polyester, a polyether, or a combination comprising at least one of the foregoing polymer;

the hardener comprises a polyisocyanate crosslinker; and

the reducer comprises a solvent; and  
the second resin comprises a first component and a second component,  
wherein the first component comprises:  
a hydroxyl functional dendritic polymer;  
optionally an acrylic polyol; and  
a plurality of metal oxide nanoparticles optionally encapsulated in a  
hydroxyl functional polymer or a hydroxyl functional fluorosurfactant; and  
the second component comprises a cross-linking agent selected from a  
polyisocyanate, a melamine formaldehyde resin, and a combination comprising at least one of  
the foregoing compound, and  
wherein the surface comprises glass.

## INTERNATIONAL SEARCH REPORT

International application No.  
**PCT/US2014/011949****A. CLASSIFICATION OF SUBJECT MATTER****B24B 1/00(2006.01)i, B24B 7/30(2006.01)i, B32B 38/10(2006.01)i, B32B 38/18(2006.01)i**

According to International Patent Classification (IPC) or to both national classification and IPC

**B. FIELDS SEARCHED**

Minimum documentation searched (classification system followed by classification symbols)

B24B 1/00; B05D 3/00; B05D 3/02; B44C 3/12; C09K 3/14; B24D 3/14; C08L 67/00; C09D 133/04; C08L 83/00; B24B 7/30; B32B 38/10; B32B 38/18

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Korean utility models and applications for utility models  
Japanese utility models and applications for utility models

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

eKOMPASS(KIPO internal) &amp; Keywords: refurbishing, resin, hydroxyl functional dendritic polymer, acrylic polyol, and metal oxide,

**C. DOCUMENTS CONSIDERED TO BE RELEVANT**

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2009-0081373 A1 (CHOATE, THOMAS F.) 26 March 2009 See claims 1, 4, 8 and paragraphs [0054]-[0055], [0089]-[0097], [0129]-[0143].	1, 44
Y		2-3, 7
A		45-47, 60-62, 70
Y	US 2011-0220266 A1 (ARAVAMUDAN, GOSAKAN) 15 September 2011 See abstract and paragraph [0038].	2-3
Y	EP 0621327 A1 (NORTON COMPANY) 26 October 1994 See abstract and page 3, lines 7-11, page 7, lines 39-41.	7
A	US 2003-0045653 A1 (FLOSBACH, CARMEN et al.) 06 March 2003 See claim 1 and paragraphs [0012]-[0040].	1-3, 7, 44-47, 60-62, 70
A	US 2004-0225057 A1 (ANDERSON, LAWRENCE G. et al.) 11 November 2004 See abstract and claims 134-140, 201.	1-3, 7, 44-47, 60-62, 70

 Further documents are listed in the continuation of Box C. See patent family annex.

\* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&amp;" document member of the same patent family

Date of the actual completion of the international search

17 April 2014 (17.04.2014)

Date of mailing of the international search report

**18 April 2014 (18.04.2014)**

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**INTERNATIONAL SEARCH REPORT**

International application No.

**PCT/US2014/011949****Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)**

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1.  Claims Nos.:  
because they relate to subject matter not required to be searched by this Authority, namely:
  
2.  Claims Nos.: 21-22, 24-25, 29-30, 38  
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:  
Claims 21-22, 24-25, 29-30, 38 are regarded to be unclear since they refer to multiple dependent claims which does not comply with PCT Rule 6.4(a).
  
3.  Claims Nos.: 4-6, 8-20, 23, 26-28, 31-37, 39-43, 48-59, 63-69  
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

**Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)**

This International Searching Authority found multiple inventions in this international application, as follows:

1.  As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.
  
2.  As all searchable claims could be searched without effort justifying an additional fees, this Authority did not invite payment of any additional fees.
  
3.  As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:
  
  
  
  
  
  
  
  
  
  
4.  No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

- Remark on Protest**
- The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.
- The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.
- No protest accompanied the payment of additional search fees.



## INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.

**PCT/US2014/011949**

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 2009-0081373 A1	26/03/2009	CA 2729773 A1	14/01/2010
		CN 102099429 A	15/06/2011
		EP 2300547 A2	30/03/2011
		JP 2011-527721 A	04/11/2011
		KR 10-2011-0053331 A	20/05/2011
		MX 2011000063 A	04/07/2011
		RU 2011102479 A	20/08/2012
		US 8568888 B2	29/10/2013
		WO 2010-006073 A2	14/01/2010
		WO 2010-006073 A3	06/05/2010
US 2011-0220266 A1	15/09/2011	US 8419871 B2	16/04/2013
		WO 2010-070669 A1	24/06/2010
EP 0621327 A1	26/10/1994	AU 5786694 A	27/10/1994
		BR 9401549 A	25/10/1994
		CA 2120872 A1	22/10/1994
		CA 2120872 C	17/11/1998
		CN 1098975 A0	22/02/1995
		JP 07-034063 A	03/02/1995
		JP 2951537 B2	20/09/1999
		KR 10-0335519 B1	25/10/2002
		NO 941425 A	24/10/1994
		NO 941425 D0	20/04/1994
		US 5135892 A	04/08/1992
		US 5330937 A	19/07/1994
		US 5366526 A	22/11/1994
		US 5456735 A	10/10/1995
		US 2003-0045653 A1	06/03/2003
BR 0212022 A	03/08/2004		
DE 60235245 D1	18/03/2010		
EP 1417245 A1	12/05/2004		
EP 1417245 B1	27/01/2010		
ES 2336656 T3	15/04/2010		
JP 2005-500415 A	06/01/2005		
JP 4276068 B2	10/06/2009		
MX PA04001471 A	20/05/2004		
US 2004-0170767 A1	02/09/2004		
WO 03-016371 A1	27/02/2003		
ZA 200400247 A	13/01/2005		
US 2004-0225057 A1	11/11/2004		
		AU 2000-63927 B2	26/02/2004
		AU 2000-63929 A1	19/02/2001
		AU 2000-63929 B2	18/03/2004
		AU 2000-65042 A1	19/02/2001
		AU 2000-65042 B2	18/03/2004
		AU 2000-66158 A1	19/02/2001

**INTERNATIONAL SEARCH REPORT**

Information on patent family members

International application No.

**PCT/US2014/011949**

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
		AU 2000-66158 B2	21/08/2003
		AU 2002-317592 A8	17/02/2003
		AU 6392900 A	19/02/2001
		AU 771279 B2	18/03/2004
		BR 0012875 A	16/04/2002
		CA 2380403 A1	08/02/2001
		CA 2380403 C	08/12/2009
		CA 2380408 A1	08/02/2001
		CA 2380408 C	22/04/2008
		CA 2380412 A1	08/02/2001
		CA 2380415 A1	08/02/2001
		CA 2380415 C	17/07/2007
		CA 2455804 A1	13/02/2003
		CA 2455804 C	08/07/2008
		CN 1209427 C0	06/07/2005
		CN 1261508 C0	28/06/2006
		CN 1262582 C0	05/07/2006
		CN 1376175 A0	23/10/2002
		CN 1376186 A0	23/10/2002
		CN 1376187 A0	23/10/2002
		CN 1377392 A0	30/10/2002
		CN 1517597 A	04/08/2004
		CN 1517597 C0	15/02/2006
		EP 1204701 A1	15/05/2002
		EP 1204701 B1	21/09/2005
		EP 1204708 A1	15/05/2002
		EP 1204709 A1	15/05/2002
		EP 1204709 B1	14/02/2007
		EP 1228155 A1	07/08/2002
		EP 1228155 B1	08/04/2009
		EP 1417273 A2	12/05/2004
		EP 1417273 B1	15/09/2010
		EP 1435493 A1	07/07/2004
		EP 1435493 B1	24/05/2006
		JP 2003-506518 A	18/02/2003
		JP 2003-506519 A	18/02/2003
		JP 2003-506520 A	18/02/2003
		JP 2003-508595 A	04/03/2003
		JP 2004-212037 A	29/07/2004
		JP 2004-536947 A	09/12/2004
		JP 2006-057098 A	02/03/2006
		JP 2006-070278 A	16/03/2006
		JP 2006-213925 A	17/08/2006
		JP 2008-111129 A	15/05/2008
		JP 2008-202056 A	04/09/2008
		JP 2008-223034 A	25/09/2008
		JP 2009-197238 A	03/09/2009
		JP 2010-018813 A	28/01/2010
		JP 3854959 B2	06/12/2006
		JP 4148891 B2	10/09/2008

**INTERNATIONAL SEARCH REPORT**

Information on patent family members

International application No.

**PCT/US2014/011949**

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
		JP 4284020 B2	24/06/2009
		KR 10-0618737 B1	01/09/2006
		KR 10-0618738 B1	31/08/2006
		KR 10-0745875 B1	02/08/2007
		KR 10-0760067 B1	18/09/2007
		KR 10-0760068 B1	18/09/2007
		KR 10-0760069 B1	18/09/2007
		KR 10-2002-0056882 A	10/07/2002
		KR 10-2004-0063218 A	14/07/2004
		MX 253908 B	28/01/2008
		MX PA02001097 A	21/07/2003
		US 2002-0086168 A1	04/07/2002
		US 2003-0207985 A1	06/11/2003
		US 2003-0212199 A1	13/11/2003
		US 2004-0110895 A1	10/06/2004
		US 2004-0129698 A1	08/07/2004
		US 2004-0176529 A1	09/09/2004
		US 6387519 B1	14/05/2002
		US 6593417 B1	15/07/2003
		US 6610777 B1	26/08/2003
		US 6623791 B2	23/09/2003
		US 6657001 B1	02/12/2003
		US 6759478 B2	06/07/2004
		US 6803408 B2	12/10/2004
		US 6987144 B2	17/01/2006
		US 7005472 B2	28/02/2006
		US 7053149 B2	30/05/2006
		US 7189950 B2	13/03/2007
		WO 01-09231 A1	08/02/2001
		WO 01-09259 A1	08/02/2001
		WO 01-09260 A1	08/02/2001
		WO 01-09261 A1	08/02/2001
		WO 03-011992 A3	05/06/2003