

RADIATION SENSITIVE COMPOSITION FOR FORMING SPACERS ON
THE DRIVE SUBSTRATE OF A THIN FILM TRANSISTOR COLOR LIQUID
CRYSTAL DISPLAY DEVICE, DRIVE SUBSTRATE HAVING SPACERS
THEREON, PRODUCTION PROCESS THEREFOR AND COLOR LIQUID
CRYSTAL DISPLAY DEVICE

Field of the Invention

The present invention relates to a radiation sensitive composition for forming spacers on the drive substrate of a transmission or reflection type thin film transistor (TFT) color liquid crystal display device, a drive substrate having spacers thereon, a production process therefor and a color liquid crystal display device.

Description of the Prior Art

In the production of a color liquid crystal display device comprising a thin film transistor (TFT) substrate, a color filter substrate for displaying a color image is manufactured separately from a drive substrate having thin film transistors (TFT) formed thereon and assembled with the drive substrate. However, since the positioning accuracy at the time of assembly is low in this system, the width of a black matrix must be made large, thereby making it difficult to obtain a high opening ratio (the ratio of openings for transmitting light).

Meanwhile, there has been developed a new system that a pigmented layer is formed on the surface of a drive substrate having thin film transistors (TFT) formed thereon directly or through a passivation film such as a silicon nitride film and this substrate having the pigmented layer formed thereon is assembled with a substrate having ITO (tin doped indium oxide) electrodes formed thereon by sputtering. Since the pigmented layer including pixels and a black matrix is directly formed

on the drive substrate in this system, the step of assembling a color filter substrate with the drive substrate becomes unnecessary and the opening ratio can be drastically improved compared with the former system, thereby making it possible to obtain a bright high-definition display device.

The spacers used in the latter system are generally formed from a radiation sensitive composition by lithography. The spacers must have light screening properties in order to prevent thin film transistors (TFT) as switching elements from malfunctioning by light incident upon the thin film transistors (TFT).

The spacers also need mechanical strength and heat resistance to stand high temperature and high pressure in the step of sealing a panel after the injection of liquid crystals for the manufacture of a display panel.

However, a radiation sensitive composition for spacers which has satisfactory light screening properties and excellent mechanical strength and heat resistance has not been found. Therefore, a gap difference in the liquid crystal layer is made by the irreversible deformation of spacers when the panel is sealed, thereby causing a display failure.

Summary of the Invention

It is an object of the present invention to provide a radiation sensitive composition for forming spacers on a drive substrate for thin film transistor (TFT) color liquid crystal display devices, which is capable of forming spacers having excellent light screening properties and such high mechanical strength and heat resistance that they do not deform irreversibly at the time of sealing a panel and free from a display failure caused by a gap difference in a liquid crystal layer.

It is another object of the present invention to provide a drive substrate having spacers formed from the radiation sensitive composition of the present invention and a production process therefor.

5 It is still another object of the present invention to provide a color liquid crystal display device comprising the above drive substrate of the present invention.

Other objects and advantages of the present
10 invention will become apparent from the following description.

According to the present invention, firstly, the above objects and advantages of the present invention are attained by a radiation sensitive composition for
15 forming spacers on the drive substrate of a thin film transistor color liquid crystal display device, which comprises (A) a colorant, (B) an alkali soluble resin, (C) a polyfunctional monomer and (D) a photopolymerization initiator.

20 According to the present invention, secondly, the above objects and advantages of the present invention are attained by a drive substrate for thin film transistor color liquid crystal display devices, which comprises spacers formed from the radiation sensitive composition
25 of the present invention.

According to the present invention, thirdly, the above objects and advantages of the present invention are attained by a process for producing a drive substrate having spacers, comprising the steps of:

30 forming a color film including a pigmented layer on the drive substrate of a thin film transistor color liquid crystal display device directly or through a passivation film; and

forming spacers from the radiation sensitive

composition of the present invention on the color film.

According to the present invention, finally, the above objects and advantages of the present invention are attained by a thin film transistor color liquid crystal display device comprising the above drive substrate of the present invention.

Brief Description of the Drawings

Fig. 1 is a sectional view of the key section of an example of a thin film transistor (TFT) color liquid crystal display device; and

Fig. 2 is a view taken on line X-X of Fig. 1.

Detailed Description of the Preferred Embodiments

The present invention will be described in detail hereinbelow. A description is first given of the radiation sensitive composition of the present invention.

The term "radiation" in the present invention includes visible radiation, ultraviolet radiation, far ultraviolet radiation, electron beams and X-rays.

(A) colorant

The colorant used in the present invention is not limited to a particular color but a colorant which has a specific OD (optical density) value, contains a black pigment, or contains a black pigment and has a specific OD value is preferred.

The expression "specific OD value" means that the OD value is 2 or more, preferably 2.5 or more, particularly preferably 3 or more when 5 μ m-thick spacers are formed.

The above black pigment can be suitably selected according to the application purpose of the spacers. It may be inorganic or organic and a single pigment or a

mixture of two or more pigments. The black pigment is preferably a pigment having high color developing properties and high heat resistance, particularly high thermal decomposition resistance, particularly
5 preferably carbon black and/or a combination of two or more organic pigments.

Examples of the carbon black used in the present invention include furnace blacks such as SAF, SAF-HS, ISAF, ISAF-LS, ISAF-HS, HAF, HAF-LS, HAF-HS, NAF, FEF,
10 FEF-HS, SRF, SRF-LM, SRF-LS, GPF, ECF, N-339 and N-351; thermal blacks such as FT and MT; and acetylene black.

These carbon blacks may be used alone or in combination of two or more.

Examples of the inorganic black pigment other than
15 carbon black used in the present invention include metal oxides such as titanium black, Cu-Fe-Mn-based oxide and synthetic iron black.

These inorganic pigments may be used alone or in combination of two or more.

20 Further, examples of the organic pigment used in the present invention include compounds classified into a group of pigments according to color index (C.I.; issued by The Society of Dyers and Colourists), specifically compounds having the following color index (C.I.)
25 numbers:

C.I. Pigment Yellow 12, C.I. Pigment Yellow 13, C.I. Pigment Yellow 14, C.I. Pigment Yellow 17, C.I. Pigment Yellow 20, C.I. Pigment Yellow 24, C.I. Pigment Yellow 31, C.I. Pigment Yellow 55, C.I. Pigment Yellow 83, C.I.
30 Pigment Yellow 93, C.I. Pigment Yellow 109, C.I. Pigment Yellow 110, C.I. Pigment Yellow 138, C.I. Pigment Yellow 139, C.I. Pigment Yellow 150, C.I. Pigment Yellow 153, C.I. Pigment Yellow 154, C.I. Pigment Yellow 155, C.I. Pigment Yellow 166, C.I. Pigment Yellow 168 and C.I.

Pigment Yellow 211;

C.I. Pigment Orange 36, C.I. Pigment Orange 43, C.I. Pigment Orange 51, C.I. Pigment Orange 61 and C.I. Pigment Orange 71;

5 C.I. Pigment Red 9, C.I. Pigment Red 97, C.I. Pigment Red 122, C.I. Pigment Red 123, C.I. Pigment Red 149, C.I. Pigment Red 168, C.I. Pigment Red 176, C.I. Pigment Red 177, C.I. Pigment Red 180, C.I. Pigment Red 207, C.I. Pigment Red 208, C.I. Pigment Red 209, C.I. Pigment Red
10 215, C.I. Pigment Red 224, C.I. Pigment Red 242 and C.I. Pigment Red 254;

C.I. Pigment Violet 19, C.I. Pigment Violet 23 and C.I. Pigment Violet 29;

C.I. Pigment Blue 15, C.I. Pigment Blue 60, C.I. Pigment
15 Blue 15:3, C.I. Pigment Blue 15:4 and C.I. Pigment Blue 15:6;

C.I. Pigment Green 7, C.I. Pigment Green 36, C.I. Pigment Green 136 and C.I. Pigment Green 210;

C.I. Pigment Brown 23 and C.I. Pigment Brown 25; and
20 C.I. Pigment Black 1 and C.I. Pigment Black 7.

These organic pigments are suitably selected and used to obtain the desired color of the spacers.

In the present invention, the organic pigment is particularly preferably a mixture of C.I. Pigment Red
25 177 and at least one selected from the group consisting of C.I. Pigment Blue 15:4 and C.I. Pigment Blue 15:6.

The above organic pigment may be purified by recrystallization, reprecipitation, cleaning with a solvent, sublimation, vacuum heating or a combination
30 thereof.

The colorant of the present invention may contain an extender pigment as required.

Examples of the extender pigment include barium sulfate, barium carbonate, calcium carbonate, silica,

basic magnesium carbonate, alumina white, gloss white, satin white and hydrotalcite.

These extender pigments may be used alone or in combination of two or more.

5 The amount of the extender pigment is preferably 0 to 100 parts by weight, more preferably 5 to 50 parts by weight, much more preferably 10 to 40 parts by weight based on 100 parts by weight of the black pigment.

10 The above pigments particles may have optionally surface modified by a polymer. Examples of the polymer for modifying the surface of each pigment particle include polymers disclosed by JP-A 8-259876 (the term "JP-A" as used herein means an "unexamined published Japanese patent application") and commercially available polymers and oligomers for dispersing pigments.

15 The colorant in the present invention may be optionally used in conjunction with a dispersant.

20 The dispersant is a cationic, anionic, nonionic, amphoteric, silicone-based or fluorine-based surfactant.

25 Examples of the surfactant include polyoxyethylene alkyl ethers such as polyoxyethylene lauryl ether, polyoxyethylene stearyl ether and polyoxyethylene oleyl ether; polyoxyethylene alkylphenyl ethers such as polyoxyethylene n-octylphenyl ether and polyoxyethylene n-nonylphenyl ether; polyethylene glycol diesters such as polyethylene glycol dilaurate and polyethylene glycol distearate; sorbitan fatty acid esters; fatty acid modified polyesters; tertiary amine modified
30 polyurethanes; and polyethylene imines. These surfactants are available from the market under the trade names of KP (of Shin-Etsu Chemical, Co., Ltd.), Polyflow (of Kyoeisha Kagaku Co., Ltd.), F Top (of Tokem Products Co., Ltd.), Megafac (of Dainippon Ink and Chemicals, Inc.),

Florade (of Sumitomo 3M Limited), Disperbyk (of Byk Chemie Japan Co., Ltd.), Solsperser (of Zeneca Co., Ltd.) and EFKA (of EFKA Chemicals, Co., Ltd.).

These surfactants may be used alone or in combination
5 of two or more.

The amount of the surfactant is preferably 50 parts or less by weight, more preferably 30 parts or less by weight based on 100 parts by weight of the colorant.

10 (B) alkali soluble resin

Any alkali soluble resin is acceptable in the present invention if it serves as a binder for the colorant (A) and is soluble in a developer used in the developing step for the formation of spacers, particularly preferably
15 an alkali developer. Examples of the alkali soluble resin include copolymers of a polymerizable unsaturated monomer having an acidic functional group such as a carboxyl group, phenolic hydroxyl group or sulfonic acid group and another copolymerizable unsaturated monomer
20 (to be referred to as "copolymerizable unsaturated monomer" hereinafter).

Examples of the polymerizable unsaturated monomer having at least one carboxyl group in the molecule (to be referred to as "carboxyl group-containing unsaturated
25 monomer" hereinafter) include unsaturated monocarboxylic acids such as (meth)acrylic acid, crotonic acid, α -chloroacrylic acid and cinnamic acid; unsaturated dicarboxylic acids and anhydrides thereof such as maleic acid, maleic anhydride, fumaric acid,
30 itaconic acid, itaconic anhydride, citraconic acid, citraconic anhydride and mesaconic acid; unsaturated polycarboxylic acids having a valence of 3 or more and anhydrides thereof; mono[(meth)acryloyloxyalkyl]esters of polycarboxylic acids having a valence of 2 or more

such as mono[2-(meth)acryloyloxyethyl]succinate and
mono[2-(meth)acryloyloxyethyl]phthalate; and
mono(meth)acrylates of polymers having a carboxyl group
and a hydroxyl group at both terminals, such as ω
5 -carboxypolycaprolactone mono(meth)acrylate.

Out of these carboxyl group-containing unsaturated
monomers, (meth)acrylic acid and
mono[2-(meth)acryloyloxyethyl]succinate are
particularly preferred.

10 The above carboxyl group-containing unsaturated
monomers may be used alone or in combination of two or
more.

Examples of the polymerizable unsaturated monomer
having a phenolic hydroxyl group include
15 o-hydroxystyrene, m-hydroxystyrene, p-hydroxystyrene,
o-hydroxy- α -methylstyrene, m-hydroxy- α -methylstyrene,
p-hydroxy- α -methylstyrene,
N-o-hydroxyphenylmaleimide,
N-m-hydroxyphenylmaleimide and
20 N-p-hydroxyphenylmaleimide.

These polymerizable unsaturated monomers having a
phenolic hydroxyl group may be used alone or in combination
of two or more.

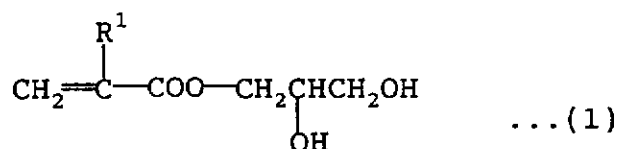
Example of the polymerizable unsaturated monomer
25 having a sulfonic acid group include isoprenesulfonic
acid and p-styrenesulfonic acid.

These polymerizable unsaturated monomers having a
sulfonic acid group may be used alone or in combination
of two or more.

30 Examples of the copolymerizable unsaturated
monomer include macromonomers having a
mono(meth)acryloyl group at a terminal of the molecular
chain of a polymer (to be simply referred to as
"macromonomers" hereinafter) such as polystyrene,

polymethyl (meth)acrylate, poly-n-butyl (meth)acrylate and polysiloxane; N-substituted maleimides such as N-(substituted) arylmaleimides including N-phenylmaleimide, N-o-methylphenylmaleimide, 5 N-m-methylphenylmaleimide, N-p-methylphenylmaleimide, N-o-methoxyphenylmaleimide, N-m-methoxyphenylmaleimide and N-p-methoxyphenylmaleimide, and N-cyclohexylmaleimide; aromatic vinyl compounds such as styrene, α 10 -methylstyrene, o-vinyltoluene, m-vinyltoluene, p-vinyltoluene, p-chlorostyrene, o-methoxystyrene, m-methoxystyrene, p-methoxystyrene, o-vinylbenzylmethyl ether, m-vinylbenzylmethyl ether, p-vinylbenzylmethyl ether, o-vinylbenzylglycidyl ether, 15 m-vinylbenzylglycidyl ether and p-vinylbenzylglycidyl ether; indenenes such as indene and 1-methylindene; unsaturated carboxylic acid esters such as methyl (meth)acrylate, ethyl (meth)acrylate, n-propyl (meth)acrylate, i-propyl (meth)acrylate, n-butyl 20 (meth)acrylate, i-butyl (meth)acrylate, sec-butyl (meth)acrylate, t-butyl (meth)acrylate, 2-hydroxyethyl (meth)acrylate, 2-hydroxypropyl (meth)acrylate, 3-hydroxypropyl (meth)acrylate, 2-hydroxybutyl (meth)acrylate, 3-hydroxybutyl (meth)acrylate, 4- 25 hydroxybutyl (meth)acrylate, allyl (meth)acrylate, benzyl (meth)acrylate, cyclohexyl (meth)acrylate, phenyl (meth)acrylate, 2-methoxyethyl (meth)acrylate, 2-phenoxyethyl (meth)acrylate, methoxydiethylene glycol (meth)acrylate, methoxytriethylene glycol 30 (meth)acrylate, methoxypropylene glycol (meth)acrylate, methoxydipropylene glycol (meth)acrylate, isobornyl (meth)acrylate, dicyclopentadienyl (meth)acrylate, 2-hydroxy-3-phenoxypropyl (meth)acrylate and monomers (to be referred to as "glycerol (meth)acrylates"

hereinafter) represented by the following formula (1):



wherein R¹ is a hydrogen atom or methyl group; unsaturated carboxylic acid aminoalkyl esters such as 2-aminoethyl (meth)acrylate, 2-dimethylaminoethyl (meth)acrylate, 2-aminopropyl (meth)acrylate, 2-dimethylaminopropyl acrylate, 3-aminopropyl (meth)acrylate and 3-dimethylaminopropyl (meth)acrylate; unsaturated carboxylic acid glycidyl esters such as glycidyl (meth)acrylate; carboxylic acid vinyl esters such as vinyl acetate, vinyl propionate, vinyl butyrate and vinyl benzoate; unsaturated ethers such as vinylmethyl ether, vinylethyl ether and allylglycidyl ether; vinyl cyanide compounds such as (meth)acrylonitrile, α-chloroacrylonitrile and vinylidene cyanide; unsaturated amides such as (meth)acrylamide, α-chloroacrylamide and N-2-hydroxyethyl (meth)acrylamide; and aliphatic conjugated dienes such as 1,3-butadiene, isoprene and chloroprene.

Out of these copolymerizable unsaturated monomers, macromonomers, N-substituted maleimides, 2-hydroxyethyl (meth)acrylate, benzyl (meth)acrylate and glycerol (meth)acrylate are preferred. Out of the macromonomers, polystyrene macromonomer and polymethyl (meth)acrylate macromonomer are particularly preferred. Out of the N-substituted maleimides, N-phenylmaleimide and N-cyclohexylmaleimide are particularly preferred.

The above copolymerizable unsaturated monomers may be used alone or in combination of two or more.

The alkali soluble resin (B) in the present invention is preferably a copolymer of a carboxyl group-containing unsaturated monomer and a copolymerizable unsaturated

monomer (to be simply referred to as "carboxyl group-containing copolymer" hereinafter).

The carboxyl group-containing copolymer is preferably a copolymer of (a) a carboxyl group-containing unsaturated monomer, (b) at least one monomer selected from the group consisting of a macromonomer having a mono(meth)acryloyl group at a terminal of a molecular chain, N-substituted maleimide, 2-hydroxy (meth)acrylate, benzyl (meth)acrylate and glycerol (meth)acrylate and optionally (c) at least one monomer selected from the group consisting of styrene, methyl (meth)acrylate, allyl (meth)acrylate and phenyl (meth)acrylate. It is more preferably a copolymer (to be referred to as "carboxyl group-containing copolymer (I)" hereinafter) of a monomer mixture containing (1) a carboxyl group-containing unsaturated monomer, (2) at least one selected from the group consisting of polystyrene macromonomer, polymethyl (meth)acrylate macromonomer, N-phenylmaleimide, N-cyclohexylmaleimide, 2-hydroxyethyl (meth)acrylate, benzyl (meth)acrylate and glycerol (meth)acrylate and optionally (3) at least one selected from the group consisting of styrene, methyl (meth)acrylate, allyl (meth)acrylate and phenyl (meth)acrylate. It is particularly preferably a copolymer (to be referred to as "carboxyl group-containing copolymer (II)" hereinafter) of a monomer mixture containing (1) a carboxyl group-containing unsaturated monomer component containing (meth)acrylic acid or a combination of (meth)acrylic acid and mono[2-(meth)acryloyloxyethyl]succinate, (2) at least one selected from the group consisting of polystyrene macromonomer, polymethyl (meth)acrylate macromonomer, N-phenylmaleimide, N-cyclohexylmaleimide,

2-hydroxyethyl (meth)acrylate, benzyl (meth)acrylate and glycerol (meth)acrylate and optionally (3) at least one selected from the group consisting of styrene, methyl (meth)acrylate, allyl (meth)acrylate and phenyl (meth)acrylate.

Illustrative examples of the carboxyl group-containing copolymer (II) include a copolymer of (meth)acrylic acid, benzyl (meth)acrylate and polystyrene macromonomer, copolymer of (meth)acrylic acid, benzyl (meth)acrylate and polymethyl (meth)acrylate macromonomer, copolymer of (meth)acrylic acid, N-phenylmaleimide, benzyl (meth)acrylate and styrene, copolymer of (meth)acrylic acid, mono[2-(meth)acryloyloxyethyl]succinate, N-phenylmaleimide, styrene and allyl (meth)acrylate, copolymer of (meth)acrylic acid, mono[2-(meth)acryloyloxyethyl]succinate, N-phenylmaleimide, benzyl (meth)acrylate and styrene, copolymer of (meth)acrylic acid, N-cyclohexylmaleimide, benzyl (meth)acrylate and styrene, copolymer of (meth)acrylic acid, mono[2-(meth)acryloyloxyethyl]succinate, N-cyclohexylmaleimide, styrene and allyl (meth)acrylate, copolymer of (meth)acrylic acid, mono[2-(meth)acryloyloxyethyl]succinate, N-cyclohexylmaleimide, benzyl (meth)acrylate and styrene, copolymer of (meth)acrylic acid, benzyl (meth)acrylate and glycerol mono(meth)acrylate, copolymer of (meth)acrylic acid, mono[2-(meth)acryloyloxyethyl]succinate, benzyl (meth)acrylate and glycerol mono(meth)acrylate, copolymer of (meth)acrylic acid and 2-hydroxyethyl (meth)acrylate, copolymer of (meth)acrylic acid, 2-hydroxyethyl (meth)acrylate and styrene, copolymer of

(meth)acrylic acid, 2-hydroxyethyl (meth)acrylate and benzyl (meth)acrylate, copolymer of (meth)acrylic acid, 2-hydroxyethyl (meth)acrylate and phenyl (meth)acrylate, copolymer of (meth)acrylic acid, 2-hydroxyethyl (meth)acrylate, benzyl (meth)acrylate and polystyrene macromonomer, copolymer of (meth)acrylic acid, 2-hydroxyethyl (meth)acrylate, benzyl (meth)acrylate and polymethyl (meth)acrylate macromonomer, copolymer of (meth)acrylic acid, N-phenylmaleimide, 2-hydroxyethyl (meth)acrylate, benzyl (meth)acrylate and styrene, and copolymer of (meth)acrylic acid, N-phenylmaleimide, benzyl (meth)acrylate, glycerol mono(meth)acrylate and styrene.

As the alkali soluble resin in the present invention, particularly preferably are a copolymer of (meth)acrylic acid, mono[2-(meth)acryloyloxyethyl]succinate, N-phenylmaleimide, benzyl (meth)acrylate and styrene, copolymer of (meth)acrylic acid, 2-hydroxyethyl (meth)acrylate and benzyl (meth)acrylate, and copolymer of (meth)acrylic acid, N-phenylmaleimide, 2-hydroxyethyl (meth)acrylate, benzyl (meth)acrylate and styrene.

The amount of the carboxyl group-containing unsaturated monomer contained in the carboxyl group-containing copolymer of the present invention is preferably 5 to 50 wt%, more preferably 10 to 40 wt%. When the amount of the carboxyl group-containing unsaturated monomer is smaller than 5 wt%, the solubility in an alkali developer of the obtained radiation sensitive composition may lower and when the amount is larger than 50 wt%, the solubility in an alkali developer becomes too high, whereby the spacers may easily fall off from the substrate during development with an alkali developer.

The weight average molecular weight in terms of polystyrene (to be referred to as "Mw" hereinafter) measured by gel permeation chromatography (GPC, solvent: tetrahydrofuran) of the alkali soluble resin in the present invention is preferably 20,000 or less, more preferably 3,000 to 20,000, particularly preferably 5,000 to 20,000.

The glass transition temperature (to be referred to as "Tg" hereinafter) of the alkali soluble resin is preferably 110°C or more, more preferably 110 to 200°C, particularly preferably 110 to 180°C.

It is particularly preferred in the present invention to adjust Mw of the alkali soluble resin contained in the radiation sensitive composition to 20,000 or less and Tg of the alkali soluble resin to 110°C or more. The fluidity of the radiation sensitive composition at the time of post-baking for the formation of spacers is thereby improved while retaining satisfactory heat resistance so that the spacers become tapered in a normal direction and can obtain mechanical strength and heat resistance thereof at the same time with ease. If the spacers are tapered in the opposite direction, they can hardly obtain mechanical strength and heat resistance thereof at the same time and may be caught and removed when an alignment film is rubbed to produce a display panel.

As for a combination of Mw and Tg of the alkali soluble resin, more preferably, Mw is 3,000 to 20,000 and Tg is 110 to 200°C and particularly preferably, Mw is 5,000 to 20,000 and Tg is 110 to 180°C.

The number average molecular weight in terms of polystyrene (to be referred as "Mn" hereinafter) measured by gel permeation chromatography (GPC, solvent: tetrahydrofuran) of the alkali soluble resin is

preferably 1,500 to 10,000.

The ratio (Mw/Mn) of Mw to Mn of the alkali soluble resin is preferably 1 to 5, more preferably 1 to 4.

In the present invention, the above alkali soluble
5 resins may be used alone or in combination of two or more.

The amount of the alkali soluble resin is preferably 10 to 1,000 parts by weight, more preferably 20 to 500 parts by weight based on 100 parts by weight of the colorant (A). When the amount of the alkali soluble resin is
10 smaller than 10 parts by weight, alkali developability may lower, or stains or film remnants may be existent on the substrate or light screening layer of a radiation unexposed portion. When the amount is larger than 1,000 parts by weight, the concentration of the colorant lowers
15 relatively, whereby it may be difficult to attain the targeted color strength for the light screening spacers.

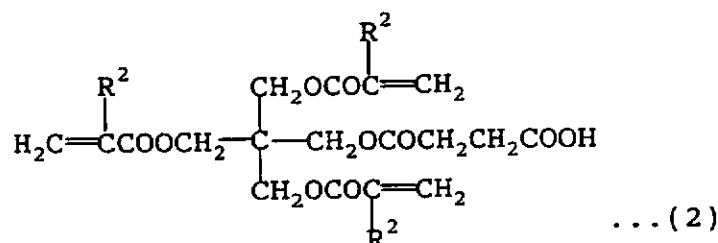
(C) polyfunctional monomer

The polyfunctional monomer in the present invention
20 is a monomer having two or more polymerizable unsaturated bonds.

Examples of the polyfunctional monomer include di(meth)acrylates of alkylene glycol such as ethylene glycol and propylene glycol; di(meth)acrylates of
25 polyalkylene glycol such as polyethylene glycol and polypropylene glycol; poly(meth)acrylates of polyhydric alcohols having a valence of 3 or more and dicarboxylic acid modified products thereof such as glycerin, trimethylolpropane, pentaerythritol and
30 dipentaerythritol; oligo(meth)acrylates such as polyester, epoxy resin, urethane resin, alkyd resin, silicone resin and spiran resin; di(meth)acrylates of both terminal hydroxylated polymers such as poly-1,3-butadiene having a hydroxyl group at both

terminals and polyisoprene having a hydroxyl group at both terminals and polycaprolactone having a hydroxyl group at both terminals; and tris[2-(meth)acryloyloxyethyl]phosphate.

5 Out of these polyfunctional monomers, poly(meth)acrylates of polyhydric alcohols having a valence of 3 or more and dicarboxylic acid modified products thereof are preferred, as exemplified by trimethylolpropane tri(meth)acrylate, pentaerythritol
10 tri(meth)acrylate, pentaerythritol tetra(meth)acrylate, dipentaerythritol penta(meth)acrylate, dipentaerythritol hexa(meth)acrylate and compounds represented by the following formula (2):



15 wherein R^2 is a hydrogen atom or methyl group, out of which trimethylolpropane triacrylate, pentaerythritol triacrylate and dipentaerythritol hexaacrylate are particularly preferred because they provide high strength spacers and hardly form stains or film remnants
20 on the substrate and light screening layer of an unexposed portion.

These functional monomers may be used alone or in combination of two or more.

25 The amount of the polyfunctional monomer in the present invention is preferably 5 to 500 parts by weight, more preferably 20 to 300 parts by weight based on 100 parts by weight of the alkali soluble resin (B). When the amount of the polyfunctional monomer is smaller than 5 parts by weight, the strength of the spacers may lower
30 and when the amount is larger than 500 parts by weight,

alkali developability may lower, or stains or film remnants may be existent on the substrate or light screening layer of a radiation unexposed portion.

In the present invention, a monofunctional monomer
5 having one polymerizable unsaturated bond may be used in combination with the polyfunctional monomer.

Examples of the monofunctional monomer include carboxyl group-containing unsaturated monomers and copolymerizable unsaturated monomers enumerated for the
10 alkali soluble resin (B), N-vinyl derivatives such as N-vinylsuccinimide, N-vinylpyrrolidone, N-vinylphthalimide, N-vinyl-2-piperidine, N-vinyl-ε-caprolactam, N-vinylpyrrole, N-vinylpyrrolidine, N-vinylimidazole, N-vinylimidazolidine, N-vinylindole,
15 N-vinylindoline, N-vinylbenzimidazole, N-vinylcarbazole, N-vinylpiperidine, N-vinylpiperazine, N-vinylmorpholine and N-vinylphenoxazine; and N-(meth)acryloylmorpholine. The monofunctional monomer is available from the market under the trade names
20 of M-5300, M-5400 and M-5600 (of Toagosei Chemical Industry Co., Ltd.).

These monofunctional monomers may be used alone or in combination of two or more.

The amount of the monofunctional monomer is
25 preferably 90 wt% or less, more preferably 50 wt% or less based on the total of the polyfunctional monomer and the monofunctional monomer. When the amount of the monofunctional monomer is larger than 90 wt%, the strength of the spacers may lower.

30

(D) photopolymerization initiator

The photopolymerization initiator in the present invention is a compound which can form active species capable of initiating the polymerization of the above

polyfunctional monomer (C) and the optionally used monofunctional monomer by the irradiation of radiation such as visible radiation, ultraviolet radiation, far ultraviolet radiation, electron beams and X-rays (to be referred to as "exposure" hereinafter).

Examples of the photopolymerization initiator include an acetophenone compound, biimidazole compound, triazine compound, benzoin compound, benzophenone compound, α -diketone compound, polynuclear quinone compound, xanthone compound and diazo compound.

In the present invention, the above photopolymerization initiators may be used alone or in combination of two or more. The photopolymerization initiator in the present invention is preferably at least one selected from the group consisting of an acetophenone compound, biimidazole compound and triazine compound.

The amount of the photopolymerization initiator in the present invention is preferably 0.01 to 80 parts by weight, more preferably 1 to 60 parts by weight based on 100 parts by weight of the total of the polyfunctional monomer (C) and the monofunctional monomer. When the amount of the photopolymerization initiator is smaller than 0.01 part by weight, it may be difficult to obtain spacers arranged in a predetermined pattern due to incomplete curing by exposure and when the amount is larger than 80 parts by weight, the formed spacers may easily fall off from the substrate during development.

Examples of the acetophenone compound out of the preferred photopolymerization initiators in the present invention include

1-phenyl-2-hydroxy-2-methylpropan-1-one,

1-[4-(methylthio)phenyl]-2-methyl-2-morpholinopropan-1-one,

1-(4-morpholinophenyl)-2-benzyl-2-dimethylaminobutan

-1-one, 1-hydroxycyclohexyl-phenyl ketone and
2,2-dimethoxy-1,2-diphenylethan-1-one.

Out of these acetophenone compounds,
1-[4-(methylthio)phenyl]-2-methyl-2-morpholinopropan
5 -1-one and
1-(4-morpholinophenyl)-2-benzyl-2-dimethylaminobutan
-1-one are particularly preferred.

The above acetophenone compounds may be used alone
or in combination of two or more.

10 When the acetophenone compound is used as the
photopolymerization initiator in the present invention,
the amount of the acetophenone compound is preferably
0.01 to 80 parts by weight, more preferably 1 to 60 parts
by weight, much more preferably 1 to 30 parts by weight
15 based on 100 parts by weight of the total of the
polyfunctional monomer (C) and the monofunctional
monomer. When the amount of the acetophenone compound
is smaller than 0.01 part by weight, it may be difficult
to obtain spacers arranged in a predetermined pattern
20 due to incomplete curing by exposure and when the amount
is larger than 80 parts by weight, the formed spacers
may easily fall off from the substrate during development.

Examples of the biimidazole compound include
2,2'-bis(2-chlorophenyl)-4,4',5,5'-tetrakis(4-ethoxy
25 carbonylphenyl)-1,2'-biimidazole,
2,2'-bis(2-bromophenyl)-4,4',5,5'-tetrakis(4-ethoxyc
arbonylphenyl)-1,2'-biimidazole,
2,2'-bis(2-chlorophenyl)-4,4',5,5'-tetraphenyl-1,2'-
biimidazole,
30 2,2'-bis(2,4-dichlorophenyl)-4,4',5,5'-tetraphenyl-1
,2'-biimidazole,
2,2'-bis(2,4,6-trichlorophenyl)-4,4',5,5'-tetrapheny
1-1,2'-biimidazole,
2,2'-bis(2-bromophenyl)-4,4',5,5'-tetraphenyl-1,2'-b

imidazole,

2,2'-bis(2,4-dibromophenyl)-4,4',5,5'-tetraphenyl-1,2'-biimidazole and

2,2'-bis(2,4,6-tribromophenyl)-4,4',5,5'-tetraphenyl
5 -1,2'-biimidazole.

Out of these biimidazole compounds,

2,2'-bis(2-chlorophenyl)-4,4',5,5'-tetraphenyl-1,2'-biimidazole,

2,2'-bis(2,4-dichlorophenyl)-4,4',5,5'-tetraphenyl-1
10 ,2'-biimidazole and

2,2'-bis(2,4,6-trichlorophenyl)-4,4',5,5'-tetraphenyl-1,2'-biimidazole are preferred, and

2,2'-bis(2,4-dichlorophenyl)-4,4',5,5'-tetraphenyl-1,2'-biimidazole is particularly preferred.

15 The above biimidazole compounds have excellent solubility in a solvent, do not form foreign matter such as an undissolved product and precipitate, have high sensitivity, fully promote a curing reaction by exposure with a small amount of energy and do not cause a curing
20 reaction in an unexposed portion. Therefore, the coating film after exposure is clearly divided into a cured portion insoluble in a developer and an uncured portion having high solubility in the developer, thereby making it possible to form fine spacers not undercut and arranged
25 in a predetermined pattern.

The above biimidazole compounds may be used alone or in combination of two or more.

When the biimidazole compound is used as the photopolymerization initiator in the present invention,
30 the amount of the biimidazole compound is preferably 0.01 to 40 parts by weight, more preferably 1 to 30 parts by weight, much more preferably 1 to 20 parts by weight based on 100 parts by weight of the total of the polyfunctional monomer (C) and the monofunctional monomer. When the

amount of the biimidazole compound is smaller than 0.01 part by weight, it may be difficult to obtain spacers arranged in a predetermined pattern due to incomplete curing by exposure and when the amount is larger than 5 40 parts by weight, the formed spacers may easily fall off from the substrate during development.

- hydrogen donor -

When the biimidazole compound is used as the 10 photopolymerization initiator in the present invention, it is preferably used in combination with the following hydrogen donor to further improve sensitivity.

The term "hydrogen donor" as used herein means a compound which can provide a hydrogen atom to a radical 15 formed from the biimidazole compound by exposure.

The hydrogen donor in the present invention is preferably a mercaptan compound or amine compound defined hereinbelow.

The above mercaptan compound is a compound having 20 a benzene ring or heterocyclic ring as a mother nucleus and 1 or more, preferably 1 to 3, more preferably 1 or 2 mercapto groups directly bonded to the mother nucleus (to be referred to as "mercaptan hydrogen donor" hereinafter).

25 The above amine compound is a compound having a benzene ring or heterocyclic ring as a mother nucleus and 1 or more, preferably 1 to 3, more preferably 1 or 2 amino groups directly bonded to the mother nucleus (to be referred to as "amino hydrogen donor" hereinafter).

30 These hydrogen donors may have a mercapto group and an amino group at the same time.

A detailed description is subsequently given of these hydrogen donors.

The mercaptan hydrogen donor may have at least one

benzene ring or heterocyclic ring, or both of them at the same time. When it has two or more of the rings, a fused ring may be formed.

When the mercaptan hydrogen donor has two or more
5 mercapto groups, if at least one free mercapto group remains, at least one of the other mercapto groups may be substituted by an alkyl, aralkyl or aryl group. Further, if at least one free mercapto group remains, the mercaptan hydrogen donor can have a structural unit
10 that two sulfur atoms are bonded together by a divalent organic group such as an alkylene group or a structural unit that two sulfur atoms are bonded together in the form of a disulfide.

Further, the mercaptan hydrogen donor may be
15 substituted by a carboxyl group, alkoxycarbonyl group, substituted alkoxycarbonyl group, phenoxycarbonyl group, substituted phenoxycarbonyl group or nitrile group at a position other than the mercapto group.

Illustrative examples of the mercaptan hydrogen
20 donor include 2-mercaptobenzothiazole, 2-mercaptobenzooxazole, 2-mercaptobenzoimidazole, 2,5-dimercapto-1,3,4-thiadiazole and 2-mercapto-2,5-dimethylaminopyridine.

Out of these mercaptan hydrogen donors,
25 2-mercaptobenzothiazole and 2-mercaptobenzooxazole are preferred and 2-mercaptobenzothiazole is particularly preferred.

The amine hydrogen donor may have at least one
30 benzene ring or heterocyclic ring, or both of them at the same time. When it has two or more of the rings, a fused ring may be formed.

At least one amino group of the amine hydrogen donor may be substituted by an alkyl group or substituted alkyl group, or the amine hydrogen donor may be substituted

by a carboxyl group, alkoxycarbonyl group, substituted alkoxycarbonyl group, phenoxycarbonyl group, substituted phenoxycarbonyl group or nitrile group at a site other than the amino group.

5 Illustrative examples of the amine hydrogen donor include 4,4'-bis(dimethylamino)benzophenone, 4,4'-bis(diethylamino)benzophenone, 4-diethylaminoacetophenone, 4-dimethylaminopropiophenone,
10 ethyl-4-dimethylaminobenzoate, 4-dimethylaminobenzoate and 4-dimethylaminobenzonitrile.

Out of these amine hydrogen donors, 4,4'-bis(dimethylamino)benzophenone and
15 4,4'-bis(diethylamino)benzophenone are preferred and 4,4'-bis(diethylamino)benzophenone is particularly preferred.

The amine hydrogen donor serves as a sensitizer in the case of a photopolymerization initiator other than
20 a biimidazole compound.

In the present invention, the above hydrogen donors may be used alone or in combination of two or more. A combination of at least one mercaptan hydrogen donor and at least one amine hydrogen donor is particularly
25 preferred because the formed spacers hardly fall off from the substrate during development and have high strength and sensitivity.

The combination of the mercaptan hydrogen donor and the amine hydrogen donor is preferably
30 2-mercaptobenzothiazole/4,4'-bis(dimethylamino)benzophenone, 2-mercaptobenzothiazole/4,4'-bis(diethylamino)benzophenone, 2-mercaptobenzoxazole/4,4'-bis(dimethylamino)benzop

henone or

2-mercaptobenzooxazole/4,4'-bis(diethylamino)benzoph
enone. The combination is more preferably

2-mercaptobenzothiazole/4,4'-bis(diethylamino)benzop
5 henone or

2-mercaptobenzooxazole/4,4'-bis(diethylamino)benzoph
enone, particularly preferably

2-mercaptobenzothiazole/4,4'-bis(diethylamino)benzop
henone.

10 The weight ratio of the mercaptan hydrogen donor
to the amine hydrogen donor in the combination of the
mercaptan hydrogen donor and the amine hydrogen donor
is preferably 1:1 to 1:4, more preferably 1:1 to 1:3.

When the biimidazole compound is used in combination
15 with the hydrogen donor in the present invention, the
amount of the hydrogen donor is preferably 0.01 to 40
parts by weight, more preferably 1 to 30 parts by weight,
particularly preferably 1 to 20 parts by weight based
on 100 parts by weight of the total of the polyfunctional
20 monomer (C) and the monofunctional monomer. When the
amount of the hydrogen donor is smaller than 0.01 part
by weight, the effect of improving sensitivity may lower
and when the amount is larger than 40 parts by weight,
the formed spacers may easily fall off from the substrate
25 during development.

Illustrative examples of the triazine compound
include triazine compounds having a halomethyl group such
as 2,4,6-tris(trichloromethyl)-s-triazine,
2-methyl-4,6-bis(trichloromethyl)-s-triazine,
30 2-[2-(5-methylfuran-2-yl)ethenyl]-4,6-bis(trichlorom
ethyl)-s-triazine,
2-[2-(furan-2-yl)ethenyl]-4,6-bis(trichloromethyl)-s
-triazine,
2-[2-(4-diethylamino-2-methylphenyl)ethenyl]-4,6-bis

(trichloromethyl)-s-triazine,
2-[2-(3,4-dimethoxyphenyl)ethenyl]-4,6-bis(trichloro
methyl)-s-triazine,
2-(4-methoxyphenyl)-4,6-bis(trichloromethyl)-s-triaz
5 ine,
2-(4-ethoxystyryl)-4,6-bis(trichloromethyl)-s-triazi
ne and
2-(4-n-butoxyphenyl)-4,6-bis(trichloromethyl)-s-tria
zine.

10 Out of these triazine compounds,
2-[2-(3,4-dimethoxyphenyl)ethenyl]-4,6-bis(trichloro
methyl)-s-triazine is preferred.

The above triazine compounds may be used alone or
in combination of two or more.

15 When the triazine compound is used as the
photopolymerization initiator in the present invention,
the amount of the triazine compound is preferably 0.01
to 40 parts by weight, more preferably 1 to 30 parts by
weight, particularly preferably 1 to 20 parts by weight
20 based on 100 parts by weight of the total of the
polyfunctional monomer (C) and the monofunctional
monomer. When the amount of the triazine compound is
smaller than 0.01 part by weight, it may be difficult
to obtain spacers arranged in a predetermined pattern
25 due to incomplete curing by exposure and when the amount
is larger than 40 parts by weight, the formed spacers
may easily fall off from the substrate during development.

additives

30 The radiation sensitive composition of the present
invention may contain various additives as required.

The above additives include an organic acid or
organic amino compound (excluding the above hydrogen
donor) which exhibits the function of further improving

the solubility in an alkali developer of the radiation sensitive composition and the function of further suppressing the existence of an undissolved product after development.

5

-organic acid-

The above organic acid is preferably an aliphatic carboxylic acid or phenyl group-containing carboxylic acid having at least one carboxyl group in the molecule.

10

Examples of the above aliphatic carboxylic acid include aliphatic monocarboxylic acids such as formic acid, acetic acid, propionic acid, butyric acid, valeric acid, pivalic acid, caproic acid, diethylacetic acid, enanthic acid and caprylic acid; aliphatic dicarboxylic acids such as oxalic acid, malonic acid, succinic acid, glutaric acid, adipic acid, pimelic acid, suberic acid, azelaic acid, sebacic acid, brassylic acid, methylmalonic acid, ethylmalonic acid, dimethylmalonic acid, methylsuccinic acid, tetramethylsuccinic acid, cyclohexanedicarboxylic acid, itaconic acid, citraconic acid, maleic acid, fumaric acid and mesaconic acid; and aliphatic tricarboxylic acids such as tricarballylic acid, aconitic acid and camphoronic acid.

15

20

The above phenyl group-containing carboxylic acid is, for example, a compound having a carboxyl group directly bonded to a phenyl group or a compound having a carboxyl group bonded to a phenyl group through a carbon chain.

25

Illustrative examples of the phenyl group-containing carboxylic acid include aromatic monocarboxylic acids such as benzoic acid, toluic acid, cuminic acid, hemellitic acid and mesitylic acid; aromatic dicarboxylic acids such as phthalic acid, isophthalic acid and terephthalic acid; aromatic

30

polycarboxylic acids having a valence of three or more such as trimellitic acid, trimesic acid, mellophanic acid and pyromellitic acid; phenylacetic acid, hydroatropic acid, hydrocinnamic acid, mandelic acid, phenylsuccinic acid, atropic acid, cinnamic acid, cinnamylidenic acid, coumaric acid and umbellic acid.

From the viewpoints of alkali solubility, solubility in a solvent to be described hereinafter, and the prevention of stains and film remnants on the substrate and light screening layer of an unexposed portion, out of these organic acids, aliphatic dicarboxylic acids are preferred as aliphatic carboxylic acids, out of which malonic acid, adipic acid, itaconic acid, citraconic acid, fumaric acid and mesaconic acid are particularly preferred. Aromatic dicarboxylic acids are preferred as phenyl group-containing carboxylic acids, out of which phthalic acid is particularly preferred.

The above organic acids may be used alone or in combination of two or more.

The amount of the above organic acid is preferably 15 wt% or less, more preferably 10 wt% or less based on the total amount of the radiation sensitive composition. When the amount of the organic acid is larger than 15 wt%, the adhesion of the formed spacers to the substrate may lower.

-organic amino compound-

The above organic amino compound is preferably an aliphatic amine or phenyl group-containing amine having at least one amino group in the molecule.

Illustrative examples of the above aliphatic amine include mono(cyclo)alkylamines such as n-propylamine, i-propylamine, n-butylamine, i-butylamine, sec-butylamine, t-butylamine, n-pentylamine,

n-hexylamine, n-heptylamine, n-octylamine,
n-nonylamine, n-decylamine, n-undecylamine,
n-dodecylamine, cyclohexylamine,
o-methylcyclohexylamine, m-methylcyclohexylamine,
5 p-methylcyclohexylamine, o-ethylcyclohexylamine,
m-ethylcyclohexylamine and p-ethylcyclohexylamine;
di(cyclo)alkylamines such as methylethylamine,
diethylamine, methyl n-propylamine, ethyl n-propylamine,
di-n-propylamine, di-i-propylamine, di-n-butylamine,
10 di-i-butylamine, di-sec-butylamine, di-t-butylamine,
di-n-pentylamine, di-n-hexylamine,
methylcyclohexylamine, ethylcyclohexylamine and
dicyclohexylamine; tri(cyclo)alkylamines such as
dimethylethylamine, methyldiethylamine, triethylamine,
15 dimethyl n-propylamine, diethyl n-propylamine, methyl
di-n-propylamine, ethyl di-n-propylamine,
tri-n-propylamine, tri-i-propylamine, tri-n-butylamine,
tri-i-butylamine, tri-sec-butylamine, tri-t-butylamine.
tri-n-pentylamine, tri-n-hexylamine,
20 dimethylcyclohexylamine, diethylcyclohexylamine,
methyldicyclohexylamine, ethyldicyclohexylamine and
tricyclohexylamine; mono(cyclo)alkanolamines such as
2-aminoethanol, 3-amino-1-propanol, 1-amino-2-propanol,
4-amino-1-butanol, 5-amino-1-pentanol,
25 6-amino-1-hexanol and 4-amino-1-cyclohexanol;
di(cyclo)alkanolamines such as diethanolamine,
di-n-propanolamine, di-i-propanolamine,
di-n-butanolamine, di-i-butanolamine,
di-n-pentanolamine, di-n-hexanolamine and
30 di(4-cyclohexanol)amine; tri(cyclo)alkanolamines such
as triethanolamine, tri-n-propanolamine,
tri-i-propanolamine, tri-n-butanolamine,
tri-i-butanolamine, tri-n-pentanolamine,
tri-n-hexanolamine and tri(4-cyclohexanol)amine;

- amino(cyclo)alkanediols such as
3-amino-1,2-propanediol, 2-amino-1,3-propanediol,
4-amino-1,2-butanediol, 4-amino-1,3-butanediol,
4-amino-1,2-cyclohexanediol,
5 4-amino-1,3-cyclohexanediol,
3-dimethylamino-1,2-propanediol,
3-diethylamino-1,2-propanediol,
2-dimethylamino-1,3-propanediol and
2-diethylamino-1,3-propanediol; cycloalkanemethanols
10 having an amino group such as
1-aminocyclopentanemethanol,
4-aminocyclopentanemethanol,
1-aminocyclohexanemethanol,
4-aminocyclohexanemethanol,
15 4-dimethylaminocyclopentanemethanol,
4-diethylaminocyclopentanemethanol,
4-dimethylaminocyclohexanemethanol and
4-diethylaminocyclohexanemethanol; and aminocarboxylic
acids such as β -alanine, 2-aminobutyric acid,
20 3-aminobutyric acid, 4-aminobutyric acid,
2-aminoisobutyric acid, 3-aminoisobutyric acid,
2-aminovaleric acid, 5-aminovaleric acid,
6-aminocaproic acid, 1-aminocyclopropanecarboxylic
acid, 1-aminocyclohexanecarboxylic acid and
25 4-aminocyclohexanecarboxylic acid.

The phenyl group-containing amine is, for example,
a compound having an amino group directly bonded to a
phenyl group or a compound having an amino group bonded
to a phenyl group through a carbon chain.

- 30 Illustrative examples of the phenyl
group-containing amine include aromatic amines such as
aniline, o-methylaniline, m-methylaniline,
p-methylaniline, p-ethylaniline, p-n-propylaniline,
p-i-propylaniline, p-n-buty laniline, p-t-buty laniline,

1-naphthylamine, 2-naphthylamine, N,N-dimethylaniline, N,N-diethylaniline and p-methyl-N,N-dimethylaniline; aminobenzyl alcohols such as o-aminobenzyl alcohol, m-aminobenzyl alcohol, p-aminobenzyl alcohol, 5 p-dimethylaminobenzyl alcohol and p-diethylaminobenzyl alcohol; aminophenols such as o-aminophenol, m-aminophenol, p-aminophenol, p-dimethylaminophenol and p-diethylaminophenol; and aminobenzoic acids (derivatives) such as m-aminobenzoic acid, 10 p-aminobenzoic acid, p-dimethylaminobenzoic acid and p-diethylaminobenzoic acid.

From the viewpoints of solubility in a solvent to be described hereinafter and the prevention of stains and film remnants on the substrate or light screening 15 layer of an unexposed portion, out of these organic amino compounds, mono(cyclo)alkanolamines and amino(cyclo)alkanediols are preferred as aliphatic amines, out of which 2-aminoethanol, 3-amino-1-propanol, 5-amino-1-pentanol, 3-amino-1,2-propanediol, 20 2-amino-1,3-propanediol and 4-amino-1,2-butanediol are particularly preferred. Aminophenols are preferred as phenol group-containing amines, out of which o-aminophenol, m-aminophenol and p-aminophenol are particularly preferred.

25 The above organic amino compounds may be used alone or in combination of two or more.

The amount of the organic amino compound is preferably 15 wt% or less, more preferably 10 wt% or less based on the total amount of the radiation sensitive 30 composition. When the amount of the organic amino compound is larger than 15 wt%, the adhesion of the formed spacers to the substrate may lower.

Additives other than the above include, for example, a dispersion aid such as blue pigment derivative or yellow

pigment derivative exemplified by copper phthalocyanine derivatives; filler such as glass or alumina; polymer compound such as polyvinyl alcohol, polyethylene glycol monoalkyl ether or poly(fluoroalkylacrylate); nonionic, 5 cationic or anionic surfactant; adhesion accelerator such as vinyl trimethoxysilane, vinyl triethoxysilane, vinyl tris(2-methoxyethoxy)silane, N-(2-aminoethyl)-3-aminopropyl methyl dimethoxysilane, N-(2-aminoethyl)-3-aminopropyl trimethoxysilane, 10 3-aminopropyl triethoxysilane, 3-glycidoxypropyl trimethoxysilane, 3-glycidoxypropyl methyl dimethoxysilane, 2-(3,4-epoxycyclohexyl)ethyl trimethoxysilane, 3-chloropropyl methyl dimethoxysilane, 3-chloropropyl 15 trimethoxysilane, 3-methacryloxypropyl trimethoxysilane or 3-mercaptopropyl trimethoxysilane; antioxidant such as 2,2-thiobis(4-methyl-6-t-butylphenol) or 2,6-di-t-butylphenol; ultraviolet light absorber such 20 as 2-(3-t-butyl-5-methyl-2-hydroxyphenyl)-5-chlorobenzotriazole or alkoxybenzophenone; anticoagulant such as sodium polyacrylate; and heat radical generating agent such as 1,1'-azobis(cyclohexane-1-carbonitrile) or 25 2-phenylazo-4-methoxy-2,4-dimethylvaleronitrile.

solvent

The radiation sensitive composition of the present invention comprises the above colorant (A), alkali 30 soluble resin (B), polyfunctional monomer (C) and photopolymerization initiator (D) as essential ingredients and is preferably prepared as a liquid composition by mixing them with a solvent.

Any solvent is acceptable if it disperses or

dissolves the components (A) to (D) and additive components, does not react with these components and has appropriate volatility.

Illustrative examples of the solvent include

5 (poly)alkylene glycol monoalkyl ethers such as ethylene glycol monomethyl ether, ethylene glycol monoethyl ether, ethylene glycol mono-n-propyl ether, ethylene glycol mono-n-butyl ether, diethylene glycol monomethyl ether, diethylene glycol monoethyl ether, diethylene glycol

10 mono-n-propyl ether, diethylene glycol mono-n-butyl ether, triethylene glycol monomethyl ether, triethylene glycol monoethyl ether, propylene glycol monomethyl ether, propylene glycol monoethyl ether, propylene glycol mono-n-propyl ether, propylene glycol

15 mono-n-butyl ether, dipropylene glycol monomethyl ether, dipropylene glycol monoethyl ether, dipropylene glycol mono-n-propyl ether, dipropylene glycol mono-n-butyl ether, tripropylene glycol monomethyl ether and tripropylene glycol monoethyl ether; (poly)alkylene

20 glycol monoalkyl ether acetates such as ethylene glycol monomethyl ether acetate, ethylene glycol monoethyl ether acetate, diethylene glycol monomethyl ether acetate, diethylene glycol monoethyl ether acetate, propylene glycol monomethyl ether acetate and propylene

25 glycol monoethyl ether acetate; other ethers such as diethylene glycol dimethyl ether, diethylene glycol methylethyl ether, diethylene glycol diethyl ether and tetrahydrofuran; ketones such as methyl ethyl ketone, cyclohexanone, 2-heptanone and 3-heptanone; lactic acid

30 alkyl esters such as methyl 2-hydroxypropionate and ethyl 2-hydroxypropionate; other esters such as ethyl 2-hydroxy-2-methylpropionate, methyl 3-methoxypropionate, ethyl 3-methoxypropionate, methyl 3-ethoxypropionate, ethyl 3-ethoxypropionate, ethyl

ethoxyacetate, ethyl hydroxyacetate, methyl
2-hydroxy-3-methylbutanoate,
3-methyl-3-methoxybutylacetate,
3-methyl-3-methoxybutylpropionate, ethyl acetate,
5 n-propyl acetate, i-propyl acetate, n-butyl acetate,
i-butyl acetate, n-pentyl formate, i-pentyl acetate,
n-butyl propionate, ethyl butyrate, n-propyl butyrate,
i-propyl butyrate, n-butyl butyrate, methyl pyruvate,
ethyl pyruvate, n-propyl pyruvate, methyl acetoacetate,
10 ethyl acetoacetate and ethyl 2-oxybutanoate; aromatic
hydrocarbons such as toluene and xylene; and amides such
as N-methylpyrrolidone, N,N-dimethylformamide and
N,N-dimethylacetamide.

Out of these solvents, propylene glycol monomethyl
15 ether, ethylene glycol monomethyl ether acetate,
propylene glycol monomethyl ether acetate, propylene
glycol monoethyl ether acetate, diethylene glycol
dimethyl ether, diethylene glycol methyl ethyl ether,
cyclohexanone, 2-heptanone, 3-heptanone, ethyl
20 2-hydroxypropionate, ethyl 3-methoxypropionate, methyl
3-ethoxypropionate, ethyl 3-ethoxypropionate,
3-methyl-3-methoxybutylpropionate, n-butyl acetate,
i-butyl acetate, n-pentyl formate, i-pentyl acetate,
n-butyl propionate, ethyl butyrate, i-propyl butyrate,
25 n-butyl butyrate and ethyl pyruvate are preferred from
the viewpoints of solubility, pigment dispersibility and
coatability.

The above solvents may be used alone or in
combination of two or more.

30 Further, a high-boiling solvent such as benzyl ethyl
ether, dihexyl ether, acetonylacetone, isophorone,
caproic acid, caprylic acid, 1-octanol, 1-nonanol,
benzyl alcohol, benzyl acetate, ethyl benzoate, diethyl
oxalate, diethyl maleate, γ -butyrolactone, ethylene

carbonate, propylene carbonate or ethylene glycol monophenyl ether acetate may be used in combination with the solvent.

5 The above high-boiling solvents may be used alone or in combination of two or more.

The amount of the solvent is not particularly limited but is desirably such that the total amount of all the components excluding the solvent of the liquid composition becomes preferably 5 to 50 wt%, particularly
10 preferably 10 to 40 wt% from the viewpoints of coatability and stability of the obtained liquid composition.

method of forming spacers

The radiation sensitive composition of the present
15 invention is used to form spacers on a drive substrate (to be referred to as "TFT liquid crystal drive substrate" hereinafter) having thin film transistors (TFT) for a thin film transistor (TFT) color liquid crystal display device formed thereon by lithography.

20 The spacers are formed on the TFT liquid crystal drive substrate having a pigmented layer formed thereon. The term "pigmented layer" as used herein means what includes only display pixels, only a black matrix or both of them.

25 To form the pigmented layer on the TFT liquid crystal drive substrate, a liquid radiation sensitive composition for a pigmented layer, which contains (a) a colorant, (b) an alkali soluble resin, (c) a polyfunctional monomer, (d) a photopolymerization
30 initiator and optionally additive components is preferably used.

The above components (a) to (d) may be identical to the (A) colorant, (B) alkali soluble resin, (C) polyfunctional monomer and (D) photopolymerization

initiator of the radiation sensitive composition in the present invention, respectively. When the pigmented layer includes pixels, at least one organic pigment is preferably used as the colorant (a) and when the pigmented
5 layer includes a black matrix, at least two organic pigments and/or carbon black are preferably used as the colorant (a). The alkali soluble resin (b) has an Mw of preferably 3,000 to 300,000, more preferably 5,000 to 100,000, an Mn of preferably 3,000 to 60,000, more
10 preferably 5,000 to 25,000, and an Mw/Mn of preferably 1 to 5, more preferably 1 to 4.

The additive components used in the radiation sensitive composition for a pigmented layer are the same as those listed for the radiation sensitive composition
15 of the present invention. Examples of the solvent used for the preparation of the liquid radiation sensitive composition for a pigmented layer are the same as those listed for the radiation sensitive composition of the present invention.

20 The method of forming the pigmented layer and the spacers on the TFT liquid crystal drive substrate will be described hereinbelow.

For the formation of pixels, a light screening layer for defining a portion where pixels are to be formed is
25 first formed as required on the surface of a TFT liquid crystal drive substrate or a substrate having a passivation film such as a silicon nitride film formed on the surface of the drive substrate and then a liquid radiation sensitive composition for a pigmented layer
30 containing, for example, a red pigment dispersed therein is applied to the substrate and prebaked to evaporate the solvent to form a coating film.

Thereafter, the coating film is exposed to light through a photomask, developed with an alkali developer

to dissolve and remove an unexposed portion of the coating film and then post-baked to form an array of red pixels arranged in a predetermined pattern. The photomask used has a pattern for forming pixels and also a pattern for
5 forming through holes or U-shaped cavities.

Subsequently, a liquid radiation sensitive composition for a pigmented layer containing a green pigment dispersed therein and a liquid radiation sensitive composition for a pigmented layer containing
10 a blue pigment dispersed therein are applied, prebaked, exposed, developed and post-baked in the same manner as described above to form an array of green pixels and an array of blue pixels on the same substrate sequentially, thereby making it possible to obtain a color liquid crystal
15 display device having arrays of red, green and blue primary color pixels formed on the TFT liquid crystal drive substrate and through holes or U-shaped cavities formed therein.

A black matrix may be formed in the same manner as
20 the above pixels.

The spacers can be formed in the same manner as the above pixels except that the liquid radiation sensitive composition of the present invention is applied to the TFT liquid crystal drive substrate having pigmented
25 layers formed thereon as described above in place of the liquid radiation sensitive composition for a pigmented layer and a photomask for spacers is used.

The TFT liquid crystal drive substrate is made from glass, silicon, polycarbonate, polyester, aromatic
30 polyamide, polyamide imide, polyimide or the like. The substrate may be optionally subjected to an appropriate pretreatment such as chemical treatment with a silane coupling agent or the like, plasma treatment, ion plating, sputtering, vapor-phase reaction or vacuum deposition.

To apply the liquid radiation sensitive compositions to the substrate to form the pigmented layer and spacers, appropriate coating such as rotational coating, cast coating or roll coating may be employed.

5 The thickness of coating for forming the pigmented layer is preferably 0.1 to 10 μm , more preferably 0.2 to 5.0 μm , particularly preferably 0.2 to 3.0 μm in terms of film thickness after drying.

10 The thickness of coating for forming the spacers is preferably 0.1 to 20 μm , more preferably 0.2 to 10 μm , particularly preferably 0.2 to 8 μm in terms of film thickness after drying.

15 The radiation used to form the pigmented layer and spacers is selected from visible radiation, ultraviolet radiation, far ultraviolet radiation, electron beams, X-rays and the like but preferably has a wavelength of 190 to 450 nm.

 The amount of exposure to radiation is preferably 10 to 10,000 J/m^2 .

20 The alkali developer used to form the pigmented layer and spacers is preferably an aqueous solution of sodium carbonate, sodium hydroxide, potassium hydroxide, tetramethylammonium hydroxide, dimethylethanolamine, choline, 1,8-diazabicyclo-[5.4.0]-7-undecane,
25 1,5-diazabicyclo-[4.3.0]-5-nonene or the like.

 An appropriate amount of a water-soluble organic solvent such as methanol or ethanol, or a surfactant may be added to the above alkali developer. The coating film is preferably washed in water after development with the
30 alkali developer.

 Development may be shower development, spray development, dip development, puddle development or the like. As for development conditions, development is preferably carried out at normal temperature for 5 to

300 sec.

Attached Fig. 1 and Fig. 2 show the key section of an example of the thin film transistor (TFT) color liquid crystal display device having pixels and spacers formed as described above. Fig. 1 is a sectional view of the device and Fig. 2 is a view taken on line X-X of Fig. 1 and shows the device before an alignment film is formed. Reference numeral 1 denotes a substrate (TFT liquid crystal drive substrate), 2 an electrode, 3 a red pixel, 4 a green pixel, 5 a blue pixel, 6 a spacer, 7 an ITO film, 8 an alignment film and 9 a liquid crystal layer.

The color liquid crystal display device having a pigmented layer and spacers formed as described above may be of a transmission type or a reflection type. The radiation sensitive composition of the present invention is useful as spacers for thin film transistor (TFT) color image pick-up tube elements and color sensors.

The following examples are provided for the purpose of further illustrating the present invention but are in no way to be taken as limiting.

The OD value in the examples were evaluated as follows.

OD value

The liquid radiation sensitive composition for spacers was applied to the surface of a glass substrate with a spin coater and prebaked in a clean oven heated at 90°C for 10 minutes to form a coating film. Thereafter, this substrate was cooled to room temperature and the entire coating film was exposed to 5,000 J/m² of ultraviolet radiation having wavelengths of 365 nm, 405 nm and 436 nm using a high-pressure mercury lamp. This substrate was then immersed in a 0.1 wt% aqueous solution of tetramethylammonium hydroxide at 23°C for 1 minute

for development, washed in ultra pure water and dried with air. Thereafter, it was post-baked in a clean oven heated at 220°C for 25 minutes to form a 5 µm-thick coating film on the substrate. The OD value of this coating film
5 was measured with an optical densitometer (McBeth TR927 of Sakata Inks Co., Ltd.).

Examples

Example 1

10 (preparation of radiation sensitive composition for pixels)

100 parts by weight of a mixture of C.I. Pigment Red 177 and C.I. Pigment Red 224 in a weight ratio of 65/35 as the colorant (a), 70 parts by weight of a copolymer
15 of methacrylic acid/N-phenylmaleimide/benzyl methacrylate/glycerol monomethacrylate/styrene (weight ratio = 15/25/35/10/15, Mw = 30,000, Mn = 10,000) as the alkali soluble resin (b), 80 parts by weight of dipentaerythritol hexaacrylate as the polyfunctional
20 monomer (c), 50 parts by weight of 2-benzyl-2-dimethylamino-1-(4-morpholinophenyl)butanone-1 as the photopolymerization initiator (d) and 1,000 parts by weight of propylene glycol monomethylether acetate as a solvent were mixed together to prepare a
25 liquid radiation sensitive composition for red pixels (R1).

<formation of pixel array>

The liquid composition (R1) was applied to the surface of a substrate prepared by forming a silicon
30 nitride film on the surface of a TFT liquid crystal drive substrate with a spin coater and prebaked in a clean oven heated at 90°C for 10 minutes to form a 1.7 µm-thick coating film.

Thereafter, this substrate was cooled to room

temperature and the coating film was exposed to 2,000 J/m² of ultraviolet radiation having wavelengths of 365 nm, 405 nm and 436 nm through a photomask using a high-pressure mercury lamp. This substrate was then
5 immersed in a 0.1 wt% aqueous solution of tetramethylammonium hydroxide at 23°C for 1 minute for development, washed in ultra-pure water and dried with air. Thereafter, it was post-baked in a clean oven heated at 220°C for 25 minutes to form a stripe-like array of
10 red pixels on the substrate.

<preparation of liquid radiation sensitive composition for spacers>

160 parts by weight of a mixture of C.I. Pigment Red 177, C.I. Pigment Blue 15:4 and C.I. Pigment Yellow
15 150 in a weight ratio of 60/20/20 and 20 parts by weight of barium sulfate as the colorants (A), 70 parts by weight of a copolymer of methacrylic acid/
mono(2-acryloyloxyethyl)succinate/N-phenylmaleimide/
benzyl methacrylate/styrene (weight ratio =
20 30/15/35/10/10, Mw = 19,000, Tg = 130°C) as the alkali soluble resin (B), 80 parts by weight of dipentaerythritol hexaacrylate as the polyfunctional monomer (C), 50 parts by weight of
2-benzyl-2-dimethylamino-1-(4-morpholinophenyl)butan
25 one-1 as the photopolymerization initiator (D) and 1,000 parts by weight of propylene glycol monomethyl ether acetate as a solvent were mixed together to prepare a liquid radiation sensitive composition for spacers (BK1).

30 <formation of spacers>

The above liquid composition (BK1) was applied to the surface of the TFT liquid crystal drive substrate having an array of pixels formed thereon as described above with a spin coater and prebaked in a clean oven

heated at 90°C for 10 minutes to form a 6.0 μm -thick coating film.

Thereafter, this substrate was cooled to room temperature and the coating film was exposed to 5,000 J/m² of ultraviolet radiation having wavelengths of 365 nm, 405 nm and 436 nm through a photomask using a high-pressure mercury lamp. This substrate was then immersed in a 0.1 wt% aqueous solution of tetramethylammonium hydroxide at 23°C for 1 minute for development, washed in ultra pure water and dried with air. Thereafter, it was post-baked in a clean oven heated at 220°C for 25 minutes to form 5 μm -thick spacers on the substrate.

<evaluation>

When a display panel was manufactured using the obtained substrate in accordance with a commonly used method, the thin film transistors (TFT) did not malfunction and the difference in cell gap was $\pm 0.19 \mu\text{m}$. The spacers did not deform irreversibly at the time of sealing the panel and a display failure did not occur due to a gap difference in the liquid crystal layer. The OD value of a 5 μm -thick coating film formed on the surface of another glass substrate using the liquid composition (BK1) was 3.3.

25

Example 2

<preparation of liquid radiation sensitive composition for spacers>

160 parts by weight of a mixture of C.I. Pigment Red 177, C.I. Pigment Blue 15:4 and C.I. Pigment Yellow 150 in a weight ratio of 60/20/20 and 20 parts by weight of barium sulfate as the colorants (A), 70 parts by weight of a copolymer of methacrylic acid/mono(2-acryloyloxyethyl)succinate/N-phenylmaleimide/

benzyl methacrylate/styrene (weight ratio =
30/10/35/15/10, Mw = 16,000, Tg = 125°C) as the alkali
soluble resin (B), 80 parts by weight of dipentaerythritol
hexaacrylate as the polyfunctional monomer (C), 20 parts
5 by weight of

2-methyl-1-[4-(methylthio)phenyl]-2-morpholinopropan
one-1 as the photopolymerization initiator (D), 15 parts
by weight of 4,4'-bis(diethylamino)benzophenone as a
sensitizer and 1,000 parts by weight of propylene glycol
10 monomethyl ether acetate as a solvent were mixed together
to prepare a liquid radiation sensitive composition for
spacers (BK2).

<formation of spacers>

An array of pixels and spacers were formed on the
15 surface of a TFT liquid crystal drive substrate in the
same manner as in Example 1 except that the liquid
composition (BK2) was used in place of the liquid
composition (BK1).

<evaluation>

20 When a display panel was manufactured using the
obtained substrate in accordance with a commonly used
method, the thin film transistors (TFT) did not
malfunction and the difference in cell gap was $\pm 0.33 \mu\text{m}$.
The spacers did not deform irreversibly at the time of
25 sealing the panel and a display failure did not occur
due to a gap difference in the liquid crystal layer. The
OD value of a 5 μm -thick coating film formed on the surface
of another glass substrate using the liquid composition
(BK2) was 3.3.

30

Example 3

<preparation of liquid radiation sensitive composition
for spacers>

200 parts by weight of a mixture of C.I. Pigment

Red 177, C.I. Pigment Green 7 and C.I. Pigment Blue 15:6
in a weight ratio of 60/20/20 as the colorant (A), 75
parts by weight of a copolymer of methacrylic acid/
mono(2-acryloyloxyethyl)succinate/N-phenylmaleimide/
5 benzyl methacrylate/styrene (weight ratio =
30/15/35/10/10, Mw = 19,000, Tg = 130°C) as the alkali
soluble resin (B), 75 parts by weight of dipentaerythritol
hexaacrylate as the polyfunctional monomer (C), 6 parts
by weight of
10 2,2'-bis(2-chlorophenyl)-4,4',5,5'-tetraphenyl-1,2'-
bisimidazole as the photopolymerization initiator (D),
6 parts by weight of 4,4'-bis(diethylamino)benzophenone
as an amine-based hydrogen donor, 3 parts by weight of
2-mercaptobenzothiazole as a mercaptan-based hydrogen
15 donor, and 700 parts by weight of propylene glycol
monomethyl ether acetate and 300 parts by weight of
cyclohexanone as solvents were mixed together to prepare
a liquid radiation sensitive composition for spacers
(BK3).

20 <formation of spacers>

An array of pixels and spacers were formed on the
surface of a TFT liquid crystal drive substrate in the
same manner as in Example 1 except that the liquid
composition (BK3) was used in place of the liquid
25 composition (BK1).

<evaluation>

When a display panel was manufactured using the
obtained substrate in accordance with a commonly used
method, the thin film transistors (TFT) did not
30 malfunction and the difference in cell gap was ± 0.25 μm .
The spacers did not deform irreversibly at the time of
sealing the panel and a display failure did not occur
due to a gap difference in the liquid crystal layer. The
OD value of a 5 μm -thick coating film formed on the surface

of another glass substrate using the liquid composition (BK3) was 3.5.

Example 4

5 <preparation of liquid radiation sensitive composition for spacers>

200 parts by weight of a mixture of C.I. Pigment Red 177 and C.I. Pigment Blue 15:6 in a weight ratio of 70/30 as the colorant (A), 75 parts by weight of a copolymer
10 of methacrylic acid/mono(2-acryloyloxyethyl)succinate/
N-phenylmaleimide/benzyl methacrylate/styrene (weight ratio = 30/10/35/15/10, Mw = 16,000, Tg = 125°C) as the alkali soluble resin (B), 75 parts by weight of
dipentaerythritol hexaacrylate as the polyfunctional
15 monomer (C), 10 parts by weight of a triazine compound as the photopolymerization initiator (D), and 700 parts by weight of propylene glycol monomethyl ether acetate and 300 parts by weight of cyclohexanone as solvents were mixed together to prepare a liquid radiation sensitive
20 composition for spacers (BK4).

<formation of spacers>

An array of pixels and spacers were formed on the surface of a TFT liquid crystal drive substrate in the same manner as in Example 1 except that the liquid
25 composition (BK4) was used in place of the liquid composition (BK1).

<evaluation>

When a display panel was manufactured using the obtained substrate in accordance with a commonly used
30 method, the thin film transistors (TFT) did not malfunction and the difference in cell gap was $\pm 0.22 \mu\text{m}$. The spacers did not deform irreversibly at the time of sealing the panel and a display failure did not occur due to a gap difference in the liquid crystal layer. The

OD value of a 5 μ m-thick coating film formed on the surface of another glass substrate using the liquid composition (BK4) was 3.5.

5 Example 5

<preparation of liquid radiation sensitive composition for spacers>

160 parts by weight of a mixture of C.I. Pigment Red 177, C.I. Pigment Blue 15:4 and C.I. Pigment Yellow 150 in a weight ratio of 60/20/20 and 20 parts by weight of barium sulfate as the colorants (A), 70 parts by weight of a copolymer of methacrylic acid/2-hydroxyethyl methacrylate/benzyl methacrylate (weight ratio = 30/10/60, Mw = 9,500, Tg = 80°C) as the alkali soluble resin (B), 80 parts by weight of dipentaerythritol hexaacrylate as the polyfunctional monomer (C), 50 parts by weight of 2-benzyl-2-dimethylamino-1-(4-morpholinophenyl)butanone-1 as the photopolymerization initiator (D), and 1,000 parts by weight of propylene glycol monomethyl ether acetate as a solvent were mixed together to prepare a liquid radiation sensitive composition for spacers (BK5).

<formation of spacers>

25 An array of pixels and spacers were formed on the surface of a TFT liquid crystal drive substrate in the same manner as in Example 1 except that the liquid composition (BK5) was used in place of the liquid composition (BK1).

30 <evaluation>

When a display panel was manufactured using the obtained substrate in accordance with a commonly used method, the thin film transistors (TFT) did not malfunction and the difference in cell gap was $\pm 0.60 \mu$ m.

The spacers did not deform irreversibly at the time of sealing the panel and a display failure did not occur due to a gap difference in the liquid crystal layer. The OD value of a 5 μm -thick coating film formed on the surface of another glass substrate using the liquid composition (BK5) was 3.3.

The radiation sensitive composition of the present invention is characterized in that spacers made therefrom have excellent light screening properties, mechanical strength and heat resistance, thin film transistors do not malfunction, the difference in cell gap is extremely small, the spacers do not deform irreversibly under high temperature and high pressure conditions at the time of sealing a panel in the production of a display panel and a display failure does not occur due to a gap difference in the liquid crystal layer.

Therefore, the radiation sensitive composition of the present invention can provide a high-quality thin film transistor (TFT) color liquid crystal display device having excellent reliability.

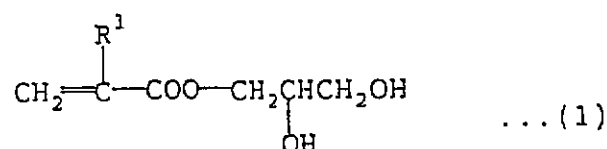
What is claimed is:

1. A drive substrate for thin film transistor color liquid crystal display devices, which has spacers formed from the radiation sensitive composition comprising (A) a colorant, (B) an alkali soluble resin, (C) a polyfunctional monomer and (D) a photopolymerization initiator.

2. The drive substrate of claim 1, wherein the colorant (A) comprises at least one selected from the group consisting of an organic pigment and carbon black.

3. The drive substrate of claim 1 or 2, wherein the alkali soluble resin (B) has a weight average molecular weight in terms of polystyrene measured by gel permeation chromatography of 20,000 or less and a glass transition temperature of 110°C or more.

4. The drive substrate of claim 1 or 2, wherein the alkali soluble resin (B) is a copolymer of (a) a polymerizable unsaturated monomer having at least one carboxyl group in the molecule, (b) at least one monomer selected from the group consisting of a macromonomer having a mono(meth)acryloyl group at a terminal of a molecular chain, N-substituted maleimide, 2-hydroxy (meth)acrylate, benzyl (meth)acrylate and a compound represented by the following formula (1):



wherein R¹ is a hydrogen atom or methyl group, and optionally (c) at least one monomer selected from the group consisting of styrene, methyl (meth)acrylate,

allyl (meth)acrylate and phenyl (meth)acrylate.

5. The drive substrate of claim 1 or 2, wherein the alkali soluble resin (B) is a copolymer of a monomer mixture comprising (1) a carboxyl group-containing unsaturated monomer, (2) at least one selected from the group consisting of polystyrene macromonomer, polymethyl (meth)acrylate macromonomer, N-phenylmaleimide, N-cyclohexylmaleimide, 2-hydroxyethyl (meth)acrylate, benzyl (meth)acrylate and glycerol (meth)acrylate and optionally (3) at least one selected from the group consisting of styrene, methyl (meth)acrylate, allyl (meth)acrylate and phenyl (meth)acrylate.

6. The drive substrate of claim 1 or 2, wherein the alkali soluble resin (B) is a copolymer of a monomer mixture comprising (1) a carboxyl group-containing unsaturated monomer component selected from the group consisting of (meth)acrylic acid and a combination of (meth)acrylic acid and mono[2-(meth)acryloyloxyethyl]succinate, (2) at least one selected from the group consisting of polystyrene macromonomer, polymethyl (meth)acrylate macromonomer, N-phenylmaleimide, N-cyclohexylmaleimide, 2-hydroxyethyl (meth)acrylate, benzyl (meth)acrylate and glycerol (meth)acrylate and optionally (3) at least one selected from the group consisting of styrene, methyl (meth)acrylate, allyl (meth)acrylate and phenyl (meth)acrylate.

7. The drive substrate of claim 1 or 2, wherein the polyfunctional monomer (C) is at least one compound selected from the group consisting of

trimethylolpropane triacrylate, pentaerythritol triacrylate and dipentaerythritol hexaacrylate.

8. The drive substrate of claim 1 or 2, wherein the photopolymerization initiator (D) is at least one compound selected from the group consisting of an acetophenone compound, biimidazole compound and triazine compound.

9. The drive substrate of claim 1 or 2, wherein the photopolymerization initiator (D) is a biimidazole compound and used in combination with a hydrogen donor.

10. The drive substrate of claim 9, wherein the photopolymerization initiator (D) further comprises at least one compound selected from the group consisting of an acetophenone compound and a triazine compound.

11. A process for producing a drive substrate having spacers, comprising the steps of:

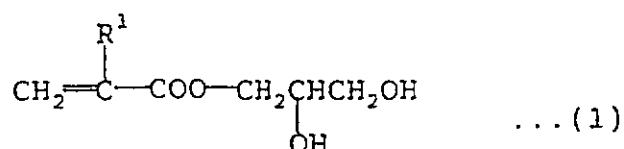
forming a color film containing a pigmented layer on the drive substrate of a thin film transistor color liquid crystal display device directly or through a passivation film; and

forming spacers from the radiation sensitive composition comprising (A) a colorant, (B) an alkali soluble resin, (C) a polyfunctional monomer and (D) a photopolymerization initiator.

12. The process of claim 11, wherein the colorant (A) comprises at least one selected from the group consisting of an organic pigment and carbon black.

13. The process of claim 11 or 12, wherein the alkali soluble resin (B) has a weight average molecular weight in terms of polystyrene measured by gel permeation chromatography of 20,000 or less and a glass transition temperature of 110°C or more.

14. The process of claim 11 or 12, wherein the alkali soluble resin (B) is a copolymer of (a) a polymerizable unsaturated monomer having at least one carboxyl group in the molecule, (b) at least one monomer selected from the group consisting of a macromonomer having a mono(meth)acryloyl group at a terminal of a molecular chain, N-substituted maleimide, 2-hydroxy (meth)acrylate, benzyl (meth)acrylate and a compound represented by the following formula (1):



wherein R¹ is a hydrogen atom or methyl group, and optionally (c) at least one monomer selected from the group consisting of styrene, methyl (meth)acrylate, allyl (meth)acrylate and phenyl (meth)acrylate.

15. The process of claim 11 or 12, wherein the alkali soluble resin (B) is a copolymer of a monomer mixture comprising (1) a carboxyl group-containing unsaturated monomer, (2) at least one selected from the group consisting of polystyrene

macromonomer, polymethyl (meth)acrylate macromonomer, N-phenylmaleimide, N-cyclohexylmaleimide, 2-hydroxyethyl (meth)acrylate, benzyl (meth)acrylate and glycerol (meth)acrylate and optionally (3) at least one selected from the group consisting of styrene, methyl (meth)acrylate, allyl (meth)acrylate and phenyl (meth)acrylate.

16. The process of claim 11 or 12, wherein the alkali soluble resin (B) is a copolymer of a monomer mixture comprising (1) a carboxyl group-containing unsaturated monomer component selected from the group consisting of (meth)acrylic acid and a combination of (meth)acrylic acid and mono[2-(meth)acryloyloxyethyl]succinate, (2) at least one selected from the group consisting of polystyrene macromonomer, polymethyl (meth)acrylate macromonomer, N-phenylmaleimide, N-cyclohexylmaleimide, 2-hydroxyethyl (meth)acrylate, benzyl (meth)acrylate and glycerol (meth)acrylate and optionally (3) at least one selected from the group consisting of styrene, methyl (meth)acrylate, allyl (meth)acrylate and phenyl (meth)acrylate.

17. The process of claim 11 or 12, wherein the polyfunctional monomer (C) is at least one compound selected from the group consisting of trimethylolpropane triacrylate, pentaerythritol triacrylate and dipentaerythritol hexaacrylate.

18. The process of claim 11 or 12, wherein the photopolymerization initiator (D) is at least one compound selected from the group consisting of an acetophenone compound, biimidazole compound and triazine compound.

19. The process of claim 11 or 12, wherein the photopolymerization initiator (D) is a biimidazole compound and used in combination with a hydrogen donor.

20. The process of claim 19, wherein the photopolymerization initiator (D) further comprises at least one compound selected from the group consisting of an acetophenone compound and a triazine compound.

21. A thin film transistor color liquid crystal display device having the drive substrate of any one of claims 1 to 10.