

TITLE

PHOTOSENSITIVE RESIN COMPOSITION

BACKGROUND OF THE INVENTION

Field of the Invention

The present invention relates to a photosensitive resin composition and more particularly, to a photosensitive resin composition having not only excellent performances in sensitivity, transmission, insulation, chemistry resistance, flatness, coating and so on but also remarkably improved adhesion especially to inorganic substances so that it is suitable to form interlayer dielectrics during LCD manufacturing process.

Description of Related Art

TFT-type liquid crystal display elements or integrated circuit elements use interlayer dielectrics to insulate space between wirings arranged in interlayers.

To form such interlayer dielectrics, there are being used photosensitive substances capable of easily forming patterns and especially, having excellent adhesion to inorganic substances such as metal films or top/bottom glasses

Recently, for the improvement of adhesion to substrates, interlayer dielectrics applied to liquid crystal display (LCD) manufacturing process have employed processes such as HMDS treatments or adhesives have been added thereto. However, such methods required additional treatment steps during LCD manufacturing process and thus increased

process number, and there was a problem with safety during development process and etching process because of lack of adhesion.

Accordingly, studies about methods capable of reducing the number of processes in LCD manufacturing process and improving the adhesion of patterns for interlayer dielectrics during development process and etching process, thereby securing safety are greatly required.

SUMMARY OF THE INVENTION

In order to solve the problems of the prior arts, it is an object of the present invention to provide a photosensitive resin composition not only having excellent performances in sensitivity, transmission, insulation, chemistry resistance, flatness, coating and so on but also capable of reducing the number of processes in LCD manufacturing process and remarkably improving the safety and adhesion of patterns for interlayer dielectrics during development and etching processes so that it is suitable for use in interlayer dielectrics of LCD manufacturing process where the thickness of a film is thick and a pattern formation method of an LCD substrate using the photosensitive resin composition.

To achieve the aforementioned objects, the invention provides photosensitive resin composition comprising:

- a) an acryl-based copolymer obtained by copolymerizing
 - i) an unsaturated carbonic acid, unsaturated carbonic anhydride or mixture thereof;
 - ii) an epoxy group containing unsaturated compound;

- iii) an olefin-based unsaturated compound; and
- iv) a silane-based monomer;
- b) a 1,2-quinonediazide compound; and
- c) a solvent.

Preferably, the invention comprises

- a) 100 parts by weight of the acryl-based copolymer obtained by copolymerizing
 - i) 5 to 40 parts by weight of the unsaturated carbonic acid, unsaturated carbonic anhydride or mixture thereof;
 - ii) 10 to 70 parts by weight of an epoxy group containing unsaturated compound;
 - iii) 10 to 70 parts by weight of the olefin-based unsaturated compound;
- and
- iv) 3 to 15 parts by weight of the silane-based monomer;
- b) 5 to 100 parts by weight of the 1,2-quinonediazide compound; and
- c) the solvent in such an amount that the content of the solids in the photosensitive resin composition is 10 to 50 % by weight.

Further, the invention provides an LCD comprising a cured product of the photosensitive resin.

Further, the invention provides a pattern formation method of an LCD substrate using the photosensitive resin composition.

DETAILED DESCRIPTION OF THE INVENTION

This invention is further described in detail.

The photosensitive resin composition of the invention is characterized by comprising a) an acryl-based copolymer obtained by copolymerizing i) an unsaturated carbonic acid, unsaturated carbonic anhydride or mixture thereof, ii) 10 to 70 parts by weight of an epoxy group containing unsaturated compound, iii) 10 to 70 parts by weight of an olefin-based unsaturated compound, and iv) 3 to 15 parts by weight of a silane-based monomer, b) a 1,2-quinonediazide compound, and c) a solvent.

The acryl-based copolymer of a) used in the invention enables prescribed patterns which do not generate scum when developed to be readily formed.

The acryl-based copolymers of a) can be synthesized by radical reaction using i) the unsaturated carbonic acid, unsaturated carbonic anhydride or mixture thereof, ii) the epoxy group containing unsaturated compound, iii) the olefin-based unsaturated compound, and iv) the silane-based compound as monomers under the presence of a solvent and polymerization initiator.

For the unsaturated carbonic acid, unsaturated carbonic anhydride or mixture thereof of a) i) used in the invention, unsaturated monocarbonic acids such as acrylic acid, methacrylic acid; unsaturated dicarbonic acids such as maleic acid, fumaric acid, citraconic acid, methaconic acid and itaconic acid; or unsaturated dicarbonic anhydride thereof can be used alone or by mixture and in particular, it is more preferable to use acrylic acid, methacrylic acid or maleic anhydride in consideration of copolymerization reactivity and solubility with regard to alkaline aqueous solution that is a development solution.

The unsaturated carbonic acid, unsaturated carbonic anhydride or mixture thereof is contained preferably in an amount of 5 to 40 parts by weight with regard to 100 parts

by weight of the total monomers and more preferably 10 to 30 parts by weight. When the amount is less than 5 parts by weight, it is difficult to be dissolved in alkaline aqueous solutions and when it exceeds 40 parts by weight, solubility with regard to alkaline aqueous solutions becomes too high.

For the epoxy group containing unsaturated compound of a) ii) used in the invention, glycidyl acrylate, glycidyl methacrylate, glycidyl α -ethylacrylate, glycidyl α -n-propylacrylate, glycidyl α -n-butylacrylate, β -methylglycidyl acrylate, β -methylglycidyl methacrylate, β -ethylglycidyl acrylate, β -ethylglycidyl methacrylate, 3,4-epoxybutyl acrylate, 3,4-epoxybutyl methacrylate, 6,7-epoxyheptyl acrylate, 6,7-epoxyheptyl methacrylate, 6,7-epoxyheptyl α -ethylacrylate, o-vinylbenzylglycidylether, m-vinylbenzylglycidylether, or p-vinylbenzylglycidylether can be used alone or by mixture.

In particular, it is more preferable to use glycidyl methacrylate, β -methylglycidyl methacrylate, 6,7-epoxyheptyl methacrylate, o-vinylbenzylglycidylether, m-vinylbenzylglycidylether, or p-vinylbenzylglycidylether as the epoxy group containing unsaturated compounds for the improvement of copolymerization reactivity and heat resistance of patterns to be obtained.

The epoxy group containing unsaturated compound is contained preferably in an amount of 10 to 70 parts by weight with regard to 100 parts by weight of the total monomers and more preferably 20 to 60 parts by weight. When the amount is less than 10 parts by weight, the heat resistance of patterns to be obtained is decreased and when it exceeds 70 parts by weight, the preservation stability of the copolymers is decreased.

For the olefin-based unsaturated compound of a) iii) used in the invention, methyl methacrylate, ethyl methacrylate, n-butyl methacrylate, sec-butyl methacrylate,

tert-butyl methacrylate, methyl acrylate, isopropyl acrylate, cyclohexyl methacrylate, 2-methylcyclohexyl methacrylate, dicyclopentenyl acrylate, dicyclopentanyl acrylate, dicyclopentenyl methacrylate, dicyclopentanyl methacrylate, 1-adamantyl acrylate, 1-adamantyl methacrylate, dicyclopentanyloxyethyl methacrylate, isobornyl methacrylate, cyclohexyl acrylate, 2-methylcyclohexyl acrylate, dicyclopentanyloxyethyl acrylate, isobornyl acrylate, phenyl methacrylate, phenyl acrylate, benzyl acrylate, 2-hydroxyethyl methacrylate. styrene, α -methyl styrene, m-methyl styrene, p-methyl styrene, vinyl toluene, p-methoxy styrene, 1,3-butadiene, isoprene, or 2,3-dimethyl 1,3-butadiene can be used alone or by mixture.

In particular, it is more preferable to use styrene, dicyclopentanyl methacrylate, or p-methoxy styrene as the olefin-based unsaturated compounds in consideration of copolymerization reactivity and solubility with regard to alkaline aqueous solution that is a development solution.

The olefin-based unsaturated compound is contained preferably in an amount of 10 to 70 parts by weight with regard to 100 parts by weight of the total monomers and more preferably 20 to 50 parts by weight. When the amount is less than 10 parts by weight, the preservation stability of acryl-based copolymers is decreased and when it exceeds 70 parts by weight, the acryl-based copolymers are difficult to be dissolved in alkaline aqueous solutions which are development solutions.

For the silane-based monomer of a) iv) used in the invention, vinyltrichlorosilane, vinyltris(β -methoxyethoxysilane), vinyltriacetoxysilane, vinyltrimethoxysilane, vinyltriethoxysilane, 3-methacryloxyethylmethyldimethoxysilane, 3-methacryloxypropylmethyldimethoxysilane, 3-methacryloxyethylmethyldiethoxysilane,

3-methacryloxypropylmethyldiethoxysilane, 3-methacryloxymethyltrimethoxysilane, 3-methacryloxyethyltrimethoxysilane, 3-methacryloxypropyltrimethoxysilane, 3-methacryloxybutyltrimethoxysilane, 3-methacryloxyethyltriethoxysilane or 3-methacryloxypropyltriethoxysilane can be used.

The silane monomer is contained preferably in an amount of 3 to 15 parts by weight with regard to 100 parts by weight of the total monomers. If the amount is less than 3 parts by weight, there is no influence on the improvement of adhesion to substrates and if it exceeds 15 parts by weight, the heat resistance of the patterns formed on substrates is decreased.

For the solvent used to solution polymerize the above unsaturated carbonic acid, unsaturated carbonic anhydride, or mixture thereof; the epoxy group containing unsaturated compound; the olefin-based unsaturated compound; and the silane-based monomer, methanol, tetrahydrofuran, toluene, dioxane and so on can be employed.

For the polymerization initiator used to solution polymerize the above monomers, radical polymerization initiators can be used and in particular, there can be used 2,2-azobisisobutyronitrile, 2,2-azobis(2,4-dimethylvaleronitrile), 2,2-azobis(4-methoxy 2,4-dimethylvaleronitrile), 1,1-azobis(cyclohexane-1-carbonitrile), or dimethyl 2,2'-azobisisobutylate.

The acryl-based copolymers of a) obtained by radical reacting the above monomers under the presence of the solvents and polymerization initiator and eliminating unreacted monomers by precipitation, filtration and vacuum dry processes have preferably a weight average molecular weight (M_w) in terms of polystyrene of 5,000 to 30,000 and more preferably, 5,000 to 20,000. In case of the interlayer dielectrics having a

weight average molecular weight in terms of polystyrene less than 5,000, their development properties, residual film rate and so on are decreased or pattern development, heat resistance, etc. are inferior and in case of the interlayer dielectrics exceeding 30,000, their sensitivity are decreased or pattern development is inferior.

The 1,2-quinonediazide compounds in the invention are used as a photosensitive compound.

For the 1,2-quinonediazide compounds, 1,2-quinonediazide-4-sulfonic ester, 1,2-quinonediazide-5-sulfonic ester, or 1,2-quinonediazide-6-sulfonic ester, etc. can be employed.

The quinonediazide compounds can be prepared by reacting naphthoquinonediazide sulfonic acid halogen compounds and phenol compounds under weak base.

For the phenol compounds, 2,3,4-trihydroxybenzophenone, 2,4,6-trihydroxybenzophenone, 2,2'-tetrahydroxybenzophenone, 4,4'-tetrahydroxybenzophenone, 2,3,4,3'-tetrahydroxybenzophenone, 2,3,4,4'-tetrahydroxybenzophenone, 2,3,4,2'-tetrahydroxy 4'-methylbenzophenone, 2,3,4,4'-tetrahydroxy 3'-methoxybenzophenone, 2,3,4,2'-pentahydroxybenzophenone, 2,3,4,6'-pentahydroxybenzophenone, 2,4,6,3'-hexahydroxybenzophenone, 2,4,6,4'-hexahydroxybenzophenone, 2,4,6,5'-hexahydroxybenzophenone, 3,4,5,3'-hexahydroxybenzophenone, 3,4,5,4'-hexahydroxybenzophenone, 3,4,5,5'-hexahydroxybenzophenone, bis(2,4-dihydroxyphenyl) methane, bis(p-hydroxyphenyl) methane, tri(p-hydroxyphenyl) methane, 1,1,1-tri(p-hydroxyphenyl) ethane, bis(2,3,4-trihydroxyphenyl) methane, 2,2-bis(2,3,4-trihydroxyphenyl) propane, 1,1,3-tris(2,5-

dimethyl 4-hydroxyphenyl)-3-phenylpropane, 4,4'-[1-[4-[1-[4-hydroxyphenyl]-1-methylethyl]phenyl]ethylenidene]bisphenol, or bis(2,5-dimethyl 4-hydroxyphenyl)-2-hydroxyphenylmethane can be used alone or by mixture.

When the quinonediazide compounds are synthesized with the above phenol compounds and naphthoquinonediazide sulfonic acid halogen compounds, their esterification rate is preferably 50 to 85 %. When the esterification rate is less than 50 %, residual film rate can be deteriorated and when it exceeds 85 %, preservation stability is decreased.

The 1,2-quinonediazide compounds are contained preferably in an amount of 5 to 100 parts by weight with regard to 100 parts by weight of the acryl-based copolymers of a) and more preferably 10 to 50 parts by weight. If the amount is less than 5 parts by weight, solubility difference between exposed parts and unexposed parts is small so that pattern formation is difficult and if it exceeds 100 parts by weight, unreacted 1,2-quinonediazide compounds remain in large quantity when irradiated with light for short period so that solubility with regard to alkaline aqueous solution that is a development solution becomes too low and development is thus difficult.

The solvent of c) used in the invention does not generate coating stain and flatness of interlayer dielectrics and thus allows uniform pattern profile to be formed.

For the solvents, there can be used benzyl alcohol, hexyl alcohol, or ethers such as diethyleneglycoldimethylether, diethyleneglycolmethylethylether, diethyleneglycoldiethylether, dipropyleneglycoldimethylether, dipropyleneglycolmethylethylether, dipropyleneglycoldiethylether, ethyleneglycol monomethylether, ethyleneglycol monoethylether, methylcellosolveacetate,

ethylcellosolveacetate, diethyleneglycol monomethylether, diethyleneglycol monoethylether, ethyleneglycol methylethylether, propyleneglycol monomethylether, propyleneglycol monoethylether, propyleneglycol propylether, propyleneglycol butylether, propyleneglycol methyletheracetate, propyleneglycol ethyletheracetate, propyleneglycol propyletheracetate, propyleneglycol butyletheracetate, propyleneglycol methyletherpropionate, propyleneglycol ethyletherpropionate, propyleneglycol propyletherpropionate, propyleneglycol butyletherpropionate, toluene, xylene, methylethylketone, cyclohexanone, 4-hydroxy 4-methyl 2-pentanone, methyl acetate, ethyl acetate, propyl acetate, butyl acetate, 2-hydroxy ethyl propionate, 2-hydroxy methyl methyl propionate, 2-hydroxy 2-methyl ethyl propionate, hydroxy methyl acetate, hydroxy ethyl acetate, hydroxy butyl acetate, methyl lactate, ethyl lactate, propyl lactate, butyl lactate, 3-hydroxy methyl propionate, 3-hydroxy ethyl propionate, 3-hydroxy propyl propionate, 3-hydroxy butyl propionate, 2-hydroxy 3-methyl methyl butyric acid, methoxy methyl acetate, methoxy ethyl acetate, methoxy propyl acetate, methoxy butyl acetate, ethoxy methyl acetate, ethoxy ethyl acetate, ethoxy propyl acetate, ethoxy butyl acetate, propoxy methyl acetate, propoxy ethyl acetate, propoxy propyl acetate, propoxy butyl acetate, butoxy methyl acetate, butoxy ethyl acetate, butoxy propyl acetate, butoxy butyl acetate, 2-methoxy methyl propionate, 2-methoxy ethyl propionate, 2-methoxy propyl propionate, 2-methoxy butyl propionate, 2-ethoxy methyl propionate, 2-ethoxy ethyl propionate, 2-ethoxy propyl propionate, 2-ethoxy butyl propionate, 2-butoxy methyl propionate, 2-butoxy ethyl propionate, 2-butoxy propyl propionate, 2-butoxy butyl propionate, 3-methoxy methyl propionate, 3-methoxy ethyl propionate, 3-methoxy propyl propionate, 3-methoxy butyl propionate, 3-ethoxy methyl propionate, 3-ethoxy ethyl

propionate, 3-ethoxy propyl propionate, 3-ethoxy butyl propionate, 3-propoxy methyl propionate, 3-propoxy ethyl propionate, 3-propoxy propyl propionate, 3-propoxy butyl propionate, 3-butoxy methyl propionate, 3-butoxy ethyl propionate, 3-butoxy propyl propionate and 3-butoxy butyl propionate can be used and these compounds can be used alone or by mixture.

The solvents are contained preferably in such an amount that the amount of the solids of the total photosensitive resin compositions becomes 10 to 50 % by weight and more preferably 15 to 40 % by weight. If the amount of the solids of the total composition is less than 10 % by weight, the thickness of coating becomes thin and coating flatness is decreased, and if it exceeds 50 % by weight, the thickness of coating becomes thick and it may affect coating machines during coating.

The photosensitive resin compositions comprising the above components may further comprise d) epoxy resins, e) adhesives, f) acryl compounds, or g) surfactants, if necessary.

The epoxy resins of d) improve the heat resistance and sensitivity of patterns obtained from the photosensitive resin compositions

For the epoxy resins, bisphenol A epoxy resins, phenol novolac epoxy resins, cresol novolac epoxy resins, aliphatic epoxy resins, alicyclic epoxy resins, glycidyl ester epoxy resins, glycidyl amine epoxy resins, epoxy resins, heterocyclic epoxy resins, or resins (co)polymerized with glycidyl methacrylates other than the acryl-based copolymers of a) can be used and in particular, it is preferable to use bisphenol A epoxy resins, cresol novolac epoxy resins, or glycidyl ester epoxy resins.

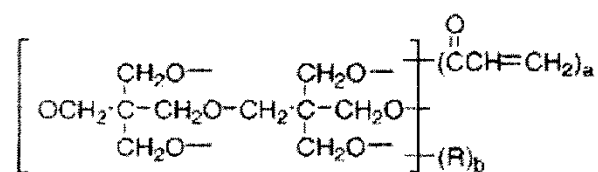
The epoxy resins are contained preferably in an amount of 0.1 to 30 parts by weight with regard to 100 parts by weight of the acryl-based copolymers of a), and if the amount deviates from the above ranges, compatibility with acryl-based copolymers is reduced and thus, sufficient coating performance cannot be obtained.

The adhesives of e) improve the adhesion to substrates, and silane coupling agents having reactive substituents such as carboxyl group, methacryl group, isocyanate group or epoxy group can be used. In particular, γ -methacryloxypropyltrimethoxysilane, vinyltriacetoxysilane, vinyltrimethoxysilane, γ -isocyanatepropyltriethoxysilane, γ -glycidoxypropyltrimethoxysilane, or β -(3,4-epoxy cyclo hexyl)ethyltrimethoxysilane can be used.

The adhesives are contained preferably in amount of 0.1 to 20 parts by weight with regard to 100 parts by weight of the acryl-based copolymers of a).

The acryl compounds of f) improve transmission, heat resistance, sensitivity, etc. of the patterns obtained from the photosensitive resin compositions.

Preferably, the acryl compounds are represented by formula 1:



wherein R is a hydrogen atom, alkyl group having 1 ~ 5 carbon atoms, alkoxy group having 1 ~ 5 carbon atoms or alkanoyl group having 1 ~ 5 carbon atoms,

$$1 < a < 6, \text{ and } a + b = 6.$$

The acryl compounds are contained preferably in an amount of 0.1 to 25 parts by weight with regard to 100 parts by weight of the acryl-based copolymers of a) and more

preferably 0.1 to 15 parts by weight. The amount within the above ranges is advisable for the improvement of the sensitivity, heat resistance and transmission of patterns.

The surfactants of g) improve the coating performance or development performance of photosensitive compositions.

For the surfactants, polyoxyethyleneoctylphenylether, polyoxyethylenenonylphenylether, F171, F172, F173 (product names: Dainippon Ink & Chemicals Inc.), FC430, FC431 (product names: Sumitomo 3M Limited), or KP341 (product name: Shin-Etsu chemical Industry Co., Ltd.) can be used.

The surfactants are contained preferably in an amount of 0.0001 to 2 parts by weight with regard to 100 parts by weight of the acryl-based copolymers of a), and the amount within the above ranges is advisable for the improvement of the development or coating performances of the photosensitive compositions

The concentration of the solids of the photosensitive resin compositions of the invention comprising the above components is preferably 10 to 50 % by weight and the compositions having the solids within the above ranges are used preferably after filtration with a millipore filter of $0.1 \sim 0.2 \mu\text{m}$.

Also, the invention provides LCD substrates comprising the cured products of the photosensitive resins and pattern formation methods of LCD substrates using the photosensitive resin compositions.

The pattern formation methods of the invention are characterized in that in methods of forming the pattern of LCD substrates by forming photosensitive resin compositions into organic insulating films, the photosensitive resin compositions are employed.

In particular, the methods of forming the pattern of LCD substrates using the photosensitive resin compositions are as follows.

First, the photosensitive resin compositions of the invention are coated onto the surface of substrates using a spray method, roll coater method, spin coating method, etc., and coating films are formed by the elimination of solvents by pre-bake. The pre-bake is preferably carried out at temperature of $70 \sim 110^{\circ}\text{C}$ for $1 \sim 15$ min.

Next, the above formed coating films are irradiated with visible rays, UV, deep UV, electron beams, X rays, etc. in accordance with the prepared patterns and developed with development solutions to remove unnecessary parts whereby prescribed patterns are formed.

For the development solutions, alkaline aqueous solutions are preferably employed and in particular, there can be used inorganic alkalines such as sodium hydroxide, potassium hydroxide and sodium carbonate; primary amines such as n-propylamine; secondary amines such as diethylamine and n-propylamine; tertiary amines such as trimethylamine, methyl diethyl amine, dimethyl ethyl amine and triethyl amine; alcohol amines such as dimethylethanolamine, methyldiethanolamine and triethanolamine; or aqueous solutions of quaternary ammonium salts such as tetramethyl ammonium hydroxide and tetraethyl ammonium hydroxide. The development solutions are used by dissolving alkaline compounds at a concentration of $0.1 \sim 10\%$ by weight, and aqueous organic solvents such as methanol and ethanol and surfactants can be added thereto in a suitable amount.

Also, after development with the above development solutions, unnecessary parts are eliminated by wash with ultra pure water and patterns are formed after dry. After the

formed patterns are irradiated with lights such as UV, the patterns are heated in heating machines such as an oven at a temperature of 150 ~ 250 °C for 30 ~ 90 min. Thus, final patterns can be obtained.

The photosensitive resin compositions in accordance with the present invention have excellent performances in sensitivity, transmission, insulation, chemistry resistance, flatness, coating and so on and also, they can reduce the number of processes in LCD manufacturing process and remarkably improve the safety and adhesion of patterns for interlayer dielectrics during development and etching processes so that they are suitable for use in interlayer dielectrics of LCD manufacturing process where the thickness of a film is thick. Also, the pattern formation method of LCD substrates of the invention using the photosensitive resin compositions of the invention enables the formation of superior patterns of interlayer dielectrics applied to LCD manufacturing process.

For better understanding of the present invention, preferred embodiments follow. The following examples are intended to merely illustrate the invention more fully without limiting the scope of the invention.

EXAMPLES

EXAMPLE 1

(Preparation of Acryl-Based Copolymer)

To a flask with a cooling tube and stirrer, 500 parts by weight of tetrahydrofuran, 25 parts by weight of methacrylic acid, 30 parts by weight of glycidyl methacrylate, 20 parts by weight of styrene, 20 parts by weight of isobornyl acrylate, 5 parts by weight of vinyltrimethoxysilane and 1 part by weight of 2,2'-azobis(2,4-

dimethylvaleronitrile) were added and gently stirred after nitrogen substitution. The reaction solution was heated to 55 °C, which was maintained for 24 hours whereby a polymer solution containing acryl-based copolymers was prepared and the average weight molecular weight of the polymers was 10,000. The weight average molecular weight is an average molecular weight in terms of polystyrene measured using GPC.

(Preparation of 1,2-Quinonediazide)

1 mol of 4,4'-[1-[4-[1-[4-hydroxyphenyl]-1-methylethyl]phenyl]ethylidene]bisphenol and 2 mols of 1,2-naphtoquinonediazide-5-sulfonic acid[chloride] were condensation-reacted and 4,4'-[1-[4-[1-[4-hydroxyphenyl]-1-methylethyl]phenyl]ethyliden]bisphenol 1,2-naphtoquinonediazide-5-sulfonic ester was thus prepared.

(Preparation of Photosensitive Resin Composition)

100 parts by weight of the above prepared acryl-based copolymers and 30 parts by weight of the prepared 4,4'-[1-[4-[1-[4-hydroxyphenyl]-1-methylethyl]phenyl]ethyliden]bisphenol 1,2-naphtoquinonediazide-5-sulfonic ester were mixed. The mixture was dissolved in benzyl alcohol so that the concentration of the solid of the mixture became 30 % by weight and then filtered using a millipore filter of 0.2 μm whereby a photosensitive resin composition was prepared.

EXAMPLE 2

With the exception that when acryl-based copolymers were prepared in Example 1, vinyltrimethoxysilane was used in an amount of 10 parts by weight, a photosensitive resin composition was prepared by carrying out the same method as used in Example 1.

EXAMPLE 3

With the exception that when acryl-based copolymers were prepared in Example 1, instead of 5 parts by weight of vinyltrimethoxysilane, 3-methacryloxypropyltrimethoxysilane was used in an amount of 3 parts by weight, a photosensitive resin composition was prepared by carrying out the same method as used in Example 1.

EXAMPLE 4

With the exception that when acryl-based copolymers were prepared in Example 1, instead of 5 parts by weight of vinyltrimethoxysilane, 3-methacryloxypropyltrimethoxysilane was used in an amount of 6 parts by weight, a photosensitive resin composition was prepared by carrying out the same method as used in Example 1.

EXAMPLE 5

With the exception that when acryl-based copolymers were prepared in Example 1, instead of 5 parts by weight of vinyltrimethoxysilane, 3-methacryloxypropyltrimethoxysilane was used in an amount of 10 parts by weight, a photosensitive resin composition was prepared by carrying out the same method as used in Example 1.

COMPARATIVE XAMPLE 1

With the exception that when acryl-based copolymers were prepared in Example 1, vinyltrimethoxysilane was not used, a photosensitive resin composition was prepared by carrying out the same method as used in Example 1.

The properties of the photosensitive resin compositions prepared in Examples 1 to 5 and Comparative Example 1 were evaluated by the following procedures and the results were shown in Table 1 below.

a) Coating RPM-The photosensitive resin compositions prepared in Examples 1 to 5 and Comparative Example 1 were coated onto glass substrates using a spin coater and then pre-baked on hot plates at 90 °C for 2 min whereby films having a thickness of 3.0 μm were formed.

b) Sensitivity-The films obtained in a) were irradiated with UV having an intensity of 15 mW/cm^2 at 365 nm for 15 seconds using predetermined pattern masks. Thereafter, they were developed with 2.38 wt.% aqueous solution of tetramethylammoniumhydroxide at 23 °C for 70 seconds and then washed with ultra pure water for 1 min.

Thereafter, the above developed patterns were irradiated with UV an intensity of 15 mW/cm^2 at 365 nm for 34 seconds and then heated, cured in a Convection oven at 220 °C for 60 min. whereby patterned films were obtained.

c) Resolution-The minimum size of the patterned films formed in above b) was measured.

d) Heat Resistance-The width of top/bottom and left/right of the patterned films formed in above b) was measured. When the change rate of angles on the basis of before-

oven heating was 0 ~ 20 %, it was marked as "○," when it was 20 ~ 40 %, "△," and when it exceeds 40 %, "×."

e) Transparency-The transmission of the patterned films at 400 nm was measured using a spectrometer.

f) Adhesion-After the compression machine of a manual roller was run at a constant speed on the patterned films formed in above b), the area that was peeled off was measured and represented by percentage with regard to the total area (100) of the substrates.

Table 1

	Coating RPM	Sensitivity (mJ/cm ²)	Resolution (μm)	Heat Resistance	Transparency	Adhesion (%)
Ex. 1	1090	54.6	3	○	90	35.05
Ex. 2	1050	51.2	3	△	92	31.71
Ex. 3	1050	54.5	3	○	90	36.06
Ex. 4	1090	54.8	3	○	90	28.88
Ex. 5	1020	50.1	3	○	91	22.75
Com. Ex. 1	1030	58.1	3	○	88	85.13

From Table 1 above, it can be seen that the photosensitive resin compositions prepared in accordance with Examples 1 to 5 showed excellent sensitivity, resolution, heat resistance, transparency and adhesion and thus they are applicable to interlayer dielectrics of LCD process according to the preference of larger substrates. In contrast, in Comparative Example 1, its sensitivity was as low as 58.1 mJ/cm² and adhesion was bad and therefore, it was difficult to be applied to interlayer dielectrics.

The photosensitive resin compositions in accordance with the present invention have excellent performances in sensitivity, transmission, insulation, chemistry resistance, flatness, coating and so on and also, they can reduce the number of processes in LCD manufacturing process and remarkably improve the safety and adhesion of patterns for interlayer dielectrics during development and etching processes so that they are suitable for use in interlayer dielectrics of LCD manufacturing process where the thickness of a film is thick. Also, the pattern formation method of LCD substrates of the invention using the photosensitive resin compositions of the invention enables the formation of superior patterns of interlayer dielectrics applied to LCD manufacturing process.

CLAIMS

What is claimed is:

1. A photosensitive resin composition comprising:

- a) an acryl-based copolymer obtained by copolymerizing
 - i) an unsaturated carbonic acid, unsaturated carbonic anhydride or mixture thereof;
 - ii) an epoxy group containing unsaturated compound;
 - iii) an olefin-based unsaturated compound; and
 - iv) a silane-based monomer;
- b) a 1,2-quinonediazide compound; and
- c) a solvent.

2. The photosensitive resin composition according to claim 1 comprising:

- a) 100 parts by weight of the acryl-based copolymer obtained by copolymerizing
 - i) 5 to 40 parts by weight of the unsaturated carbonic acid, unsaturated carbonic anhydride or mixture thereof;
 - ii) 10 to 70 parts by weight of an epoxy group containing unsaturated compound;
 - iii) 10 to 70 parts by weight of the olefin-based unsaturated compound;
- and
- iv) 3 to 15 parts by weight of the silane-based monomer;

b) 5 to 100 parts by weight of the 1,2-quinonediazide compound; and

c) the solvent in such an amount that the content of the solids in the photosensitive resin composition is 10 to 50 % by weight.

3. The photosensitive resin composition according to claim 1 wherein the unsaturated carbonic acid, unsaturated carbonic anhydride or mixture thereof of a) i) is selected from the group consisting of acrylic acid, methacrylic acid, maleic acid, fumaric acid, citraconic acid, methaconic acid, itaconic acid, unsaturated dicarbonic anhydride thereof and mixture thereof.

4. The photosensitive resin composition according to claim 1 wherein the epoxy group containing unsaturated compound of a) ii) is selected from the group consisting of glycidyl acrylate, glycidyl methacrylate, glycidyl α -ethylacrylate, glycidyl α -n-propylacrylate, glycidyl α -n-butylacrylate, β -methylglycidyl acrylate, β -methylglycidyl methacrylate, β -ethylglycidyl acrylate, β -ethylglycidyl methacrylate, 3,4-epoxybutyl acrylate, 3,4-epoxybutyl methacrylate, 6,7-epoxyheptyl acrylate, 6,7-epoxyheptyl methacrylate, 6,7-epoxyheptyl α -ethylacrylate, o-vinylbenzylglycidylether, m-vinylbenzylglycidylether, p-vinylbenzylglycidylether and mixture thereof.

5. The photosensitive resin composition according to claim 1 wherein the olefin-based unsaturated compound of a) iii) is selected from the group consisting of methyl methacrylate, ethyl methacrylate, n-butyl methacrylate, sec-butyl methacrylate, tert-butyl methacrylate, methyl acrylate, isopropyl acrylate, cyclohexyl methacrylate, 2-

methyleyclohexyl methacrylate, dicyclopentenyl acrylate, dicyclopentanyl acrylate, dicyclopentenyl methacrylate, dicyclopentanyl methacrylate, 1-adamantyl acrylate, 1-adamantyl methacrylate, dicyclopentanyloxyethyl methacrylate, isobornyl methacrylate, cyclohexyl acrylate, 2-methylcyclohexyl acrylate, dicyclopentanyloxyethyl acrylate, isobornyl acrylate, phenyl methacrylate, phenyl acrylate, benzyl acrylate, 2-hydroxyethyl methacrylate, styrene, α -methyl styrene, m-methyl styrene, p-methyl styrene, vinyl toluene, p-methoxy styrene, 1,3-butadiene, isoprene, 2,3-dimethyl 1,3-butadiene and mixture thereof.

6. The photosensitive resin composition according to claim 1 wherein the silane-based monomer of a) iv) is selected from the group consisting of vinyltrichlorosilane, vinyltris(β -methoxyethoxysilane), vinyltriacetoxysilane, vinyltrimethoxysilane, vinyltriethoxysilane, 3-methacryloxyethylmethyldimethoxysilane, 3-methacryloxypropylmethyldimethoxysilane, 3-methacryloxyethylmethyldiethoxysilane, 3-methacryloxypropylmethyldiethoxysilane, 3-methacryloxymethyltrimethoxysilane, 3-methacryloxyethyltrimethoxysilane, 3-methacryloxypropyltrimethoxysilane, 3-methacryloxybutyltrimethoxysilane, 3-methacryloxyethyltriethoxysilane, 3-methacryloxypropyltriethoxysilane and mixture thereof.

7. The photosensitive resin composition according to claim 1 wherein the acryl-based copolymer of a) has a weight average molecular weight (Mw) in terms of polystyrene of 5,000 to 30,000.

8. The photosensitive resin composition according to claim 1 wherein the 1,2-quinonediazide compound of b) is selected from the group consisting of 1,2-quinonediazide-4-sulfonic ester, 1,2-quinonediazide-5-sulfonic ester, 1,2-quinonediazide-6-sulfonic ester and mixture thereof.

9. The photosensitive resin composition according to claim 1 further comprising at least one additive selected from the group consisting of d) 0.1 to 30 parts by weight of an epoxy resin, e) 0.1 to 20 parts by weight of an adhesive, f) 0.1 to 25 parts by weight of an acryl compound, and g) 0.0001 to 2 parts by weight of a surfactant with regard to 100 parts by weight of the acryl-based copolymer of a).

10. The photosensitive resin composition according to claim 1 wherein the solvent is selected from the group consisting of benzyl alcohol, hexyl alcohol, diethyleneglycoldimethylether, diethyleneglycolmethylethylether, diethyleneglycoldiethylether, dipropyleneglycoldimethylether, dipropyleneglycolmethylethylether, dipropyleneglycoldiethylether, and mixture thereof.

11. An LCD substrate comprising a cured product of the photosensitive resin of any one of claims 1 to 10.

12. A pattern formation method of an LCD substrate using the photosensitive resin of any one of claims 1 to 10.