

**RADIATION-SENSITIVE COMPOSITION FOR FORMING COLORED LAYER,
COLOR FILTER AND COLOR LIQUID CRYSTAL DISPLAY DEVICE**

BACKGROUND OF THE INVENTION

Field of the Invention

[0001]

The present invention relates to a radiation-sensitive composition for forming a colored layer, a color filter and a color liquid crystal display device, and more specifically, to a radiation-sensitive composition for forming a colored layer which is usefully used as a color filter for a transmissive or reflective color liquid crystal display device and a color imaging device, etc., a color filter having the colored layer formed by using the radiation-sensitive composition, and a color liquid crystal display device having the color filter.

Description of the Related Art

[0002]

As a method for forming a color filter using a colored radiation-sensitive composition, a method including forming a coating of a colored radiation-sensitive composition on a substrate or a substrate having a light shielding layer with a desired pattern previously formed thereon, irradiating (hereinafter, referred to as "exposure") it with radiation through a

photomask having a desired pattern shape, developing it with an alkaline developer to dissolve and remove unexposed portions, and thereafter, subjecting it to post-baking by use of a clean oven or a hot plate to obtain pixels of various colors (see, for example, JP-A-2-144502 and JP-A-3-53201) is known.

[0003]

Recently, with an increase in the chromatic purity of a color crystal display device, the concentration of a pigment contained in a colored radiation-sensitive composition has been increased more and more. With this tendency, generation of residues and scum during a developing process on unexposed portions of a substrate or a light shielding layer has been a significant problem. In addition, as the concentration of a pigment contained in a colored radiation-sensitive composition increases, solubility of a coating to an alkaline developer tends to significantly decrease. For this reason, in a developing process by a shower developing method, the coating of the unexposed portions, which is once removed but does not completely dissolved and remains as floating matter in a developing vessel, attaches again onto a color filter as a foreign substance. This is a major cause of reducing product yield.

Furthermore, with an increase in the contrast of a color crystal display device, the particle size of a pigment contained in a colored radiation-sensitive

composition has been reduced more and more. To stably disperse fine-particles of the pigment, use of a dispersant having a high amine value has been found to be effective. However, use of the high amine-value dispersant makes it difficult to perform developing itself with an alkaline developer. Such a dispersant has not yet been used in practice.

In the circumstance, it has been strongly desired to develop a radiation-sensitive composition for a color filter that can overcome these problems involved in recent requirements for higher chromaticity and higher contrast.

[0004]

Meanwhile, to deal with a problem of generation of residues and scum during a developing process on unexposed portions of a substrate or a light shielding layer, it is found that use of a polyfunctional monomer containing a carboxyl group is effective, as is disclosed, for example, in JP-A-10-332929. However, the free carboxylic acid-containing monoester compound of pentaerythritol triacrylate and succinic acid, disclosed in JP-A-10-332929 has the following problem. When the monoester compound is used in a pigment-rich colored radiation-sensitive composition having a pigment content as high as 30 wt% or more based on the total solid content, the rigidity of resultant coating becomes insufficient and the surface smoothness of a pattern

significantly deteriorates. As a result, the orientation of liquid crystals is degraded.

Moreover, as is disclosed, for example, in JP-A-2004-287230, it is known that the development property and the like of a curable resin composition for forming a colored pattern is improved by adding a light-curable compound having one or more acidic functional groups and three or more light-curable functional groups thereto. However, no effective means have been disclosed to overcome the above problems of a resin composition for a red, green or blue pattern, containing a pigment in a high concentration of 30 wt% or more based on the total solid content.

Accordingly, it has been strongly desired to develop a further improved colored radiation-sensitive composition, which satisfies various requirements recently desired with respect to development property and product yield in manufacturing color filters and provides a pattern having sufficient surface smoothness.

SUMMARY OF THE INVENTION

[0005]

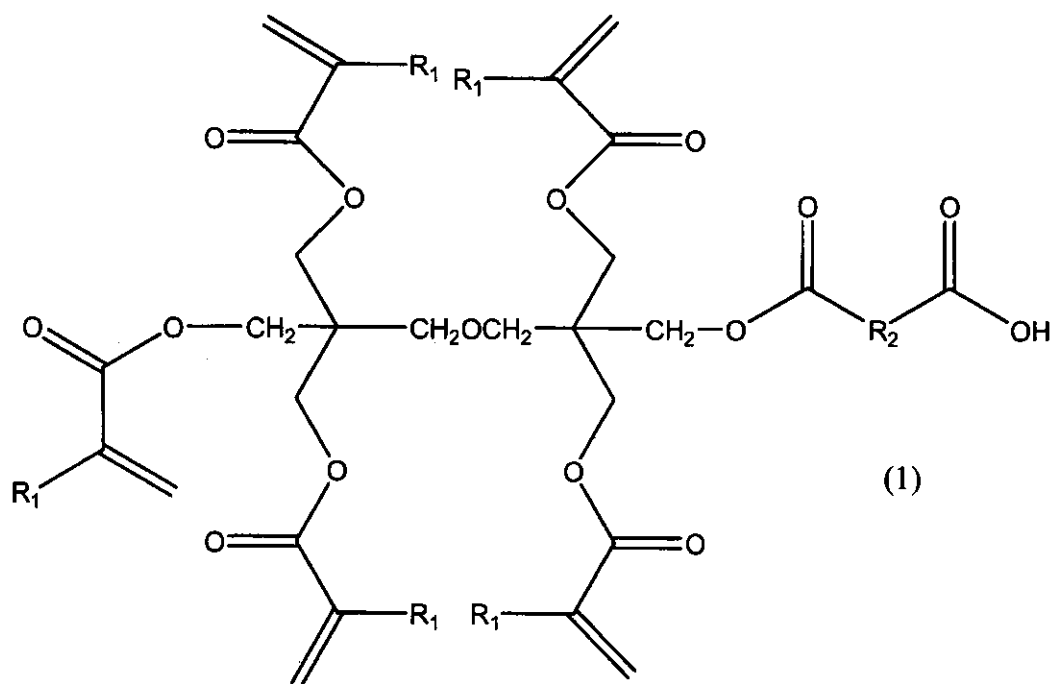
An object of the present invention is to provide a radiation-sensitive composition for forming a colored layer which can be used for forming a color filter free from generation of residue and scum with high product yield even if the content of a pigment is high and which

can provide a pattern having sufficient surface smoothness.

[0006]

Firstly, the present invention provides a radiation-sensitive composition for forming a colored layer, which contains (A) at least one pigment selected from the group consisting of red pigments, green pigments and blue pigments, (B) a dispersant, (C) an alkali-soluble resin, (D) a polyfunctional monomer represented by the formula (1) below, (E) a photopolymerization initiator and (F) a solvent, in which the content of the pigment (A) is 30 to 60 wt% based on the total weight of the composition except (F) the solvent.

[0007]



[0008]

where R_1 represents a hydrogen atom or a methyl group, and R_2 represents a group selected from the group consisting of a methylene group, a straight or branched alkylene group and a straight or branched alkenylene group each having 2 to 8 carbon atoms, a phenylene group that may have a substituent, a cyclohexylene group that may have a substituent and a cyclohexylene group that may have a substituent and partly has an unsaturated bond.

[0009]

Secondly, the present invention provides a color filter having a colored layer formed by using the radiation-sensitive composition for forming a colored layer.

[0010]

Thirdly, the present invention provides a color liquid crystal display device having the color filter.

[0011]

The radiation-sensitive composition for forming a colored layer according to the present invention, even if the concentration of the pigment contained in the composition is high, can be used for forming a color filter free from residue and scum and having sufficient surface smoothness. Furthermore, the composition attains high solubility of a coating to an alkaline developer and high product yield even if developing is performed by the shower developing method.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0012]

The present invention will be described in detail, below.

Radiation-sensitive Composition for Forming Colored Layer

- (A) Pigment -

In the present invention, the pigment is not particularly limited as long as it contains at least one pigment selected from the group consisting of red pigments, green pigments and blue pigments. Either an organic pigment or an inorganic pigment may be used. Of them, the organic pigment is particularly preferred since the color filter requires emission of highly-pure and highly transmissible color and heat resistance.

Examples of the organic pigment may include compounds classified in pigments based on the Color Index, and more specifically, the compounds assigned with the Color Index (C.I.) numbers as set forth below.

[0013]

As the red pigments, C.I. pigment red 1, C.I. pigment red 2, C.I. pigment red 5, C.I. pigment red 17, C.I. pigment red 31, C.I. pigment red 32, C.I. pigment red 41, C.I. pigment red 122, C.I. pigment red 123, C.I. pigment red 144, C.I. pigment red 149, C.I. pigment red 166, C.I. pigment red 168, C.I. pigment red 170, C.I. pigment red 171, C.I. pigment red 175, C.I. pigment red 176, C.I. pigment red 177, C.I. pigment red 178, C.I.

pigment red 179, C.I. pigment red 180, C.I. pigment red 185, C.I. pigment red 187, C.I. pigment red 202, C.I. pigment red 206, C.I. pigment red 207, C.I. pigment red 209, C.I. pigment red 214, C.I. pigment red 220, C.I. pigment red 221, C.I. pigment red 224, C.I. pigment red 242, C.I. pigment red 243, C.I. pigment red 254, C.I. pigment red 255, C.I. pigment red 262, C.I. pigment red 264 and C.I. pigment red 272;

[0014]

As the green pigments, C.I. pigment green 7, C.I. pigment green 36 and C.I. pigment green 58;

As the blue pigments, C.I. pigment blue 15, C.I. pigment blue 15:3, C.I. pigment blue 15:4, C.I. pigment blue 15:6, C.I. pigment blue 60 and C.I. pigment blue 80.

Usually in preparing a radiation-sensitive composition for forming a colored layer in red, green or blue, toning is generally performed by using a yellow pigment, a purple pigment and others. Examples thereof include specifically those assigned with the Color Index (C.I.) Numbers as set forth below.

[0015]

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. 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 5, C.I. pigment orange 13, C.I. pigment orange 14, C.I. pigment orange 24, C.I. pigment orange 34, C.I. pigment orange 36, C.I. pigment orange 38, C.I. pigment orange 40, C.I. pigment orange 43, C.I. pigment orange 46, C.I. pigment orange 49, C.I. pigment orange 61, C.I. pigment orange 64, C.I. pigment orange 68, C.I. pigment orange 70, C.I. pigment orange 71, C.I. pigment orange 72, C.I. pigment orange 73 and C.I. pigment orange 74;

[0016]

C.I. pigment violet 1, C.I. pigment violet 19, C.I. pigment violet 23, C.I. pigment violet 29, C.I. pigment violet 32, C.I. pigment violet 36 and C.I. pigment violet 38;

C.I. pigment blown 23 and C.I. pigment blown 25; and C.I. pigment black 1 and C.I. pigment black 7.

These organic pigments can be used alone or as a mixture of two or more thereof.

[0017]

Of these organic pigments, at least one pigment selected from the group consisting of C.I. pigment red 177, C.I. pigment red 242, C.I. pigment red 254, C.I. pigment green 7, C.I. pigment green 36, C.I. pigment

green 58, C.I. pigment blue 15:3, C.I. pigment blue 15:4, C.I. pigment blue 15:6, C.I. pigment blue 60, C.I. pigment blue 80, C.I. pigment yellow 83, C.I. pigment yellow 138, C.I. pigment yellow 139, C.I. pigment yellow 150, C.I. pigment yellow 180 and C.I. pigment violet 23, is preferred.

[0018]

In the present invention, the organic pigment can be purified by a re-crystallization method, a re-sedimentation method, a solvent cleaning method, a sublimation method, a vacuum-heating method or a combination thereof and then put in use.

[0019]

Examples of the inorganic pigment may include titanium oxide, barium sulfate, calcium carbonate, zinc white, lead sulfate, yellow lead, zinc yellow, red iron oxide (iron oxide red (III)), cadmium red, ultramarine blue, iron blue, chromic oxide green, cobalt green, invar steel, titanium black, synthesized iron black and carbon black.

These inorganic pigments can be used alone or as a mixture of two or more thereof.

[0020]

Further, in the present invention, one or more dyes and natural colorants may be used in combination with the above pigments, as needed.

[0021]

In the present invention, the pigment may be used after the surface of the particles thereof is modified with a polymer if desired. Examples of the polymer for use in modifying the surface of the pigment particles may include polymers described in JP-A-8-259876 and various types of polymers or oligomers for dispersing pigment particles available in the market.

[0022]

In the present invention, the content of the pigment (A) is usually 30 to 60 wt%, and preferably 30 to 50 wt% based on the total weight of the composition except the solvent (F) according to the present invention in order to obtain sufficient chromaticity and development property.

- (B) Dispersant -

[0023]

As the dispersant (B) in the present invention, an appropriate dispersant such as a cationic, anionic, nonionic or amphoteric dispersant can be used. However, to stably disperse fine pigment particles, which can realize a color liquid crystal display device providing a high contrast ratio exceeding 1000:1, a dispersant having a high amine value (hereinafter referred to as a "high amine-value dispersant) of 70 to 400 (unit: mgKOH/g) is preferably contained and more preferably, a dispersant having an amine value of 70 to 200 is contained. The amine value used herein refers to a value (mg) of KOH,

which is equivalent to HCl required to neutralize a dispersant solid content (1 g).

[0024]

Examples of the high amine-value dispersant may include Disperbyk 106 (non-volatile content = 85%, amine value = 74, manufactured by BYK Chemie (BYK)); Disperbyk 108 (non-volatile content = 97%, amine value = 71, manufactured by BYK Chemie (BYK)); Disperbyk 140 (non-volatile content = 52%, amine value = 76, manufactured by BYK Chemie (BYK)); Disperbyk 142 (non-volatile content = 60%, amine value = 43, manufactured by BYK Chemie (BYK)); Disperbyk 145 (non-volatile content = 100%, amine value = 71, manufactured by BYK Chemie (BYK)); Disperbyk 2150 (non-volatile content = 52%, amine value = 57, manufactured by BYK Chemie (BYK)); and AJISPER PB-711 (non-volatile content = 40%, amine value = 45, manufactured by Ajinomoto Fine-Techno Co., Inc.).

[0025]

Examples of the dispersant except the high amine-value dispersant may include polyoxyethylene alkyl ethers such as polyoxyethylene lauryl ether, polyoxyethylene stearyl ether and polyoxyethylene oleyl ether; polyoxyethylene alkyl phenyl ethers such as polyoxyethylene-n-octylphenyl ether and polyoxyethylene-n-nonyl phenyl ether; polyethylene glycol di-fatty acid esters such as polyethylene glycol dilaurate and polyethylene glycol distearate; sorbitan fatty acid

esters; fatty acid modified polyesters; tertiary amine modified polyurethanes and polyethyleneimines. Examples of the dispersant other than them may include, by trade name, KP (manufactured by Shin-Etsu Chemical Co., Ltd.), Polyflow (manufactured by Kyoeisha Chemical Co., Ltd.), F top (manufactured by Tochem Products Co., Ltd.), Magafac (manufactured by DIC corporation), Florard (manufactured by Sumitomo 3M), Asahi guard, Surflon (manufactured by Asahi Glass Co., Ltd.), Disperbyk-101, Disperbyk-103, Disperbyk-110, Disperbyk-111, Disperbyk-160, Disperbyk-161, Disperbyk-162, Disperbyk-163, Disperbyk-164, Disperbyk-165, Disperbyk-166, Disperbyk-170, Disperbyk-182, Disperbyk-2000, Disperbyk-2001, Disperbyk-2020 (manufactured by BYK Chemie (BYK)); Solsperse S5000, Solsperse 12000, Solsperse 17000, Solsperse 20000, Solsperse 22000, Solsperse 24000, Solsperse 24000GR, Solsperse 26000, Solsperse 27000, Solsperse 28000 (manufactured by The Lubrizol Corporation), EFKA46, EFKA 47 (EFKA chemicals), and AJISPER PB-821, AJISPER PB-822 (manufactured by Ajinomoto Fine-Techno Co., Inc.).

In the present invention, these dispersants can be used alone or as a mixture of two or more thereof.

[0026]

In the present invention, the content of the dispersant in terms of solid content is preferably 1 to 60 parts by weight, more preferably 3 to 50 parts by weight based on 100 parts by weight of the pigment (A) in

viewpoints of storage stability and development property of a composition.

[0027]

- (C) Alkali-soluble resin -

In the present invention, the alkali-soluble resin (C) is not particularly limited as long as it serves as a binder for the pigment (A) and it has solubility to a developer to be used in a developing step for manufacturing a color filter, particularly preferably, to an alkaline developer. Of such resins, an alkali-soluble resin having a carboxyl group is preferred. In particular, a copolymer containing a carboxyl group (hereinafter referred to as a "carboxyl group-containing copolymer") is preferred, which is a copolymer of an unsaturated ethylene monomer (hereinafter referred to as a "carboxyl group-containing unsaturated monomer") containing one or more carboxylic groups and another copolymerizable unsaturated ethylene monomer (hereinafter, referred to as a "co-polymerizable unsaturated monomer").

[0028]

Examples of the carboxyl group-containing unsaturated monomer may include:
unsaturated monocarboxylic acids such as (meth)acrylic acid, crotonic acid, α -chloroacrylic acid and cinnamic acid;
unsaturated dicarboxylic acids or anhydrides thereof such as maleic acid, maleic anhydride, fumaric acid, itaconic

acid, itaconic anhydride, citraconic acid, citraconic anhydride and mesaconic acid;
trivalent or higher unsaturated polycarboxylic acids or anhydrides thereof;
mono[(meth)acryloyloxyalkyl] esters of divalent or higher polycarboxylic acids such as mono[2-(meth)acryloyloxyethyl] succinate and mono[2-(meth)acryloyloxyethyl] phthalate; and
mono(meth)acrylates of a polymer having a carboxyl group and a hydroxyl group on the both ends such as ω -carboxypolycaprolactone mono(meth)acrylate.

Of these carboxyl group-containing unsaturated monomers, mono[2-acryloyloxyethyl] succinate and mono[2-acryloyloxyethyl] phthalate are commercially available under the trade names of light ester HOA-MS and light ester HOA-MPE (both are manufactured by Kyoeisha Chemical Co., Ltd.), respectively.

The above carboxyl group-containing unsaturated monomers can be used alone or as a mixture of two or more thereof.

[0029]

Furthermore, examples of the co-polymerizable unsaturated monomer may include
maleimide;
N-substituted maleimides such as N-phenylmaleimide, N-o-hydroxyphenylmaleimide, N-m-hydroxyphenylmaleimide, N-p-hydroxyphenylmaleimide, N-benzylmaleimide, N-

cyclohexylmaleimide, N-succinimidyl-3-maleimide benzoate, N-succinimidyl-4-maleimide butyrate, N-succinimidyl-6-maleimide caproate, N-succinimidyl-3-maleimide propionate and N-(acridinyl)maleimide;

aromatic vinyl compounds such as styrene, α -methylstyrene, o-vinyltoluene, m-vinyltoluene, p-vinyltoluene, p-chlorostyrene, o-methoxystyrene, m-methoxystyrene, p-methoxystyrene, p-hydroxy- α -methylstyrene, o-vinylbenzyl methyl ether, m-vinylbenzyl methyl ether, p-vinylbenzyl methyl ether, o-vinylbenzyl glycidyl ether, m-vinylbenzyl glycidyl ether and p-vinylbenzyl glycidyl ether;

indenes such as indene and 1-methylindene;

[0030]

unsaturated carboxylic acid esters such as methyl (meth)acrylate, ethyl (meth)acrylate, n-propyl (meth)acrylate, i-propyl (meth)acrylate, n-butyl (meth)acrylate, i-butyl (meth)acrylate, sec-butyl (meth)acrylate, t-butyl (meth)acrylate, 2-ethylhexyl (meth)acrylate, 2-hydroxyethyl (meth)acrylate, 2-hydroxypropyl (meth)acrylate, 3-hydroxypropyl (meth)acrylate, 2-hydroxybutyl (meth)acrylate, 3-hydroxybutyl (meth)acrylate, 4-hydroxybutyl (meth)acrylate, allyl (meth)acrylate, benzyl (meth)acrylate, cyclohexyl (meth)acrylate, phenyl (meth)acrylate, 2-methoxyethyl (meth)acrylate, 2-phenoxyethyl (meth)acrylate, methoxydiethyleneglycol (meth)acrylate, methoxytriethyleneglycol (meth)acrylate,

methoxypropyleneglycol (meth)acrylate,
methoxydipropyleneglycol (meth)acrylate, isobornyl
(meth)acrylate, tricyclo[5.2.1.0^{2,6}]decan-8-yl
(meth)acrylate, 2-hydroxy-3-phenoxypropyl (meth)acrylate,
glycerol mono(meth)acrylate, 4-hydroxyphenyl
(meth)acrylate and EO-modified (meth)acrylate of
paracumyl phenol;

[0031]

unsaturated aminoalkyl carboxylates such as 2-aminoethyl
(meth)acrylate, 2-dimethylaminoethyl (meth)acrylate, 2-
aminopropyl (meth)acrylate, 2-dimethylaminopropyl
(meth)acrylate, 3-aminopropyl (meth)acrylate and 3-
dimethylaminopropyl (meth)acrylate;

unsaturated glycidyl carboxylates such as glycidyl
(meth)acrylate;

vinyl carboxylates such as vinyl acetate, vinyl
propionate, vinyl butyrate and vinyl benzoate;

unsaturated ethers such as vinyl methyl ether, vinyl
ethyl ether and allyl glycidyl 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;

aliphatic conjugated dienes such as 1,3-butadiene,
isoprene and chloroprene; and

macromonomers each having a mono(meth)acryloyl group at
an end of a polymer molecule chain such as polystyrene,

polymethyl (meth)acrylate, poly-n-butyl (meth)acrylate and polysiloxane.

These co-polymerizable unsaturated monomers can be used alone or as a mixture of two or more thereof.

[0032]

A preferred example of the carboxyl group-containing copolymer in the present invention is a copolymer (hereinafter referred to as a "carboxyl group-containing copolymer (C1) "), of (c1) a carboxyl group-containing unsaturated monomer, which contains (meth)acrylic acid as an essential component and optionally contains mono[2-(meth)acryloyloxyethyl] succinate and/or ω -carboxypolycaprolactone mono(meth)acrylate; (c2) the N-substituted maleimide; and (c3) at least one of other polymerizable unsaturated monomers selected from the group consisting of styrene, α -methylstyrene, p-hydroxy- α -methylstyrene, methyl (meth)acrylate, n-butyl (meth)acrylate, 2-ethylhexyl (meth)acrylate, 2-hydroxyethyl (meth)acrylate, allyl (meth)acrylate, benzyl (meth)acrylate, glycerol mono(meth)acrylate, 4-hydroxyphenyl (meth)acrylate, EO-modified (meth)acrylate of paracumyl phenol, polystyrene macromonomer and polymethyl (meth)acrylate macromonomer.

[0033]

Specific examples of the carboxyl group-containing copolymer (C1) may preferably include

(meth)acrylic acid/N-phenylmaleimide/styrene/benzyl
(meth)acrylate copolymers,
(meth)acrylic acid/N-m-
hydroxyphenylmaleimide/styrene/benzyl (meth)acrylate
copolymers,
(meth)acrylic acid/N-p-
hydroxyphenylmaleimide/styrene/benzyl (meth)acrylate
copolymers,
(meth)acrylic acid/N-cyclohexylmaleimide/styrene/benzyl
(meth)acrylate copolymers,
(meth)acrylic acid/N-phenylmaleimide/ α -
methylstyrene/benzyl (meth)acrylate copolymers,
(meth)acrylic acid/N-phenylmaleimide/styrene/n-butyl
(meth)acrylate copolymers,
(meth)acrylic acid/N-phenylmaleimide/styrene/2-ethylhexyl
(meth)acrylate copolymers,
(meth)acrylic acid/N-phenylmaleimide/p-hydroxy- α -
methylstyrene/benzyl (meth)acrylate copolymers,
(meth)acrylic acid/N-phenylmaleimide/styrene/n-butyl
(meth)acrylate copolymers,
(meth)acrylic acid/N-phenylmaleimide/styrene/2-ethylhexyl
(meth)acrylate copolymers,
(meth)acrylic acid/N-phenylmaleimide/styrene/2-
hydroxyethyl (meth)acrylate/benzyl (meth)acrylate
copolymers,
(meth)acrylic acid/N-phenylmaleimide/styrene/benzyl
(meth)acrylate/glycerol mono(meth)acrylate copolymers,

(meth)acrylic acid/N-p-hydroxyphenylmaleimide/styrene/benzyl (meth)acrylate/glycerol mono(meth)acrylate copolymers, (meth)acrylic acid/N-phenylmaleimide/styrene/phenyl (meth)acrylate/2-hydroxyethyl (meth)acrylate/polystyrene macromonomer copolymers, (meth)acrylic acid/N-phenylmaleimide/styrene/phenyl (meth)acrylate/2-hydroxyethyl (meth)acrylate/polymethyl methacrylate macromonomer copolymers, (meth)acrylic acid/mono[2-(meth)acryloyloxyethyl] succinate/N-phenylmaleimide/styrene/benzyl (meth)acrylate copolymers, (meth)acrylic acid/mono[2-(meth)acryloyloxyethyl] succinate/N-p-hydroxyphenylmaleimide/styrene/benzyl (meth)acrylate copolymers, (meth)acrylic acid/mono[2-(meth)acryloyloxyethyl] succinate/N-phenylmaleimide/styrene/allyl (meth)acrylate copolymers, (meth)acrylic acid/mono[2-(meth)acryloyloxyethyl] succinate/N-cyclohexylmaleimide/styrene/allyl (meth)acrylate copolymers, (meth)acrylic acid/mono[2-(meth)acryloyloxyethyl] succinate/N-cyclohexylmaleimide/styrene/benzyl (meth)acrylate copolymers, (meth)acrylic acid/ ω -carboxypolycaprolactone mono(meth)acrylate/N-m-

hydroxyphenylmaleimide/styrene/benzyl (meth)acrylate copolymers,
(meth)acrylic acid/ ω -carboxypolycaprolactone mono(meth)acrylate/N-p-hydroxyphenylmaleimide/styrene/benzyl (meth)acrylate copolymers,
(meth)acrylic acid/ ω -carboxypolycaprolactone mono(meth)acrylate/N-phenylmaleimide/styrene/benzyl (meth)acrylate/glycerol mono(meth)acrylate copolymers and (meth)acrylic acid/ ω -carboxypolycaprolactone mono(meth)acrylate/N-p-hydroxyphenylmaleimide/styrene/benzyl (meth)acrylate/glycerol mono(meth)acrylate copolymers.
[0034]

Examples of a carboxyl group-containing copolymer except the carboxyl group-containing copolymer (C1) may include

(meth)acrylic acid/methyl (meth)acrylate copolymers,
(meth)acrylic acid/benzyl (meth)acrylate copolymers,
(meth)acrylic acid/2-hydroxyethyl (meth)acrylate/benzyl (meth)acrylate copolymers,
(meth)acrylic acid/methyl (meth)acrylate/polystyrene macromonomer copolymers,
(meth)acrylic acid/methyl (meth)acrylate/polymethyl methacrylate macromonomer copolymers,
(meth)acrylic acid/benzyl (meth)acrylate/polystyrene macromonomer copolymers,

(meth)acrylic acid/benzyl (meth)acrylate/polymethyl methacrylate macromonomer copolymers, (meth)acrylic acid/2-hydroxyethyl (meth)acrylate/benzyl (meth)acrylate/polystyrene macromonomer copolymers and (meth)acrylic acid/2-hydroxyethyl (meth)acrylate/benzyl (meth)acrylate/polymethyl methacrylate macromonomer copolymers.

[0035]

In the carboxyl group-containing copolymer, the copolymerization ratio of a carboxyl group-containing unsaturated monomer is preferably 5 to 50 wt%, and more preferably, 10 to 40 wt%. When the copolymerization ratio herein is less than 5 wt%, the solubility of the resultant radiation-sensitive composition to an alkaline developer is likely to decrease. On the other hand, when the copolymerization ratio exceeds 50 wt%, the solubility to the alkaline developer becomes excessively large. As a result, when a developing operation is performed with the alkaline developer, pixels readily peel off from a substrate and the surface film of the pixels is likely to be rough.

[0036]

In the present invention, a carboxyl group-containing copolymer obtained by copolymerizing an unsaturated compound having a hydroxy group such as 2-hydroxyethyl (meth)acrylate is reacted with an unsaturated isocyanate compound such as 2-

(meth)acryloyloxyethyl isocyanate to introduce a polymerizable unsaturated bond to a side chain of the carboxyl group-containing copolymer.

[0037]

The weight average molecular weight (hereinafter referred to as "Mw") of a carboxyl group-containing copolymer according to the present invention in terms of polystyrene and measured by gel permeation chromatography (GPC, elution solvent: tetrahydrofuran) is usually 1,000 to 45,000 and preferably 3,000 to 20,000.

The number average molecular weight (hereinafter referred to as "Mn") of the carboxyl group-containing copolymer according to the present invention in terms of polystyrene and measured by gel permeation chromatography (GPC, elution solvent: tetrahydrofuran) is usually 1,000 to 45,000 and preferably 3,000 to 20,000.

In this case, when Mw is less than 1,000, the remaining rate of the resultant coating reduces, and pattern shape and heat resistance deteriorate. Furthermore, electric properties degrade. On the other hand, when Mw exceeds 45,000, resolution decreases and pattern shape deteriorates. Furthermore, dry foreign substances may easily generate during a coating process by a slit-nozzle method.

[0038]

The carboxyl group-containing copolymer can be produced, for example, by polymerizing a carboxyl group-

containing unsaturated monomer and a copolymerizable unsaturated monomer in an appropriate solvent in the presence of a radical polymerization initiator such as 2,2'-azobisisobutyronitrile, 2,2'-azobis(2,4-dimethylvaleronitrile) or 2,2'-azobis(4-methoxy-2,4-dimethylvaleronitrile).

[0039]

The carboxyl group-containing copolymer, after radical polymerization of unsaturated monomers are performed as mentioned above, can be purified by a reprecipitation method using two or more organic solvents different in polarization. To describe more specifically, after polymerization, the carboxyl group-containing copolymer is added in a good solvent, and the mixture is filtrated or centrifuged to remove insoluble impurities, if necessary. Thereafter, the resultant solution is poured in a large amount of precipitating agent (poor solvent, usually, 5 to 10 fold based on the volume of the polymer solution) to reprecipitate the copolymer to purify it. At this time, of the impurities remaining in the solution, the impurities soluble in the precipitating agent are left in a liquid phase and separated from the purified copolymer (B1).

Examples of a combination of good solvent/precipitating agent to be used in the reprecipitation method may include diethylene glycol monomethyl ether acetate/n-hexane, methyl ethyl ketone/n-

hexane, diethylene glycol monomethyl ether acetate/n-heptane and methyl ethyl ketone/n-heptane.

[0040]

The carboxyl group-containing copolymer can be produced through living radical polymerization of constituents, unsaturated compounds in the presence of a radical polymerization initiator such as 2,2'-azobis(isobutyronitrile), 2,2'-azobis(2,4-dimethylvaleronitrile) or 2,2'-azobis(4-methoxy-2,4-dimethylvaleronitrile) and a molecular-weight controlling agent serving as an iniferter such as pyrazole-1-dithiocarboxylic acid cyano(dimethyl)methyl ester, pyrazole-1-dithiocarboxylic acid benzyl ester, tetraethylthiuram disulfide, bis(pyrazol-1-yl thiocarbonyl)disulfide, bis(3-methyl-pyrazol-1-yl thiocarbonyl)disulfide, bis(4-methyl-pyrazol-1-yl thiocarbonyl)disulfide, bis(5-methyl-pyrazol-1-yl thiocarbonyl)disulfide, bis(3,4,5-trimethyl-pyrazol-1-yl thiocarbonyl)disulfide, bis(pyrrol-1-yl thiocarbonyl)disulfide, bis(thiobenzoyl)disulfide, bis(n-octylsulfanylthiocarbonyl)disulfide or bis(n-dodecylsulfanylthiocarbonyl)disulfide, in an inert solvent at a reaction temperature of usually 0 to 150°C and preferably 50 to 120°C.

[0041]

In the present invention, the alkali-soluble resins can be used alone or as a mixture of two or more thereof.

The content of the alkali-soluble resin in the present invention is preferably 10 to 1,000 parts by weight, and more preferably 20 to 500 parts by weight based on the 100 parts by weight of the pigment (A). In this case, when the content of the alkali-soluble resin is less than 10 parts by weight, development property with alkali may decrease and scum and film residue may occur on unexposed portions of a substrate and a light shielding layer. On the other hand, when the content exceeds 1,000 parts by weight, the content of the pigment relatively decreases. As a result, it may be difficult to attain a desired color density as a thin film.

[0042]

- (D) Polyfunctional Monomer -

The polyfunctional monomer in the present invention includes a polyfunctional monomer represented by the above formula (1) (hereinafter referred to as a "carboxyl group-containing pentafunctional monomer").

In the formula (1), examples of the straight or branched alkylene group having 2 to 8 carbon atoms and represented by R_2 may include an ethylene group, a propylene group, a trimethylene group, a tetramethylene group, a pentamethylene group and a hexamethylene group. Of these, the alkylene group having 2 to 4 carbon groups is preferred. Examples of the straight or branched alkenylene group having 2 to 8 carbon atoms may include a vinyl group and a 1-methyldiene-ethylene group(-

C(=CH₂)CH₂-). Examples of the cyclohexylene group partly having an unsaturated bond may include a cyclohexenylene group. Furthermore, examples of a group by which the phenylene group, the cyclohexylene group and the unsaturated cyclohexylene group may be substituted include an alkyl group having 1 to 4 carbon atoms such as a methyl group and an ethyl group, a halogen atom and an alkoxy group having 1 to 4 carbon atoms.

In the formula (1), as R₂, a methylene group or an alkylene group having 2 to 4 carbon atoms is preferred and an ethylene group is particularly preferred.

[0043]

Specific examples of the carboxyl group-containing pentafunctional monomer may include monoester compounds of dipentaerythritol penta(meth)acrylate and any one of dicarboxylic acids such as malonic acid, succinic acid, glutaric acid, adipic acid, pimelic acid, suberic acid, itaconic acid, terephthalic acid and hexahydrophthalic acid.

Of these carboxyl group-containing pentafunctional monomers, a mixture of monoester compounds of dipentaerythritol hexaacrylate, dipentaerythritol pentaacrylate and dipentaerythritol pentaacrylate and succinic acid is commercially available under the trade name of TO-1382 (manufactured by Toagosei Co., Ltd.).

The carboxyl group-containing pentafunctional monomers can be used alone or as a mixture of two or more thereof.

[0044]

In the present invention, a different polyfunctional monomer may be used in combination with the carboxyl group-containing pentafunctional monomer. Examples thereof may include

di(meth)acrylates of alkylene glycols such as ethylene glycol and propylene glycol;

di(meth)acrylates of polyalkylene glycols such as polyethylene glycol and polypropylene glycol;

poly(meth)acrylates of polyhydric alcohols having three or more valences such as glycerin, trimethylolpropane, pentaerythritol and dipentaerythritol;

oligo(meth)acrylates such as polyesters, epoxy resins, urethane resins, alkyd resins, silicone resins and spiran resins;

di(meth)acrylates of polymers having hydroxyl groups at the both ends such as poly 1,3-butadiene having hydroxyl groups at the both ends, polyisoprene having hydroxyl groups at the both ends and polycaprolactone having hydroxyl groups at the both ends; and

tris[2-(meth)acryloyloxyethyl]phosphate.

[0045]

Of these polyfunctional monomers, poly(meth)acrylates of polyhydric alcohols having three

or more valences are preferred. Specifically, preferred examples thereof include trimethylolpropane triacrylate, trimethylolpropane trimethacrylate, pentaerythritol triacrylate, pentaerythritol trimethacrylate, pentaerythritol tetraacrylate, pentaerythritol tetramethacrylate, dipentaerythritol pentaacrylate, dipentaerythritol pentamethacrylate, dipentaerythritol hexaacrylate and dipentaerythritol hexamethacrylate. Particularly, trimethylolpropane triacrylate, pentaerythritol triacrylate and dipentaerythritol hexaacrylate are preferred because a colored layer has high strength and excellent surface smoothness, and scum and film residues etc. unlikely occur on unexposed portions of a substrate and on a light shielding layer.

These different polyfunctional monomers can be used alone or as a mixture of two or more thereof.

[0046]

The total amount of (D) the carboxyl group-containing pentafunctional monomer and the different polyfunctional monomer used in the present invention is usually 5 to 500 parts by weight and preferably 20 to 300 parts by weight, based on 100 parts by weight of the alkali-soluble resin (C). In this case, when the content of the polyfunctional monomer is excessively low, the strength and surface smoothness of the colored layer may decrease. On the other hand, when the content is excessively large, for example, development property with

alkali may decrease, and scum and film residue etc. readily occur on unexposed portions of a substrate and on a light shielding layer.

[0047]

Further in the present invention, the content of the carboxyl group-containing pentafunctional monomer is usually 20 to 80 wt%, and preferably 30 to 70 wt% based on the total of the carboxyl group-containing pentafunctional monomer and the different polyfunctional monomer. In this case, when the content of the carboxyl group-containing pentafunctional monomer is excessively low, a desired effect cannot be obtained. On the other hand, when the content is excessively large, the surface smoothness of the resultant colored layer may be insufficient.

[0048]

- (E) Photopolymerization Initiator -

The photopolymerization initiator of the present invention is a compound which generates radicals which can start polymerization of (D) the above polyfunctional monomer by exposure to radiation such as visible rays, ultraviolet rays, far-ultraviolet rays, electron beams or X-rays.

Examples of the photopolymerization initiator include acetophenone compounds, biimidazole compounds, triazine compounds, O-acyl oxime compounds, onium salt compounds, benzoin compounds, benzophenone compounds, α -

diketone compounds, multinuclear quinone compounds, xanthone compounds, diazo compounds and imidosulfonate compounds. These compounds refer to components generating active radicals or active acid or both of them by exposure.

[0049]

In the present invention, the photopolymerization initiators can be used alone or as a mixture of two or more thereof. However, as the photopolymerization initiator to be used in the present invention, at least one selected from the group consisting of acetophenone compounds, biimidazole compounds, triazine compounds and O-acyl oxime compounds is preferred.

[0050]

In the present invention, the general content of the photopolymerization initiator is usually 0.01 to 120 parts by weight, and preferably 1 to 100 parts by weight based on 100 parts by weight of (D) the polyfunctional monomer. In this case, when the content of the photopolymerization initiator is excessively low, curing by exposure becomes insufficient. As a result, a color filter in which patterns of a colored layer are arranged in accordance with a predetermined array may not be easily obtained. On the other hand, when the content is excessively large, the formed colored layer is likely to peel off from a substrate during a developing process.

[0051]

Specific examples of the acetophenone compounds of the photopolymerization initiator preferred in the present invention, include 2-hydroxy-2-methyl-1-phenylpropan-1-one, 2-methyl-1-[4-(methylthio)phenyl]-2-morpholinopropanon-1-one, 2-benzyl-2-dimethylamino-1-(4-morpholinophenyl)butanon-1-one, 1-hydroxycyclohexyl phenyl ketone, 2,2-dimethoxy-1,2-diphenylethan-1-one and 1,2-octanedione.

Of these acetophenone compounds, 2-methyl-1-[4-(methylthio)phenyl]-2-morpholinopropanon-1-one, 2-benzyl-2-dimethylamino-1-(4-morpholinophenyl)butaneon-1-one and 1,2-octanedione and the like are particularly preferred.

The above acetophenone compounds can be used alone or as a mixture of two or more thereof.

[0052]

In the present invention, the content of the acetophenone compound to be used as the photopolymerization initiator is usually 0.01 to 80 parts by weight, preferably 1 to 70 parts by weight and more preferably 1 to 60 parts by weight based on 100 parts by weight of (D) the polyfunctional monomer. In this case, when the content of the acetophenone compound excessively low, curing by exposure becomes insufficient. As a result, a color filter in which patterns of a colored layer are arranged in accordance with predetermined array may not be easily obtained. On the other hand, when the content is excessively large, the formed colored layer is

likely to peel off from a substrate during a developing process.

[0053]

Further, specific examples of the above biimidazole compound may include 2,2'-bis(2-chlorophenyl)-4,4',5,5'-tetrakis(4-ethoxycarbonylphenyl)-1,2'-biimidazole, 2,2'-bis(2-bromophenyl)-4,4',5,5'-tetrakis(4-ethoxycarbonylphenyl)-1,2'-biimidazole, 2,2'-bis(2-chlorophenyl)-4,4',5,5'-tetraphenyl-1,2'-biimidazole, 2,2'-bis(2,4-dichlorophenyl)-4,4',5,5'-tetraphenyl-1,2'-biimidazole, 2,2'-bis(2,4,6-trichlorophenyl)-4,4',5,5'-tetraphenyl-1,2'-biimidazole, 2,2'-bis(2-bromophenyl)-4,4',5,5'-tetraphenyl-1,2'-biimidazole, 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-1,2'-biimidazole.

[0054]

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-1,2'-biimidazole, 2,2'-bis(2,4,6-trichlorophenyl)-4,4',5,5'-tetraphenyl-1,2'-biimidazole and the like are preferred. Particularly, 2,2'-bis(2-chlorophenyl)-4,4',5,5'-tetraphenyl-1,2'-biimidazole is preferred.

These biimidazole compounds are excellent in solubility to a solvent and free from generation of foreign substances such as insoluble matter and deposit.

In addition, since they have high sensitivity, a curing reaction can sufficiently proceed by exposure in a small amount of energy and no curing reaction occurs in unexposed portions. Therefore, in the coating after exposure, cured portions insoluble in the developer can be distinguishable divided from uncured portions highly soluble in the developer. In this way, a high-definition color filter in which colored layer patterns having no undercut are arranged in accordance with a predetermined array can be formed.

The above biimidazole compounds can be used alone or as a mixture of two or more thereof.

[0055]

In the present invention, the content of the biimidazole compound to be used as a photopolymerization initiator is usually 0.01 to 40 parts by weight, preferably 1 to 30 parts by weight, and further preferably 1 to 20 parts by weight based on 100 parts by weight of (D) the polyfunctional monomer. In this case, when the content of the biimidazole compound is excessively low, curing by exposure becomes insufficient. As a result, a color filter in which patterns of a colored layer are arranged in accordance with a predetermined array may not be easily obtained. On the other hand, when the content is excessively large, the formed colored layer is likely to peel off from a

substrate and the surface of a colored layer may readily roughen during a developing process.

[0056]

In the present invention, when the biimidazole compound is used as the photopolymerization initiator, a hydrogen donor as described below is preferably used in combination because it can further improve the sensitivity.

The term "hydrogen donor" as used herein refers to a compound which can donate a hydrogen atom to a radical generated from a biimidazole compound by exposure.

As the hydrogen donor in the present invention, mercaptan compounds and amine compounds etc., defined below are preferred.

[0057]

The above mercaptan compound is a compound which has a benzene ring or a heterocyclic ring as a mother nucleus, and one or more, preferably 1 to 3, and more preferably 1 to 2 mercapto groups which are directly bound to the mother nucleus (hereinafter, referred to as the "mercaptan hydrogen donor").

The above amine compound is a compound which has a benzene ring or a heterocyclic ring as a mother nucleus and one or more, preferably 1 to 3 and more preferably 1 to 2 amino groups which are directly bound to the mother nucleus (hereinafter, referred to as the "amine hydrogen donor").

It is to be noted that these hydrogen donors also may have a mercapto group and an amino group at the same time.

[0058]

The hydrogen donor will be more specifically described below.

The mercaptan hydrogen donor can have one or more benzene rings or heterocyclic rings, and can have both thereof. When the donor has two or more of these rings, a fused ring may be formed or not.

In addition, when the mercaptan hydrogen donor has two or more mercapto groups, as long as at least one free mercapto group remains, one or more remaining mercapto groups may be substituted with an alkyl, aralkyl or aryl group. Furthermore, as long as at least one free mercapto group remains, the donor may have a structural unit in which two sulfur atoms are bound to each other through a divalent organic group such as an alkylene group or a structural unit in which two sulfur atoms are bound to each other to form a disulfide bond.

Furthermore, the mercaptan hydrogen donor may be substituted at a position other than the mercapto group, with a carboxyl group, an alkoxycarbonyl group, a substituted alkoxycarbonyl group, a phenoxycarbonyl group, a substituted phenoxycarbonyl group, a nitrile group or the like.

[0059]

Specific examples of the mercaptan hydrogen donor include 2-mercaptobenzothiazole, 2-mercaptobenzoxazole, 2-mercaptobenzimidazole, 2,5-dimercapto-1,3,4-thiadiazole and 2-mercapto-2,5-dimethylaminopyridine.

Of these mercaptan hydrogen donors, 2-mercaptobenzothiazole and 2-mercaptobenzoxazole are preferred, and 2-mercaptobenzothiazole is particularly preferred.

[0060]

Further, the amine hydrogen donor can have one or more benzene rings or heterocyclic rings, and can have both thereof, and when the donor has two or more of these rings, a fused ring may be formed or not.

Furthermore, in the amine hydrogen donor, one or more amino groups may be substituted with an alkyl group or a substituted alkyl group. Alternatively, the amine hydrogen donor may be substituted at a position other than the amino group with a carboxyl group, an alkoxycarbonyl group, a substituted alkoxycarbonyl group, a phenoxycarbonyl group, a substituted phenoxycarbonyl group, a nitrile group or the like.

[0061]

Specific examples of the amine hydrogen donor may include 4,4'-bis(dimethylamino)benzophenone, 4,4'-bis(diethylamino)benzophenone, 4-diethylaminoacetophenone, 4-dimethylaminopropiophenone, ethyl 4-

dimethylaminobenzoate, 4-dimethylaminobenzoic acid and 4-dimethylaminobenzonitrile.

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

It is to be noted that the amine hydrogen donor has a function as a sensitizer also when a radical generator other than the biimidazole compound is used.

[0062]

In the present invention, the hydrogen donor can be used alone or as a mixture of two or more thereof. However, at least one mercaptan hydrogen donor and at least one amine hydrogen donor are preferably used in combination. This is because the formed colored layer is unlikely to peel off from a substrate during a developing process and the strength and sensitivity of the colored layer are high.

Specific examples of the combination of the mercaptan hydrogen donor and the amine hydrogen donor may include 2-mercaptobenzothiazole/4,4'-bis(dimethylamino)benzophenone, 2-mercaptobenzothiazole/4,4'-bis(diethylamino)benzophenone, 2-mercaptobenzoxazole/4,4'-bis(dimethylamino)benzophenone and 2-mercaptobenzoxazole/4,4'-bis(diethylamino)benzophenone. More preferable combinations are 2-mercaptobenzothiazole/4,4'-

bis(diethylamino)benzophenone and 2-mercaptobenzoxazole/4,4'-bis(diethylamino)benzophenone. Particularly preferable combination is 2-mercaptobenzothiazole/4,4'-bis(diethylamino)benzophenone.

In the combination of the mercaptan hydrogen donor and the amine hydrogen donor, the weight ratio of the mercaptan hydrogen donor to the amine hydrogen donor is usually 1:1 to 1:4, and preferably 1:1 to 1:3.

[0063]

In the present invention, when the hydrogen donor is used in combination with the biimidazole compound, the content thereof is preferably 0.01 to 40 parts by weight, more preferably 1 to 30 parts by weight and particularly preferably 1 to 20 parts by weight, based on 100 parts by weight of (D) the polyfunctional monomer. In this case, when the content of the hydrogen donor is excessively low, the effect of improving the sensitivity tends to decrease. On the other hand, when the content is excessively large, the formed colored layer likely peels off from a substrate during a developing process.

[0064]

Further, specific examples of the above triazine compounds may include triazine compounds having a halomethyl group such as 2,4,6-tris(trichloromethyl)-s-triazine, 2-methyl-4,6-bis(trichloromethyl)-s-triazine, 2-[2-(5-methylfuran-2-yl)ethenyl]-4,6-bis(trichloromethyl)-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(trichloromethyl)-s-triazine, 2-(4-methoxyphenyl)-4,6-bis(trichloromethyl)-s-triazine, 2-(4-ethoxystyryl)-4,6-bis(trichloromethyl)-s-triazine and 2-(4-n-butoxyphenyl)-4,6-bis(trichloromethyl)-s-triazine.

[0065]

Of these triazine compounds, 2-[2-(3,4-dimethoxyphenyl)ethenyl]-4,6-bis(trichloromethyl)-s-triazine is particularly preferred.

The above triazine compounds can be used alone or as a mixture of two or more thereof.

[0066]

In the present invention, when the triazine compound is used as the photopolymerization initiator, the content thereof is preferably 0.01 to 40 parts by weight, more preferably 1 to 30 parts by weight and particularly preferably 1 to 20 parts by weight, based on 100 parts by weight of (D) the polyfunctional monomer. In this case, when the content of the triazine compound is excessively low, curing by exposure becomes insufficient. As a result, a color filter in which patterns of a colored layer are arranged in accordance with a predetermined array may not be easily obtained. On the other hand, when the content is excessively large, the formed colored

layer is likely to peel off from a substrate during a developing process.

[0067]

Further, specific examples of the above O-acyl oxime compound may include 1,2-heptanedione, 1-[4-(phenylthio)phenyl]-, -2-(O-benzoyl oxime); 1,2-octanedione, 1-[4-(phenylthio)phenyl]-, -2-(O-benzoyl oxime); 1,2-octanedione, 1-[4-(benzoyl)phenyl]-, -2-(O-benzoyl oxime); ethanone, 1-[9-ethyl-6-(2-methylbenzoyl)-9H-carbazol-3-yl]-, 1-(O-acetyloxime); ethanone, 1-[9-ethyl-6-(3-methylbenzoyl)-9H-carbazol-3-yl]-, 1-(O-acetyloxime); ethanone, 1-[9-ethyl-6-benzoyl-9H-carbazol-3-yl]-, 1-(O-acetyloxime); ethanone, 1-[9-ethyl-6-(2-methyl-4-tetrahydrofuranylbzoyl)-9H-carbazol-3-yl]-, 1-(O-acetyloxime); ethanone, 1-[9-ethyl-6-(2-methyl-4-tetrahydropyranylbzoyl)-9H-carbazol-3-yl]-, 1-(O-acetyloxime); ethanone, 1-[9-ethyl-6-(2-methyl-5-tetrahydrofuranylbzoyl)-9H-carbazol-3-yl]-, 1-(O-acetyloxime); ethanone, 1-[9-ethyl-6-(2-methyl-5-tetrahydropyranylbzoyl)-9H-carbazol-3-yl]-, 1-(O-acetyloxime); ethanone, 1-[9-ethyl-6-{2-methyl-4-(2,2-dimethyl-1,3-dioxolanyl)benzoyl}-9H-carbazol-3-yl]-, 1-(O-acetyloxime); ethanone, 1-[9-ethyl-6-(2-methyl-4-tetrahydrofuranylmethoxybenzoyl)-9H-carbazol-3-yl]-, 1-(O-acetyloxime); ethanone, 1-[9-ethyl-6-(2-methyl-4-tetrahydropyranylmethoxybenzoyl)-9H-carbazol-3-yl]-, 1-(O-acetyloxime); ethanone, 1-[9-ethyl-6-(2-methyl-5-

tetrahydrofuranylmethoxybenzoyl)-9H-carbazol-3-yl]-, 1-(O-acetyloxime); ethanone, 1-[9-ethyl-6-(2-methyl-5-tetrahydropyranylmethoxybenzoyl)-9H-carbazol-3-yl]-, 1-(O-acetyloxime); and ethanone, 1-[9-ethyl-6-{2-methyl-4-(2,2-dimethyl-1,3-dioxolanyl)methoxybenzoyl}-9H-carbazol-3-yl]-, 1-(O-acetyloxime).

[0068]

Of the O-acyl oxime compounds, 1,2-octanedione, 1-[4-(phenylthio)phenyl]-, - 2-(O-benzoyloxime); ethanone, 1-[9-ethyl-6-(2-methylbenzoyl)-9H-carbazol-3-yl]-, 1-(O-acetyloxime); ethanone, 1-[9-ethyl-6-(2-methyl-4-tetrahydrofuranylmethoxybenzoyl)-9H-carbazol-3-yl]-, 1-(O-acetyloxime); ethanone, 1-[9-ethyl-6-{2-methyl-4-(2,2-dimethyl-1,3-dioxolanyl)methoxybenzoyl}-9H-carbazol-3-yl]-, 1-(O-acetyloxime) and the like are particularly preferable.

The above O-acyl oxime compounds can be used alone or as a mixture of two or more thereof.

[0069]

In the present invention, the amount of the O-acyl oxime compound to be used as the photopolymerization initiator is preferably 0.01 to 80 parts by weight, more preferably 1 to 70 parts by weight and particularly preferably, 1 to 60 parts by weight based on 100 parts by weight of (D) the polyfunctional monomer. In this case, when the content of the O-acyl oxime compound excessively low, curing by exposure becomes insufficient. As a

result, a color filter in which patterns of a colored layer are arranged in accordance with a predetermined array may not be easily obtained. On the other hand, when the content is excessively large, the formed colored layer is likely to peel off from a substrate during a developing process.

[0070]

- Other Additives -

The radiation-sensitive composition for forming the colored layer of the present invention contains the above components (A) to (E) as essential components, but can also further contain other additives as required.

Examples of the other additives include: fillers such as glass and alumina; polymer compounds such as a polyvinyl alcohol and a poly(fluoroalkyl acrylate); surfactants such as a nonionic surfactant, a cationic surfactant and an anionic surfactant; adhesion promoters such as vinyltrimethoxysilane, vinyltriethoxysilane, vinyltris(2-methoxyethoxy)silane, N-(2-aminoethyl)-3-aminopropylmethyldimethoxysilane, N-(2-aminoethyl)-3-aminopropyltrimethoxysilane, 3-aminopropyltriethoxysilane, 3-glycidoxypropyltrimethoxysilane, 3-glycidoxypropylmethyldimethoxysilane, 2-(3,4-epoxycyclohexyl)ethyltrimethoxysilane, 3-chloropropylmethyldimethoxysilane, 3-chloropropyltrimethoxysilane, 3-methacryloyloxypropyltrimethoxysilane and 3-

mercaptopropyltrimethoxysilane; antioxidants such as 2,2'-thiobis(4-methyl-6-t-butylphenol) and 2,6-di-t-butylphenol; UV absorbers such as 2-(3-t-butyl-5-methyl-2-hydroxyphenyl)-5-chlorobenzotriazole and an alkoxybenzophenone; aggregation inhibitors such as sodium polyacrylate; and residue improving agents such as malonic acid, adipic acid, itaconic acid, citraconic acid, fumaric acid and mesaconic acid.

[0071]

Preparation of Liquid Composition

The radiation-sensitive composition for forming the colored layer of the present invention is usually prepared as a liquid composition by adding (F) the solvent thereto.

As the solvent, any solvent can be appropriately selected and used as long as it can disperse or dissolve the components (A) to (E) constituting the radiation-sensitive composition and other additive components and as long as it does not react with these components and has proper volatility.

[0072]

Examples of the solvent may include

propylene glycol monoalkyl ethers such as propylene glycol monomethyl ether and propylene glycol monoethyl ether;

(poly)alkylene glycol monoalkyl ether acetates such as ethylene glycol monomethyl ether acetate, ethylene glycol

monoethyl ether acetate, ethylene glycol mono-n-propyl ether acetate, ethylene glycol mono-n-butyl ether acetate, diethylene glycol monomethyl ether acetate, diethylene glycol monoethyl ether acetate, propylene glycol monomethyl ether acetate, propylene glycol monoethyl ether acetate, dipropylene glycol monomethyl ether acetate, dipropylene glycol monoethyl ether acetate and 3-methoxybutyl acetate;

(poly)alkylene glycol diethers such as diethylene glycol dimethyl ether, diethylene glycol methyl ethyl ether, diethylene glycol diethyl ether, dipropylene glycol dimethyl ether, dipropylene glycol methyl ethyl ether and dipropylene glycol diethyl ether;

ethers such as tetrahydrofuran;

ketones such as methyl ethyl ketone, cyclohexanone, 2-heptanone and 3-heptanone;

ketoalcohols such as diacetone alcohol (i.e. 4-hydroxy-4-methylpentan-2-one) and 4-hydroxy-4-methylhexan-2-one;

[0073]

lactic acid alkyl esters such as methyl lactate and ethyl lactate;

the other esters such as ethyl 2-hydroxy-2-methylpropanoate, ethyl hydroxyacetate, methyl 2-hydroxy-3-methylbutanoate, methyl 3-methoxypropionate, ethyl 3-methoxypropionate, methyl 3-ethoxypropionate, ethyl 3-ethoxypropionate, ethyl ethoxyacetate, 3-methyl-3-methoxybutyl acetate, 3-methyl-3-methoxybutyl propionate,

ethyl acetate, 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, ethyl acetoacetate and ethyl 2-oxobutanoate;

aromatic hydrocarbons such as toluene and xylene; and amides such as N-methylpyrrolidone, N,N-dimethylformamide and N,N-dimethylacetamide.

[0074]

Of these solvents, propylene glycol monomethyl ether, propylene glycol monoethyl ether, ethylene glycol monomethyl ether acetate, ethylene glycol mono-n-propyl ether acetate, ethylene glycol mono-n-butyl ether acetate, diethylene glycol monomethyl ether acetate, diethylene glycol monoethyl ether acetate, propylene glycol monomethyl ether acetate, propylene glycol monoethyl ether acetate, dipropylene glycol monomethyl ether acetate, diethylene glycol dimethyl ether, diethylene glycol methyl ethyl ether, dipropylene glycol dimethyl ether, cyclohexanone, 2-heptanone, 3-heptanone, ethyl 3-methoxypropionate, methyl 3-ethoxypropionate, ethyl 3-ethoxypropionate, 3-methoxybutyl acetate, 3-methyl-3-methoxybutyl propionate, n-butyl acetate, i-butyl acetate, n-pentyl formate, i-pentyl acetate, n-butyl propionate, ethyl butyrate, i-propyl butyrate, n-butyl butyrate,

ethyl pyruvate and the like are preferred from the viewpoints of the dissolubility, pigment dispersibility and coating properties.

The above solvents can be used alone or as a mixture of two or more thereof.

[0075]

Further, the above solvents can be used in combination with high boiling-point solvents such as benzyl ethyl ether, di-n-hexyl 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 and ethylene glycol monophenyl ether acetate.

The above high boiling-point solvents can be used alone or as a mixture of two or more thereof.

[0076]

The use amount of the solvent is not particularly limited. However, the amount of the solvent is desirably set such that the total concentration of the components of the composition except for the solvent is preferably 5 to 50 wt% and particularly preferably 10 to 40 wt%, from the viewpoints of the coating properties and stability of the resultant liquid composition.

[0077]

Method for Forming Color Filter

Next, a method for forming the color filter of the present invention using the radiation-sensitive composition for forming the colored layer of the present invention will be described.

The method for forming the color filter usually includes at least the following steps (1) to (4).

(1) A step of forming a coating of the radiation-sensitive composition for forming the colored layer of the present invention on a substrate

(2) A step of exposing at least a part of the coating to radiation

(3) A step of developing the coating after exposure

(4) A step of baking (hereinafter, referred to as "post-baking") the coating after the developing step.

These steps will be sequentially described below.

[0078]

- Step (1) -

At first, a light shielding layer is formed on the surface of a substrate to section a part that forms pixels as required, and a liquid composition of the radiation-sensitive composition for forming a colored layer which contains, for example, a red pigment, is applied on this substrate. Then, the substrate is subjected to pre-baking to evaporate a solvent to form a coating.

Examples of the substrate to be used in this step may include glass, silicon, polycarbonates, polyesters,

aromatic polyamides, polyamide-imides, polyimides, polyethersulfones and other compounds such as ring-opened polymers of a cyclic olefin and hydrogenated substances thereof.

In addition, these substrates, if desired, may also be previously treated with a chemical such as a silane coupling agent or treated by plasma, ion plating, sputtering, a gas phase reaction or vacuum deposition.

In applying the liquid composition to the substrate, appropriate coating methods such as rotary coating (spin coating), flow casting coating, roll coating and coating with a slit nozzle can be employed. However, the radiation-sensitive composition in the present invention has high solubility to a cleaning solvent even after dried, and therefore coating with the slit nozzle is suitably applied thereto.

Pre-baking is usually performed in the conditions of 70 to 110°C for about 2 to 4 minutes.

The coating thickness, which is measured as a film thickness after the solvent is removed, is usually 0.1 to 10 μm , preferably, 0.2 to 8.0 μm and more preferably 0.2 to 6.0 μm .

[0079]

- Step (2) -

Then, at least a part of the formed coating is exposed to radiation. When a part of the coating is

exposed to radiation, it is usually exposed through a photomask having an appropriate pattern.

Examples of the radiation to be used in this step may include visible rays, ultraviolet rays, far-ultraviolet rays, electron beams and X-rays, but radiation having a wavelength within the range of 190 to 450 nm is preferred.

The exposure amount of radiation is usually about 10 to 10,000 J/m².

[0080]

- Step (3) -

Then, the exposed coating is preferably developed with an alkaline developer. Unexposed portions of the coating are dissolved and removed to form a pattern.

As the above alkaline developer, aqueous solutions of, for example, sodium carbonate, sodium hydroxide, potassium hydroxide, tetramethylammonium hydroxide, choline, 1,8-diazabicyclo-[5.4.0]-7-undecene and 1,5-diazabicyclo-[4.3.0]-5-nonene are preferred.

To the above alkaline developer, for example, a water-soluble organic solvent such as methanol or ethanol or a surfactant can be also added in an appropriate amount. Note that, after the developing process with the alkali, washing with water is usually performed.

As the developing method, a shower developing method, a spray developing method, a dip (immersion) developing method, a puddle developing method and the like can be

applied. However, the radiation-sensitive composition in the present invention has high solubility to the alkaline developer and is therefore suitably subjected to the shower developing method.

The developing process is preferably performed at ordinary temperature for about 5 to 300 seconds.

[0081]

- Step (4) -

Then, the coating after the developing process is subjected to post-baking to obtain a substrate in which pixel patterns constituted of the cured radiation-sensitive composition are arranged in a predetermined array.

Post-baking is preferably performed in the conditions of 180 to 230°C for about 20 to 40 minutes.

The film thickness of the pixels thus formed is usually 0.5 to 5.0 μm and preferably 1.5 to 3.0 μm .

[0082]

Further, green and blue pixel patterns are formed on the same single substrate by repeating the above steps (1) to (4) using a liquid form radiation-sensitive composition for forming a colored layer containing a green or blue pigment. In this way, the colored layer in which pixel patterns of the three primary colors (red, green and blue) are arranged in a predetermined array can be formed on the substrate. However, the order of

forming pixel patterns of individual colors in the present invention is not limited to the above order.

[0083]

Color Filter

The color filter of the present invention has a colored layer formed using the radiation-sensitive composition for forming the colored layer of the present invention.

The color filter of the present invention is extremely useful for use in, for example, transmissive or reflective color liquid crystal display devices, color imaging devices and color sensors etc.

[0084]

Color Liquid Crystal Display Device

The color liquid crystal display device of the present invention has the color filter of the present invention.

The color liquid crystal display device of the present invention can be formed appropriately, for example, by forming a color filter on a different substrate from a driving substrate having a thin film transistor (TFT) disposed thereon, arranging the driving substrate and the substrate having the color filter formed thereon to face each other with a liquid crystal layer interposed between them, or alternatively, by placing, on the surface of the driving substrate having a thin film transistor (TFT) disposed thereon, a substrate

having the color filter formed thereon and a substrate having an ITO (indium oxide doped with tin) electrode formed thereon are arranged so as to face each other with a liquid crystal layer interposed between them. The structure of the latter one has an advantage in that the numerical aperture can be significantly improved and therefore a bright and high definition color liquid crystal display device can be obtained.

[Examples]

[0085]

Hereinafter, the embodiments of the present invention will be more specifically described by way of Examples. However, the present invention is not limited to the Examples below.

The Mw and Mn of the resin obtained in the following Synthesis Examples were measured by gel permeation chromatography (GPC) in accordance with the following specification.

Apparatus: GPC-101 (manufactured by SHOWA DENKO K.K.)

Column: Columns GPC-KF-801, GPC-KF-802, GPC-KF-803 and GPC-KF-804 were connected and put in use.

Mobile phase: Tetrahydrofuran containing 0.5 wt% phosphoric acid.

[0086]

Synthesis of Alkali-Soluble Resin

Synthesis Example 1

A flask equipped with a cooling tube and a stirrer was charged with 3 parts by weight of 2,2'-azobisisobutyronitrile and 200 parts by weight of propylene glycol monomethyl ether acetate, and subsequently, with 15 parts by weight of methacrylic acid, 5 parts by weight of ω -carboxypolycaprolactone monoacrylate, 22 parts by weight of N-phenylmaleimide, 13 parts by weight of styrene, 35 parts by weight of benzyl methacrylate, 10 parts by weight of glycerol mono(meth)acrylate and 5 parts by weight of α -methylstyrene dimer as a molecular weight controlling agent. After the flask was purged with nitrogen gas, the reaction solution was gently stirred while increasing the temperature to 80°C. Polymerization was performed by maintaining this temperature for 5 hours to obtain a copolymer solution (S-1) (Mw of 10,500, Mn=5,200, the concentration of solid content: 31.2 wt%).

[0087]

Immersion Test

Example 1

A mixed solution was prepared by adding a pigment (A), which is 40 parts by weight of a mixture of C.I. Pigment Green 36, C.I. Pigment Yellow 150 (weight ratio = 50/50), a dispersant, which is 10 parts by weight of Disperbyk 2001 (in terms of solid content) containing a nonvolatile component of 46% and an amine value of 29, and a solvent, which is 100 parts by weight of propylene

glycol monomethyl ether acetate. The mixed solution was stirred and dispersed by Diamond Fine Mill (trade name), which is a beads mill having a bead diameter of 1.0 mm manufactured by Mitsubishi Materials Corporation, for 12 hours to prepare a pigment dispersion fluid (p-1).

Subsequently, 450 parts by weight of this pigment dispersion fluid (p-1), 90 parts by weight of the copolymer (S-1) (in terms of solid content) as an alkali-soluble resin (B), 60 parts by weight of TO-1382 as a polyfunctional monomer (C), a photopolymerization initiator (D), which was a mixture of 15 parts by weight of 2-benzyl-2-dimethylamino-1-(4-morpholinophenyl)butan-1-one and 5 parts by weight of 1-[9-ethyl-6-(2-methylbenzoyl)-9H-carbazol-3-yl]-ethanone 1-(O-acetyloxime), and 800 parts by weight of ethyl 3-ethoxypropionate as a solvent were mixed to prepare a liquid composition (r-1). The content of the pigment in the liquid composition (r-1) was 37.5 % based on the total solid content.

Next, the liquid composition (r-1) was applied by spin-coating onto a soda glass substrate of 4 inch diameter having an SiO₂ film formed on the surface thereof for preventing elution of sodium ions and subjected to pre-baking in a clean oven at 80°C for 10 minutes to form a coating of 3.0 μm on the substrate.

Then, this substrate was immersed for 2 minutes in 1000 cc of a developer of a 0.04 wt% aqueous potassium

hydroxide solution stirred by a magnetic stirrer. The coating was completely dissolved.

[0088]

Example 2

A liquid composition (r-2) was prepared to form a coating on a soda glass substrate in the same manner as in Example 1 except that Disperbyk 142 (a nonvolatile component = 60% and an amine value = 43) was used as a dispersant in place of Disperbyk 2001.

Then, this substrate was immersed in 1000 cc of a developer of a 0.04 wt% aqueous potassium hydroxide solution for 2 minutes in the same manner as in Example 1. As a result, the coating was completely dissolved.

[0089]

Example 3

A liquid composition (r-3) was prepared to form a coating on a soda glass substrate in the same manner as in Example 1 except that Disperbyk 145 (a nonvolatile component = 100% and an amine value = 71) was used as a dispersant in place of Disperbyk 2001.

Then, this substrate was immersed in 1000 cc of a developer of a 0.04 wt% aqueous potassium hydroxide solution for 2 minutes in the same manner as in Example 1. As a result, the coating was completely dissolved.

[0090]

Example 4

A liquid composition (r-4) was prepared and a coating was formed on a soda glass substrate in the same manner as in Example 1 except that Disperbyk 2150 (a nonvolatile component = 52% and an amine value = 57) was used as a dispersant in place of Disperbyk 2001.

Then, this substrate was immersed in 1000 cc of a developer of a 0.04 wt% aqueous potassium hydroxide solution for 2 minutes in the same manner as in Example 1. As a result, the coating was completely dissolved.

[0091]

Comparative Example 1

A liquid composition (r-5) was prepared to form a coating on a soda substrate in the same manner as in Example 1 except that TO-756 (manufactured by Toagosei Co., Ltd.) serving as (C) the polyfunctional monomer, which contained a monoester of pentaerythritol acrylate and succinic acid as a main component, was used in place of TO-1382.

Then, this substrate was immersed in 1000 cc of a developer of a 0.04 wt% aqueous potassium hydroxide solution for 2 minutes in the same manner as in Example 1. As a result, the coating was completely dissolved.

[0092]

Comparative Example 2

A liquid composition (r-6) was prepared to form a coating on a soda substrate in the same manner as in Example 1 except that dipentaerythritol hexaacrylate

serving as (C) the polyfunctional monomer was used in place of TO-1382.

Then, this substrate was immersed in 1000 cc of a developer of a 0.04 wt% aqueous potassium hydroxide solution for 2 minutes in the same manner as in Example 1. As a result, the coating was not completely dissolved. A large amount of insoluble matter was observed in the solution in the form of mass.

[0093]

Comparative Example 3

A liquid composition (r-7) was prepared to form a coating on a soda substrate in the same manner as in Example 2 except that dipentaerythritol hexaacrylate serving as (C) the polyfunctional monomer was used in place of TO-1382.

Then, this substrate was immersed in 1000 cc of a developer of a 0.04 wt% aqueous potassium hydroxide solution for 2 minutes in the same manner as in Example 1. As a result, the coating was not completely dissolved. A large amount of insoluble matter was observed in the solution in the form of mass.

[0094]

Reference Example 1

A liquid composition (r-8) was prepared to form a coating on a soda substrate in the same manner as in Comparative Example 1 except that the content of a pigment dispersion solution (p-1) was changed from 450

parts by weight to 225 parts by weight and the content of ethyl 3-ethoxy propionate serving as a solvent was changed from 800 parts by weight to 600 parts by weight. The content of the pigment of the liquid composition (r-8) is 24.5% based on the total solid component.

Then, this substrate was immersed in 1000 cc of a developer of a 0.04 wt% aqueous potassium hydroxide solution for 2 minutes in the same manner as in Example 1. As a result, the coating was completely dissolved.

[0095]

Evaluation of Development Property

Example 5

The liquid composition (r-1) was applied by using a spin coater to a soda glass substrate of 4 inch in diameter having an SiO_2 film formed on the surface thereof for preventing elution of sodium ions and subjected to pre-baking on a hot plate at 90°C for 2 minutes to form a coating of $2.5\ \mu\text{m}$ in thickness.

Subsequently, the substrate was cooled to room temperature and thereafter exposed to UV rays containing wavelengths of 365 nm, 405 nm and 436 nm through a photomask (slit width: $90\ \mu\text{m}$) by using a high-pressure mercury lamp. The exposure amount at this time was $1000\ \text{J/m}^2$. Thereafter, the coating was sprayed with a 0.04 wt% aqueous potassium hydroxide solution controlled at 23°C through a nozzle (1 mm in diameter) at a developing pressure of $1\ \text{kgf/cm}^2$ for one minute. After the shower

developing was performed in this manner, post baking was performed at 220°C for 30 minutes to form a red-stripe pixel pattern on the substrate.

When the pixel array on the substrate was observed by an optical microscope, no development residue was observed on the unexposed portion of the substrate and no defect was observed in the edge of the pixel pattern.

[0096]

Example 6

The same process as in Example 5 was repeated except that the liquid composition (r-2) was used in place of the liquid composition (r-1). When development property was evaluated, no development residue was observed on the unexposed portions of the substrate and no defect was observed in the edge of the pixel pattern.

[0097]

Example 7

The same process as in Example 5 was repeated except that the liquid composition (r-3) was used in place of the liquid composition (r-1). When development property was evaluated, no development residue was observed on the unexposed portions of the substrate and no defect was observed in the edge of the pixel pattern.

[0098]

Example 8

The same process as in Example 5 was repeated except that the liquid composition (r-4) was used in place of

the liquid composition (r-1). When development property was evaluated, no development residue was observed on the unexposed portions of the substrate and no defect was observed in the edge of the pixel pattern.

[0099]

Comparative Example 4

The same process as in Example 5 was repeated except that the liquid composition (r-5) was used in place of the liquid composition (r-1). When development property was evaluated, no development residue was observed on the unexposed portions of the substrate and no defect was observed in the edge of the pixel pattern.

[0100]

Comparative Example 5

The same process as in Example 5 was repeated except that the liquid composition (r-6) was used in place of the liquid composition (r-1). When development property was evaluated, no defect was observed in the edge of the pixel pattern; however, development residue was slightly observed on the unexposed portions of the substrate.

[0101]

Comparative Example 6

The same process as in Example 5 was repeated except that the liquid composition (r-7) was used in place of the liquid composition (r-1). When development property was evaluated, unexposed portions were not completely

dissolved in the developer and thus a pixel pattern was not formed.

[0102]

Reference Example 2

The same process as in Example 5 was repeated except that the liquid composition (r-8) was used in place of the liquid composition (r-1). When development property was evaluated, no development residue was observed on the unexposed portions of the substrate and no defect was observed in the edge of the pixel pattern.

[0103]

Evaluation of Surface Smoothness

The surface roughness of the upper portion of individual pixel patterns obtained in the above evaluation of adhesion was measured by an atomic force microscope (manufactured by Digital Instrument) and evaluated. Generally, when the surface roughness is 60 angstroms or less, it is determined that the surface smoothness is satisfactory.

[0104]

Example 9

When the surface smoothness of the pattern formed in Example 5 was measured, the surface roughness was 50 angstroms.

[0105]

Example 10

When the surface smoothness of the pattern formed in Example 6 was measured, the surface roughness was 40 angstroms.

[0106]

Example 11

When the surface smoothness of the pattern formed in Example 7 was measured, the surface roughness was 37 angstroms.

[0107]

Example 12

When the surface smoothness of the pattern formed in Example 8 was measured, the surface roughness was 44 angstroms.

[0108]

Comparative Example 7

When the surface smoothness of the pattern formed in Comparative Example 4 was measured, the surface roughness was 80 angstroms.

[0109]

Comparative Example 8

When the surface smoothness of the pattern formed in Comparative Example 5 was measured, the surface roughness was 40 angstroms.

[0110]

Comparative Example 9

When the surface smoothness of the pattern formed in Comparative Example 6 was measured, the surface roughness was 35 angstroms.

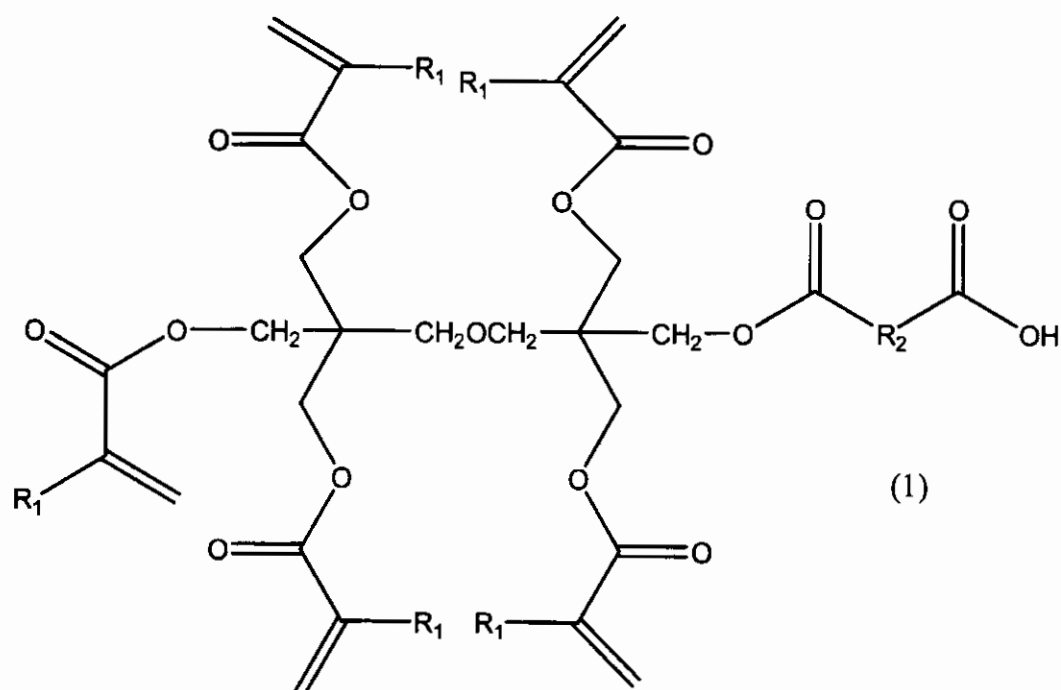
[0111]

Reference Example 3

When the surface smoothness of the pattern formed in Reference Example 2 was measured, the surface roughness was 50 angstroms.

What is claimed is:

1. A radiation-sensitive composition for forming a colored layer, comprising (A) at least one pigment selected from the group consisting of red pigments, green pigments and blue pigments, (B) a dispersant, (C) an alkali-soluble resin, (D) a polyfunctional monomer represented by the following formula (1):



where R_1 represents a hydrogen atom or a methyl group, and R_2 represents a group selected from the group consisting of a methylene group, a straight or branched alkylene group and a straight or branched alkenylene group each having 2 to 8 carbon atoms, a phenylene group that may have a substituent, a cyclohexylene group that may have a substituent and a cyclohexylene group that may have a substituent and partly has an unsaturated bond;

(E) a photopolymerization initiator, and (F) a solvent, wherein the content of the pigment (A) is 30 to 60 wt% based on a total weight of the composition except (F) the solvent.

2. The radiation-sensitive composition according to claim 1, wherein an amine value (unit: mgKOH/g) of the dispersant (B) is 70 to 400.

3. A color filter formed of the radiation-sensitive composition according to claim 1 or 2.

4. A color liquid crystal display device comprising the color filter according to claim 3.