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(54) **Title:** CONDUCTIVE POLYMER COMPOSITION AND TRANSPARENT ELECTRODE AND/OR ANTISTATIC LAYER MADE THEREFROM

(57) **Abstract:** The present invention concerns compositions comprising at least one conductive polymer, at least one binder, and at least one solvent, wherein said binder comprises a silicon containing binder selected from a polysilsesquioxane binder and a polysiloxane binder having a two-dimensional structure, preferably obtainable by reacting a polysilazane with a source of oxygen. The compositions according to the present invention can be used a layer, such as a transparent electrode and/or antistatic layer, especially for touch sensor function, in display devices.

Conductive Polymer Composition and Transparent Electrode and/or  
Antistatic Layer made therefrom

This application claims priority to European patent application No. 12177617.3 filed on 24 July, 2012, the whole content of this application being incorporated herein by reference for all purposes.

**FIELD OF THE INVENTION**

5           The present invention relates to a conductive polymer composition and to a layer made from said conductive polymer composition suitable for use as a transparent electrode and/or antistatic layer for display device, such as liquid crystal display (LCD) device.

**BACKGROUND OF THE INVENTION**

10           Display devices, such as liquid crystal display (LCD) devices, are used for a television, a projector, a mobile phone, a PDA, etc. and recently, particularly mobile devices include a touch sensor such that the device can be operated by touching. Conventional conductive materials of the transparent electrode for a touch sensor in such display device are transparent conductive oxides (TCO),  
15           such as indium tin oxide (ITO), indium zinc oxide (IZO) and antimony tin oxide (ATO). The materials are typically deposited by using sputtering, and thus, has drawbacks such as a rather complicated and costly process. Also, these materials are disadvantageous because many cracks may be generated upon their formation, and indium which is a main element of ITO and IZO is a limited  
20           resource that is becoming quickly exhausted these days.

            Conductive polymers have a good flexibility and are considered to be inexpensive because these can be formed by simple processing. Having these characteristics, it is believed that the conductive polymers are among the potential candidates to replace TCO in forming transparent electrode and/or  
25           antistatic layer in display devices.

            For instance, Korean patent application No. KR 2010-0047440 A discloses a conductive composition forming an electrode of a liquid crystal display containing 0.1~10 parts by weight of conductive polymer, 0.1~10 parts by weight of dopant, 3~30 parts by weight of silane coupling agent, and 50~90 parts  
30           by weight of solvent, in order to provide good permeability and surface hardness of the electrode.

**DESCRIPTION OF THE INVENTION**

The purpose of the present invention is to provide compositions comprising at least one conductive polymer having particular advantageous properties, which can be suitably used for forming transparent electrode and/or antistatic layer in display devices, especially for the transparent electrode and/or antistatic layer for touch sensor function in display devices. The compositions according to the present invention can exhibit high stability and/or sheet uniformity. Also, the compositions according to the present invention can have advantageous permeability characteristics, e.g. less reactivity with moisture and/or oxygen.

The present invention therefore relates to compositions comprising at least one conductive polymer, at least one binder, and at least one solvent, wherein said binder comprises a silicon containing binder selected from a polysilsesquioxane binder and a polysiloxane binder having a two-dimensional structure, preferably obtainable by reacting a polysilazane with a source of oxygen. Also, the present invention relates to compositions comprising at least one conductive polymer, at least one binder, and at least one solvent, wherein said binder comprises a polysilazane binder. Indeed, it has been surprisingly found that the compositions according to the present invention display superior wet/air endurance and/or better stability. It has been also found that the compositions according to the present invention possess a high sheet uniformity when processed to a transparent electrode and/or antistatic layer. In addition, the compositions according to the present invention can satisfy the other requirements for the use as transparent electrode and/or antistatic layer for touch sensor function in display devices, such as coatability, chemical stability, heat stability, high transmittance, and surface hardness. Especially, the compositions according to the present invention have satisfactory adhesion property to the substrate, especially when directly applied on a glass substrate of display devices.

Further, the present invention provides transparent electrodes and/or antistatic layers, which are in particular suitable for display devices including a touch sensor, made of the compositions according to the present invention. The transparent electrodes and/or antistatic layers according to the present invention can exhibit high sheet uniformity, surface hardness and/or transmittance.

**DETAILED DESCRIPTION OF THE INVENTION**

In the present invention, a conductive polymer is understood to denote in particular any polymers that conduct electricity. In the compositions according

to the invention, the conductive polymers can be, for example, dissolved or dispersed in the solvent. Preferably the conductive polymers are dispersed in water and/or alcohol.

In the present invention, a substrate is understood to denote in particular a solid, in particular a transparent solid on which a layer of material can be deposited using a composition according to the invention. Examples of such substrates include a glass substrate, or preferably transparent solid polymers, for example polyethyleneterephthalate(PET), polyethylene naphthalene dicarboxylate, polycarbonate(PC), polyethersulfone(PES), polyimide(PI), cyclic olefin copolymer(COC), styrene copolymers, polyethylene, polypropylene, and any combination thereof. Preferably, the substrate is in the form of a sheet.

In the present invention, "alkyl groups" is understood to denote in particular a straight chain, branched chain, or cyclic hydrocarbon groups usually having from 1 to 20 carbon atoms, preferably having from 1 to 8 carbon atoms. Examples of alkyl groups include methyl, ethyl, propyl, isopropyl, butyl, isobutyl, sec-butyl, tert-butyl, pentyl, neopentyl, hexyl, cyclopropyl, cyclobutyl, cyclopentyl, and cyclohexyl.

In the present invention, "alkoxy groups" is understood to denote in particular a straight chain, branched chain, or cyclic hydrocarbon group usually having from 1 to 20 carbon atoms, preferably from 1 to 8 carbon atoms, singularly bonded to oxygen (Alk-O-).

In the present invention, "aryl groups" is understood to denote in particular any functional group or substituent derived from an aromatic ring. In particular, the aryl groups can have 6 to 20 carbon atoms, preferably 6 to 12 carbon atoms, in which some or all of the hydrogen atoms of the aryl group may or may not be substituted with other groups, especially alkyl groups, alkoxy groups, aryl groups, or hydroxyl groups. The aryl groups are preferably optionally substituted phenyl groups, naphthyl groups, anthryl group and phenanthryl group.

In the present invention, "aryloxy groups" is understood to denote in particular the aryl group as defined above singularly bonded to oxygen (Ar-O-).

In one embodiment, the conductive polymer is selected from the group consisting of polyacetylene polymers, poly(p-phenylene) polymers, poly(p-phenylenesulfide) polymers, poly(p-phenylenevinylene) polymers, polyaniline polymers, polyacetylene polymers, polypyrrole polymers, polythiophene polymers, polyethylenedioxythiophene(PEDOT) polymers, and any combination thereof, preferably polyaniline polymers, polythiophene polymers, PEDOT

polymers, and any combination thereof. More preferably, the conductive polymer in the present invention comprises PEDOT polymers.

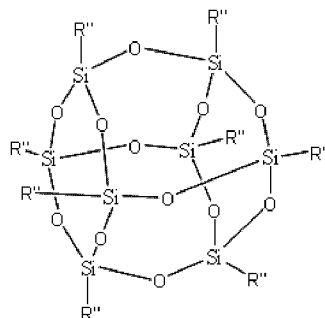
In the present invention, the PEDOT polymer is preferably doped with at least one further compound. The examples of doped PEDOT polymers include  
5 PEDOT doped with lignosulfonic acid (LSA) (PEDOT/LSA), PEDOT doped with polyethyleneglycol (PEG) (PEDOT/PEG), PEDOT doped with polyoxometalate (POM) (PEDOT/POM), PEDOT doped with sulfonated polyimide (SPI) (PEDOT/SPI), PEDOT doped with carbon materials, such as activated carbon, graphene and carbon nanotube (CNT) (activated  
10 carbon/PEDOT composite, PEDOT/graphene composite, or PEDOT/CNT composite), PEDOT doped with DMSO and CNT (PEDOT/DMSO/CNT), PEDOT doped with tosylate, PEDOT doped with Cl<sup>-</sup>, PEDOT doped with NO<sub>3</sub>, PEDOT doped with PSS (PEDOT:PSS), PEDOT/PSS doped with pentacene, PEDOT doped with ammonium persulfate (APS) (PEDOT/APS), and PEDOT  
15 doped with dimethyl sulfoxide (DMSO) (PEDOT/DMSO), but the present invention is not limited thereto.

In another embodiment, the conductive polymer is a polyethylenedioxythiophene/polystyrenesulfonate (PEDOT/PSS). In this embodiment, PEDOT/PSS enables a precise control of the conductivity and  
20 enhanced dispersion stability of the conductive polymer composition. In this embodiment, the ratio of PEDOT and PSS is preferably 5:95 to 50:50 by weight.

In the composition according to the present invention, the binder comprises a silicon containing binder, preferably selected from a polysilsesquioxane binder and a polysiloxane binder having a two-dimensional structure, preferably  
25 obtainable by reacting a polysilazane with a source of oxygen. Moreover, in the composition of the present invention, the binder comprises polysilazane binder. It has been found that the compositions according to the invention comprising these binders provide superior adhesion property of a layer to a substrate. Also, the compositions according to the invention allow for high wet/air endurance,  
30 and/or good storage stability. The binder can consist of one type of binder. Alternatively, the binder may be constituted of two or more types of different binders.

In a specific embodiment, the polysilsesquioxane binder in the composition according to the present invention comprises or preferably consists of a  
35 polyhedral oligomeric silsesquioxane (POSS), comprising the structure below :

- 5 -

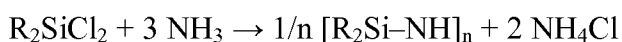


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wherein R'' is independently selected from the group consisting of hydroxyl group, alkyl groups, aryl groups, alkoxy groups and aryloxy groups. It has been found that compositions according to the invention having a POSS binder provide even better adhesion to the substrate. Also, it has been found that the compositions comprising POSS binder according to the present invention can exhibit better wet/air endurance and/or stability of the composition.

In a further specific embodiment, the binder in the composition according to the present invention comprises a polysilazane binder. In the present invention, the polysilazane binder is preferably perhydropolysilazane, which may be prepared by ammonolysis reaction of ammonia and chlorosilanes. It has been found that the composition according to the present invention comprising the polysilazane binder leads to a superior stability of the compositions as well as a uniform sheet resistance in the layer resulting from the composition.

In another specific embodiment, the binder in the composition according to the present invention comprises a polysiloxane binder having a two-dimensional structure which is preferably obtainable by reacting a polysilazane, preferably a perhydropolysilazane with a source of oxygen atoms. The perhydropolysilazane can be prepared by ammonolysis reaction of ammonia and chlorosilanes. For instance, the perhydropolysilazane may be synthesized by the following chemical reaction :



(wherein R denotes in particular hydroxyl group, alkyl groups, aryl groups, alkoxy groups and aryloxy groups).

Thereafter, the thus produced perhydropolysilazane can be further processed to the polysiloxane binder having a two-dimensional structure in the present invention. For example, the perhydropolysilazane can be reacted with oxygen and water in a presence of a catalyst, preferably metal catalyst, resulting in the polysiloxane binder with a generation of hydrogen and ammonia. The catalyst which is described hereinafter can be used to accelerate the conversion

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of the polysilazane into the polysiloxane. The resulting polysiloxane binder has a particular two-dimensional recurring rhombic structure. It has been found that the composition according to the present invention comprising the polysiloxane binder having the two-dimensional structure leads to even better wet/air  
5 endurance quality. Also, the compositions of this embodiment can have superior stability of the compositions.

In a special embodiment, the binder in the composition according to the present invention comprises polysilazane/polysiloxane block copolymers, preferably prepared by copolymerizing at least one polysilazane with at least one  
10 polysiloxane.

In a further embodiment, the binder in the composition according to the present invention further comprises at least one thermosetting monomer and/or binder. Particularly, the thermosetting monomer and/or binder can be selected from the group consisting of trialkoxysilane, trichlorosilane, tetrachlorosilane,  
15 aminosilane-based binders, tetraalkoxysilane-based binders, and any combination thereof. Preferable examples of the thermosetting monomer and/or binder are tetraethoxysilane (TEOS), tetramethoxysilane (TMOS), TEOS-based binder, TMOS-based binder and any combination thereof. More preferably, the composition according to the present invention comprises TEOS binder in  
20 addition to a polysilsesquioxane binder or a polysilazane binder.

In a certain embodiment, the solvent in the composition according to the present invention is selected from the group consisting of water ; aliphatic alcohols, such as methanol, ethanol, isopropanol, butanol, n-propylalcohol, ethylene glycol, propylene glycol, butanediol, neopentyl glycol, 1,3-pentanediol,  
25 1,4-cyclohexanedimethanol, diethyleneglycol, polyethelene glycol, polybutylene glycol, dimethylolpropane, trimethylolpropane, sorbitol, esterification products of the afore-mentioned alcohols ; aliphatic ketones, such as methyl cellosolve, propyleneglycol methylether, diacetone alcohol, ethylacetate, butylacetate, acetone and methylethylketone ; ethers such as tetrahydrofuran, dibutyl ether,  
30 mono- and polyalkylene glycol dialkyl ethers ; aliphatic carboxylic acid esters ; aliphatic carboxylic acid amides ; aromatic hydrocarbons ; aliphatic hydrocarbons ; acetonitrile ; aliphatic sulfoxides ; and any combination thereof. Preferred solvents are water, isopropanol, ethylene glycol, propylene glycol methyl ether, propylene glycol methyl ether acetate, toluene, xylene, methyl  
35 ethyl ketone, dibutyl ether, butyl acetate, or any combination thereof.

In a certain other embodiment, the conductive polymer is used in an amount of 0.01 to 10 wt %, preferably 0.05 to 5 wt %, more preferably 0.1 to 2 wt % of the composition. By comprising the conductive polymer in an amount of 0.01 to 10 wt % of the composition, the composition according to the present invention can exhibit good coatability.

In a further certain embodiment, the binder is used in an amount of 1 to 40 wt %, preferably 5 to 20 wt %, more preferably 10 to 15 wt % of the conductive polymer composition. By comprising the binder in an amount of 1 to 40 wt % of the composition, the composition according to the present invention can exhibit good surface hardness when processed to a layer and also a good compatibility.

In a further certain other embodiment, the solvent is used in an amount of 50 to 98.99 wt %, preferably 50 to 95 wt %, more preferably 50 to 90 wt % of the conductive polymer composition. By comprising the solvent in an amount of 50 to 98.99 wt % of the composition, the composition according to the present invention can exhibit good coatability and surface hardness when processed to a layer.

In a further particular embodiment, the composition according to the present invention further comprises at least one additive selected from the group consisting of a coupling agent, a surfactant, an inhibitor, a catalyst, and any combination thereof.

In the present invention, a coupling agent is understood to function to aid an adhesion to the substrate when applied to the substrate. Such coupling agent can be selected, for example, from the group consisting of ammonia, chlorosilane, monomeric aminosilane,  $\gamma$ -glycidoxypropyltrimethoxysilane,  $\gamma$ -glycidoxypropyltriethoxysilane,  $\gamma$ -glycidoxypropylethyldimethoxysilane,  $\gamma$ -glycidoxypropylethyldiethoxysilane, vinyltrimethoxysilane, vinyltriethoxysilane,  $\beta$ -glycidoxypropyltrimethoxysilane, N- $\beta$ -aminoethyl- $\gamma$ -aminopropyltrimethoxysilane, N- $\beta$ -aminoethyl- $\gamma$ -aminopropyltriethoxysilane,  $\gamma$ -mercaptopropyltrimethoxysilane,  $\gamma$ -chloropropyltrimethoxysilane,  $\gamma$ -acryloxypropyldimethoxysilane and any combination thereof. Preferred examples of the coupling agent are chlorosilane, monomeric amino silane, vinyltrimethoxysilane, and vinyltriethoxysilane.

In the present invention, a surfactant is understood to denote in particular a material that lowers the surface tension of a liquid, the interfacial tension between two liquids, or that between a liquid and a solid. The surfactant in the



present invention preferably has a hydrophile lipophile balance (HLB) of 8 to 16, preferably 10 to 13. Preferred examples of the surfactant include BYK<sup>®</sup> surfactants (obtainable from BYK Additives & Instruments), such as BYK<sup>®</sup>-307, alkanesulfonates, betaines, alkylethoxylates, ethersulfates, and any combination thereof. More preferably, the surfactants are BYK<sup>®</sup>-307, alkanesulfonates, and alkylethoxylates.

In the present invention, an inhibitor can be optionally added to the composition in order to keep the adequate extent of the polymerization. The examples of the inhibitor include hydroquinone, dialkylacetylenedicarboxylate, dimethylacetylenedicarboxylate, diethylenedicarboxylate, dibutylacetylenedicarboxylate, methylbutylacetylenedicarboxylate, methylethylacetylenedicarboxylate, and any combination thereof. Preferred inhibitors are hydroquinone, dialkylacetylenedicarboxylate, and dimethylacetylenedicarboxylate.

In the present invention, a catalyst can be used to accelerate the conversion of the polysilazane, preferably a perhydropolysilazane, into the polysiloxane having two-dimensional structure. Amines, organic or inorganic acids, metals or metal salts, peroxides, or any combination thereof can be used as the catalyst in the present invention. The non-limiting examples of the amines include ammonia, methylamine, dimethylamine, trimethylamine, ethylamine, diethylamine, triethylamine, n-propylamine, isopropylamine, di-n-propylamine, di-isopropylamine, tri-n-propylamine, n-butylamine, isobutylamine, di-n-butylamine, di-isobutylamine, tri-n-butylamine, n-pentylamine, di-n-pentylamine, tri-n-pentylamine, dicyclohexylamine, aniline, 2,4-dimethylpyridine, 4,4-trimethylenebis(1-methylpiperidine), 1,4-di-azabicyclo[2,2,2]octane, N,N-dimethylpiperazine, cis-2,6-dimethylpiperazine, trans-2,5-dimethylpiperazine, 4,4-methylenebis(cyclohexylamine), stearylamine, 1,3-di-(4-piperidyl)propane, N,N-dimethylpropanolamine, N,N-dimethylhexanolamine, N,N-dimethyloctanolamine, N,N-diethylethanolamine, 1-piperidineethanol, 4-piperidinol, and any combination thereof. The non-limiting examples of organic or inorganic acids include acetic acid, propionic acid, butyric acid, valeric acid, caproic acid, maleic acid, stearic acid, hydrochloric acid, nitric acid, sulfuric acid, phosphoric acid, chloric acid, hypochlorous acid, and any combination thereof. The non-limiting examples of metals and metal salts include palladium, palladium acetate, palladium acetylacetonate, silver, silver

acetylacetonate, platinum, platinum acetylacetonate, ruthenium, ruthenium acetylacetonate, ruthenium carbonyls, gold, copper, copper acetylacetonate, aluminum acetylacetonate, aluminum tris(ethylacetoacetate), and any combination thereof. The non-limiting examples of peroxides include hydrogen peroxide, metal chlorides, organometallic compounds, such as ferrocenes and zirconocenes, and any combination thereof. Preferred examples of the catalyst in the present invention are 4,4-methylenebis(cyclohexylamine), acetic acid, hydrochloric acid, platinum, platinum acetylacetonate, hydrogen peroxide, and dicumyl peroxide.

10 In a preferred embodiment, the composition according to the present invention comprises at least one conductive polymer comprising PEDOT polymer, in particular PEDOT/PSS polymer, at least one binder comprising a polysilsesquioxane binder or polysilazane binder, and at least one solvent.

The present invention also concerns a layer comprising or preferably consisting of the composition according to the present invention. In the present invention, the layer is selected from a transparent electrode and/or antistatic layer. Such layer according to the present invention is particularly suitable for touch sensor function in display devices. The layer can be formed by applying the compositions of the present invention on the substrate, in particular on a surface of glass substrate. Such application can be brought about for example using laser etching, wetting, such as dipping, printing, such as gravure printing and inkjet printing, coating, such as spin coating, bar coating, slit coating, spray coating, roll coating, and spreading, or deposition. The thickness of the layer on the substrate is preferably from 100 to 10,000 Å, more preferably 3,000 to 4,000 Å. After applying the composition on the substrate the layer can be formed for example by curing. Typical temperatures for the curing are from 25 to 150°C, preferably 100 to 150°C. Typical curing time is from 5 to 30 min, preferably 10 to 30 min. It has been found that the composition according to the present invention can exhibit better hardening at relatively mild curing condition during processing to a layer to the substrate.

The present invention also concerns a process for the manufacture of a layer comprising a conductive polymer and a silicon containing binder, obtainable by using the composition according to the present invention.

In a special embodiment, the process for the manufacture of the layer comprises (a) evenly spreading the composition according to the present

invention on the surface of the substrate and (b) curing the composition spread on the surface.

In a further particular embodiment, the layer, preferably a transparent electrode and/or antistatic layer, according to the present invention is formed on a surface of substrate of display devices. The substrate is a glass substrate or polymeric film substrate, preferably a glass substrate.

Thus formed transparent electrode according to the present invention has generally a sheet resistance of  $10^2$  to  $10^5 \Omega/\square$ , preferably  $10^2$  to  $10^3 \Omega/\square$ . In case of the antistatic layer according to the present invention, it generally has a sheet resistance of  $10^5$  to  $10^{11} \Omega/\square$ , preferably  $10^7$  to  $10^9 \Omega/\square$ . Alternatively, the antistatic layer according to the present invention has a sheet resistance of  $10^3$  to  $10^{11} \Omega/\square$ , preferably  $10^4$  to  $10^8 \Omega/\square$ . Also, the layer has generally a pencil hardness of equal to or more than 9 H, which sufficiently satisfies the requirement as a transparent electrode and/or antistatic layer in display device, especially LCD device having touch sensor function.

The following examples illustrate the invention in further detail without however limiting it.

### Examples

#### *Example 1 : Preparation of Conductive Polymer Compositions*

Example 1-1 : Conductive polymer solution 1

0.4 wt % of PEDOT/PSS, 12 wt % of polysilsequioxane binder, 0.5 wt % of BYK<sup>®</sup>-307, 0.1 wt % of hydroquinone, and remainder of isopropanol and water were incorporated to stirrer, and those components are mixed under stirring, thus obtaining the conductive polymer solution 1.

Example 1-2 : Conductive polymer solution 2

0.4 wt % of PEDOT/PSS, 12 wt % of polysilazane binder, 0.5 wt % of BYK<sup>®</sup>-307, 0.1 wt % of hydroquinone, and remainder of isopropanol and water were incorporated to stirrer, and those components were mixed under stirring, thus obtaining the conductive polymer solution 2.

*Example 2 : Evaluation of coating films made of Conductive Polymer Solutions*

The conductive polymer solutions 1 and 2 each prepared according to Example 1-1 and 1-2 were supplied to a spin coater, and coated with rotation speed at 300 rpm for 3 seconds, 1000 rpm for 15 seconds, and 300 rpm for 3 seconds at a room temperature. The coating workability of the conductive polymer solutions was excellent without any problems. Thereafter, the formed coating film using the conductive polymer solution 1 was treated in dry oven at a

temperature of about 140°C for 10 min. Additionally, the formed coating film using the conductive polymer solution 2 was treated in thermo-hygrostat at a temperature of about 65°C and humidity of 90 % for 10 min.

- A sheet resistance, transmittance, surface hardness, reliability (e.g. high temperature/high humidity test), heat stability, storage stability and sheet uniformity of the coating film were evaluated, and summarized as below :
- Sheet resistance : measured using 2-point probe
  - Transmittance : measured using UV-VIS spectrometer at 550 nm
  - Surface hardness : measured using pencil hardness test method
  - 10 - Reliability at high temperature/high humidity : temperature test performed at temperature of 65°C, and humidity test performed at 90 % of humidity
  - Reliability of heat stability : temperature test performed at temperature of 80°C
  - Storage stability : measured at room temperature and low temperature of 6°C
  - 15 with a duration of about 500 hours
  - Sheet uniformity : deviation of resistance values at different points of the coating film were measured

**Table 1 : Evaluation Results**

	Conductive Polymer Solution 1	Conductive Polymer Solution 2
Resistance( $\Omega/\square$ )	$10^7 \sim 10^9$	$10^7 \sim 10^9$
Transmittance	102 %	98 %
Hardness	9H	9H
High temperature/ High humidity	Good	Good
Heat stability	Good	Good
Storage stability	Good	Good
Sheet uniformity	3 ~ 5 %	~ 5 %

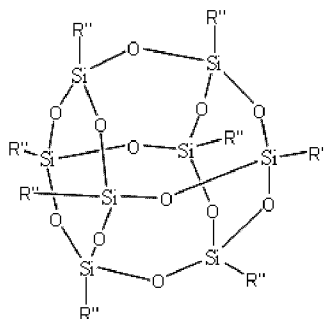
CLAIMS

1. A composition comprising at least one conductive polymer, at least one binder, and at least one solvent, wherein said binder comprises a silicon containing binder selected from a polysilsesquioxane binder, and a polysiloxane binder having a two-dimensional structure, preferably obtainable by reacting a polysilazane with a source of oxygen.

2. The composition according to Claim 1, wherein the conductive polymer is selected from the group consisting of polyacetylene polymers, poly(p-phenylene) polymers, poly(p-phenylenesulfide) polymers, poly(p-phenylenevinylene) polymers, polyaniline polymers, polyacetylene polymers, polypyrrole polymers, polythiophene polymers, polyethylenedioxythiophene (PEDOT) polymers, their derivatives and any combination thereof.

3. The composition according to Claim 1 or 2, wherein the conductive polymer is a polyethylenedioxythiophene/polystyrenesulfonate (PEDOT/PSS).

4. The composition according to any one of Claims 1 to 3, wherein the polysilsesquioxane binder is a polyhedral oligomeric silsesquioxane (POSS), comprising the structure below :



wherein R'' is independently selected from the group consisting of hydroxyl group, alkyl groups, aryl groups, alkoxy groups and aryloxy groups.

5. The composition according to any one of Claims 1 to 4, wherein the polysilazane is a perhydropolysilazane.

6. The composition according to any one of Claims 1 to 5, wherein the binder further comprises at least one thermosetting monomer and/or binder, in particular at least one thermosetting monomer and/or binder selected from the group consisting of trialkoxysilane, trichlorosilane, tetrachlorosilane, aminosilane-based binders, tetraalkoxysilane-based binders, and any combination thereof, especially tetraethoxysilane (TEOS), tetramethoxysilane (TMOS), TEOS-based binder, TMOS-based binder, and any combination thereof.

7. The composition according to any one of Claims 1 to 6, wherein the solvent is selected from the group consisting of water ; aliphatic alcohols, such as methanol, ethanol, isopropanol, butanol, n-propylalcohol, ethylene glycol, propylene glycol, butanediol, neopentyl glycol, 1,3-pentanediol, 1,4-cyclohexanedimethanol, diethyleneglycol, polyethelene glycol, polybutylene glycol, dimethylolpropane, trimethylolpropane, sorbitol, esterification products of the afore-mentioned alcohols ; aliphatic ketones, such as methyl cellosolve, propyleneglycol methylether, diacetone alcohol, ethylacetate, butylacetate, acetone and methylethylketone ; ethers such as tetrahydrofuran, dibutyl ether, mono- and polyalkylene glycol dialkyl ethers ; aliphatic carboxylic acid esters ; aliphatic carboxylic acid amides ; aromatic hydrocarbons ; aliphatic hydrocarbons ; acetonitrile ; aliphatic sulfoxides ; and any combination thereof.

8. The composition according to any one of Claims 1 to 7, comprising the conductive polymer in an amount of 0.01 to 10 wt %, preferably 0.05 to 5 wt %, more preferably 0.1 to 2 wt % of the composition.

9. The composition according to any one of Claims 1 to 8, comprising the binder in an amount of 1 to 40 wt %, preferably 5 to 20 wt %, more preferably 10 to 15 wt % of the composition.

10. The composition according to any one of Claims 1 to 9, comprising the solvent in an amount of 50 to 98.99 wt %, preferably 50 to 95 wt %, more preferably 50 to 90 wt % of the composition.

11. The composition according to any one of Claims 1 to 10, further comprising at least one additive selected from the group consisting of a coupling agent, a surfactant, an inhibitor, a catalyst, and any combination thereof.

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12. A layer comprising a conductive polymer and a silicon containing binder, obtainable by using the composition according to any one of Claims 1 to 10.

5 13. The layer according to Claim 12, which is formed on a surface of substrate, in particular on a surface of glass substrate.

14. The layer according to Claim 12, which is a transparent electrode and/or an antistatic layer.

10 15. A process for the manufacture of the layer according to Claim 13 or 14, which comprises (a) evenly spreading the composition according to any one of Claims 1 to 10 on the surface of the substrate and (b) curing the composition spread on the surface.

**INTERNATIONAL SEARCH REPORT**

International application No  
PCT/EP2013/065163

**A. CLASSIFICATION OF SUBJECT MATTER**  
INV. H01B1/24  
ADD.  
  
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)  
H01B  
  
Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)  
EPO-Internal, WPI Data

**C. DOCUMENTS CONSIDERED TO BE RELEVANT**

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 5 721 299 A (ANGELOPOULOS MARIE [US] ET AL) 24 February 1998 (1998-02-24) claims; examples; tables -----	1-15
X	US 2007/190385 A1 (LEE JIN-GYU [KR] ET AL) 16 August 2007 (2007-08-16) claims -----	1-15
X	US 2007/138483 A1 (LEE TAE-WOO [KR] ET AL) 21 June 2007 (2007-06-21) examples -----	1-15

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	"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
"E" earlier application or patent but published on or after the international filing date	"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
"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)	"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
"O" document referring to an oral disclosure, use, exhibition or other means	"&" document member of the same patent family
"P" document published prior to the international filing date but later than the priority date claimed	

Date of the actual completion of the international search  23 September 2013	Date of mailing of the international search report  02/10/2013
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Name and mailing address of the ISA/ European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Authorized officer  Zeslawski, Wojciech
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# INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No PCT/EP2013/065163
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Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 5721299	A	24-02-1998	NONE
US 2007190385	A1	16-08-2007	CN 101020755 A 22-08-2007
			JP 4733654 B2 27-07-2011
			JP 2007220672 A 30-08-2007
			KR 20070081936 A 20-08-2007
			US 2007190385 A1 16-08-2007
US 2007138483	A1	21-06-2007	CN 1986645 A 27-06-2007
			JP 2007169593 A 05-07-2007
			KR 20070064882 A 22-06-2007
			US 2007138483 A1 21-06-2007