

## 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, heat resistance, resolution, etc. but also remarkably improved transmission and preservation stability at room temperature 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 and flat space between wirings arranged in interlayers.

Recently, interlayer dielectrics applied to liquid crystal display (LCD) manufacturing process require photoresists capable of increasing backlight efficiency and reducing consumed electricity by increasing transmission and flatness.

Prior interlayer dielectrics have included PAC, binders, solvents, etc. and as monomers for hardening the binders, epoxy-based acrylates have been mostly used. However, in case of the prior epoxy-based acrylates, there were problems in the transmission and preservation stability of interlayer dielectrics and therefore, they caused inferiority during LCD manufacturing process.

Accordingly, studies about the improvement of the transmission and preservation stability of the interlayer dielectrics applied to LCD manufacturing process are greatly required.

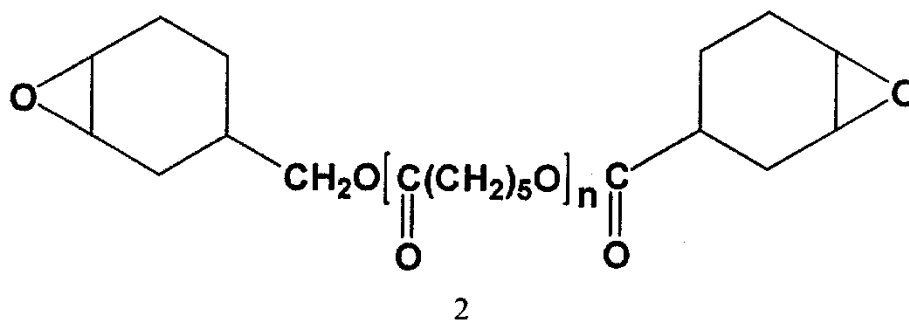
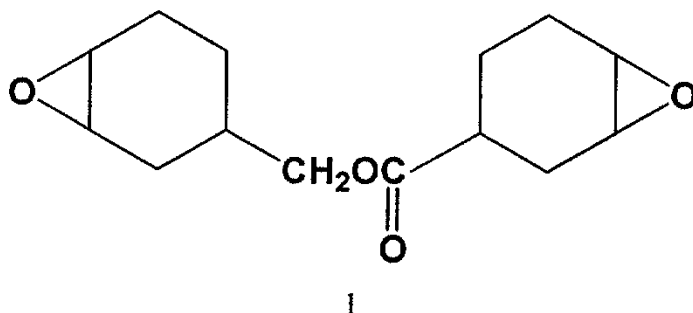
## SUMMARY OF THE INVENTION

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 several performances such as sensitivity, heat resistance and resolution but also remarkably improving transmission and preservation stability at room temperature so that it is

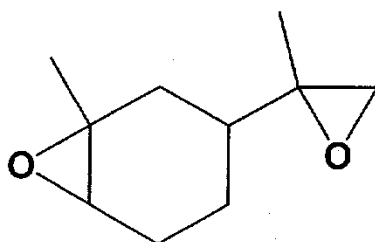
suitable to form interlayer dielectrics during LCD manufacturing process and it is suitable for use in interlayer dielectrics of LCD manufacturing process where the thickness of a film is thick, an LCD substrate comprising the cured product of the photosensitive resin and a pattern formation method of an LCD substrate using the photosensitive resin composition.

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

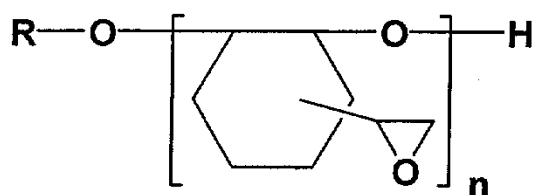
- a) an acryl-based copolymer obtained by copolymerizing
  - i) an unsaturated carbonic acid, unsaturated carbonic anhydride or mixture thereof,
  - ii) a hydroxy group containing olefin-based unsaturated compound, and
  - iii) an olefin-based unsaturated compound and then eliminating unreacted monomers;
- b) a 1,2-quinonediazide compound;
- c) an epoxy-based compound represented by formula 1 to 6:



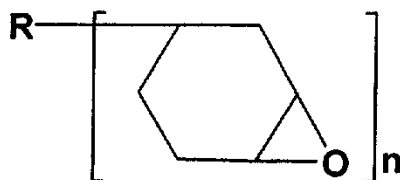
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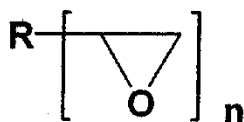
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4



5



6

wherein R is a hydrocarbon group having 1 to 10 carbon atoms and n is 1 to 5;  
and

d) a solvent.

Preferably, the invention comprises:

- a) 100 parts by weight of the acryl-based copolymer obtained by copolymerizing
  - i) 5 to 50 parts by weight of the unsaturated carbonic acid, unsaturated carbonic anhydride or mixture thereof;
  - ii) 5 to 50 parts by weight of the hydroxy group containing olefin-based unsaturated compound; and
  - iii) 5 to 70 parts by weight of the olefin-based unsaturated compound and then eliminating unreacted monomers;
- b) 5 to 50 parts by weight of the 1,2-quinonediazide compound;

c) 1 to 50 parts by weight of the epoxy-based compound represented by formula 1 to 6 as defined above; and

d) 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 substrate 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) a hydroxy group containing olefin-based unsaturated compound, and iii) an olefin-based unsaturated compound and then eliminating unreacted monomers; b) a 1,2-quinonediazide compound; c) an epoxy-based compound represented by any one of formula 1 to 6 as defined above; and 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.

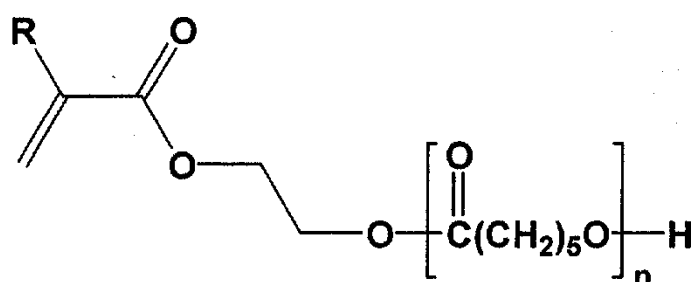
The acryl-based copolymers of a) can be obtained by radically reacting i) the unsaturated carbonic acid, unsaturated carbonic anhydride or mixture thereof, ii) the hydroxy group containing olefin-based unsaturated compound, and iii) the olefin-based unsaturated compound under the presence of a solvent and polymerization initiator and then eliminating unreacted monomers through precipitation, filtration and vacuum drying processes.

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 and 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 50 parts by weight with regard to 100 parts by weight of the total monomers and more preferably 10 to 40 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 50 parts by weight, solubility with regard to alkaline aqueous solutions becomes too high.

For the hydroxy containing olefin-based unsaturated compound of a) ii) used in the invention, there can be used 2-hydroxyethylacrylate, 2-hydroxyethylmethacrylate, 2-hydroxypropylacrylate, 2-hydroxypropylmethacrylate, or a compound represented by formula 7:



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wherein R is H or CH<sub>3</sub> and n is 1~2, and these compounds can be used alone or by mixture. In particular, using the compound represented by formula 7 is advisable because it can enhance flexibility.

The hydroxy group containing olefin-based unsaturated compound is contained preferably in an amount of 5 to 50 parts by weight with regard to 100 parts by weight of the total monomers and more preferably 10 to 40 parts by weight. When the amount is less than 5 parts by weight, heat resistance is decreased and when it exceeds 50 parts by weight, solubility with regard to an alkaline aqueous solutions becomes too high.

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, styrene,  $\alpha$ -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, methyl methacrylate, or p-methoxy styrene as the olefin-based unsaturated compounds in consideration of copolymerization reactivity and solubility with regard to an alkaline aqueous solution that is a development solution.

The olefin-based unsaturated compound is contained preferably in an amount of 5 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 5 parts by weight, the heat resistance 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 solvent used to solution polymerize the above monomers, methanol, tetrahydroxyfuran, 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 radically reacting the above monomers under the presence of the solvents and polymerization initiator and eliminating unreacted monomers by precipitation, filtration and vacuum drying 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 compound of b) in the invention is 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 a 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]ethylidene]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 90 %. When the esterification rate is less than 50 %, residual film rate can be deteriorated and when it exceeds 90 %, scum on patterns may occur.

The 1,2-quinonediazide compounds are contained preferably in an amount of 5 to 50 parts by weight with regard to 100 parts by weight of the acryl-based copolymers of a)

and more preferably 10 to 40 parts by weight. If the amount is less than 5 parts by weight, solubility difference between exposed parts and unexposed parts is so small that pattern formation is difficult and if it exceeds 50 parts by weight, unreacted 1,2-quinonediazide compounds remain in large quantity when irradiated with light for a short period so that solubility with regard to an alkaline aqueous solution that is a development solution becomes too low and development is thus difficult.

The epoxy-based compounds represented by any one of formula 1 to 6 of c) can increase heat resistance and adhesion by causing crosslinking reaction with the acryl-based copolymers of a) and substrates.

The epoxy-based compounds are contained preferably in an amount of 1 to 50 parts by weight with regard to 100 parts by weight of the acryl-based copolymers of a) and more preferably 5 to 30 parts by weight. When the amount is less than 1 part by weight, heat resistance can be decreased and when it exceeds 50 parts by weight, it may cause the outgassing of unreacted epoxy-based compounds and the decrease of transmission.

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

For the solvents, alcohols such as methanol, ethanol, benzyl alcohol and hexyl alcohol; ethyleneglycol alkylether acetates such as ethyleneglycol methylether acetate and ethyleneglycol ethylether acetate; ethyleneglycol alkylether propionates such as ethyleneglycol methylether propionate and ethyleneglycol ethylether propionate; ethyleneglycol monoalkylethers such as ethyleneglycol methylether and ethyleneglycol ethylether; diethyleneglycol alkylethers such as diethyleneglycol monomethylether, diethyleneglycol monoethylether, diethyleneglycol dimethylether and diethyleneglycol methylethylether; propyleneglycol alkyletheracetates such as propyleneglycol methyletheracetate, propyleneglycol ethyletheracetate and propyleneglycol propyletheracetate; propyleneglycol alkyletherpropionates such as propyleneglycol methyletherpropionate, propyleneglycol ethyletherpropionate and propyleneglycol propyletherpropionate; propyleneglycol monoalkylethers such as propyleneglycol methylether, propyleneglycol ethylether, propyleneglycol propylether and propyleneglycol butylether; dipropyleneglycol alkylethers such as dipropyleneglycol

dimethylether and dipropyleneglycol diethylether; butyleneglycol monoalkylethers such as butyleneglycol monomethylether and butyleneglycol monoethylether; or dibutyleneglycol alkylethers such as dibutyleneglycol dimethylether and dibutyleneglycol diethylether can be used.

The solvents are contained preferably in such an amount that the content 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 e) a nitrogen containing crosslinking agent comprising an alkanol group f) a silane coupling agent, g) an acryl compound, or h) a surfactant, if necessary.

The nitrogen containing crosslinking agent comprising the alkanol group of e) improves heat resistance and adhesion to substrates, and it is contained preferably in an amount of 0.1 to 20 parts by weight with regard to 100 parts by weight of the acryl-based copolymers of a).

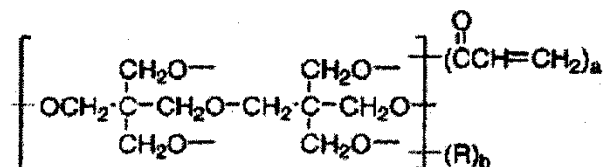
The acryl-based copolymers of a) form crosslinking structures using the nitrogen containing crosslinking agent comprising the alkanol group. For such nitrogen containing crosslinking agent, there can be employed condensation products of formaldehyde and urea, condensation products of melamine and formaldehyde, methylolmelaminealkylethers and methylolureaalkylethers obtained from alcohols.

The silane coupling agent of f) improves adhesion to substrates and it is contained preferably in an amount of 0.1 to 20 parts by weight with regard to 100 parts by weight of the acryl-based copolymer of a).

For the adhesive, silane coupling agents having reactive substituents such as a carboxyl group, methacryl group, isocyanate group or epoxy group can be used. Specifically,  $\gamma$ -methacryloxypropyltrimethoxysilane, vinyltriacetoxysilane, vinyltrimethoxysilane,  $\gamma$ -isocyanatepropyltriethoxysilane,  $\gamma$ -glycidoxypropyltrimethoxysilane, or  $\beta$ -(3,4-epoxy cyclo hexyl)ethyltrimethoxysilane can be used.

The acryl compound of g) improves the transmission, heat resistance, sensitivity, etc. of the patterns obtained from the photosensitive resin compositions.

Preferably, the acryl compound is a compound represented by formula 8:



8

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,

$1 < a < 6$ , and  $a + b = 6$ .

The acryl compounds 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 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 h) 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 parts by weight and the compositions having the solids within the above ranges are used preferably after being filtered with a millipore filter of 0.1 ~ 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 eliminating solvents by pre-bake. The pre-bake is preferably carried out at a temperature of 70~110 °C for 1~15 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 di-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 ~ 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 being washed with ultra pure water for 30~90 sec. 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, heat resistance, resolution and so on and in particular, they can remarkably improve preservation stability at room temperature and transmission so that they obtain reliability as interlayer dielectrics of LCD manufacturing process and at the same time, the pattern formation method of LCD substrates of the invention using the photosensitive resin compositions enables the formation of superior patterns of interlayer dielectrics applied to LCD manufacturing process after photo process.

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

## EXAMPLES

### EXAMPLE 1

#### (Preparation of Acryl-Based Copolymer)

To a flask with a cooling tube and stirrer, 10 parts by weight of 2,2'-azobis(2,4-dimethylvaleronitrile), 500 parts by weight of tetrahydroxyfuran, 25 parts by weight of methacrylic acid, 25 parts by weight of compound of formula 7 wherein R is CH<sub>3</sub> and n is 1, 15 parts by weight of styrene, 15 parts by weight of butylmethacrylate and 20 parts by weight of dicyclopentenyl methacrylate were added and gently stirred after nitrogen substitution. The reaction solution was heated to 62 °C, which was maintained for 10 hours whereby a polymer solution containing acryl-based copolymers was prepared.

100 parts by weight of the polymer solution comprising the acryl-based copolymers was precipitated in 1000 parts by weight of ether Poor Solvent to eliminate unreacted monomers. Then, Poor solvent in which unreacted products are dissolved was removed through filtering process using mesh. Thereafter, they were vacuum dried under 30 °C whereby the solvent containing the unreacted monomers remaining after the filtering process were completely removed. Hence, the acryl-based copolymers having the average weight molecular weight of 10,000 were prepared. The weight average

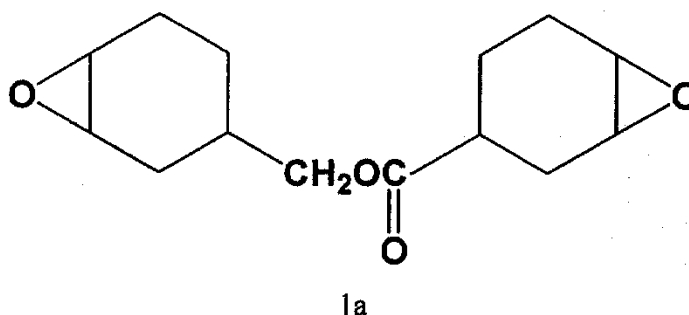
molecular weight is an average molecular weight in terms of polystyrene measured using GPC.

(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-naphthoquinonediazide-5-sulfonic acid[chloride] were condensation-reacted and 4,4'-[1-[4-[1-[4-hydroxyphenyl]-1-methylethyl]phenyl]ethyliden]bisphenol 1,2-naphthoquinonediazide-5-sulfonic ester was thus prepared.

(Preparation of Photosensitive Resin Composition)

100 parts by weight of the above prepared acryl-based copolymers, 25 parts by weight of the prepared 4,4'-[1-[4-[1-[4-hydroxyphenyl]-1-methylethyl]phenyl]ethyliden]bisphenol 1,2-naphthoquinonediazide-5-sulfonic ester and 10 parts by weight of epoxy-based crosslinking agent represented by formula 1a:



were mixed. The mixture was dissolved in dipropylene glycol dimethylether so that the concentration of the solid of the mixture became 20 % by weight and then filtered using a millipore filter of 0.2  $\mu\text{m}$  whereby a photosensitive resin composition was prepared.

## EXAMPLE 2

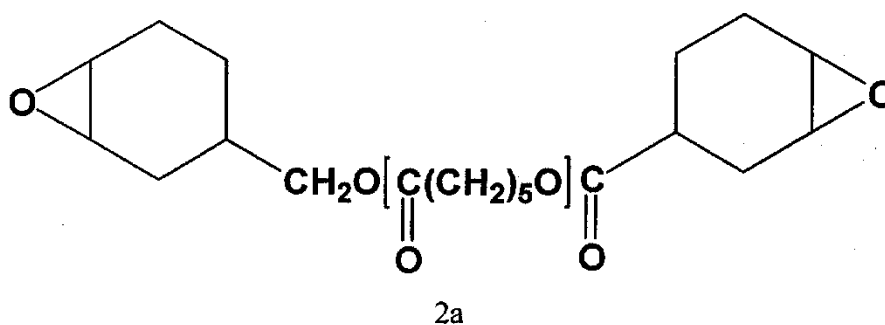
With the exception that when the acryl-based copolymers were polymerized in Example 1, 2-hydroxyethylmethacrylate was used instead of the compound of formula 7, a photosensitive resin composition was prepared in accordance with the same method as used in Example 1.

## EXAMPLE 3

With the exception that when the acryl-based copolymers were polymerized in Example 1, 2-hydroxypropylmethacrylate was used instead of the compound of formula 7, a photosensitive resin composition was prepared in accordance with the same method as used in Example 1.

#### EXAMPLE 4

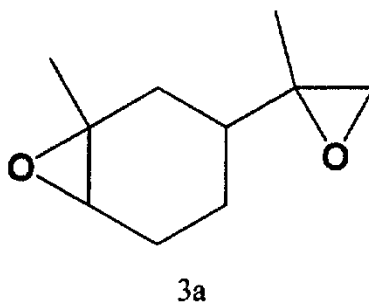
With the exception that when the photosensitive resin composition was prepared in Example 1, an epoxy-based compound represented by formula 2a:



was used instead of the epoxy-based compound of formula 1a, a photosensitive resin composition was prepared in accordance with the same method as used in Example 1.

#### EXAMPLE 5

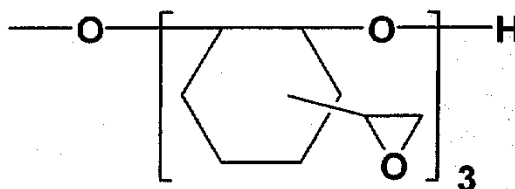
With the exception that when the photosensitive resin composition was prepared in Example 1, an epoxy-based compound represented by formula 3a:



was used instead of the epoxy-based compound of formula 1a, a photosensitive resin composition was prepared in accordance with the same method as used in Example 1.

**EXAMPLE 6**

With the exception that when the photosensitive resin composition was prepared in Example 1, an epoxy-based compound represented by formula 4a:

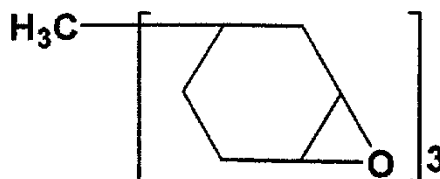


4a

was used instead of the epoxy-based compound of formula 1a, a photosensitive resin composition was prepared in accordance with the same method as used in Example 1.

**EXAMPLE 7**

With the exception that when the photosensitive resin composition was prepared in Example 1, an epoxy-based compound represented by formula 5a:

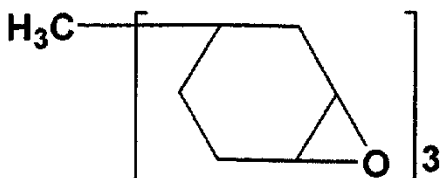


5a

was used instead of the epoxy-based compound of formula 1a, a photosensitive resin composition was prepared in accordance with the same method as used in Example 1.

**EXAMPLE 8**

With the exception that when the photosensitive resin composition was prepared in Example 1, an epoxy-based compound represented by formula 6a:



6a

was used instead of the epoxy-based compound of formula 1a, a photosensitive resin composition was prepared in accordance with the same method as used in Example 1.

#### COMPARATIVE EXAMPLE 1

With the exception that when the acryl-based copolymers were polymerized in Example 1, glycidyl methacrylate was used instead of the compound of formula 7 and when the photosensitive resin composition was prepared, the epoxy-based compound of formula 1a was not used, a photosensitive resin composition was prepared in accordance with the same method as used in Example 1.

#### COMPARATIVE EXAMPLE 2

With the exception that when the acryl-based copolymers were polymerized in Example 1,  $\beta$ -methylglycidyl methacrylate was used instead of the compound of formula 7 and when the photosensitive resin composition was prepared, the epoxy-based compound of formula 1a was not used, a photosensitive resin composition was prepared in accordance with the same method as used in Example 1.

The properties of the photosensitive resin compositions prepared in Examples 1 to 8 and Comparative Examples 1 and 2 were evaluated by the following procedures and the results were shown in Table 1 below.

a) Preservation stability at room temperature-After the photosensitive resin compositions were placed in a clean room, which was maintained at 23°C and 40% humidity, from one day to two weeks, change in sensitivity ( $\text{mJ}/\text{cm}^2$ ) was checked every day. When change during two weeks was less than 10%, it was marked as "○," when it was 10 ~ 20 %, "△," and when it exceeded 20%, "×."

b) Sensitivity- The photosensitive resin compositions prepared in Examples 1 to 8 and Comparative Examples 1 and 2 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  $\mu\text{m}$  were formed. After the formed films were irradiated with UV having

an intensity of 20 mW/cm<sup>2</sup> at 435 nm in an amount of Dose to Clear on the basis of 10  $\mu$ m Line & Space 1:1 CD using predetermined pattern masks, they were developed with 2.38 wt.% aqueous solution of tetramethylammoniumhydroxide at 23 °C for 1 min and then washed with ultra pure water for 1 min. Thereafter, the above developed patterns were irradiated with UV having an intensity of 20 mW/cm<sup>2</sup> at 435 nm for 500 mJ/cm<sup>2</sup> and then heated to cure in an oven at 230 °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-midbaking was 0 ~ 20 %, it was marked as "○," when it was 20 ~ 40 %, "△," and when it exceeds 40 %, "×."

e) Transmission-The transmission rate of the patterned films formed in above b) at 400 nm was measured using a spectrometer.

Table 1

|            | Preservation Stability<br>at room temp | Sensitivity (mJ/cm <sup>2</sup> ) | Resolution ( $\mu$ m) | Heat Resistance | Transmission |
|------------|----------------------------------------|-----------------------------------|-----------------------|-----------------|--------------|
| Ex. 1      | ○                                      | 275                               | 3                     | ○               | 92.8         |
| Ex. 2      | ○                                      | 280                               | 3                     | ○               | 93.0         |
| Ex. 3      | ○                                      | 280                               | 3                     | ○               | 93.1         |
| Ex. 4      | ○                                      | 275                               | 3                     | ○               | 92.9         |
| Ex. 5      | ○                                      | 280                               | 3                     | ○               | 93.1         |
| Ex. 6      | ○                                      | 280                               | 3                     | ○               | 93.2         |
| Ex. 7      | ○                                      | 280                               | 3                     | ○               | 92.9         |
| Ex. 8      | ○                                      | 285                               | 3                     | ○               | 93.1         |
| Com. Ex. 1 | X                                      | 280                               | 3                     | ○               | 87.3         |
| Com. Ex 2  | X                                      | 280                               | 3                     | ○               | 88.1         |

From Table 1 above, the photosensitive resin compositions prepared in accordance with Examples 1 to 8 showed excellent sensitivity, resolution, heat resistance and so on and in particular, their preservation stability at room temperature and transmission were very excellent when compared with Comparative Examples 1 to 2 so

that they could obtain much superior reliability when applied to the interlayer dielectrics of LCD process. In contrast, in case of Comparative Examples 1 and 2, their preservation stability at room temperature was not good and transmission was inferior and therefore, they had difficulty in being applied to interlayer dielectrics.

The photosensitive resin compositions in accordance with the present invention have excellent performances in sensitivity, resolution, heat resistance and so on and in particular, they can remarkably improve preservation stability at room temperature and transmission so that they can obtain reliability as interlayer dielectrics of LCD manufacturing process and at the same time, the pattern formation method of LCD substrates of the invention using the photosensitive resin compositions enables the formation of superior patterns of interlayer dielectrics applied to LCD manufacturing process after photo process.

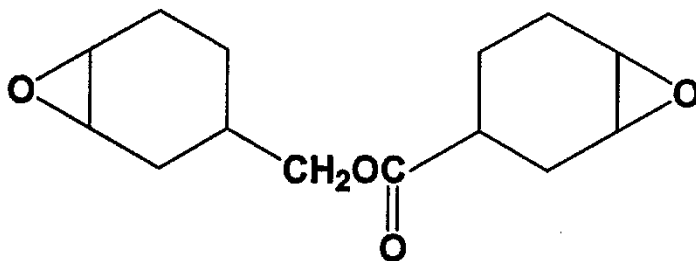
## CLAIMS

What is claimed is:

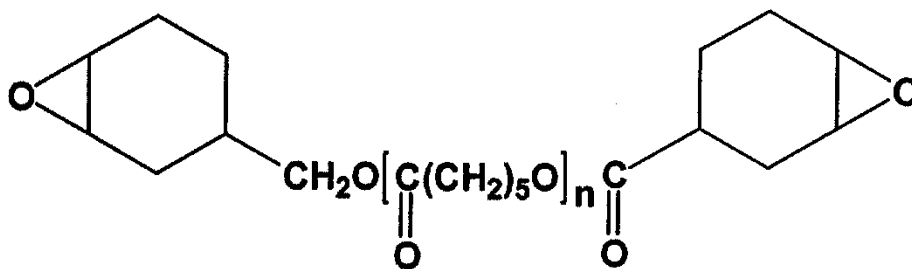
1. A photosensitive resin composition to form interlayer dielectrics during LCD manufacturing process comprising:

- a) 100 parts by weight of an acryl-based copolymer obtained by copolymerizing
  - i) 5 to 50 parts by weight of an unsaturated carbonic acid, unsaturated carbonic anhydride or mixture thereof,
  - ii) 5 to 50 parts by weight of a hydroxy group containing olefin-based unsaturated compound, and
  - iii) 5 to 70 parts by weight of an olefin-based unsaturated compound and then eliminating unreacted monomers;
- b) 5 to 50 parts by weight of a 1,2-quinonediazide compound;
- c) 1 to 50 parts by weight of an epoxy-based compound represented by formula 1

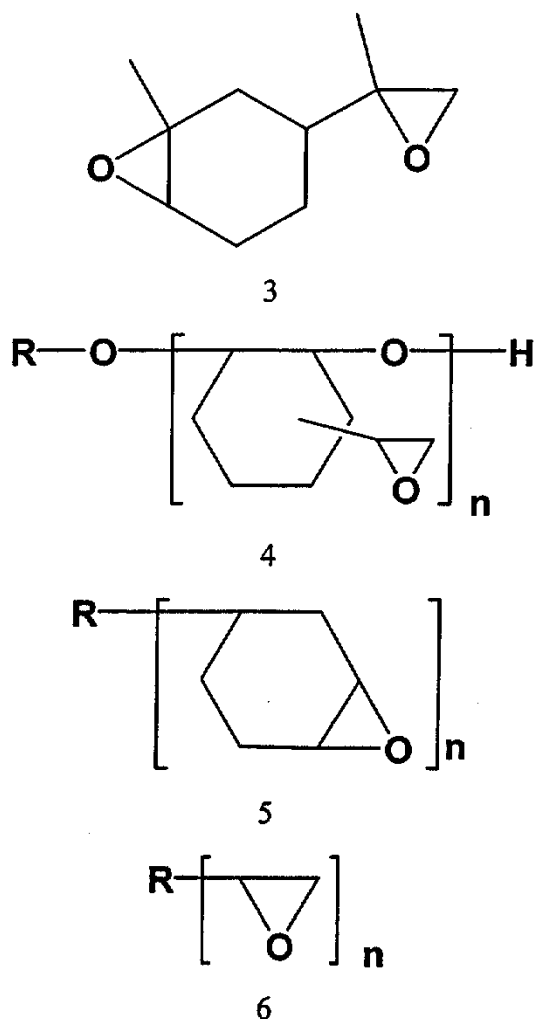
to 6:



1



2

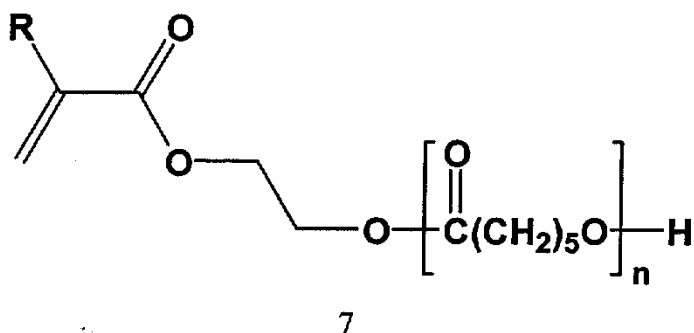


wherein Ris is a hydrocarbon group having 1 to 10 carbon atoms and n is 1 to 5;  
and

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

2. The photosensitive resin composition to form interlayer dielectrics during LCD manufacturing process 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.

3. The photosensitive resin composition to form interlayer dielectrics during LCD manufacturing process according to claim 1 wherein the hydroxy group containing olefin-based unsaturated compound of a) ii) is selected from the group consisting of 2-hydroxyethylacrylate, 2-hydroxyethylmethacrylate, 2-hydroxypropylacrylate, 2-hydroxypropylmethacrylate, a compound represented by formula 7:



wherein R is H or CH<sub>3</sub> and n is 1~2 and mixture thereof.

4. The photosensitive resin composition to form interlayer dielectrics during LCD manufacturing process 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-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, styrene,  $\alpha$ -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.

5. The photosensitive resin composition to form interlayer dielectrics during LCD manufacturing process 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.

6. The photosensitive resin composition to form interlayer dielectrics during LCD manufacturing process 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.

7. The photosensitive resin composition to form interlayer dielectrics during LCD manufacturing process according to claim 1 wherein the solvent of d) is selected from the group consisting of alcohols such as methanol, ethanol, benzyl alcohol and hexyl alcohol; ethyleneglycol alkylether acetates such as ethyleneglycol methylether acetate and ethyleneglycol ethylether acetate; ethyleneglycol alkylether propionates such as ethyleneglycol methylether propionate and ethyleneglycol ethylether propionate; ethyleneglycol monoalkylethers such as ethyleneglycol methylether and ethyleneglycol ethylether; diethyleneglycol alkylethers such as diethyleneglycol monomethylether, diethyleneglycol monoethylether, diethyleneglycol dimethylether and diethyleneglycol methylethylether; propyleneglycol alkyletheracetates such as propyleneglycol methyletheracetate, propyleneglycol ethyletheracetate and propyleneglycol propyletheracetate; propyleneglycol alkyletherpropionates such as propyleneglycol methyletherpropionate, propyleneglycol ethyletherpropionate and propyleneglycol propyletherpropionate; propyleneglycol monoalkylethers such as propyleneglycol methylether, propyleneglycol ethylether, propyleneglycol propylether and propyleneglycol butylether; dipropyleneglycol alkylethers such as dipropyleneglycol dimethylether and dipropyleneglycol diethylether; butyleneglycol monoalkylethers such as butyleneglycol monomethylether and butyleneglycol monoethylether; dibutyleneglycol alkylethers such as dibutyleneglycol dimethylether and dibutyleneglycol diethylether; and mixture thereof.

8. The photosensitive resin composition to form interlayer dielectrics during LCD manufacturing process according to claim 1 further comprising at least one additive selected from the group consisting of e) a nitrogen containing crosslinking agent comprising an alkanol group f) a silane coupling agent, g) an acryl compound and h) a surfactant.

9. An LCD substrate comprising a cured product of the photosensitive resin composition to form interlayer dielectrics during LCD manufacturing process of any one of claims 1 to 8.

10. A pattern formation method of an LCD substrate using the photosensitive resin composition to form interlayer dielectrics during LCD manufacturing process of any one of claims 1 to 8.