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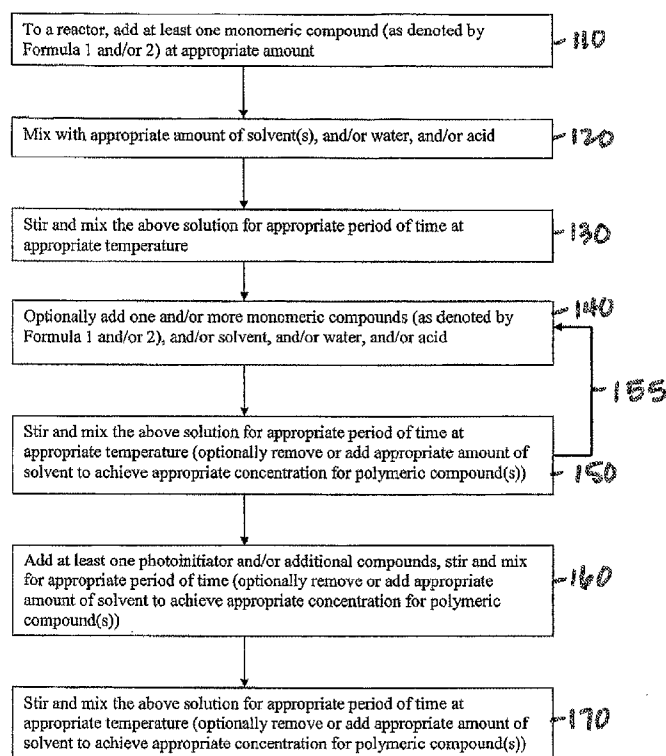
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(54) Title: PHOTSENSITIVE MATERIALS AND USES THEREOF



(57) Abstract: Photosensitive compositions are described that include a) at least one monomeric compound, polymeric compound or a combination thereof; b) at least one photoinitiator; and c) at least one solvent. Photosensitive compositions are also formed from the combination of a) at least one monomeric compound, polymeric compound or a combination thereof; b) at least one photoinitiator; and c) at least one solvent. Methods of producing the photosensitive compositions are described, which comprise a) provide at least one monomeric compound, polymeric compound or a combination thereof; b) providing at least one photoinitiator; c) providing at least one solvent; and d) combining the at least one monomeric compound, polymeric compound or a combination thereof, the at least one photoinitiator and the at least one solvent to form the photosensitive composition.



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PHOTOSENSITIVE MATERIALS AND USES THEREOF

FIELD OF THE SUBJECT MATTER

Photosensitive materials, compounds and compositions for use in various applications are described herein. In addition, films, layers and dielectric materials comprising these photosensitive materials, compounds and compositions are also contemplated.

BACKGROUND

In the production of certain applications in the microelectronics industry, it is necessary and/or useful to have a patterned dielectric material or layer. Integrated circuits, interposers, flat panel displays, multichip modules, bumping redistribution, passivation stress buffers, and thin film build-up layers on printed circuit boards are examples of applications where having a patterned dielectric material or layer is useful and sometimes necessary. Currently, wet etching is utilized to form these patterns in dielectric materials and layers because of its higher etching speed and lower price compared to dry etching.

Typically, a photoresist composed of a material that is resistant to etching process is used in the wet etching process. The photoresist is applied over the dielectric material and exposed to patterned and activating radiation. The radiation may either be applied to the photoresist material through a pattern or in a patterned exposure. The photoresist and the dielectric material are then usually removed in corresponding image-wise manner during a developing step (typically with an aqueous base). The remaining photoresist material is subsequently removed, leaving an image-wise distribution of the dielectric material.

When the dielectric material or dielectric precursor is photosensitive, some costs and complexities of the previously mentioned etching methods can be avoided. Specifically, there is no need for a photoresist, and therefore, no need to coat, image, and remove the photoresist. In positive systems, the portion of the dielectric material or its precursor which is exposed to activating radiation is removed during development. (See for example, US Issued Patent 6,361,926 and US Publication 2003/0193624). In negative photosensitive systems, the portion of the dielectric material or its precursor which is not exposed to activating radiation is removed during development.

Organic and hybrid materials, such as polyimides (PI), benzocyclobutene (BCB), polynorbornene (PNB) and polysiloxanes, are typically used as dielectric materials. Polysiloxane, which can be viewed as a hybrid consisting of silica and an organic moiety, is utilized primarily because of good thermal stability, excellent transmittance, outstanding
5 adhesion, good planarization and good mechanical properties.

B.R.Harkness et al., "Photopatternable Thin Films from Silyl Hydride Containing Silicone Resins and Photobase Generators", *Polymers for Advanced Technologies*, **10**, 669-677 (1999), and "Demonstration of a Directly Photopatternable Spin-On-Glass Based on Hydrogen Silsesquioxane and Photobase Generators", *Macromolecules*, **31**, 4798-4805 (1998)
10 disclosed silyl hydride-containing polysiloxane utilized as photosensitive dielectric materials. However, the thickness is too low and the materials cannot satisfy the need of a passivation layer for flat panel displays.

US Issued Patent 6,974,970 discloses that an unsaturated carbon-carbon group and a polysiloxane having aryl substituents can be utilized as a photoactive dielectric material.
15 Unfortunately, the steric hindrance of the aryl group on the Si atom limits the potential for beneficial crosslinking of Si-OH (silanol) groups. It is believed that the steric hindrance and lack of Si-OH crosslinking will detrimentally reduce the electrical properties.

Y. Lyu et al., "Photo Patternable Porous Siloxane Thin Films Using Cyclodextrines as Template Materials", *Thin Solid Films*, **496**, 526-532 (2006), teaches the use of polysiloxanes
20 containing pore-generating groups, also known as porogens, as dielectric materials. However, the corresponding developer is not an alkane aqueous solution, which is not accepted by the FPD industry.

Therefore, it would be ideal to produce and utilize photosensitive materials, compounds and compositions that a) can be patterned without the use of a separate
25 photoresist material layered on top of dielectric materials, b) can be produced and used with materials and methods that are generally accepted by the flat panel display (FPD) industry, along with other industries that produce and utilize microelectronics, c) can be produced prior to application or in situ, and d) can be utilized in the production of displays, such as FPDs, light-emitting diodes, photovoltaic applications, integrated circuit applications, interlayer
30 dielectrics, passivation films and planarization films, such as those used in fabricating thin-film transistors (TFT).

SUMMARY OF THE SUBJECT MATTER

Photosensitive compositions are disclosed that include: a) at least one monomeric compound, polymeric compound or a combination thereof; b) at least one photoinitiator; and c) at least one solvent. Photosensitive compositions are also formed from the combination of a) at least one monomeric compound, polymeric compound or a combination thereof; b) at least one photoinitiator; and c) at least one solvent.

Methods are disclosed of producing a photosensitive composition, comprising: a) providing at least one monomeric compound, polymeric compound or a combination thereof; b) providing at least one photoinitiator; c) providing at least one solvent; and d) combining the at least one monomeric compound, polymeric compound or a combination thereof, the at least one photoinitiator and the at least one solvent to form the photosensitive composition.

BRIEF DESCRIPTION OF THE FIGURES

Figure 1: A process flow chart for a contemplated embodiment.

Figure 2 shows an example of process flow chart for a use of contemplated photosensitive materials.

- 5 Figure 3 shows a sectional view of a conventional active matrix type liquid crystal display (LCD) device.

Figure 4 shows another type of conventional display device.

Figure 5 shows a contemplated method for calculating planarization data.

DETAILED DESCRIPTION

Photosensitive materials have been developed and are described herein that a) can be patterned without the use of a separate photoresist material layered on top of dielectric materials, b) can be produced and used with materials and methods that are generally accepted by the flat panel display (FPD) industry, along with other industries that produce and utilize microelectronics, c) can be produced prior to application or in situ, and d) can be utilized in the production of displays, such as FPDs, light-emitting diodes, photovoltaic applications, integrated circuit applications, interlayer dielectrics, passivation films and planarization films, such as those used in fabricating thin-film transistors (TFT). These photosensitive materials are made from and/or comprise at least one monomeric compound, polymeric compound or a combination thereof. The monomeric compounds and polymeric compounds are also contemplated to be crosslinkable.

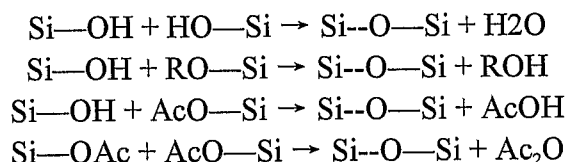
Contemplated photosensitive materials (which may also be dielectric precursors) are prepared from a composition comprising at least one monomeric compound, polymeric compound or a combination thereof, at least one photoinitiator, which may be a radical photoinitiator or cation photoinitiator, and optionally water. In addition, at least one solvent and/or other components may also be included. The photosensitive material is applied to a suitable surface or substrate, e.g., for production of a device such as a semiconductor device, an integrated circuit ("IC"), a display device, a thin film transistor or the like, by any art-known method to form a film. The material is then exposed, developed and cured to produce a patterned silicon containing (for example, silica) film.

As used herein, the term "monomeric compound" is used to describe the class of monomers and pre-polymers that may be utilized in the contemplated compositions and materials disclosed. Monomers generally describe those molecules or compounds that contain carbon and are of relatively low molecular weight. (see *Hawley's Condensed Chemical Dictionary*, 12th Edition, Richard J. Lewis, Sr. (editor).) Pre-polymers describe that class of molecules or compounds that are not generally considered monomers, such as free radical compounds or groups, larger molecular weight compounds and molecules, heterocycles and heteromolecules, non-carbon-based molecules, etc.

As used herein, the term "polymeric compound" is used to describe the class of oligomers and polymers that may be utilized in the contemplated compositions and materials disclosed. Oligomers generally describe those polymer molecules or compounds that contain

only a few monomer units, such as a dimer, trimer or tetramer. (see *Hawley's Condensed Chemical Dictionary*, 12th Edition, Richard J. Lewis, Sr. (editor).) Polymers generally describe those high molecular weight, macromolecular compounds that comprise monomers, pre-polymers, oligomers or a combination thereof.

5 As mentioned, contemplated photosensitive materials are made from and/or comprise at least one monomeric compound, polymeric compound or a combination thereof. The monomeric compounds and polymeric compounds are also contemplated to be crosslinkable. In some embodiments, contemplated monomeric compounds and polymeric compounds should have at least two reactive groups that can be hydrolyzed. These reactive groups
10 include those groups that can be hydrolyzed, such as alkoxy (RO), acetoxy (AcO), etc. Without being bound by any hypothesis, it is believed that water hydrolyzes the reactive groups on the silicon-based monomeric compounds and polymeric compounds to form Si-OH groups (silanols). These silanol groups will then undergo condensation reactions (crosslinking) with other silanols or with other reactive groups, as illustrated by the following
15 formulas:



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where:

R comprises alkyl or aryl groups, and Ac means "acyl", which is represented as CH_3CO .

25 These contemplated condensation reactions lead to formation of silicon-containing polymeric compounds. In one embodiment, the at least one monomeric compound includes at least one compound denoted by Formula 1:



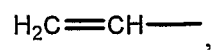
30 wherein x is in the range from 0 to 3, y is in the range from 0 to 3, and z is in the range from 1 to 4,

R comprises alkyl, aryl, hydrogen, alkylene, arylene groups or combinations thereof,

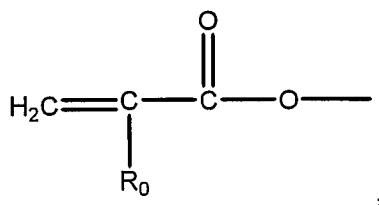
F comprises at least one alkyl group, wherein the at least one alkyl group either comprises at least one unsaturated bond or is terminally combined with at least one unsaturated functional group, such as:

a) a vinyl group

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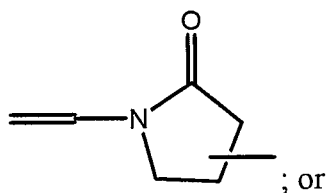


b) a (meth)acryl group (where R_0 is H, or CH_3 , or other alkyl group):

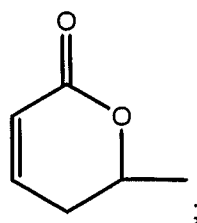


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c) N-vinylpyrrolidone group

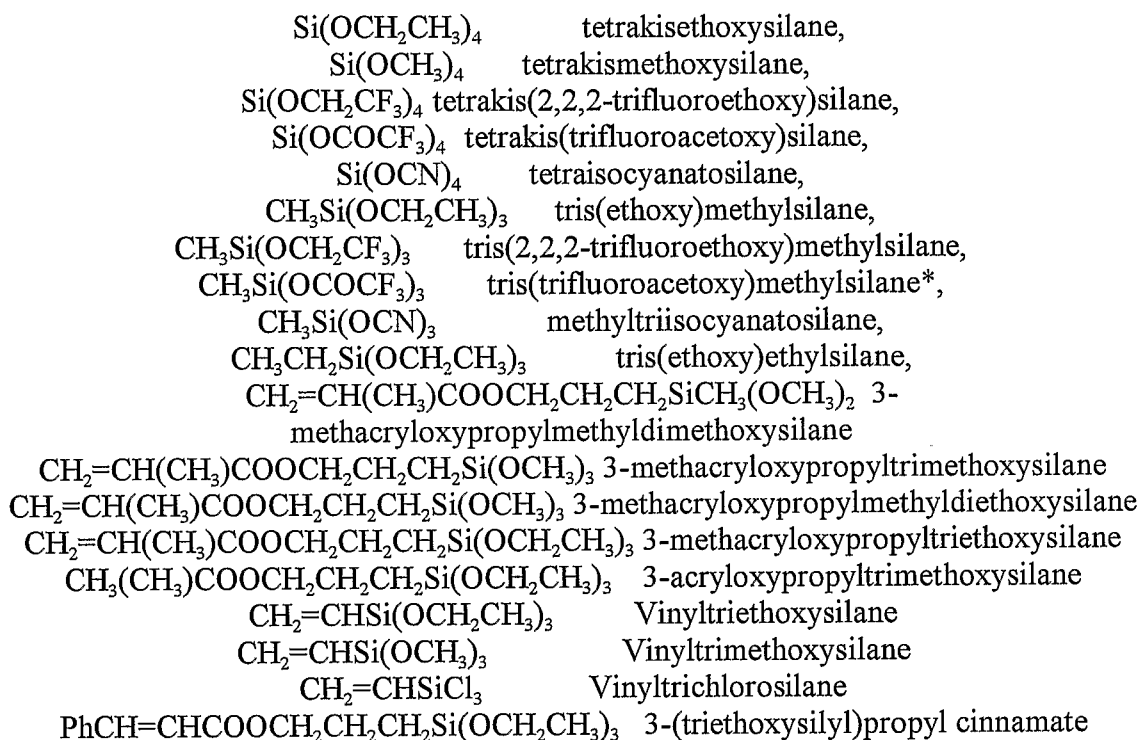


15 d) dihydropyrandone group



L comprises at least one electronegative group, such as a hydroxyl group, an alkoxy group, a carboxyl group, an amino group, an amido group, a halide group, an isocyanato group or a combination thereof.

An example of a contemplated monomeric compound is shown by Formula 1 when x is less than 3, y is less than 3, z is in the range of 1 to 4; R comprises alkyl, aryl or H; F is unsaturated and L comprises an electronegative group. Additional examples of suitable compounds comprise:

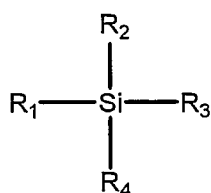


* generates an acid catalyst upon exposure to water.

Combinations of the above-mentioned monomeric compounds may also be utilized in the compositions to form the films disclosed herein. In addition, methacryloxy(alkyl)_nalkoxysilane may also be utilized in the compositions and films disclosed herein, where n is 1-100. It should be understood that for these compounds having more than one alkyl group in the compound that the alkyl or alkoxy group may be the same or different. For example, 3-methacryloxypropylmethyldimethoxysilane is contemplated, along with 3-methacryloxypropyltrimethoxysilane, 3-methacryloxyalkyltriethoxysilane and 3-methacryloxyalkyltrimethoxysilane.

In another embodiment, compositions contemplated herein include a polymeric compound synthesized using those compounds denoted by Formula 1, and reacting those compounds together, such as by hydrolysis and condensation, wherein the number average molecular weight (MW_n) is less than about 300,000. In some embodiments, MW_n is in the range of about 150 to about 300,000 amu, and in other embodiments, MW_n is in the range of about 150 to about 10,000 amu.

In other embodiments, silicon-based monomeric compounds may also comprise organosilanes, including, for example, alkoxysilanes according to Formula 2:



Formula 2

Formula 2 is a variation of Formula 1, where x and y are zero. In this embodiment, Formula 2 represents an alkoxysilane wherein R_1 , R_2 , R_3 , and R_4 groups are independently C1 to C4 alkoxy groups, and the balance, if any, comprise hydrogen, alkyl, phenyl, halogen, substituted phenyl or a combination thereof. As used herein, the term “alkoxy” includes any other organic groups which can be readily cleaved from silicon at temperatures near room temperature by hydrolysis. In Formula 2, R_x ($x = 1, 2, 3, 4$) groups may comprise ethylene glycoxy, propylene glycoxy or the like, and in some contemplated embodiments, all four R_x ($x = 1, 2, 3, 4$) groups comprise methoxy, ethoxy, propoxy or butoxy. In yet other embodiments, alkoxysilanes according to Formula 2 comprise tetraethoxysilane (TEOS) and tetramethoxysilane.

In additional embodiments, contemplated monomeric compounds may also comprise alkylalkoxysilane as described by Formula 2, where at least two of the R groups are independently C1 to C4 alkylalkoxy groups, wherein the alkyl moiety is C1 to C4 alkyl and the alkoxy moiety is C1 to C6 alkoxy, or ether-alkoxy groups; and the balance, if any, comprise hydrogen, alkyl, phenyl, halogen, substituted phenyl or combinations thereof. In one embodiment, each R_x comprises methoxy, ethoxy or propoxy. In another embodiment, at least two R_x groups are alkylalkoxy groups, wherein the alkyl moiety is C1 to C4 alkyl and the alkoxy moiety is C1 to C6 alkoxy. In yet another embodiment for a vapor phase precursor,

at least two R_x groups are ether-alkoxy groups of the formula (C1 to C6 alkoxy)_n wherein n is 2 to 6.

Contemplated silicon-based monomeric compounds include, for example, at least one alkoxy silane, such as tetraethoxysilane, tetrapropoxysilane, tetraisopropoxysilane, 5 tetra(methoxyethoxy)silane, tetra(methoxyethoxyethoxy)silane, all of which have four groups which may be hydrolyzed and then condensed to produce alkylalkoxysilanes, such as methyltriethoxysilane silane and arylalkoxysilanes, such as phenyltriethoxysilane and polymer precursors, such as triethoxysilane, all of which provide Si-H functionality to the film.

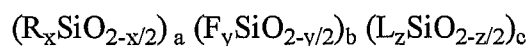
10 Tetrakis(methoxyethoxyethoxy)silane, tetrakisalkoxysilane, tris(trifluoroacetoxy)alkylsilane, alkyltriisocyanatosilane tetrakis(ethoxyethoxy)silane, tetrakis(butoxyethoxyethoxy)silane, 3-acryloxyalkyltrimethoxysilane tetrakis(2-ethylthoxy)silane, tetrakis(methoxyethoxy)silane, vinyltrialkoxysilane and tetrakis(methoxypropoxy)silane are contemplated as also being useful in the compositions and films described herein alone or in combinations with other monomeric compounds and/or 15 polymeric compounds.

In other embodiments, monomeric compounds comprise acetoxysilane, ethoxysilane, methoxysilane or combinations thereof. In some embodiments, the monomeric compound includes a tetraacetoxysilane, a C1 to about C6 alkyl or aryl-triacetoxysilane or combinations thereof. In other embodiments, the monomeric compound comprises triacetoxysilane, such 20 as methyltriacetoxysilane. In yet other embodiments, the monomeric compound comprises at least one tetraalkoxysilane and one silicon-based acryl group. In yet another embodiment, the monomeric compound comprises at least one tetraalkoxysilane, one alkylalkoxysilane and one silicon-based acryl group.

The at least one monomeric compound, at least one polymeric compound or 25 combination thereof may be present in any suitable amount, as long as the compositions meet the goals previously described. It is contemplated that at least one monomeric compound, at least one polymeric compound or combination thereof is present in an amount less than about 80 weight percent (wt %) to form the photosensitive composition. In other embodiments, the at least one monomeric compound, at least one polymeric compound or combination thereof 30 is present in an amount less than 60 weight percent. In yet other embodiments, the at least one monomeric compound, at least one polymeric compound or combination thereof is present in an amount in the range of 10 to 80 weight percent. And in other embodiments, the

at least one monomeric compound, at least one polymeric compound or combination thereof is present in an amount in the range of 20 to 60 weight percent.

Photosensitive materials described herein may comprise at least one monomeric compound, at least one polymeric compound or combination thereof, at least one photoinitiator, and at least one solvent. The contemplated polymeric compound may be formed from the monomeric compound as denoted by Formula 1 and/or Formula 2, through reactions such as hydrolysis and condensation. In some embodiment, the number average molecular weight (MW_n) of such polymeric compound is less than about 1,000,000. In some embodiments, MW_n is in the range of about 150 to about 100,000 amu, and in other embodiments, MW_n is in the range of about 500 to about 10,000 amu. The typical structure of contemplated polymeric compounds formed from monomeric compounds described herein is shown by Formula 3:



Formula 3

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wherein x is ranging from 0 to 4, y is from 0 to 4, z is from 0 to 4, a is from 0 to 10,000, b is from 0 to 10,000, and c is from 0 to 10,000; R comprises alkyl, aryl, hydrogen, alkylene, arylene groups, or combinations thereof; F comprises at least one alkyl group, which is capped with and incorporated with at least one unsaturated functional group, such as vinyl group, (meth)acryl group, N-vinylpyrrolidone group, dihydropyranone group, or combinations thereof; and L comprises an electronegative group, such as an hydroxyl group, an alkoxy group, a carboxyl group, an amino group, an amido group, a halide group, an isocyanato group or combinations thereof.

As mentioned earlier, compositions described herein may comprise at least one photoinitiator, which is designed to generate free radicals. Contemplated photoinitiators comprise both Type I and Type II photoinitiators. The phrase "Type I photoinitiators" as used herein means that those photoinitiators undergo a unimolecular bond cleavage reaction upon irradiation thereby yielding free radicals. Suitable Type I photoinitiators comprise benzoin ethers, benzyl ketals, α -dialkoxy-acetophenones, α -hydroxyalkylphenones and acylphosphine oxides. The phrase "Type II photoinitiators" as used herein means that those photoinitiators undergo a bimolecular reaction where the photoinitiators interact in an excited state with a second compound acting as co-initiators. Suitable type II photoinitiators comprise

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benzophenones, thioxanthenes and titanocenes. Suitable co-initiators comprise amine-functional monomers, oligomers or polymers. Primary, secondary and tertiary amines can be utilized. In some contemplated embodiments, tertiary amines are utilized in the compositions described herein.

Both Type I and Type II photoinitiators are commercially available, for example, as IRGACURE™ 184 (1-hydroxycyclohexyl phenyl ketone), IRGACURE™ 907 (2-methyl-1-[4-(methylthio) phenyl]-2-morpholino propan-1-one), IRGACURE™ 369 (2-benzyl-2-N,N-dimethylamino-1-(4-morpholinophenyl)-1-butanone), IRGACURE™ 819 (bis(2,4,6-trimethylbenzoyl)-phenylphosphineoxide), IRGACURE™ 500 (the combination of 50% by weight 1-hydroxy cyclohexyl phenyl ketone and 50% by weight benzophenone), Irgacure 651 (2,2-dimethoxy-2-phenyl acetophenone), IRGACURE™ 1700 (the combination of 25% by weight bis(2,6-dimethoxybenzoyl-2,4,4-trimethyl pentyl) phosphine oxide, and 75% by weight 2-hydroxy-2-methyl-1-phenyl-propan-1-one), IRGACURE™ 1800 (25% Bis(2,6-dimethoxybenzoyl)-2,4,4-trimethyl-pentylphosphineoxide and 75% 1-hydroxy-cyclohexyl-phenyl-ketone), IRGACURE™ 379 (2-Dimethylamino-2-(4-methyl-benzyl)-1-(4-morpholin-4-yl-phenyl)-butan-1-one), IRGACURE™ 2959(1-[4-(2-Hydroxyethoxy)-phenyl]-2-hydroxy-2-methyl-1-propane-1-one), IRGACURE™ 127(2-Hydroxy-1-{4-[4-(2-hydroxy-2-methyl-propionyl)-benzyl]-phenyl}-2-methyl-propan-1-one), IRGACURE™ 784(Bis(2,4-cyclopentadien-1-yl)-bis(2,6-difluoro-3-(1H-pyrrol-1-yl)-phenyl) titanium), IRGACURE™ OXE01(1,2-Octanedione, 1-[4-(phenylthio) phenyl]-,2-(O-benzoyloxime)), IRGACURE™ OXE02(Ethanone, 1-[9-ethyl-6-(2-methylbenzoyl)-9H-carbazol-3-yl]-, 1-(Oacetyloxime)), DAROCUR™ ITX(2-Isopropylthioxanthone), DAROCUR™ 1173 (2-hydroxy-2-methyl-1-phenyl-1-propanone) and DAROCUR™ 4265 (the combination of 50% by weight 2,4,6-trimethylbenzoyldiphenyl-phosphine oxide, and 50% by weight 2-hydroxy-2-methyl-1-phenyl-propan-1-one), from Ciba-Geigy Corp., Tarrytown, N.Y.; ESACURE™ KIP 100 and ESACURE™ TZT from Lamberti Spa, Gallarate, Italy; 2- or 3-methylbenzophenone from Aldrich Co., Milwaukee, Wis., U. S. A. ; or GENOCURE™ CQ, GENOCURE™ BOK, and GENOCURE™ M. F., from Rahn Radiation Curing. Combinations of these materials may also be utilized herein.

The at least one photoinitiator component may be present in an amount of less than about 20% by weight of the overall composition. In some embodiments, the at least one photoinitiator component may be present in an amount of about 0.01% to about 20% by weight of the overall composition. In other embodiments, the at least one photoinitiator

component may be present in an amount of about 0.02% to about 15% and in yet other embodiments - from about 0.05% to about 10%.

Compositions contemplated herein may also comprise polymerization inhibitors, or light stabilizers. These materials are utilized in varying amounts in accordance with the particular use or application desired. When included, their amounts will be sufficient to provide increased storage stability yet still obtain adequate photosensitivity for the composition. Suitable inhibitors include benzoquinone, naphthaquinone, hydroquinone derivatives and mixtures thereof. Suitable light stabilizers include hydroxybenzophenones; benzotriazoles; cyanoacrylates; triazines; oxanilide derivatives; poly(ethylene naphthalate); hindered amines; formamidines; cinnamates; malonate derivatives and combinations thereof.

Contemplated photosensitive compositions may optionally include at least one solvent. Contemplated solvents include any suitable pure or mixture of molecules that are volatilized at a desired temperature, such as the critical temperature, or that can facilitate any of the above-mentioned design goals or needs. The solvent may also comprise any suitable pure or mixture of polar and non-polar compounds. As used herein, the term "pure" means that component that has a constant composition. For example, pure water is composed solely of H₂O. As used herein, the term "mixture" means that component that is not pure, including salt water. As used herein, the term "polar" means that characteristic of a molecule or compound that creates an unequal charge, partial charge or spontaneous charge distribution at one point of or along the molecule or compound. As used herein, the term "non-polar" means that characteristic of a molecule or compound that creates an equal charge, partial charge or spontaneous charge distribution at one point of or along the molecule or compound. A solvent may be optionally included in the composition to lower its viscosity and promote uniform coating onto a substrate by art-standard methods.

Contemplated solvents are those which are easily removed within the context of the applications disclosed herein. For example, contemplated solvents comprise relatively low boiling points as compared to the boiling point of the precursor components. In some embodiments, contemplated solvents have a boiling point of less than about 250°C. In other embodiments, contemplated solvents have a boiling point in the range from about 50°C to about 250°C, in order to allow the solvent to evaporate from the applied film and leave the active portion of the photosensitive composition in place. In order to meet various safety and environmental requirements, the at least one solvent has a high flash point (generally greater than about 40°C) and relatively low levels of toxicity.

Suitable solvents comprise any single or mixture of organic, organometallic, or inorganic molecules that are volatilized at a desired temperature. In some contemplated embodiments, the solvent or solvent mixture (comprising at least two solvents) comprises those solvents that are considered part of the hydrocarbon family of solvents. Hydrocarbon solvents are those solvents that comprise carbon and hydrogen. It should be understood that a majority of hydrocarbon solvents are non-polar; however, there are a few hydrocarbon solvents that could be considered polar. Hydrocarbon solvents are generally broken down into three classes: aliphatic, cyclic and aromatic. Aliphatic hydrocarbon solvents may comprise both straight-chain compounds and compounds that are branched and possibly crosslinked, however, aliphatic hydrocarbon solvents are not considered cyclic. Cyclic hydrocarbon solvents are those solvents that comprise at least three carbon atoms oriented in a ring structure with properties similar to aliphatic hydrocarbon solvents. Aromatic hydrocarbon solvents are those solvents that comprise generally three or more unsaturated bonds with a single ring or multiple rings attached by a common bond and/or multiple rings fused together. Contemplated hydrocarbon solvents include toluene, xylene, p-xylene, m-xylene, mesitylene, solvent naphtha H, solvent naphtha A, alkanes, such as pentane, hexane, isohexane, heptane, nonane, octane, dodecane, 2-methylbutane, hexadecane, tridecane, pentadecane, cyclopentane, 2,2,4-trimethylpentane, petroleum ethers, halogenated hydrocarbons, such as chlorinated hydrocarbons, nitrated hydrocarbons, benzene, 1,2-dimethylbenzene, 1,2,4-trimethylbenzene, mineral spirits, kerosine, isobutylbenzene, methylnaphthalene, ethyltoluene, ligroine.

In other contemplated embodiments, the solvent or solvent mixture may comprise those solvents that are not considered part of the hydrocarbon solvent family of compounds, such as ketones, such as acetone, diethyl ketone, methyl ethyl ketone and the like, alcohols, esters, ethers, amides and amines. In yet other contemplated embodiments, the solvent or solvent mixture may comprise a combination of any of the solvents mentioned herein. Contemplated solvents may also comprise aprotic solvents, for example, cyclic ketones such as cyclopentanone, cyclohexanone, cycloheptanone, and cyclooctanone; cyclic amides such as N-alkylpyrrolidinone, wherein the alkyl has from about 1 to 4 carbon atoms; N-cyclohexylpyrrolidinone and mixtures thereof.

Other organic solvents may be used herein insofar as they are able to aid dissolution of an adhesion promoter (if used) and at the same time effectively control the viscosity of the resulting solution as a coating solution. It is contemplated that various methods such as

stirring and/or heating may be used to aid in the dissolution. Other suitable solvents include methylethylketone, methylisobutylketone, dibutyl ether, cyclic dimethylpolysiloxanes, butyrolactone, γ -butyrolactone, 2-heptanone, ethyl 3-ethoxypropionate, 1-methyl-2-pyrrolidinone, propylene glycol methyl ether acetate (PGMEA), hydrocarbon solvents, such as mesitylene, xylenes, benzene, toluene di-n-butyl ether, anisole, acetone, 3-pentanone, 2-heptanone, ethyl acetate, n-propyl acetate, n-butyl acetate, ethyl lactate, ethanol, 2-propanol, dimethyl acetamide, propylene glycol methyl ether acetate, and/or combinations thereof. It is contemplated and preferred that the solvent does not react with the silicon-containing monomer or pre-polymer component.

At least one solvent may be present in compositions and coatings contemplated herein in any suitable amount. In some embodiments, the at least one solvent may be present in an amount of less than about 95% by weight of the overall composition. In other embodiments, the at least one solvent may be present in an amount less than about 75% by weight of the overall composition. In yet other embodiments, the at least one solvent may be present in an amount of less than about 60% by weight of the overall composition. In another contemplated embodiment, the at least one solvent may be present in an amount from about 10% to about 95% by weight of the overall composition. In yet another contemplated embodiment, the at least one solvent may be present in an amount from about 20% to about 75% by weight of the overall composition. In other contemplated embodiments, the at least one solvent may be present in an amount from about 20% to about 60% by weight of the overall composition. It should be understood that the greater the percentage of solvent utilized, the thinner the resulting film.

As discussed earlier, the composition may also optionally comprise water, as either liquid water or water vapor. For example, compositions disclosed herein may be applied to a substrate and then exposed to an ambient atmosphere that includes water vapor at standard temperatures and standard atmospheric pressure. The composition may also be prepared with water prior to application to a substrate. The amount of water added should be suitable to initiate timely aging of the precursor composition. In other words, the amount of water present in the composition or coating should not be in such amount to result in composition aging or gelling before it can be applied to a desired substrate. The term "gelling", as referred to herein, means condensing, or polymerization, of the combined silica-based precursor composition on the substrate after deposition. In some embodiments, suitable molar ratios of water to Si atoms in the silicon-based composition are in the range of about

0.1:1 to about 50:1. In other embodiments, the water:Si atoms are in the range of about 0.1:1 to about 10:1, and in yet other embodiments, the water:Si atoms are in the range of about 0.5:1 to about 1.5:1.

5 The compositions and coatings contemplated herein may also comprise additional components such as at least one polymerization inhibitor, at least one light stabilizer, at least one adhesion promoter, at least one antifoam agent, at least one detergent, at least one flame retardant, at least one pigment, at least one plasticizer, at least one surfactant or a combination thereof. In some embodiments, contemplated compositions and coatings further comprise phosphorus and/or boron doping. In those embodiments that comprise phosphorus and/or boron, these components are present in an amount of less than about 10% by weight of the composition. In other embodiments, these components are present in an amount ranging from about 10 parts per million to 10% by weight of the composition.

A contemplated method for forming a photosensitive composition comprises: a) providing at least one monomeric compound, polymeric compound or combination thereof, b) providing at least one photoinitiator, c) providing at least one solvent, and d) combining the at least one monomeric compound, polymeric compound or combination thereof, the at least one photoinitiator and the at least one solvent to form the photosensitive composition. This method (100) is also shown for a contemplated embodiment in **Figure 1**. In the embodiment (100) shown in Figure 1, at least one monomeric compound (as denoted by Formula 1 and/or Formula 2) is added to a reactor in an appropriate amount (110), the at least one monomeric compound is mixed with an appropriate amount of solvent(s), and/or water, and or acid (120). The solution is then stirred and mixed for an appropriate amount of time at an appropriate temperature (130). Optionally, one or more monomeric compounds are added to the solution (140) and the solution is stirred/mixed again for an appropriate amount of time at a suitable temperature (150). These two steps may be repeated as necessary (155). At least one photoinitiator and/or additional compounds/components are added to the solution and its stirred/mixed (160). The solution is then stirred/mixed for an appropriate amount of time at a suitable temperature (170). In these compositions, at least one additional component may be combined with the composition in additional method steps. In some embodiments, at least one monomeric compound is combined with at least one photoinitiator and at least one solvent to form a photosensitive composition in situ. Once blended, the at least one monomeric compound may be hydrolyzed to form a polymeric compound. In other embodiments, at least one monomeric compound is hydrolyzed or condensed to form at least

one polymeric compound, which is then combined with the at least one photoinitiator and the at least one solvent to form a photosensitive composition.

Methods of forming photosensitive dielectric films (200), as demonstrated by the embodiment shown in **Figure 2**, comprise a) providing the compositions disclosed herein, b) applying the composition to a surface (210), c) patterning (including exposure and developing) the composition to form a patterned film (230), and d) curing the patterned film (260). A contemplated method for producing patterned dielectric films comprise: a) preparing at least one monomeric compound composition, b) formulating photosensitive composition solutions with the at least one silicon-based monomeric compound composition, at least one solvent and optionally at least one additive, c) applying the solutions to a substrate to form a thin coating on the substrate and optionally followed by pre-bake of the resulting coating film (210) and (220), d) exposing the coating or layer with light from a light source, such as ultraviolet (UV) radiation, g-line, i-line, h-line or other wavelength, or mixed of the above wavelengths, or complete wavelengths) through a mask (230), e) forming a pattern from the exposed layer with alkaline aqueous developers (250), and f) curing the patterned layer to form a patterned and crosslinked polymer film (260). Pre-bake (220) and Post-Exposure Baking (240) are optional in these embodiments.

Prior to use, contemplated photosensitive compositions and coatings may be filtered under ambient conditions via any of the filtration devices well known in the art. It is generally preferable to use a filtration device having a pore size less than about 1 micron. In other embodiments, contemplated pore sizes of filtration devices are less than about 0.1 micron. In yet other embodiments, contemplated pore sizes of filtration devices are less than about 0.02 micron.

As contemplated herein, applying the solutions to a substrate to form a thin layer comprises any suitable method, such as spin-coating, slit-coating, cast-coating, dip coating, brushing, rolling, spraying, and/or ink-jet printing. Prior to application of the photosensitive compositions, the surface or substrate can be prepared for coating by standard and suitable cleaning methods. The solution is then applied and processed to achieve the desired type and consistency of coating. Although the general method is outlined above, it should be understood that these steps can be tailored for the selected precursor and the desired final product.

The term "substrate", as used herein, includes any suitable surface where the compounds and/or compositions described herein are applied and/or formed. For example, a substrate may be a silicon wafer suitable for producing an integrated circuit, and contemplated materials are applied onto the substrate by conventional methods. In another
5 example, the substrate may comprise not only a silicon wafer but other layers that are designed to lie under the contemplated photosensitive compositions.

Suitable substrates include films, glass, ceramic, plastic, metal, composite materials, silicon and compositions containing silicon such as crystalline silicon, polysilicon, amorphous silicon, epitaxial silicon, silicon dioxide ("SiO₂"), silicon nitride, silicon oxide,
10 silicon oxycarbide, silicon carbide, silicon oxynitride, organosiloxanes, organosilicon glass, fluorinated silicon glass, indium tin oxide (ITO) glass, ITO coated plastic, and semiconductor materials such as gallium arsenide ("GaAs"), and mixtures thereof. In other embodiments, suitable substrates comprise at least one material common in the packaging and circuit board industries such as silicon, glass and polymers. A circuit board made of the compositions
15 described herein may comprise surface patterns for various electrical conductor circuits. The circuit board may also include various reinforcements, such as woven non-conducting fibers or glass cloth. Contemplated circuit boards may also be single sided or double sided.

The surface or substrate may comprise an optional pattern of raised lines, such as oxide, nitride, oxynitride, or metal lines which are formed by well known lithographic
20 techniques. Suitable materials for the lines include silicon oxide, silicon nitride, silicon oxynitride, ITO, aluminium, copper, silver, chromium, tantalum, titanium, cobalt, nickel, gold, tungsten, or the combination thereof. Other optional features of the surface of a suitable substrate include an oxide layer, such as an oxide layer formed by heating a silicon wafer in air, or more preferably, an SiO₂ oxide layer formed by chemical vapor deposition of such art-
25 recognized materials as, e.g., plasma-enhanced tetraethoxysilane oxide ("PETEOS"), plasma enhanced silane oxide ("PE silane") and combinations thereof, as well as one or more previously formed silica dielectric films.

As contemplated herein, curing the patterned layer to form a patterned and crosslinked photosensitive film comprises crosslinking the film by heating the composition at
30 a sufficient temperature and time to ensure that the film is sufficiently crosslinked. For example, the composition may be heated at temperature of 300°C or below for 1 hour or less. This curing step produces a patterned silicon-based dielectric film that comprises a silicon-based dielectric polymer. In some embodiments, these dielectric polymer films may have a

thickness of at least 0.1 micron, weight ratios of organic groups to SiO groups of at least about 0.15:1, a field breakdown voltage of at least about 2.0MV/cm, and a transparency to light in the range of about 400nm to about 800nm of at least about 80%. In addition, these films may be substantially crack-free and void free, exhibit superior gap-fill, and withstand further processing steps required to prepare an electronic device, as compared to conventional films.

Films contemplated herein can be utilized in microelectronics applications, such as flat panel displays, thin film transistors (TFT) or suitable display devices. They may also be used in photovoltaic applications, interlayer dielectrics, gate dielectrics, passivation films, planarization films, such as those used in fabricating TFT or thin-film-transistors, and integrated circuit applications. An active matrix-type liquid crystal display (LCD) is a microelectronic application contemplated herein and is shown in **Figure 3**. As shown in **Figure 3**, a metal gate electrode 2 is formed on a base plate (substrate) 1, which comprises any suitable material such as glass. A gate insulation film 3 is formed to coat the gate electrode 2. On the gate insulation film 3, an amorphous (non-crystalline) semiconductor thin film 4A is formed, which operates as an active layer of a thin film transistor. On one end of the semiconductor thin film 4A, a drain electrode 5D is formed with a semiconductor thin film 4A (n+), which has a high impurity concentration and is designed to provide low resistance between the drain electrode 5D and the semiconductor thin film 4A. On the other end of the semiconductor thin film 4A, a source electrode 5S is formed with another semiconductor thin film 4A (n+), which is also designed to provide a low resistance between the source electrode 5S and the semiconductor thin film 4A. A leveling film 9 covers the drain electrode 5D and the source electrode 5S. On the leveling film 9, a pixel electrode 10, which comprises a transparent conductive film, is formed to connect electrically with the drain electrode 5D through a contact hole CON. Contemplated transparent conductive films comprise indium tin oxide as its main ingredient.

Another conventional display is shown in **Figure 4**, where a gate electrode 2 is formed on a glass base plate 1. A gate insulation film 3 covers the gate electrode 2. A polycrystalline semiconductor thin film 4P is then formed on the gate insulation film 3. A part of the polycrystalline semiconductor thin film 4P is formed as a channel region a portion of the channel region on both sides is formed as a source region S and a drain region D, where impurities are channeled in a high concentration. The semiconductor thin film 4P is covered with an interlayer insulation film 7. The insulation film is patterned and etched to

form a drain electrode 5D and a source electrode 5S. These electrodes (5D and 5S) are covered with a protection film 8.

5 In both of these examples, there are layers where contemplated materials and films can be utilized. Contemplated materials and films, as described herein, may be used as the gate insulation film 3, the interlayer insulation film 7, the protection film 8 or the leveling film 9. The silicon-based dielectric films described herein can be applied so as to cover and/or lie between optional electronic surface features, e.g., circuit elements and/or conduction pathways that may have been previously formed features of the substrate. Such optional substrate features can also be applied on top of contemplated silicon-based dielectric films in at least one additional layer, so that the low dielectric film serves to insulate one or more, or a plurality of electrically and/or electronically functional layers of the resulting integrated circuit. Thus, contemplated substrates include a silicon material that is formed over or adjacent to a contemplated silicon-based dielectric film, during the manufacture of a multilayer and/or multicomponent integrated circuit. In a further option, a substrate bearing a contemplated silicon-based dielectric film or films can be further covered with any art known non-porous insulation layer, e.g., a glass cap layer.

20 Contemplated compositions also have utility in non-microelectronic applications such as thermal insulation, encapsulates, matrix materials for polymer and ceramic composites, light weight composites, acoustic insulation, anti-corrosive coatings, binders for ceramic powders, and fire retardant coatings.

EXAMPLES**EXAMPLE 1: PREPARATION OF ACRYLIC GRAFT POLYSILOXANE (HEREINAFTER REFERRED TO AS “POLYMERIC COMPOUND”)**

3-acryloyloxypropyltrimethoxysilane (AcTMOS, 0.2mol, KBM-5103 from Shin-Etsu) and tetraethyl orthosilicate (TEOS, 0.2mol, ULSI grade from Honeywell) are dissolved in a solvent blend comprising isopropanol (IPA, 118.1g, ULSI grade from Honeywell) and propylene glycol methyl ether acetate (PGMEA, 59.0g, ULSI grade from Honeywell).

The solution is transferred to a 500ml three-neck flask equipped with a thermometer, a stirrer and a condenser, and stirred for 1 hour at room temperature. To this mixture (and with vigorous stirring) were added a pre-mixed diluted nitric acid (1.4 ml of 0.1N nitric acid, Analytical grade from Aldrich and 1.1 ml deionized water) slowly and steadily. Then the mixture is heated. When the system is heated to 80°C, 25.2ml deionized water is added dropwise and slowly into the flask with stirring. The solution is stirred and refluxed for 6 hours. Heating is then stopped and the solution continues to be stirred for 15 hours at ambient temperature. At this point, the reaction is substantially complete. The Mw of resultant polymeric compounds will be about 1200~5200.

EXAMPLE 2: PREPARATION OF PHOTSENSITIVE COMPOSITIONS**Preparation of additive solutions:**

Additive Solution A: 10 parts by weight BYK307 (a polyether-modified polydimethylsiloxane-based surfactant available from BYK-Chemie GmbH) and 5 parts by weight IRGACURETM369 (2-benzyl-2-N,N-dimethylamino-1-(4-morpholinophenyl)-1-butanone available from Ciba-Geigy Corp) is dissolved into 90 parts by weight PGMEA.

Additive Solution B: 10 parts by weight of BYK307 and 10 parts by weight IRGACURETM369 are dissolved into 90 parts by weight of PGMEA.

Polymeric compound:

The polymeric compound formed in **Example 1** is concentrated to 60% (by weight) with a rotary evaporator.

Formulation I:

20 parts by weight of concentrated polymeric compound, 2 parts by weight of PGMEA and 2.8 parts by weight of additive solution A are mixed together and stored preferably in refrigerator at a temperature below 5°C to form the photosensitive composition used in **Example 3** to form a patterned film.

Formulation II:

20 parts by weight of concentrated polymeric compound, 2 parts by weight of PGMEA and 2.8 parts by weight of additive solution B are mixed together and stored preferably in refrigerator at a temperature below 5°C.

EXAMPLE 3

An exemplary process for forming a patterned dielectric film using contemplated photosensitive compositions is shown below.

Coating Step:

5 The photosensitive composition from **Example 2** is applied to the surface of a substrate, and the solvent is removed by conducting pre-bake, thereby forming a coating for formation of a photosensitive dielectric film.

 Art-known methods for applying the dielectric precursor composition, include, but are not limited to, spin-coating, slit-coating, cast-coating, dip coating, brushing, rolling, spraying,
10 and/or ink-jet printing. Prior to application of the base materials to form the dielectric film, the substrate surface is optionally prepared for coating by standard, art-known cleaning methods.

 The photosensitive composition is dispensed onto a substrate, for example, a wafer through a suitable spin-coating process. In some embodiments, the wafer will remain
15 stationary during the dispense cycle, while in other embodiments, the wafer will turn or spin at a relatively low speed, typically less than about 400 revolutions per minute (rpm). The dispense cycle is followed by a short period at a low rotation speed, typically less than 800 rpm, and then higher speed spins, herein referred to as "thickness spins", generally between about 800 and 3000 rpm, although other spin speeds may be used, as appropriate.

20 Once the coating process is completed, the coated substrate (the substrate coated with the photosensitive composition solution) is heated to effect a pre-bake process, herein referred to as "softbake". The softbake process effectively removes the solvent from the photosensitive composition solution on the substrate, causes the resulting polymer to flow, and begins conversion of the coating to a tack-free film. Any conventional apparatus known
25 in the art can be utilized for these processes.

 In some contemplated embodiments, the spin-coating apparatus also comprises apparatus for bake processing the composition. However, in other contemplated embodiments, the spin-coating apparatus and the curing apparatus may be separate and performed in different locations. The bake process can be carried out in an inert atmosphere,
30 such as an atmosphere of an inert gas (nitrogen or a nitrogen/air mixture). One commonly utilized heating apparatus uses one or more "hot plates" to heat the coated wafer from below. The coated wafer is typically heated for up to about 120 sec at each of several hot plates at

successively higher temperatures. Typically, the hot plates are at temperatures between about 60°C and 150°C. One typical process utilizes a heating apparatus having three hot plates.

In other embodiments, the softbake process can utilize a hot plate curing module, which has an oxygen-density-controlled environment. For example, a suitable atmosphere is achieved with a nitrogen flow rate of between about 10 and about 30 liters/min.

The bake and cure processes described herein should not be considered limiting, and it should be understood that other temperatures, durations, and number of bake cycles can be utilized, where appropriate.

The thickness of contemplated dielectric films on substrates depends on a number of variables. The variables include: a) organic content of the polysiloxane resin, b) type of substituent in the resin, c) solvent properties, d) photosensitive composition molecular weight, e) percentage of the photosensitive composition solids in the solution, f) the amount of photosensitive composition solution dispensed onto the substrate, and g) the speed of the thickness spin. The higher the percentage of photosensitive composition solids in the solution, the thicker the resulting dielectric film. Conversely, the higher the speed of the thickness spin, the thinner the resulting dielectric film. In addition, the thickness of the dielectric film can depend on the nature and amount of the organic constituents in the photosensitive composition. Typically, the thickness of the dielectric film is varied from about 0.01 to about 100µm. In one embodiment, the film thickness is about 0.1 to about 20µm. In another embodiment, the film thickness is about 0.1 to about 10µm. In yet another embodiment, the film thickness is about 1.0 to 5.0µm.

In some embodiments, dielectric films formed from photosensitive composition solutions by spin coating methods are provided. The dielectric films are formed from solutions of photosensitive compositions that may have a mole percent of organic substituents in the range (but not limited to) between about 30 Mol % and about 80 Mol %.

Exposure step

The photosensitive dielectric layer is then imaged with activating radiation through a mask in a conventional manner. The exposure energy is sufficient to effectively activate the photoactive component of the photosensitive layer to produce a patterned image in the

dielectric coating layer. Typically, the exposure energy ranges from about 3 to 2000 mJ/cm² and depends in part upon the exposure tool, the particular photoactive component, and exposure processing that is utilized.

The exposure process may utilize ultraviolet (UV), deep-ultraviolet (DUV) or e-beam lithography. Contemplated and useful wavelengths for exposure are in the range of about 190nm to about 450nm. In some embodiments, contemplated wavelengths are in the range of about 320 to about 450nm. In other embodiments, contemplated wavelengths are in the range of about 350nm to about 440nm. In yet another embodiment, a full wavelength range can be used.

In one embodiment, the lithography step utilizes 365nm wavelength UV radiation (hereinafter referred as "i-line") and in another embodiment, 436nm wavelength UV radiation (hereinafter referred as "g-line") for exposure. In some embodiments, the exposure process can be performed in an oxygen-density-controlled environment, which may enhance the photosensitivity of the film.

The exposed dielectric layer may be subjected to a post-exposure bake (PEB) in order to create or enhance solubility differences between exposed and unexposed regions of a coating layer. Typically post-exposure bake conditions include temperatures of at least about 50°C. In some embodiments, the temperature may be in the range of about 50°C to about 160°C.

Developing step

After the coating film is exposed through a mask of a contemplated pattern, a developing treatment is performed with a developing solution to form a prescribed pattern. There are different etching rates in the developing solutions between exposed area and unexposed area. If the exposed area is etched much faster than the unexposed area, then the exposed area will be removed while un-exposed area will remain, which is a positive tone process. If the exposed area is etched much slower than the unexposed area, then the unexposed area will be removed while exposed area will remain, which is a negative tone process. In one embodiment, the un-exposed area of the coatings is removed by developing solutions (negative tone process). Generally, development is in accordance with art recognized procedures.

Conventional methods for developing the exposed coating film, include, but are not limited to, liquid-banking methods, dipping methods and shower methods. The developing time is about 5 to 300 seconds, and in some embodiments, 15 to 120 seconds.

Contemplated developers may comprise an aqueous based solution, such as an alkali exemplified by tetra methyl ammonium hydroxide (TMAH, Electronic grade from Greenda Chemical), tetra butyl ammonium hydroxide, sodium hydroxide, potassium hydroxide, sodium carbonate, sodium bicarbonate, sodium silicate, sodium metasilicate, aqueous ammonia or the like. The concentration of the aqueous solution may vary according to the material being developed, and one of ordinary skill in the art should understand how these solutions vary. The higher the concentration of the developer, the shorter the developing time. A contemplated pH value is from about 12 to about 14. In one embodiment, the developer is employed with 2.38% TMAH aqueous solutions.

Curing step

A final cure process is performed on the surface/composition combination to form the final film. Contemplated curing steps may utilize a furnace to complete the curing of the film. In contemplated embodiments, the curing step is performed in an inert atmosphere, as described above for the bake process. This final cure process may utilize a conventional thermal curing apparatus, for example a horizontal furnace with a temperature range of about 200°C to about 250°C and in some embodiments, from about 375°C to about 425°C. In a typical furnace cure process, the baked wafer is cured for 30 minutes to two hours at 200°C at a nitrogen flow rate of 4 liters/min to 20 liters/min.

Alternatively, the cure process can utilize a high-temperature hotplate, which has an oxygen-density-controlled environment. In this process, the baked wafer is cured on a hot plate at a temperature between about 200°C and 250°C for a period of from about 1 to about 30 minutes in a nitrogen or inert atmosphere with an oxygen density of less than about 100 parts per million. For example, a suitable cure atmosphere is achieved with a nitrogen flow rate of between about 10 and about 30 liters/min.

Those skilled in the art will appreciate that specific conditions for crosslinking the dielectric films will depend on the selected materials, substrate and desired structure, as is readily determined by routine manipulation of these parameters. Generally, the coated substrate is subjected to a treatment such as heating, UV or e-beam to effect crosslinking of

the composition on the substrate to produce a sufficiently crack-free, and sufficiently void-free silicon-based dielectric film. In some embodiments, the photoactive silicon-based dielectric polymer and film have one or more of the following characteristics: a SiC:SiO bond ratio of at least about 0.015, a dielectric constant of less than about 6.0, a field breakdown voltage(FBD) of at least about 2.5 MV/cm, a wet etch resistance of less than 10 angstroms/minute, either in an ITO etchant, 95.7:4.3 by weight mixture of water and oxalic acid, or in an Al etchant, a mixture of H_3PO_4 : H_2O : HNO_3 : CH_3COOH =16:2:1:1(volume), and a transparency to light in the range of about 400 nm to about 700 nm of at least about 90% or 95%. In one embodiment, the film has a transparency to light in the range of about 400 nm to about 800 nm of about 100%. In one embodiment, the silicon-based dielectric polymer and film have a weight ratio of organic groups to SiO groups of at least about 0.15:1.

The composition may be used in electrical devices and more specifically, as an interlayer dielectric in an interconnect associated with a single integrated circuit ("IC") chip. An integrated circuit chip typically has on its surface a plurality of layers of the present composition and multiple layers of metal conductors. It may also include regions of the present composition between discrete metal conductors or regions of conductor in the same layer or level of an integrated circuit.

EXAMPLE 4

Photosensitive compositions are used as a material for dielectrics, especially forming an interlayer dielectric (ILD) film, planarization film or passivation layer on a TFT, as shown in the following four steps.

5

Coating Step

The photosensitive compositions obtained in **Example 2** were applied on to a 4 inch silicon wafer by means of a spin-coating method and softbake at a temperature of 100°C for 15 seconds on a hot plate to form a coating having a film thickness of about 1.3 micron. The conditions for application of the composition solution were such that the spin speed is controlled to 1200 rpm to conduct spinning for 15 seconds.

10

Exposure Step

The coating was then exposed with ultraviolet (UV) steppers (i-line, 365nm) through a mask to form a pattern. The dosage of the exposure treatment is controlled to 50 to 150 mJ/cm².

15

Developing Step

A developing treatment was then conducted with a 2.38% tetramethylammonium hydroxide (TMAH) aqueous solution at room temperature for about 30 to 60 seconds using a liquid-banking method, and a water flow cleaning treatment with purified water was performed for 60 seconds, and a drying treatment by a spin drying method was then performed.

20

Curing Step

The patterned film, after developed, is then subjected to furnace curing at 200 °C for one hour with a nitrogen flow. The final thickness of the patterned dielectric film is about 1.25 micron.

25

EXAMPLE 5

Spectral data was collected for a contemplated composition produced in **Example 2**. These films were formed and processed by a) spin coating the composition on a surface, such as a 4" wafer, b) baking the composition, c) exposing the baked composition to a light source, d) developing the material on the surface and e) curing the material to form the final patterned film. In the spin coating step, for example, 1 mL of the composition is dispensed by a static dispense method onto a wafer at 300 RPM for 3 seconds and then 1200 RPM for 30 seconds. In the bake step, the composition is baked at 100°C for 15 seconds. The baked composition can be exposed by utilizing a UV light source to apply 200 mW/cm² of energy for 1 second. The material is developed, for example, by 2.38 wt % of TMAH for 45 seconds in a static condition. The material is finally cured at 200°C for about 20 minutes. **Table 1** shows the summary of the properties of the film developed by this composition.

PROPERTY	COMPOSITION RESULTS
POSITIVE/NEGATIVE TONE	NEGATIVE
PHOTOSENSITIVITY	50 – 200 MJ/CM ² (I LINE)
TRANSMITTANCE (400NM)	>95%
REFRACTIVE INDEX (633NM)	1.47
PATTERN RESOLUTION	5 μM
DEVELOPER	TMAH 2.38 WT%
THERMAL BUDGET	CURE AT 200-250 °C
THERMAL STABILITY (5WT% LOSS)	250 - 300 °C
THICKNESS	1.2-1.3 μM
FILM UNIFORMITY	1-3 % OF TOTAL THICKNESS
PLANARIZATION	>90% (OVER 0.5, 0.75, 1.0μM LINE HEIGHT)
CHEMICAL RESISTANCE	RESIST ITO ETCHANT
ADHESION	PASS 3M TAPE TEST ON SI WAFER
DIELECTRIC CONSTANT	5.3
FBD	3.5 MV/CM

Table 2 shows the film transmittance data, measured by UV-Vis Spectrophotometer (UV-VIS Cary 4000, VARIAN, Australia), collected from the film. For the purposes of this Example, the film thickness was 1.2 μ m, measured by ellipsometer (GES-5, SOPRA SA, France).

Table 2

Wavelength (nm)	Transmittance(%)	
	Formulation I	Formulation II
350	91	83
360	95	89
370	96	95
380	97	96
390	99	97
400	99	98

This spectral data shows that the compositions and films described herein can be used in the design and fabrication of liquid crystal displays (LCDs) without any need to compensate for the color of the film. Surprisingly, the spectral data shows a “flat” or relatively unchanging transmission across the visible spectrum.

EXAMPLE 6

Planarization data was collected for a contemplated composition obtained from **Example 2**. Composition coatings were applied to wafers and patterned in a dense pattern and in an “iso-pattern”. **Table 3** shows the planarization and surface roughness summary for the data collected. Surface measurements were taken with an atomic force microscope (AFM, XE-100™, PSIA Corp, Korea). The planarization data was calculated as below, as shown in **Figure 5**.

Table 3

	Max Thickness Difference (by AFM)		Film Thickness	Planarization		Ra @ 3μm Square
	Dense-Pattern	Iso-Pattern		Dense-Pattern	Iso-Pattern	
0.5μm line height	10nm	20nm	1.3μm	99.2%	98.5%	0.577nm
0.75μm line height	60nm	100nm	1.0μm	94.0%	90.0%	0.310nm
1.0μm line height	55nm	100nm	1.7μm	96.8%	94.1%	0.329nm

The planar structure shown by the films produced in this example results in a more uniform LCD or OLED (organic light emitting display). Substantial uniformity is observed with respect to color and brightness. In a LCD, the planarity creates a bottom surface that leads to a more uniform cell gap. In an OLED, a lack of planarity causes charge injection that increases brightness of an area or individual pixel. This area or pixel darkens more rapidly. Many of the films contemplated herein can have a planarity that exceeds about 90%. In some embodiments, the planarity of films contemplated herein exceeds about 94%. In other embodiments, the planarity of films contemplated exceeds about 98%. The planarity of the film will often be dictated by the end use of the photosensitive composition.

Thus, specific embodiments and applications of photosensitive materials and their uses thereof have been disclosed. It should be apparent, however, to those skilled in the art that many more modifications besides those already described are possible without departing from the inventive concepts herein. The inventive subject matter, therefore, is not to be

restricted except in the spirit of the disclosure. Moreover, in interpreting the disclosure, all terms should be interpreted in the broadest possible manner consistent with the context. In particular, the terms “comprises” and “comprising” should be interpreted as referring to elements, components, or steps in a non-exclusive manner, indicating that the referenced
5 elements, components, or steps may be present, or utilized, or combined with other elements, components, or steps that are not expressly referenced.

CLAIMS

We claim:

- 5 1. A photosensitive composition, comprising:
at least one monomeric compound, polymeric compound or a combination thereof,
at least one photoinitiator; and
at least one solvent.

- 10 2. The composition of claim 1, wherein the at least one monomeric compound,
polymeric compound or a combination thereof comprises compounds having the
formula:



- 15 wherein x is ranging from 0 to 3, y is from 0 to 3, and z is ranging from 1 to 4,
R comprises alkyl, aryl, hydrogen, alkylene, arylene groups or combinations thereof,
and

- F comprises at least one alkyl group, wherein the at least one alkyl group either
comprises at least one unsaturated bond or is terminally combined with at least one
unsaturated functional group, and

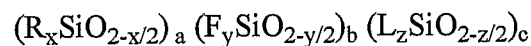
- 20 L comprises at least one electronegative group.

3. The composition of claim 2, wherein the at least one electronegative group comprises
a hydroxyl group, an alkoxy group, a carboxyl group, an amino group, an amido
group, a halide group, an isocyanato group or combinations thereof.
4. The composition of claim 2, wherein the at least one monomeric compound,
25 polymeric compound or a combination thereof comprises at least two reactive groups.
5. The composition of claim 4, wherein the at least two reactive groups comprises those
groups which can be hydrolyzed.
6. The composition of claim 5, wherein the at least two reactive groups comprise an
alkoxy group, an acetoxy group or a combination thereof.

30

7. The composition of claim 1, wherein the at least one monomeric compound comprises tetrakisalkoxysilane, tetrakis(2,2,2-trifluoroethoxy)silane, tetrakis(trifluoroacetoxy)silane, tetraisocyanatosilane, tris(ethoxy)methylsilane, tris(2,2,2-trifluoroethoxy)alkylsilane, tris(trifluoroacetoxy)alkylsilane, alkyltriisocyanatosilane, tris(ethoxy)alkylsilane, 3-methacryloxyalkyltrimethoxysilane, 3-methacryloxyalkyltriethoxysilane, 3-acryloxyalkyltrimethoxysilane, vinyltrialkoxysilane, vinyltrimethoxysilane, vinyltrichlorosilane or a combination thereof.

8. The composition of claim 1, wherein the at least one polymeric compound comprises the following structure:



wherein x is in the range from 0 to 4, y is in the range from 0 to 4, z is in the range from 0 to 4, a is in the range from 0 to 10,000, b is in the range from 0 to 10,000, and c is in the range from 0 to 10,000;

R comprises an alkyl group, an aryl group, a hydrogen group, an alkylene group, an arylene group, or a combination thereof;

F comprises at least one alkyl group, wherein the at least one alkyl group either comprises at least one unsaturated bond or is terminally combined with at least one unsaturated functional group; and

L comprises an electronegative group.

9. The composition of claim 8, wherein F comprises a vinyl group, a (meth)acryl group, a N-vinylpyrrolidone group, a dihydropyranone group, or combinations thereof.

10. The composition of claim 8, wherein L comprises a hydroxyl group, an alkoxy group, a carboxyl group, an amino group, an amido group, a halide group, an isocyanato group or combinations thereof.

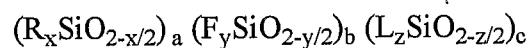
11. The composition of claim 1, further comprising water.

12. The composition of claim 11, wherein water comprises water vapor or water in liquid form.

13. The composition of claim 1, wherein the at least one photoinitiator comprises Type I photoinitiators, Type II photoinitiators or a combination thereof.
14. The composition of claim 1, wherein the at least one solvent comprises a solvent having a boiling point of less than 250°C.
- 5 15. The composition of claim 1, comprising at least one additional component.
16. The composition of claim 15, wherein the at least one additional component comprises at least one polymerization inhibitor, at least one light stabilizer or a combination thereof.
17. A coating comprising the composition of claim 1.
- 10 18. A photosensitive material formed from at least one monomeric compound, polymeric compound or a combination thereof; at least one photoinitiator; and at least one solvent.
19. The composition of claim 18, wherein the at least one monomeric compound, polymeric compound or a combination thereof comprises compounds having the formula:
- 15
- $$R_xF_y-Si-L_z \quad (\text{Formula 1})$$
- wherein x is ranging from 0 to 3, y is from 0 to 3, and z is ranging from 1 to 4,
- R comprises alkyl, aryl, hydrogen, alkylene, arylene groups or combinations thereof,
- 20 and
- F comprises at least one alkyl group, wherein the at least one alkyl group either comprises at least one unsaturated bond or is terminally combined with at least one unsaturated functional group, and
- L comprises at least one electronegative group.
- 25 20. The composition of claim 19, wherein the at least one electronegative group comprises a hydroxyl group, an alkoxy group, a carboxyl group, an amino group, an amido group, a halide group, an isocyanato group or combinations thereof.
21. The composition of claim 19, wherein the at least one monomeric compound, polymeric compound or a combination thereof comprises at least two reactive groups.

22. The composition of claim 21, wherein the at least two reactive groups comprises those groups which can be hydrolyzed.
23. The composition of claim 22, wherein the at least two reactive groups comprise an alkoxy group, an acetoxy group or a combination thereof.
- 5 24. The composition of claim 18, wherein the at least one monomeric compound comprises tetrakisalkoxysilane, tetrakis(2,2,2-trifluoroethoxy)silane, tetrakis(trifluoroacetoxy)silane, tetraisocyanatosilane, tris(ethoxy)methylsilane, tris(2,2,2-trifluoroethoxy)alkylsilane, tris(trifluoroacetoxy)alkylsilane, alkyltriisocyanatosilane, tris(ethoxy)alkylsilane, 3-
- 10 methacryloxyalkyltrimethoxysilane, 3-methacryloxyalkyltriethoxysilane, 3-acryloxyalkyltrimethoxysilane, vinyltrialkoxysilane, vinyltrimethoxysilane, vinyltrichlorosilane or a combination thereof.
25. The composition of claim 18, wherein the at least one polymeric compound comprises the following structure:

15



20

wherein x is in the range from 0 to 4, y is from 0 to 4, z is in the range from 0 to 4, a is in the range from 0 to 10,000, b is in the range from 0 to 10,000, and c is in the range from 0 to 10,000;

R comprises an alkyl group, an aryl group, a hydrogen group, an alkylene group, an arylene group, or a combination thereof;

25

F comprises at least one alkyl group, wherein the at least one alkyl group either comprises at least one unsaturated bond or is terminally combined with at least one unsaturated functional group; and

L comprises an electronegative group.

26. The composition of claim 25, wherein F comprises a vinyl group, a (meth)acryl group, a N-vinylpyrrolidone group, a dihydropyranone group, or combinations thereof.

27. The composition of claim 25, wherein L comprises a hydroxyl group, an alkoxy group, a carboxyl group, an amino group, an amido group, a halide group, an isocyanato group or combinations thereof.
28. The composition of claim 18, further comprising water.
- 5 29. The composition of claim 28, wherein water comprises water vapor or water in liquid form.
30. The composition of claim 18, wherein the at least one photoinitiator comprises Type I photoinitiators, Type II photoinitiators or a combination thereof.
31. The composition of claim 18, wherein the at least one solvent comprises a solvent
10 having a boiling point of less than 250°C.
32. The composition of claim 18, comprising at least one additional component.
33. The composition of claim 32, wherein the at least one additional component comprises at least one polymerization inhibitor, at least one light stabilizer or a combination thereof.
- 15 34. A coating comprising the composition of claim 18.
35. A method of producing a photosensitive composition, comprising:
providing at least one monomeric compound, polymeric compound or combination thereof;
providing at least one photoinitiator;
20 providing at least one solvent; and
combining the at least one monomeric compound, polymeric compound or combination thereof; the at least one photoinitiator; and the at least one solvent to form the photosensitive composition.
36. The method of claim 35, wherein at least one additional component is provided and
25 combined with the composition.
37. A method of forming a crosslinked photosensitive dielectric film, comprising:
providing the composition of claim 1,
applying the composition of claim 1 to a surface or substrate,
patterning the composition of claim 1 to form a patterned film,

curing the patterned film.

38. The method of claim 37, wherein patterning the composition comprising applying light from a light source to the surface of the composition.
39. A photosensitive dielectric film produced from the method of claim 37.
- 5 40. A microelectronic application utilizing the dielectric film of claim 39.
41. The microelectronic application of claim 40, wherein the application comprises displays, LED, photovoltaic applications and integrated circuit applications.
42. An interlayer dielectric (ILD) comprising the film of claim 39.
43. A passivation film comprising the composition of claim 1.
- 10 44. A planarization film used in fabricating Thin-Film-Transistors (TFT) comprising the composition of claim 1.
45. The composition of claim 1, wherein the composition is crosslinkable by the application of ultraviolet (UV) light, visible light, E-beam or mixture thereof.
- 15 46. The method of claim 37, wherein patterning the composition comprises developing the composition with an alkaline aqueous solutions.
47. The film of claim 43, wherein the thickness can be varied between 0.01 to 100 μ m.
48. A film for use in a display applications, wherein the film is clear across the visible spectrum.
49. A film for use in display applications, wherein the planarity of the film exceeds 90%.
- 20 50. The film of claim 49, wherein the planarity of the film exceeds 94%.
51. The film of claim 50, wherein the planarity of the film exceeds 98%.
52. The composition of claim 1, wherein the at least one monomeric compound comprises an alkoxysilane.
53. The composition of claim 52, wherein the at least one monomeric compound further
25 comprises a silicon-based acrylic compound.
54. The composition of claim 52 or claim 53, wherein the alkoxysilane comprises tetraethoxysilane.

AMENDED CLAIMS
received by the International Bureau on
08 October 2007 (08.10.07)

THE CLAIMS AMENDED UNDER ARTICLE 19

We claim:

1. A photosensitive composition, comprising:

at least one monomeric compound, polymeric compound or a combination thereof, wherein the at least one monomeric compound, polymeric compound or a combination thereof comprise at least one unsaturated bond or at least one unsaturated functional group,

at least one photoinitiator; and

at least one solvent.

2. The composition of claim 1, wherein the at least one monomeric compound, polymeric compound or a combination thereof comprises compounds having the formula:



wherein x is ranging from 0 to 3, y is from 0 to 3, and z is ranging from 1 to 4,

R comprises alkyl, aryl, hydrogen, alkylene, arylene groups or combinations thereof, and

F comprises at least one alkyl group, wherein the at least one alkyl group either comprises at least one unsaturated bond or is terminally combined with at least one unsaturated functional group, and

L comprises at least one electronegative group.

3. The composition of claim 2, wherein the at least one electronegative group comprises a hydroxyl group, an alkoxy group, a carboxyl group, an amino group, an amido group, a halide group, an isocyanato group or combinations thereof.

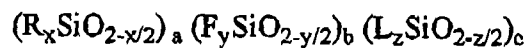
4. The composition of claim 2, wherein the at least one monomeric compound, polymeric compound or a combination thereof comprises at least two reactive groups.

5. The composition of claim 4, wherein the at least two reactive groups comprises those groups which can be hydrolyzed.

6. The composition of claim 5, wherein the at least two reactive groups comprise an alkoxy group, an acetoxy group or a combination thereof.

7. The composition of claim 1, wherein the at least one monomeric compound comprises tetrakisalkoxysilane, tetrakis(2,2,2-trifluoroethoxy)silane, tetrakis(trifluoroacetoxy)silane, tetrakisocyanatosilane, tris(ethoxy)methylsilane, tris(2,2,2-trifluoroethoxy)alkylsilane, tris(trifluoroacetoxy)alkylsilane, alkyltriisocyanatosilane, tris(ethoxy)alkylsilane, 3-methacryloxyalkyltrimethoxysilane, 3-methacryloxyalkyltriethoxysilane, 3-acryloxyalkyltrimethoxysilane, vinyltrialkoxysilane, vinyltrimethoxysilane, vinyltrichlorosilane or a combination thereof.

8. The composition of claim 1, wherein the at least one polymeric compound comprises the following structure:



wherein x is in the range from 0 to 4, y is in the range from 0 to 4, z is in the range from 0 to 4, a is in the range from 0 to 10,000, b is in the range from 0 to 10,000, and c is in the range from 0 to 10,000;

R comprises an alkyl group, an aryl group, a hydrogen group, an alkylene group, an arylene group, or a combination thereof;

F comprises at least one alkyl group, wherein the at least one alkyl group either comprises at least one unsaturated bond or is terminally combined with at least one unsaturated functional group; and

L comprises an electronegative group.

9. The composition of claim 8, wherein F comprises a vinyl group, a (meth)acryl group, a N-vinylpyrrolidone group, a dihydropyranone group, or combinations thereof.

10. The composition of claim 8, wherein L comprises a hydroxyl group, an alkoxy group, a carboxyl group, an amino group, an amido group, a halide group, an isocyanato group or combinations thereof.

11. The composition of claim 1, further comprising water.

12. The composition of claim 11, wherein water comprises water vapor or water in liquid form.

13. The composition of claim 1, wherein the at least one photoinitiator comprises Type I photoinitiators, Type II photoinitiators or a combination thereof.

14. The composition of claim 1, wherein the at least one solvent comprises a solvent having a boiling point of less than 250°C.

5 15. The composition of claim 1, comprising at least one additional component.

16. The composition of claim 15, wherein the at least one additional component comprises at least one polymerization inhibitor, at least one light stabilizer or a combination thereof.

17. A coating comprising the composition of claim 1.

10 18. A photosensitive material formed from at least one monomeric compound, polymeric compound or a combination thereof, wherein the at least one monomeric compound, polymeric compound or a combination thereof comprise at least one unsaturated bond or at least one unsaturated functional group; at least one photoinitiator; and at least one solvent.

19. The composition of claim 18, wherein the at least one monomeric compound, polymeric compound or a combination thereof comprises compounds having the formula:

15
$$R_xF_y-Si-L_z \text{ (Formula 1)}$$

wherein x is ranging from 0 to 3, y is from 0 to 3, and z is ranging from 1 to 4,

R comprises alkyl, aryl, hydrogen, alkylene, arylene groups or combinations thereof, and

20 F comprises at least one alkyl group, wherein the at least one alkyl group either comprises at least one unsaturated bond or is terminally combined with at least one unsaturated functional group, and

L comprises at least one electronegative group.

20 20. The composition of claim 19, wherein the at least one electronegative group comprises a
25 hydroxyl group, an alkoxy group, a carboxyl group, an amino group, an amido group, a halide group, an isocyanato group or combinations thereof.

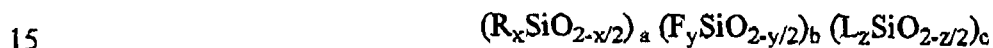
21. The composition of claim 19, wherein the at least one monomeric compound, polymeric compound or a combination thereof comprises at least two reactive groups.

22. The composition of claim 21, wherein the at least two reactive groups comprises those groups which can be hydrolyzed.

23. The composition of claim 22, wherein the at least two reactive groups comprise an alkoxy group, an acetoxy group or a combination thereof.

5 24. The composition of claim 18, wherein the at least one monomeric compound comprises tetrakisalkoxysilane, tetrakis(2,2,2-trifluoroethoxy)silane, tetrakis(trifluoroacetoxy)silane, tetraisocyanatosilane, tris(ethoxy)methylsilane, tris(2,2,2-trifluoroethoxy)alkylsilane, tris(trifluoroacetoxy)alkylsilane, alkyltriisocyanatosilane, tris(ethoxy)alkylsilane, 3-methacryloxyalkyltrimethoxysilane, 3-methacryloxyalkyltriethoxysilane, 3-acryloxyalkyltrimethoxysilane, vinyltrialkoxysilane, vinyltrimethoxysilane, vinyltrichlorosilane or a combination thereof.

25. The composition of claim 18, wherein the at least one polymeric compound comprises the following structure:



wherein x is in the range from 0 to 4, y is from 0 to 4, z is in the range from 0 to 4, a is in the range from 0 to 10,000, b is in the range from 0 to 10,000, and c is in the range from 0 to 10,000;

20 R comprises an alkyl group, an aryl group, a hydrogen group, an alkylene group, an arylene group, or a combination thereof;

F comprises at least one alkyl group, wherein the at least one alkyl group either comprises at least one unsaturated bond or is terminally combined with at least one unsaturated functional group; and

25 L comprises an electronegative group.

26. The composition of claim 25, wherein F comprises a vinyl group, a (meth)acryl group, a N-vinylpyrrolidone group, a dihydropyranone group, or combinations thereof.

27. The composition of claim 25, wherein L comprises a hydroxyl group, an alkoxy group, a carboxyl group, an amino group, an amido group, a halide group, an isocyanato group or combinations thereof.

28. The composition of claim 18, further comprising water.
29. The composition of claim 28, wherein water comprises water vapor or water in liquid form.
30. The composition of claim 18, wherein the at least one photoinitiator comprises Type I photoinitiators, Type II photoinitiators or a combination thereof.
31. The composition of claim 18, wherein the at least one solvent comprises a solvent having a boiling point of less than 250°C.
32. The composition of claim 18, comprising at least one additional component.
33. The composition of claim 32, wherein the at least one additional component comprises at least one polymerization inhibitor, at least one light stabilizer or a combination thereof.
34. A coating comprising the composition of claim 18.
35. A method of producing a photosensitive composition, comprising:
- providing at least one monomeric compound, polymeric compound or combination thereof, wherein the at least one monomeric compound, polymeric compound or a combination thereof comprise at least one unsaturated bond or at least one unsaturated functional group;
 - providing at least one photoinitiator;
 - providing at least one solvent; and
 - combining the at least one monomeric compound, polymeric compound or combination thereof, the at least one photoinitiator; and the at least one solvent to form the photosensitive composition.
36. The method of claim 35, wherein at least one additional component is provided and combined with the composition.
37. A method of forming a crosslinked photosensitive dielectric film, comprising:
- providing the composition of claim 1,
 - applying the composition of claim 1 to a surface or substrate,
 - patterning the composition of claim 1 to form a patterned film,
 - curing the patterned film.

38. The method of claim 37, wherein patterning the composition comprising applying light from a light source to the surface of the composition.
39. A photosensitive dielectric film produced from the method of claim 37.
40. A microelectronic application utilizing the dielectric film of claim 39.
- 5 41. The microelectronic application of claim 40, wherein the application comprises displays, LED, photovoltaic applications and integrated circuit applications.
42. An interlayer dielectric (ILD) comprising the film of claim 39.
43. A passivation film comprising the composition of claim 1.
44. A planarization film used in fabricating Thin-Film-Transistors (TFT) comprising the
10 composition of claim 1.
45. The composition of claim 1, wherein the composition is crosslinkable by the application of ultraviolet (UV) light, visible light, E-beam or mixture thereof.
46. The method of claim 37, wherein patterning the composition comprises developing the composition with an alkaline aqueous solutions.
- 15 47. The film of claim 43, wherein the thickness can be varied between 0.01 to 100 μ m.
48. A film for use in a display applications, wherein the film is clear across the visible spectrum.
49. A film for use in display applications, wherein the planarity of the film exceeds 90%.
50. The film of claim 49, wherein the planarity of the film exceeds 94%.
- 20 51. The film of claim 50, wherein the planarity of the film exceeds 98%.
52. The composition of claim 1, wherein the at least one monomeric compound comprises an alkoxysilane.
53. The composition of claim 52, wherein the at least one monomeric compound further comprises a silicon-based acrylic compound.
- 25 54. The composition of claim 52 or claim 53, wherein the alkoxysilane comprises tetraethoxysilane.

Statement under Article 19 (1) (Rule 46.4)

Claims 1, 18 and 35 have been amended by incorporating the feature of “wherein the at least one monomeric compound, polymeric compound or a combination thereof comprise at least one unsaturated bond or at least one unsaturated functional group” into said claims on the basis of the contents of the description, and no new subject matter has been added.

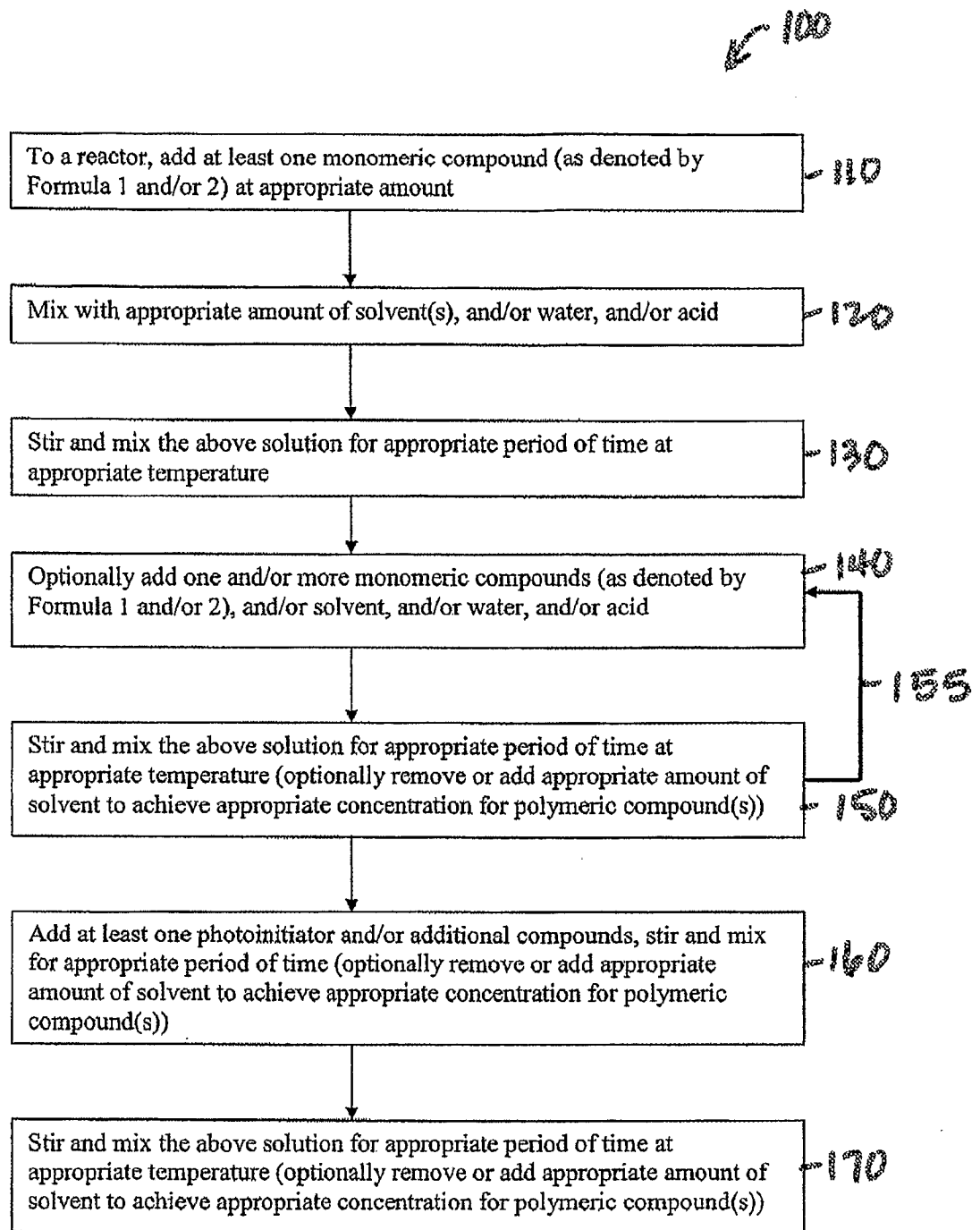


Fig. 1

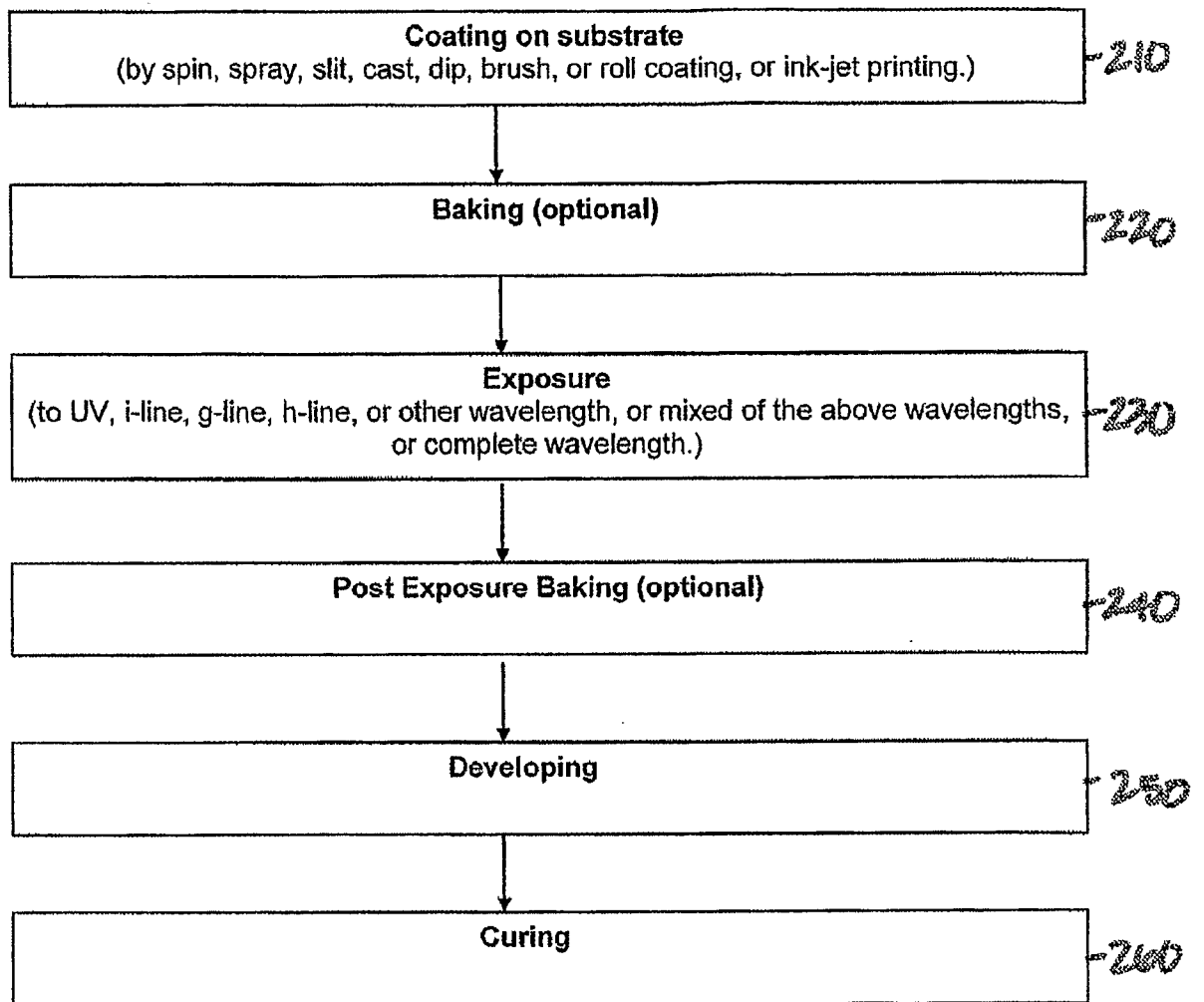


Fig. 2

Fig. 3

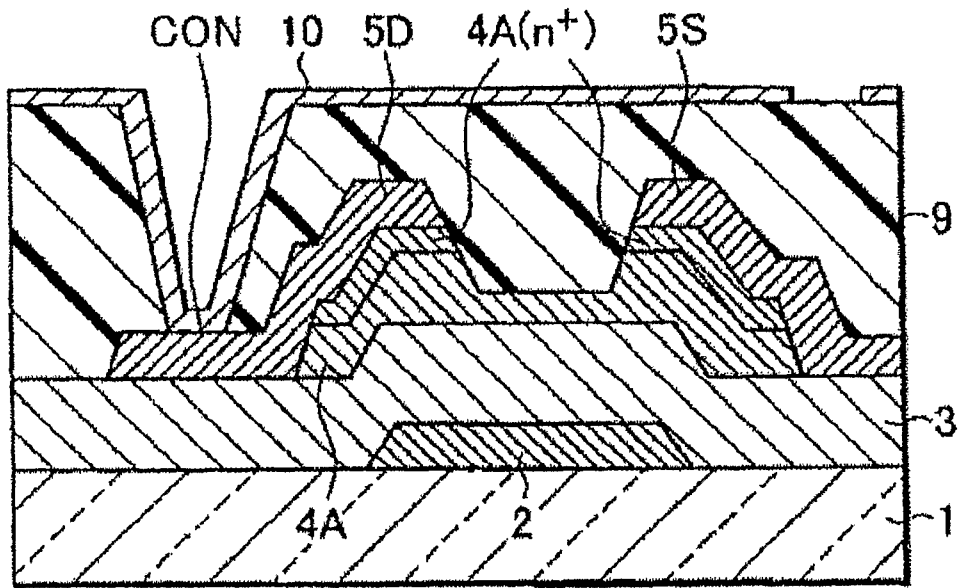
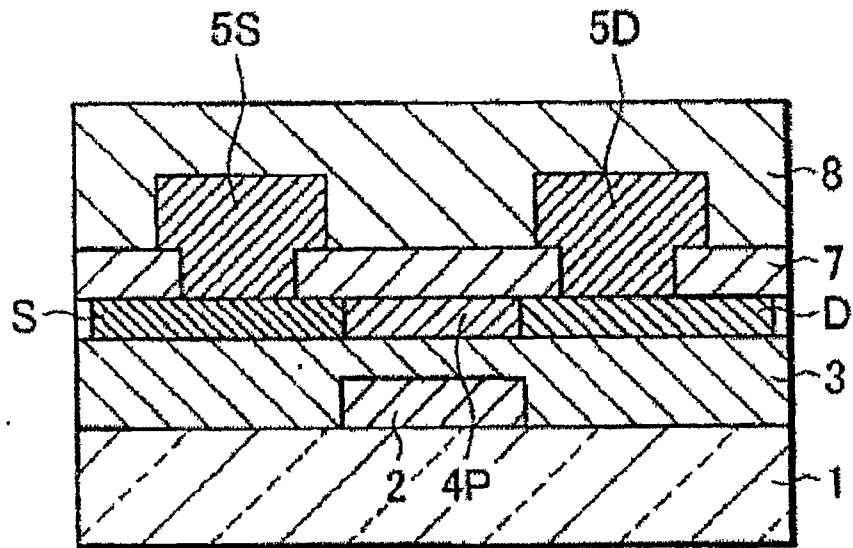
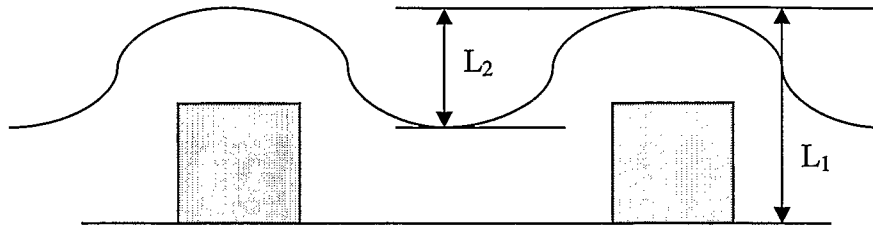


Fig. 4





$$\text{Planarization} = 100\% - L_2 / L_1$$

Where L_1 is film thickness;

L_2 is maximum thickness difference over the pattern (dense- or iso-pattern)

Figure 5

INTERNATIONAL SEARCH REPORT

International application No.

PCT/CN2006/001351

A. CLASSIFICATION OF SUBJECT MATTER

See extra sheet

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)

IPC: G03F7/075, C08G77, C09D183, C09D201, H01L21, H01L29

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)

WPI,EPODOC,PAJ, CNPAT, CNKI,CA photoinitiator light initiator silane? silicane siloxane?
polyorganosiloxane polysiloxane polysilane photosensitive light sensitive photo active photocurable UV
curable radia+ curable light curable

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	JP2005004052A 06 Jan. 2005 (06.01.2005) SHINETSU CHEM IND CO LTD (CLAIMS, DESCRIPTION [0018]-[0047], EXAMPLE, DESCRIPTION [0072])	1-7, 13-24, 30-36, 45, 52-54
Y		37-44, 47
A		8-12, 25-29, 46, 48-51
X	CN1337013A 20 Feb. 2002 (20.02.2002) NIPPON SHEET GLASS CO LTD (ABSTRACT, DESCRIPTION PAGES 6, 9, 15)	1, 11, 12, 18, 28, 29

☒ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

* Special categories of cited documents:	"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
"A" document defining the general state of the art which is not considered to be of particular relevance	"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
"E" earlier application or patent but published on or after the international filing date	"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
"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)	"&" document member of the same patent family
"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	

Date of the actual completion of the international search
08 Mar. 2007 (08.03.2007)

Date of mailing of the international search report

05 · APR 2007 05 · 04 · 2007

Name and mailing address of the ISA/CN
The State Intellectual Property Office, the P.R.China
6 Xitucheng Rd., Jimen Bridge, Haidian District, Beijing, China
100088
Facsimile No. 86-10-62019451

Authorized officer

LIANG, Shuang

Telephone No. (86-10)62085641

INTERNATIONAL SEARCH REPORT

International application No.

PCT/CN2006/001351

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	CN1172972 A 11 Feb. 1998 (11.02.1998) DOW CORNING ASIA KK (ABSTRACT, CLAIMS 1, 6, 7, DESCRIPTION PAGES 8)	2-10, 13-17, 19-27, 30-54
X		1, 8, 18, 25
A	JP5181273A 23 Jul. 1993 (23.07.1993) NIPPON STEEL CHEM CO (ABSTRACT, CLAIMS, DESCRIPTION COLUMN 9-10)	2-7, 9-17, 19-24, 26-54
Y		37-43, 47
A	JP2006154037A 15 Jun. 2006 (15.06.2006) TORAY IND INC (ABSTRACT, CLAIMS, DESCRIPTION [0001])	1-36, 44-46, 48-54
X		48-51
Y	CN1782878A 07 Jun. 2006 (07.06.2006) TORAY IND INC (FULL TEXT)	44
A		1-43, 45-47, 52-54
A		1-54

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/CN2006/001351

Patent Documents referred in the Report	Publication Date	Patent Family	Publication Date
JP2005004052 A	06.01.2005	None	
CN1337013 A	20.02.2002	WO0137049A1	25.05.2001
		EP1154323A1	14.11.2001
		JP2001539079T	27.05.2003
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		US5820944A	13.10.1998
		TW354803A	21.03.1999
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		EP0799858B1	24.09.2003
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		CN1087443C	10.07.2002
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		US2006115766A	01.06.2006
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