

**RADIATION-SENSITIVE COMPOSITION FOR FORMING COLORED LAYER,
COLOR FILTER AND 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 liquid crystal display device, and more specifically, to a radiation-sensitive composition for forming a colored layer useful for a color filter for use in 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 radiation-sensitive composition for forming a colored layer, a method including forming a coating of a radiation-sensitive composition for forming a colored layer having a pigment dispersed therein 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 predetermined pattern, developing it to dissolve and remove unexposed portions, and thereafter, subjecting it to post-baking to obtain pixels of various colors (see, for example, JP-A-2-144502 and JP-A-3-53201) is known.

In a post-baking step, generally, heat-baking is performed at a temperature of 200°C to 250°C for about 30 minutes. Recently, from the necessity of reducing manufacturing cost and dealing with a substrate such as a plastic substrate whose heat resistance is limited, reduction in temperature and time in the post-baking step has been studied. It has been strongly desired to develop a radiation-sensitive composition for forming a colored layer having the same performance as that of a conventional composition even in a heat-baking process which is performed under lower temperature or shorter time conditions than those in a conventional process.

[0003]

On the other hand, with an increase in the chromatic purity of a color crystal display device, the concentration of a pigment contained in a radiation-sensitive composition for forming a colored layer tends to be increasingly high. However, as the concentration of a pigment contained in a radiation-sensitive composition for forming a colored layer increases, the resistance of the formed pattern to various types of solvents and adhesiveness thereof to a substrate

disadvantageously decrease. To solve these problems, JP-A-2002-296778 proposes that a binder polymer, which is obtained by copolymerization using a monomer having an oxetane skeleton, is added to a radiation-sensitive composition for forming a colored layer. However, the proposal cannot be applied to the post-baking step in reducing temperature/time.

SUMMARY OF THE INVENTION

[0004]

The present invention was made under the aforementioned circumstances and an object of the present invention is to provide a novel radiation-sensitive composition for forming a colored layer, which is capable of providing pixels and black matrices having excellent resistance to a wide variety of solvents and excellent adhesiveness to a substrate even at a post-baking temperature of less than 200°C. Another object of the present invention is to provide a color filter formed by using such a radiation-sensitive composition for forming the colored layer and a liquid crystal display device having the color filter.

[0005]

The present inventors found that pixels and black matrices having excellent resistance to a wide variety of solvents and excellent adhesiveness to a substrate can be formed at a post-baking temperature of less than 200°C by

containing more than predetermined amounts of a dispersant having a specific property and a polymer containing repeating units each having a specific skeleton in a radiation-sensitive composition for forming a colored layer.

[0006]

To be described more specifically, firstly, the present invention provides a radiation-sensitive composition for forming a colored layer, containing (A) a pigment, (B) a dispersant having an acid value and an amine value either one of which exceeds 0, (C) an alkali-soluble resin, (D) a polyfunctional monomer, (E) a photopolymerization initiator and (F) a polymer in which a content of repeating units each having an oxetanyl group is not less than 70% by mass.

[0007]

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

[0008]

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

[0009]

According to the radiation-sensitive composition for forming the colored layer of the present invention, it is possible to form pixels and black matrices having excellent resistance to a wide variety of solvents and

excellent adhesiveness to a substrate even at a post-baking temperature of less than 200°C.

Accordingly, the radiation-sensitive composition for forming the colored layer of the present invention is extremely useful for manufacturing various types of color filters including those for use in color liquid crystal display panels, and liquid crystal display panels in the field of electronics industry.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0010]

The present invention will be described in detail below.

Radiation-Sensitive Composition for Forming a Colored Layer

In the radiation-sensitive composition for forming the colored layer (hereinafter, also simply referred to as a "radiation-sensitive composition") of the present invention, the "colored layer" means a layer formed of pixels and/or black matrixes for use in a color filter.

Now, constitutional components of the radiation-sensitive composition for forming the colored layer of the present invention will be described below.

[0011]

- (A) Pigment -

(A) The pigment in the present invention is not particularly limited and either an organic pigment or an

inorganic pigment may be used. Of them, the organic pigment is particularly preferred since the color filter requires highly pure and highly transparency color and heat resistance.

As the organic pigment, for example, compounds classified as pigments based on the Color Index (C.I.: published by The Society of Dyers and Colourists) may be mentioned. Specific examples thereof may include the compounds assigned with the Color Index (C.I.) numbers as set forth below:

[0012]

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;

[0013]

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;

[0014]

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;

[0015]

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 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, C.I. pigment blue 80;
C.I. pigment green 7, C.I. pigment green 36, C.I. pigment green 58;
C.I. pigment brown 23 and C.I. pigment brown 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.

[0016]

Of these organic pigments, at least one pigment selected from the group consisting of 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, C.I. pigment red 177, C.I. pigment red 242, C.I. pigment red 254, C.I. pigment blue 15:3, C.I. pigment blue 15:4, C.I. pigment blue 15:6, C.I. pigment green 7, C.I. pigment green 36, C.I. pigment green 58, and C.I. pigment violet 23, is preferred.

[0017]

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 and a combination thereof and then put in use.

[0018]

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.

[0019]

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

[0020]

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 polymers or oligomers for dispersing pigment particles available in the market.

[0021]

- (B) Dispersant -

(B) The dispersant in the present invention is a dispersant having an acid value and an amine value either one of which exceeds 0 (hereinafter, also referred to as a "specific dispersant"). By virtue of such a dispersant

selected, a structure of cross-linkage formed by (F) the component as described later in a post-baking step becomes rigid, whereby a pattern having excellent solvent resistance and excellent adhesiveness to a substrate can be obtained.

[0022]

The dispersant is not particularly limited as long as it has an acid value and an amine value either one of which exceeds 0; however, a polymer dispersant is preferred. Specific examples thereof may include modified acrylic copolymers, acrylic copolymers, modified polyurethanes, polyesters, alkylammonium salts or phosphate salts of a high-molecular weight copolymer and cationic comb polymers. The cationic comb polymer herein refers to a polymer having a structure in which branched polymers of two or more molecules are grafted to a single stem-polymer molecule having a plurality of basic groups (cationic functional groups). For example, a polymer whose stem-polymer portion is constituted of polyethylene imine and whose branched polymer portion is constituted of a ring-opened polymer of ϵ -caprolactone may be mentioned. Of these dispersants, the modified acrylic copolymers, the acrylic copolymers and the cationic comb polymers are preferred.

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

[0023]

The acid value (mgKOH/g) of the dispersant is preferably 5 to 100, more preferably 10 to 50, and particularly preferably 20 to 50. The amine value (mgKOH/g) thereof is preferably 1 to 100, more preferably 10 to 70, and particularly preferably 20 to 70. By virtue of such a dispersant selected, a pattern having excellent solvent resistance and excellent adhesiveness to a substrate can be obtained and further a radiation-sensitive composition having excellent storage stability and substantially free from occurrence of film residue and scum. The amine value used herein refers to the amount (mg) of KOH, which is equivalent to HCl required for neutralizing the solid content (1 g) of the dispersant. Furthermore, the acid value refers to the amount (mg) of KOH required for neutralizing the solid content (1 g) of the dispersant.

[0024]

Such a dispersant is commercially available.

Examples of the dispersant may include:

Disperbyk-142 (nonvolatile content = 60%, amine value = 43, acid value = 46),

Disperbyk-145 (nonvolatile content = 100%, amine value = 71, acid value = 76),

Disperbyk-161 (nonvolatile content = 30%, amine value = 11),

Disperbyk-170 (nonvolatile content = 30%, acid value = 11),

Disperbyk-182 (nonvolatile content = 43%, amine value = 13),

Disperbyk-2000 (nonvolatile content = 40%, amine value = 4),

Disperbyk-2001 (nonvolatile content = 46%, amine value = 29, acid value = 19),

Disperbyk-2020 (nonvolatile content = 70%, amine value = 38, acid value = 35),

Disperbyk-2150 (nonvolatile content = 52%, amine value = 57),

Disperbyk-9076 (nonvolatile content = 96%, amine value = 44, acid value = 38) [these are manufactured by BYK Chemie (BYK)];

AJISPER PB-711 (nonvolatile content = 40%, amine value = 45),

AJISPER PB-821 (nonvolatile content = 100%, amine value = 9, acid value = 13),

AJISPER PB-822 (nonvolatile content = 100%, amine value = 13, acid value = 16) [these are manufactured by Ajinomoto Fine-Techno Co., Inc.];

Solsperse 24000 (nonvolatile content = 100%, amine value = 42, acid value = 25),

Solsperse 32000 (nonvolatile content = 100%, amine value = 31, acid value = 15),

Solsperse 32500 (nonvolatile content = 40%, amine value = 12, acid value = 7),

Solsperse 32550 (nonvolatile content = 50%, amine value = 15, acid value = 7),
Solsperse 32600 (nonvolatile content = 40%, amine value = 12, acid value = 6),
Solsperse 35100 (nonvolatile content = 40%, amine value = 14, acid value = 6),
Solsperse 35200 (nonvolatile content = 40%, amine value = 14, acid value = 6), and
Solsperse 37500 (nonvolatile content = 40%, amine value = 11, acid value = 5) [there are manufactured by Lubrizol Corporation].

[0025]

In the present invention, the specific dispersant may be used in combination with other dispersants.

As other dispersants, for example, 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-nonyl phenyl ether; polyethylene glycol di-fatty acid esters such as polyethylene glycol dilaurate and polyethylene glycol distearate; sorbitan fatty acid esters; and fatty acid modified polyesters may be mentioned.

These other dispersants can be used alone or as a mixture of two or more thereof.

[0026]

The content of the other dispersants (in terms of solid content) is preferably 0 to 75% by mass and more preferably 0 to 50% by mass based on the total mass of the specific dispersant and other dispersants from the viewpoints of ensuring good balance between developing property and storage stability.

The content of the specific dispersant (in terms of solid content) in the present invention, is preferably 1 to 50 parts by mass and more preferably 3 to 30 parts by mass based on 100 parts by mass of (A) the pigment from the viewpoints of storage stability of the radiation-sensitive composition and prevention of film residue left on a substrate.

[0027]

- (C) Alkali-soluble Resin -

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

ethylene monomer (hereinafter, referred to as a "copolymerizable 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.

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

In the present invention, as the carboxyl group-containing unsaturated monomer, (meth)acrylic acid, mono[2-(meth)acryloyloxyethyl] succinate and ω -

carboxypolycaprolactone mono(meth)acrylate are preferred and particularly, (meth)acrylic acid is preferred.

[0029]

Examples of the co-polymerizable unsaturated monomer may include the following compounds:

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, o-vinylphenol, m-vinylphenol, p-vinylphenol, 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 ethyleneoxide-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 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; 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; aliphatic conjugated dienes such as 1,3-butadiene, isoprene and chloroprene; and macromonomers 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]

In the present invention, as the co-polymerizable unsaturated monomer, the N-substituted maleimides, the aromatic vinyl compounds, the unsaturated carboxylic esters, and the macro monomer having a mono(meth)acryloyl group at an end of a polymer molecule chain are preferred and particularly N-phenylmaleimide, N-cyclohexylmaleimide, 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, ethylene oxide modified (meth)acrylate of paracumyl

phenol, polystyrene macromonomer, and polymethylmethacrylate macromonomer are preferred.

[0033]

Specific examples of the carboxyl group-containing copolymer may include the following compounds:

(meth)acrylic acid/methyl (meth)acrylate copolymers,
(meth)acrylic acid/benzyl (meth)acrylate copolymers,
(meth)acrylic acid/2-hydroxyethyl (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 (meth)acrylate macromonomer copolymers,
(meth)acrylic acid/benzyl (meth)acrylate/glycerol mono(meth)acrylate copolymers,
(meth)acrylic acid/styrene/2-hydroxyethyl (meth)acrylate copolymers,
(meth)acrylic acid/2-hydroxyethyl (meth)acrylate/benzyl (meth)acrylate copolymers,
(meth)acrylic acid/2-hydroxyethyl (meth)acrylate/phenyl (meth)acrylate copolymers,

[0034]

(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/ethyleneoxide-modified
(meth)acrylate of paracumyl phenol copolymer,
(meth)acrylic acid/N-phenylmaleimide/styrene/2-ethylhexyl
(meth)acrylate/2-hydroxyethyl (meth)acrylate/benzyl
(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,

[0035]

(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.
[0036]

In the carboxyl group-containing copolymer, the copolymerization ratio of the carboxyl group-containing unsaturated monomer is usually 5 to 50% by mass, and preferably, 10 to 40% by mass. When the copolymerization ratio is less than 5% by mass, the solubility of the radiation-sensitive composition to be obtained to an alkaline developer tends to decrease. On the other hand, when the copolymerization ratio exceeds 50% by mass, the solubility to the alkaline developer becomes excessively

large. As a result, when a developing operation is performed with the alkaline developer, the colored layer tends to peel off from a substrate and the surface film of the colored layer tends to roughened.

[0037]

The weight average molecular weight (hereinafter referred to as "Mw") of the alkali-soluble resin in the present invention is usually 3,000 to 300,000, and preferably 5,000 to 100,000.

Furthermore, the number average molecular weight (hereinafter referred to as "Mn") of the alkali-soluble resin in the present invention is usually 3,000 to 60,000 and preferably 5,000 to 25,000.

In the present specification, the weight average molecular weight (Mw) refers to Mw in terms of polystyrene measured by gel permeation chromatography (GPC, elution solvent: tetrahydrofuran) and the number average molecular weight (Mn) refers to Mn in terms of polystyrene measured by GPC (elution solvent: tetrahydrofuran).

In the present invention, by use of such an alkali-soluble resin having specific Mw and Mn, a radiation-sensitive composition having an excellent developing property can be obtained. By virtue of this, pixels and black matrices having shape pattern edges can be formed; at the same time, substantially no residue, scum and remaining film, etc. are left on unexposed portions of a

substrate and a shielding layer during a developing process.

The ratio of Mw to Mn (M_w/M_n) of the alkali-soluble resin in the present invention is preferably 1 to 5 and more preferably 1 to 4.

[0038]

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

The content of the alkali-soluble resin (in terms of solid content) in the present invention is usually 10 to 1,000 parts by mass and preferably 20 to 500 parts by mass based on the 100 parts by mass of (A) the pigment. When the content of the alkali-soluble resin is less than 10 parts by mass, for example, the developing property with alkali may decrease and scum and film residue may occur on unexposed portions of a substrate or a light shielding layer. On the other hand, when the content exceeds 1,000 parts by mass, the concentration of the pigment relatively decreases. As a result, it may be difficult to attain a desired color density of a thin film.

[0039]

- (D) Polyfunctional Monomer -

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

Examples of the polyfunctional monomer may include

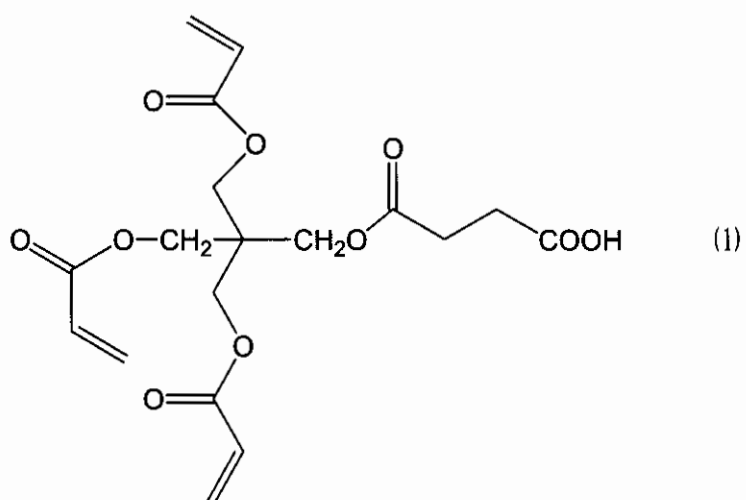
di(meth)acrylates of alkylene glycols such as ethylene glycol and propylene glycol;
di(meth)acrylates of polyalkylene glycols such as polyethylene glycol and polypropylene glycol;
poly(meth)acrylates of three or more valent polyhydric alcohols such as glycerin, trimethylolpropane, pentaerythritol and dipentaerythritol and modified dicarboxylic acids thereof;
oligo(meth)acrylates such as a polyester, an epoxy resin, a urethane resin, an alkyd resin, a silicone resin and a spiran resin;
di(meth)acrylates of polymers having a hydroxyl group 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.

[0040]

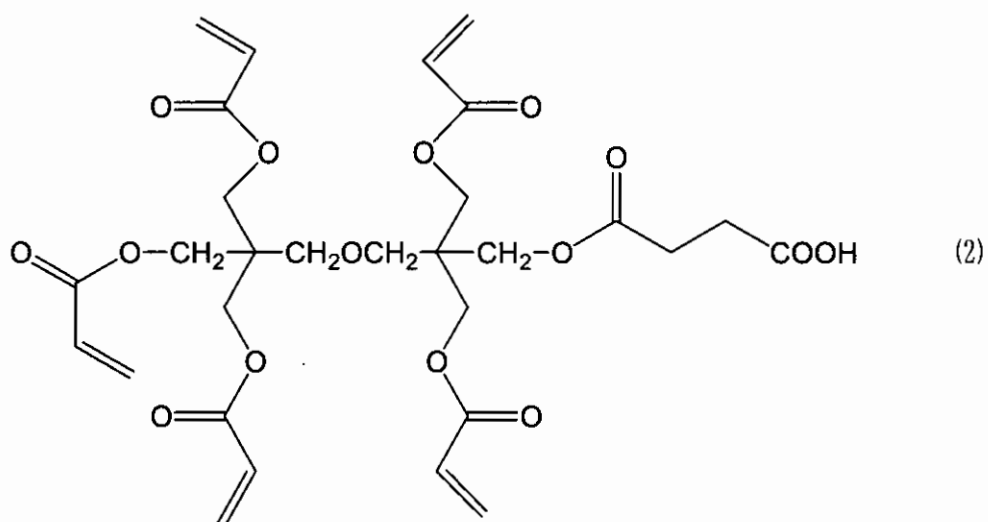
Of these polyfunctional monomers, the poly(meth)acrylate of three or more valent polyhydric alcohol and the modified dicarboxylic acid thereof are preferred. Specifically, trimethylolpropane triacrylate, trimethylolpropane trimethacrylate, pentaerythritol triacrylate, pentaerythritol trimethacrylate, pentaerythritol tetraacrylate, pentaerythritol tetramethacrylate, dipentaerythritol pentaacrylate, dipentaerythritol pentamethacrylate, dipentaerythritol

hexaacrylate and dipentaerythritol hexamethacrylate, the compound represented by the following formula (1) and the compound represented by the following formula (2) are preferred.

[0041]



[0042]



[0043]

Of them, particularly, trimethylolpropane triacrylate, pentaerythritol triacrylate, dipentaerythritol hexaacrylate and the compounds represented by the above formulas (1) and (2) are preferred because the colored layer has high strength and excellent surface smoothness, and scum and film residue etc. are unlikely to occur on unexposed portions of a substrate and on a light shielding layer.

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

[0044]

In the present invention, part of the polyfunctional monomer can be replaced with a monofunctional monomer having a single polymerizable unsaturated bond.

Examples of the monofunctional monomer may include the same compounds as the carboxyl group-containing unsaturated monomers, and the co-polymerizable unsaturated monomers as exemplified in (C) the alkali-soluble resin, and N-(meth)acryloyl morpholine, N-vinyl pyrrolidone, N-vinyl- ϵ -caprolactam and a commercially available product, M-5600 (trade name; manufactured by Toagosei Co., Ltd.).

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

The content of the monofunctional monomer is usually not more than 90% by mass and preferably not more than 50% by mass, based on the total mass of the

polyfunctional monomer and the monofunctional monomer. When the content of the monofunctional monomer exceeds 90% by mass, the strength and surface smoothness of the colored layer to be obtained may become insufficient.

[0045]

In the present invention, the content of the polyfunctional monomer is usually 5 to 500 parts by mass and preferably 20 to 300 parts by mass based on 100 parts by mass (in terms of solid content) of (C) the alkali-soluble resin. When the content is less than 5 parts by mass, the strength and surface smoothness of the colored layer tends to decrease. On the other hand, when the content exceeds 500 parts by mass, developing property with alkali tends decrease, and scum and film residue, etc. tend to occur on unexposed portions of a substrate and on a light shielding layer. Note that when a polyfunctional monomer is used in combination with the monofunctional monomer, the mass of the monofunctional monomer is included in the mass of the polyfunctional monomer.

[0046]

- (E) Photopolymerization Initiator -

The photopolymerization initiator of the present invention is a compound which generates a radical capable of starting polymerization of (D) the 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.

[0047]

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

[0048]

In the present invention, the total content of the photopolymerization initiators is usually 0.01 to 120 parts by mass, and preferably 1 to 100 parts by mass based on 100 parts by mass of (D) the polyfunctional monomer. When the content of the photopolymerization initiator is less than 0.01 part by mass, curing by exposure becomes insufficient. As a result, a color filter in which patterns of colored layers are arranged in accordance with predetermined arrays may not be easily

obtained. On the other hand, when the content exceeds 120 parts by mass, the formed colored layer tends to peel off from a substrate during a developing process. Note that when the polyfunctional monomer is used in combination with the monofunctional monomer, the mass of the monofunctional monomer is included in the mass of the polyfunctional monomer.

[0049]

Of the preferable photopolymerization initiators in the present invention, specific examples of the acetophenone compounds may include acetophenone compounds having a morpholino group such as 2-methyl-1-[4-(methylthio)phenyl]-2-morpholinopropanon-1-one and 2-benzyl-2-dimethylamino-1-(4-morpholinophenyl)butane-1-one; 2-hydroxy-2-methyl-1-phenylpropan-1-one; 1-hydroxycyclohexyl-phenyl ketone; 2,2-dimethoxy-1,2-diphenylethan-1-one; and 1,2-octane dione.

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

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

[0050]

In the present invention, when the acetophenone compound is used as the photopolymerization initiator, the content thereof is usually 0.01 to 80 parts by mass, preferably 1 to 70 parts by mass, and more preferably 1 to 60 parts by mass based on 100 parts by mass of (D) the polyfunctional monomer. When the content of the acetophenone compound is less than 0.01 part by mass, curing by exposure becomes insufficient. As a result, a color filter in which patterns of colored layers are arranged in accordance with predetermined arrays may not be easily obtained. On the other hand, when the content exceeds 80 parts by mass, the formed colored layer tends to peel off from a substrate during a developing process. Note that when the polyfunctional monomer is used in combination with the monofunctional monomer, the mass of the monofunctional monomer is included in the mass of the polyfunctional monomer.

[0051]

Further, specific examples of the biimidazole compound may include bis(halogen-substituted phenyl)tetrakis(alkoxycarbonylphenyl)biimidazoles such as 2,2'-bis(2-chlorophenyl)-4,4',5,5'-tetrakis(4-ethoxycarbonylphenyl)-1,2'-biimidazole and 2,2'-bis(2-bromophenyl)-4,4',5,5'-tetrakis(4-ethoxycarbonylphenyl)-1,2'-biimidazole; and bis(halogen-substituted phenyl)tetraphenylbiimidzoles such as 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.

[0052]

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, and 2,2'-bis(2,4,6-trichlorophenyl)-4,4',5,5'-tetraphenyl-1,2'-biimidazole 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 precipitation. 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 a developer can be distinguishably divided from uncured portions highly soluble in the developer. In this way, a high-definition color filter in which the colored layer

patterns having no undercut are arranged in accordance with predetermined arrays can be formed.

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

[0053]

In the present invention, when the biimidazole compound is used as a photopolymerization initiator, the content thereof is usually 0.01 to 40 parts by mass, preferably 1 to 30 parts by mass, and more preferably 1 to 20 parts by mass based on 100 parts by mass of (D) the polyfunctional monomer. When the content of the biimidazole compound is less than 0.01 part by mass, curing by exposure becomes insufficient. As a result, a color filter in which patterns of colored layers are arranged in accordance with predetermined arrays may not be easily obtained. On the other hand, when the content exceeds 40 parts by mass, the formed colored layer tends to peel off from a substrate and the surface of the colored layer tends to roughen during a developing process. Note that when the polyfunctional monomer is used in combination with the monofunctional monomer, the mass of the monofunctional monomer is included in the mass of the polyfunctional monomer.

[0054]

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 the biimidazole compound by exposure.

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

[0055]

The mercaptan compound means 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").

Furthermore, the above amine compound means 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.

[0056]

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.

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 a 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.

[0057]

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.

[0058]

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.

Furthermore, in the amine hydrogen donor, one or more of 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 an 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.

[0059]

Specific examples of the amine hydrogen donor may include amino-substituted benzophenones such as 4,4'-bis(dimethylamino)benzophenone and 4,4'-bis(diethylamino)benzophenone, 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 photopolymerization initiator other than the biimidazole compound is used.

[0060]

In the present invention, the hydrogen donor can be used alone or as a mixture of two or more thereof. Particularly, 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 a mercaptan hydrogen donor and an 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. Of them, 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 mass 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.

[0061]

In the present invention, when the hydrogen donor is used in combination with the biimidazole compound, the content of the hydrogen donor is preferably 0.01 to 40 parts by mass, more preferably 1 to 30 parts by mass, and particularly preferably 1 to 20 parts by mass based on 100 parts by mass of (D) the polyfunctional monomer. When the content of the hydrogen donor is less than 0.01 part by mass, an improvement effect of sensitivity tends to decrease. On the other hand, when the content exceeds 40 parts by mass, the formed colored layer tends to peel off from a substrate during a developing process. Note that when the polyfunctional monomer is used in combination with the monofunctional monomer, the mass of the monofunctional monomer is included in the mass of the polyfunctional monomer.

[0062]

It is to be noted that the amine hydrogen donor may have a function as a sensitizer when it is used in combination with a photopolymerization initiator other than the biimidazole compound such as the acetophenone compound. When the amine hydrogen donor is used as the sensitizer, the content thereof is usually not more than

300 parts by mass, preferably not more than 200 parts by mass, and more preferably not more than 100 parts by mass based on 100 parts by mass of the photopolymerization initiator other than the biimidazole compound. Note that when the content is excessively low, sufficient effect is rarely obtained. For this reason, it is desirable that the lower limit of the content is preferably set at 2 parts by mass and more preferably, at 5 parts by mass.

[0063]

Further, specific examples of the 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.

[0064]

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

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

[0065]

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 mass, more preferably 1 to 30 parts by mass, and particularly preferably 1 to 20 parts by mass based on 100 parts by mass of (D) the polyfunctional monomer. When the content of the triazine compound is less than 0.01 part by mass, curing by exposure becomes insufficient. As a result, a color filter in which patterns of colored layers are arranged in accordance with predetermined arrays may not be easily obtained. On the other hand, when the content exceeds 40 parts by mass, the formed colored layer tends to peel off from a substrate during a developing process. Note that when the polyfunctional monomer is used in combination with the monofunctional monomer, the mass of the monofunctional monomer is included in the mass of the polyfunctional monomer.

[0066]

Further, examples of the O-acyl oxime compound may include 1,2-octanedione, 1-[4-(phenylthio)phenyl]-, 2-(O-benzoyloxime); 1-[9-ethyl-6-benzoyl-9H-carbazol-3-yl]-nonane-1,2-nonane-2-oxime-O-benzoate; 1-[9-ethyl-6-benzoyl-9H-carbazol-3-yl]-nonane-1,2-nonane-2-oxime-O-acetate, 1-[9-ethyl-6-

benzoyl-9H-carbazol-3-yl]-pentane-1,2-pentane-2-oxime-O-acetate;

1-[9-ethyl-6-benzoyl-9H-carbazol-3-yl]-octan-1-one oxime-O-acetate;

1-[9-ethyl-6-(2-methyl benzoyl)-9H-carbazol-3-yl]-ethan-1-one oxime-O-benzoate;

1-[9-ethyl-6-(1,3,5-trimethylbenzoyl)-9H-carbazol-3-yl]-ethan-1-one oxime-O-benzoate; 1-[9-butyl-6-(2-ethylbenzoyl)-9H-carbazol-3-yl]-ethan-1-one oxime-O-benzoate;

ethanone, 1-[9-ethyl-6-(2-methylbenzoyl)-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).

[0067]

Of these 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-(2,2-dimethyl-1,3-dioxolanyl)methoxybenzoyl]-9H-carbazol-3-yl]-, and 1-(O-acetyloxime) are preferred.

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

[0068]

In the present invention, when the O-acyl oxime compound is used as the photopolymerization initiator, the content thereof is preferably 0.01 to 60 parts by

mass, more preferably 1 to 50 parts by mass, and particularly preferably 1 to 40 parts by mass based on 100 parts by mass of (D) the polyfunctional monomer. When the content of the O-acyl oxime compound is less than 0.01 part by mass, curing by exposure becomes insufficient. As a result, a color filter in which patterns of colored layers are arranged in accordance with predetermined arrays may not be easily obtained. On the other hand, when the content exceeds 60 parts by mass, the formed colored layer tends to peel off from a substrate during a developing process. Note that when the polyfunctional monomer is used in combination with the monofunctional monomer, the mass of the monofunctional monomer is included in the mass of the polyfunctional monomer.

[0069]

Examples of the xanthone compound may include xanthone; and thioxanthenes such as thioxanthone, 2,4-diethylthioxanthone and 2-chlorothioxanthone.

[0070]

In the present invention, when the xanthone compound is used as the photopolymerization initiator, the content thereof is preferably 0.01 to 50 parts by mass, more preferably 1 to 40 parts by mass, and particularly preferably 1 to 30 parts by mass based on 100 parts by mass of (D) the polyfunctional monomer. When the content of the xanthone compound is less than 0.01 part by mass,

curing by exposure becomes insufficient. As a result, a color filter in which patterns of colored layers are arranged in accordance with predetermined arrays may not be easily obtained. On the other hand, when the content exceeds 50 parts by mass, the formed colored layer tends to peel off from the substrate during a developing process. Note that when the polyfunctional monomer is used in combination with the monofunctional monomer, the mass of the monofunctional monomer is included in the mass of the polyfunctional monomer.

[0071]

- (F) Polymer in which the content of Repeating Units each having an Oxetanyl Group is not less than 70% by mass -

(F) The polymer in which the content of repeating units each having an oxetanyl group is not less than 70% by mass (hereinafter also referred to as a "polymer"(F)) in the present invention is a component capable of crosslinking a specific dispersant and (C) the alkali-soluble resin in the post-baking step. In addition (F) the polymers can be self-polymerized by heating to form a crosslinked structure.

(F) The polymer can provide a colored layer having excellent solvent resistance and adhesiveness even at a low post-baking temperature. From this, the content of the repeating units having an oxetanyl group is preferably not less than 90% by mass, and particularly

preferably not less than 95% by mass. The content of the repeating units having an oxetanyl group is a value based on the total mass of all repeating units constituting (F) the polymer.

[0072]

A monomer providing a repeating unit having an oxetanyl group is not particularly limited as long as it is an unsaturated compound having an oxetanyl group. Examples of the monomer may include the following compounds:

(meth)acryloyloxyalkyloxetanes such as 3-

[(meth)acryloyloxymethyl]oxetane, 3-[2-

(meth)acryloyloxyethyl]oxetane, 2-

[(meth)acryloyloxymethyl]oxetane and 2-[2-

(meth)acryloyloxyethyl]oxetane;

[0073]

[(Meth)acryloyloxyalkyl]alkyloxetanes such as 3-

[(meth)acryloyloxymethyl]-2-methyloxetane, 3-

[(meth)acryloyloxymethyl]-3-methyloxetane, 3-

[(meth)acryloyloxymethyl]-2-ethyloxetane, 3-

[(meth)acryloyloxymethyl]-3-ethyloxetane, 3-[2-

(meth)acryloyloxyethyl]-2-methyloxetane, 3-[2-

(meth)acryloyloxyethyl]-3-methyloxetane, 3-[2-

(meth)acryloyloxyethyl]-2-ethyloxetane, 3-[2-

(meth)acryloyloxyethyl]-3-ethyloxetane, 2-

[(meth)acryloyloxymethyl]-2-methyloxetane, 2-

[(meth)acryloyloxymethyl]-3-methyloxetane, 2-

[(meth)acryloyloxyethyl]-4-methyloxetane, 2-
[(meth)acryloyloxyethyl]-2-ethyloxetane, 2-
[(meth)acryloyloxyethyl]-3-ethyloxetane, 2-
[(meth)acryloyloxyethyl]-4-ethyloxetane, 2-[2-
(meth)acryloyloxyethyl]-2-methyloxetane, 2-[2-
(meth)acryloyloxyethyl]-3-methyloxetane, 2-[2-
(meth)acryloyloxyethyl]-4-methyloxetane, 2-[2-
(meth)acryloyloxyethyl]-2-ethyloxetane, 2-[2-
(meth)acryloyloxyethyl]-3-ethyloxetane and 2-[2-
(meth)acryloyloxyethyl]-4-ethyloxetane;

[0074]

[(meth)acryloyloxyalkyl]fluorooxetanes such as 3-
[(meth)acryloyloxyethyl]-2-trifluoromethyloxetane, 3-
[(meth)acryloyloxyethyl]-2-pentafluoroethyloxetane, 3-
[(meth)acryloyloxyethyl]-2-phenyloxetane, 3-
[(meth)acryloyloxyethyl]-2,2-difluorooxetane, 3-
[(meth)acryloyloxyethyl]-2,2,4-trifluorooxetane, 3-
[(meth)acryloyloxyethyl]-2,2,4,4-tetrafluorooxetane, 3-
[2-(meth)acryloyloxyethyl]-2-trifluoromethyloxetane, 3-
[2-(meth)acryloyloxyethyl]-2-pentafluoroethyloxetane, 3-
[2-(meth)acryloyloxyethyl]-2-phenyloxetane, 3-[2-
(meth)acryloyloxyethyl]-2,2-difluorooxetane, 3-[2-
(meth)acryloyloxyethyl]-2,2,4-trifluorooxetane, 3-[2-
(meth)acryloyloxyethyl]-2,2,4,4-tetrafluorooxetane, 2-
[(meth)acryloyloxyethyl]-2-trifluoromethyloxetane, 2-
[(meth)acryloyloxyethyl]-3-trifluoromethyloxetane, 2-
[(meth)acryloyloxyethyl]-4-trifluoromethyloxetane, 2-

[(meth)acryloyloxyethyl]-2-pentafluoroethyloxetane, 2-
[(meth)acryloyloxyethyl]-3-pentafluoroethyloxetane, 2-
[(meth)acryloyloxyethyl]-4-pentafluoroethyloxetane,
[0075]

2-[(meth)acryloyloxyethyl]-2,3-difluorooxetane, 2-
[(meth)acryloyloxyethyl]-2,4-difluorooxetane, 2-
[(meth)acryloyloxyethyl]-3,3-difluorooxetane, 2-
[(meth)acryloyloxyethyl]-3,4-difluorooxetane, 2-
[(meth)acryloyloxyethyl]-4,4-difluorooxetane, 2-
[(meth)acryloyloxyethyl]-3,3,4-trifluorooxetane, 2-
[(meth)acryloyloxyethyl]-3,4,4-trifluorooxetane, 2-
[(meth)acryloyloxyethyl]-3,3,4,4-tetrafluorooxetane, 2-
[2-(meth)acryloyloxyethyl]-2-trifluoromethyloxetane, 2-
[2-(meth)acryloyloxyethyl]-3-trifluoromethyloxetane, 2-
[2-(meth)acryloyloxyethyl]-4-trifluoromethyloxetane, 2-
[2-(meth)acryloyloxyethyl]-2-pentafluoroethyloxetane, 2-
[2-(meth)acryloyloxyethyl]-3-pentafluoroethyloxetane, 2-
[2-(meth)acryloyloxyethyl]-4-pentafluoroethyloxetane, 2-
[2-(meth)acryloyloxyethyl]-2,3-difluorooxetane, 2-[2-
(meth)acryloyloxyethyl]-2,4-difluorooxetane, 2-[2-
(meth)acryloyloxyethyl]-3,3-difluorooxetane, 2-[2-
(meth)acryloyloxyethyl]-3,4-difluorooxetane, 2-[2-
(meth)acryloyloxyethyl]-4,4-difluorooxetane, 2-[2-
(meth)acryloyloxyethyl]-3,3,4-trifluorooxetane, 2-[2-
(meth)acryloyloxyethyl]-3,4,4-trifluorooxetane, and 2-[2-
(meth)acryloyloxyethyl]-3,3,4,4-tetrafluorooxetane;
[0076]

(meth)acrylic acid esters of
[(meth)acryloyloxyalkyl]phenyloxetanes such as 2-
[(meth)acryloyloxymethyl]-2-phenyloxetane, 2-
[(meth)acryloyloxymethyl]-3-phenyloxetane, 2-
[(meth)acryloyloxymethyl]-4-phenyloxetane, 2-[2-
(meth)acryloyloxyethyl]-2-phenyloxetane, 2-[2-
(meth)acryloyloxyethyl]-3-phenyloxetane, and 2-[2-
(meth)acryloyloxyethyl]-4-phenyloxetane; and
aromatic vinyl compounds such as 4-[3-(3-ethyloxetan-3-
ylmethoxy)propoxy]styrene, 4-[4-(3-ethyloxetan-3-
ylmethoxy)butyloxy]styrene, 4-[5-(3-ethyloxetan-3-
ylmethoxy)pentyloxy]styrene, 4-[6-(3-ethyloxetan-3-
ylmethoxy)hexyloxy]styrene and 4-[7-(3-ethyloxetan-3-yl
methoxy)heptyloxy]styrene.

Note that the number of carbon atoms of each alkyl
moiety of the above (meth)acryloyloxyalkyl and
alkyloxetane is preferably 1 to 4.

[0077]

Of these unsaturated compounds each having an
oxetanyl group, 3-[(meth)acryloyloxymethyl]oxetane, 3-
[(meth)acryloyloxymethyl]-3-ethyloxetane, 3-
[(meth)acryloyloxymethyl]-2-trifluoromethyloxetane, 3-
[(meth)acryloyloxymethyl]-2-phenyloxetane, 2-
[(meth)acryloyloxymethyl]oxetane, and 2-
[(meth)acryloyloxymethyl]-4-trifluoromethyloxetane are
preferred, and particularly 3-
(methacryloyloxymethyl)oxetane, 3-

(methacryloyloxymethyl)-3-ethyloxetane, 3-(methacryloyloxymethyl)-2-trifluoromethyloxetane, 3-(methacryloyloxymethyl)-2-phenyloxetane, 2-(methacryloyloxymethyl)oxetane, and 2-(methacryloyloxymethyl)-4-trifluoromethyloxetane are preferred since the developing margin of the radiation-sensitive composition to be obtained becomes wide and the chemical resistance of the colored layer to be obtained is enhanced.

[0078]

Further, in the present invention, as the unsaturated compound having an oxetanyl group, other than those mentioned above, (oxetanylalkyl)ethers of vinylphenols such as

(3-oxetanyl methoxy)-p-vinylbenzene, [2-(3-oxetanyl)ethoxy]-p-vinylbenzene, (2-oxetanylmethoxy)-p-vinylbenzene and [2-(2-oxetanyl)ethoxy]-p-vinylbenzene; and

(oxetanylalkyl)vinyl ethers such as (3-oxetanylmethyl)vinyl ether, [2-(3-oxetanyl)ethyl]vinyl ether, (2-oxetanylmethyl)vinyl ether, [2-(2-oxetanyl)ethyl]vinyl ether can be used.

In (F) the polymer, the unsaturated compounds each having an oxetanyl group can be used alone or as a mixture of two or more thereof.

[0079]

In (F) the polymer, the unsaturated compound having an oxetanyl group may be copolymerized with another unsaturated compound copolymerizable therewith.

Examples of another unsaturated compound may include the co-polymerizable unsaturated monomers mentioned as examples of (C) the alkali-soluble resin such as the N-substituted maleimides, the unsaturated carboxylic acid esters, the unsaturated carboxylic acid aminoalkylesters, the unsaturated carboxylic acid glycidyl esters, the vinyl cyanide compounds, the unsaturated amides, the carboxylic acid vinyl esters, the unsaturated ethers, the aliphatic conjugated dienes, the macromonomers having a mono(meth)acryloyl group at an end of a polymer molecular chain, and the aromatic vinyl compounds such as styrene, α -methylstyrene, o-vinytoluene, m-vinytoluene, p-vinytoluene, p-chlorostyrene, o-methoxystyrene, m-methoxystyrene, p-methoxystyrene, o-vinylbenzylmethyl ether, m-vinylbenzylmethyl ether, p-vinylbenzylmethyl ether, o-vinylbenzylglycidyl ether, m-vinylbenzylglycidyl ether and p-vinylbenzylglycidyl ether.

[0080]

The M_w of (F) the polymer in the present invention is preferably 2,000 to 50,000, and particularly preferably 2,000 to 30,000.

The ratio of M_w to M_n (M_w/M_n) of (F) the polymer in the present invention is preferably 1.0 to 2.5, and more preferably 1.0 to 2.0.

In the present invention, by use of (F) the polymer having such a specific Mw and/or Mw/Mn, the solvent resistance of the radiation-sensitive composition to be obtained and adhesiveness thereof to a substrate can be enhanced.

[0081]

(F) The polymer in the present invention can be produced, for example, by polymerizing the unsaturated compound having an oxetanyl group in an appropriate solvent and in the presence of a radical polymerization initiator such as 2,2'-azobisisobutyronitrile, 2,2'-azobis(2,4-dimethylvaleronitrile), 2,2'-azobis(4-methoxy-2,4-dimethylvaleronitrile), 4,4'-azobis(4-cyanopropionic acid), 4,4'-azobis(4-cyanobutyric acid), 4,4'-azobis(4-cyanovaleric acid), 4,4'-azobis(4-cyanoethyl benzoic acid) or 4,4'-azobis(4-cyanoethylcyclohexane carboxylic acid).

[0082]

To control Mw/Mn to fall within the above range, (F) the polymer in the present invention is preferably produced by radical polymerization of the unsaturated compound having an oxetanyl group in the presence of the above radical polymerization initiator and a polyvalent thiol compound serving as a chain transfer agent in an appropriate solvent. In the specification, the polyvalent thiol compound refers to a compound having not less than 2 thiol groups per molecule. Examples thereof

may include trimethylolpropanetris(3-mercaptopropionate), pentaerythritol tetrakis(3-mercaptopropionate), tetraethyleneglycol bis(3-mercaptopropionate), dipentaerythritolhexakis(3-mercaptopropionate), pentaerythritoltetrakis(thioglycolate), 1,4-bis(3-mercaptobutyryloxy)butane, pentaerythritoltetrakis(3-mercaptobutyrate) and 1,3,5,-tris(3-mercaptobutyloxyethyl)-1,3,5-triazine-2,4,6(1H,3H,5H)-trione.

[0083]

The use amount of the polyvalent thiol compound when (F) the polymer is synthesized by polymerization is usually 0.5 to 20 parts by mass, and preferably 1 to 10 parts by mass based on 100 parts by mass of the unsaturated compound having an oxetanyl group. The use amount of the radical polymerization initiator is usually 0.1 to 50 parts by mass, and preferably 0.1 to 20 parts by mass based on 100 parts by mass of the unsaturated compound.

Furthermore, a polymerization temperature is usually 0 to 150°C, and preferably 50 to 120°C and polymerization time is usually 10 minutes to 20 hours, and preferably 30 minutes to 6 hours.

[0084]

In the present invention, when (F) the polymer is synthesized by polymerization, at least one chain transfer agent other than a polyvalent thiol compound,

such as t-dodecyl mercaptan and 2,4-diphenyl-4-methyl-1-pentene may be used in combination usually in an amount of not more than 90% by mass, and preferably, in an amount of not more than 60% by mass based on the total mass of the chain transfer agent.

[0085]

The content of (F) the polymer in the present invention is usually 1 to 400 parts by mass, preferably 3 to 200 parts by mass, and particularly preferably 5 to 100 parts by mass based on 100 parts by mass (in terms of solid content) of (C) the alkali-soluble resin. When the content is less than 1 part by mass, a desired effect is unlikely obtained. On the other hand, when the content exceeds 400 parts by mass, the developing property tends to significantly deteriorate.

[0086]

- Other Additives -

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

As the additives, for example, an organic acid or an organic amino compound (excluding the above-described hydrogen donor), a curing agent and a curing aid, etc. may be mentioned.

[0087]

The organic acid and organic amino compound are components which further improve the solubility of a radiation-sensitive composition to an alkaline developer

and further suppress insoluble matter left after a developing process. As the organic acid, a group having not less than one carboxyl group per molecule such as an aliphatic carboxylic acid or a phenyl group-containing carboxylic acid is preferred.

Examples of the aliphatic carboxylic acid may include 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; 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 tricarboxylic acids such as tricarballic acid, aconitic acid and camphoronic acid.

[0088]

As the phenyl group-containing carboxylic acid, for example, a compound having a carboxyl group directly bound to a phenyl group, and a carboxylic acid having a carboxyl group directly bound to a phenyl group via a carbon chain may be mentioned.

Examples of the phenyl group-containing carboxylic acid may include aromatic monocarboxylic acids such as benzoic acid, toluic acid, cuminic acid, hemellitic acid and mesitylenic acid; aromatic dicarboxylic acids such as phthalic acid, isophthalic acid, terephthalic acid and cinnamylidene malonic acid; three or more valent aromatic polycarboxylic acids of such as trimellitic acid, trimesic acid, mellophanic acid and pyromellitic acid; phenylacetic acid; hydratropic acid; hydrocinnamic acid; mandelic acid; phenylsuccinic acid; atropic acid; cinnamic acid; cinnamylideneacetic acid; coumaric acid and umbellic acid.

[0089]

Of these organic acids, from the viewpoints such as solubility to alkali, solubility to the solvent described later, prevention of scum and film residue on unexposed portions of a substrate or a light shielding layer, an aliphatic carboxylic acid, specifically, an aliphatic dicarboxylic acid is preferred, in particular, malonic acid, adipic acid, itaconic acid, citraconic acid, fumaric acid, and mesaconic acid are preferred. Furthermore, as the phenyl group-containing carboxylic acid, aromatic dicarboxylic acid is preferred, and particularly, phthalic acid is preferred.

The organic acids can be used alone or as a mixture of two or more thereof.

The content of the organic acid is usually not more than 15% by mass and preferably not more than 10% by mass, based on the total solid content of the radiation-sensitive composition. When the content of the organic acid exceeds 15% by mass, the adhesiveness of the formed colored layer to the substrate tends to decrease.

[0090]

As the organic amino compound, an aliphatic amine or a phenyl group-containing amine having one or more amino groups per molecule is preferred.

Examples of the aliphatic amine may include the following compounds:

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, 2-methylcyclohexylamine, 3-methylcyclohexylamine, 4-methylcyclohexylamine, 2-ethyl cyclohexyl amine, 3-ethylcyclohexylamine and 4-ethylcyclohexylamine;

di(cyclo)alkylamines such as methylethylamine, diethylamine, methyl-n-propylamine, ethyl-n-propylamine, di-n-propylamine, di-i-propylamine, di-n-butylamine, di-i-butylamine, di-sec-butylamine, di-t-butylamine, di-n-

pentylamine, di-n-hexylamine, methylcyclohexylamine, ethylcyclohexylamine and dicyclohexyl amine;

[0091]

tri(cyclo)alkylamines such as dimethylethylamine, methyldiethylamine, triethylamine, dimethyl-n-propylamine, diethyl-n-propylamine, methyldi-n-propylamine, ethyldi-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, dimethylcyclohexylamine, diethylcyclohexylamine, methyldicyclohexylamine, ethyldicyclohexylamine and tricyclohexyl amine;

mono(cyclo)alkanol amines such as 2-aminoethanol, 3-amino-1-propanol, 1-amino-2-propanol, 4-amino-1-butanol, 5-amino-1-pentanol, 6-amino-1-hexanol and 4-amino-1-cyclohexanol;

[0092]

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 di(4-cyclohexanol)amine;

tri(cyclo)alkanol amines such as triethanol amine, tri-n-propanolamine, tri-i-propanolamine, tri-n-butanol amine, tri-i-butanol amine, tri-n-pentanol amine, tri-n-hexanol amine and tri(4-cyclohexanol)amine;

[0093]

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, 4-amino-1,3-cyclohexanediol, 3-dimethylamino-1,2-propanediol, 3-diethyl amino-1,2-propanediol, 2-dimethylamino-1,3-propanediol and 2-diethyl amino-1,3-propanediol; amino group-containing cycloalkanemethanols such as 1-aminocyclopentanemethanol, 4-aminocyclopentanemethanol, 1-aminocyclohexanemethanol, 4-aminocyclohexanemethanol, 4-dimethylaminocyclopentanemethanol, 4-diethylaminocyclopentane methanol, 4-dimethylaminocyclohexanemethanol and 4-diethylaminocyclohexanemethanol; and aminocarboxylic acids such as β -alanine, 2-aminobutyric acid, 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 4-aminocyclohexanecarboxylic acid.

[0094]

Furthermore, as the phenyl group-containing amine, for example, a compound having an amino group directly bound to a phenyl group, and a compound having an amino group bound to a phenyl group via a carbon chain may be mentioned.

Examples of the phenyl group-containing amine may include

aromatic amines such as aniline, 2-methylaniline, 3-methylaniline, 4-methylaniline, 4-ethylaniline, 4-n-propylaniline, 4-i-propylaniline, 4-n-butyylaniline, 4-t-butylianiline, 1-naphthylamine, 2-naphthylamine, N,N-dimethylaniline, N,N-diethylaniline and 4-methyl-N,N-dimethylaniline;

aminobenzyl alcohols such as 2-aminobenzyl alcohol, 3-aminobenzyl alcohol, 4-aminobenzyl alcohol, 4-dimethylaminobenzyl alcohol, and 4-diethylaminobenzyl alcohol; and

aminophenols such as 2-aminophenol, 3-aminophenol, 4-aminophenol, 4-dimethylaminophenol and 4-diethylaminophenol.

[0095]

Of these organic amino compounds, from the viewpoints such as solubility to the solvent described later, prevention of scum and film residue on unexposed portions of a substrate or a light shielding layer, as the aliphatic amine, mono(cyclo)alkanolamines and amino(cyclo)alkanediols are preferred and particularly 2-aminoethanol, 3-amino-1-propanol, 5-amino-1-pentanol, 3-amino-1,2-propanediol, 2-amino-1,3-propanediol, and 4-amino-1,2-butanediol are preferred. Furthermore, as the phenyl group-containing amine, aminophenols are preferred

and particularly 2-aminophenol, 3-aminophenol, and 4-aminophenol are preferred.

[0096]

The curing agent is a component which reacts with a specific dispersant, the carboxyl group-containing copolymer and/or (F) the polymer to be incorporated itself into a crosslinked structure, thereby improving degree of cure and solvent resistance.

Examples of the curing agent may include an epoxy compound, an oxetane compound (excluding (F) the polymer) and a polyvalence carboxylic acid anhydride.

[0097]

As the epoxy compound, a polyfunctional epoxy compound is preferred. Specific examples thereof may include aromatic epoxy resins such as bisphenol A epoxy resin, hydrogenated bisphenol A epoxy resin, bisphenol F epoxy resin, hydrogenated bisphenol F epoxy resin, and Novolak type epoxy resin; and other epoxy resins such as alicyclic epoxy resin, heterocyclic epoxy resin, glycidyl ester resin, glycidyl amine resin, and epoxidized oil; brominated derivatives of these epoxy resins; epoxy compounds of a butadiene (co)polymer; epoxy compounds of an isoprene (co)polymer; (co)polymers of glycidyl group-containing unsaturated compound; and triglycidylisocyanurate.

[0098]

Furthermore, as the epoxy compound, an epoxy group-containing unsaturated compound is also preferred.

Specific examples thereof may include

glycidyl(meth)acrylate, 3,4-epoxybutyl(meth)acrylate, 6,7-epoxyheptyl(meth)acrylate, o-vinylbenzylglycidyl ether, m-vinylbenzylglycidyl ether and p-vinylbenzylglycidyl ether.

[0099]

As the oxetane compound, a polyfunctional oxetane compound is preferred. Specific examples thereof may include low molecular weight compounds such as bis-oxetanyl carbonate, bis-oxetanyl adipate, bis-oxetanyl terephthalate, bis-oxetanyl p-xylylene dicarboxylate, and bis-oxetanyl 1,4-cyclohexanedicarboxylate; and macromolecule compounds such as an oxetane ether compound of a phenol novolak resin.

Furthermore, as the oxetane compound, a compound other than the monomer to be used in (F) the polymer can be used.

[0100]

Specific examples of the polyvalent carboxylic anhydride may include aromatic polyvalent carboxylic anhydrides such as phthalic anhydride, pyromellitic anhydride, trimellitic anhydride and 3,3',4,4' - benzophenone tetracarboxylic dianhydride;

aliphatic polyvalent carboxylic anhydrides such as itaconic anhydride, succinic anhydride, citraconic

anhydride, dodecenyl succinic anhydride, tricarballlylic anhydride, maleic anhydride and 1,2,3,4-butanetetra carboxylic dianhydride;

alicyclic polyvalent carboxylic anhydrides such as hexahydrophthalic anhydride, 3,4-dimethyltetrahydrophthalic anhydride , 1,2,4-cyclopentanetricarboxylic anhydride , 1,2,4-cyclohexanetricarboxylic anhydride, cyclopentanetetracarboxylic dianhydride, 1,2,4,5-cyclohexanetetracarboxylic dianhydride, himic anhydride and nadic anhydride; ester group-containing carboxylic anhydrides such as ethylene glycol bis-trimellitic anhydride and glycerin tris-trimellitic anhydride. Besides these, epoxy resin hardeners sold under trade names of Adeka hardener EH-700 (manufactured by Adeka Corporation) and Rikacid HH (manufactured by New Japan Chemical Co. Ltd.) and MH-700 (manufactured by New Japan Chemical Co. Ltd.) may be mentioned.

[0101]

These curing agents may be used alone or as a mixture of two or more thereof.

The content of the curing agents is usually not more than 30% by mass and preferably not more than 20% by mass based on the total solid content of the radiation-sensitive composition. When the content of the curing agent exceeds 30% by mass, storage stability of the

radiation-sensitive composition to be obtained tends to decrease.

[0102]

The curing aid is a component which opens a functional group contained in (F) the polymer and the curing agent (e.g., epoxy group, oxetanyl group) and accelerates a curing reaction without being incorporated into a crosslinked structure.

Examples of the curing aid may include thermo acid generators such as sulfonium salts, benzothiazonium salts, ammonium salts, phosphonium salts, sulfonic acid ester compounds, sulfonimide compounds and diazomethane compounds. Of them, the sulfonium salts, the benzothiazonium salts, the sulfonic acid ester compounds, the sulfonimide compounds, and the diazomethane compounds are preferred.

[0103]

Specific examples of the sulfonium salts may include the following compounds:

alkylsulfonium salts such as 4-acetophenyldimethylsulfonium hexafluoroantimonate, 4-acetoxyphenyldimethylsulfonium hexafluoroarsenate, dimethyl-4-(benzyloxycarbonyloxy)phenylsulfonium hexafluoroantimonate, dimethyl-4-(benzoyloxy)phenylsulfonium hexafluoroantimonate, dimethyl-4-(benzoyloxy)phenylsulfonium hexafluoroarsenate

and dimethyl-3-chloro-4-acetoxyphenylsulfonium hexafluoroantimonate;
benzylsulfonium salts such as benzyl-4-hydroxyphenylmethylsulfonium hexafluoroantimonate, benzyl-4-hydroxyphenylmethylsulfonium hexafluorophosphate, 4-acetoxyphenylbenzylmethylsulfonium hexafluoroantimonate, benzyl-4-methoxyphenylmethylsulfonium hexafluoroantimonate, benzyl-2-methyl-4-hydroxyphenylmethylsulfonium hexafluoroantimonate, benzyl-3-chloro-4-hydroxyphenylmethylsulfonium hexafluoroarsenate and 4-methoxybenzyl-4-hydroxyphenylmethylsulfonium hexafluorophosphate;

[0104]

dibenzylsulfonium salts such as dibenzyl-4-hydroxyphenylsulfonium hexafluoroantimonate, dibenzyl-4-hydroxyphenylsulfonium hexafluorophosphate, 4-acetoxyphenyldibenzylsulfonium hexafluoroantimonate, dibenzyl-4-methoxyphenylsulfonium hexafluoroantimonate, dibenzyl-3-chloro-4-hydroxyphenylsulfonium hexafluoroarsenate, dibenzyl-3-methyl-4-hydroxy-5-tert-butylphenylsulfonium hexafluoroantimonate and benzyl-4-methoxybenzyl-4-hydroxyphenylsulfonium hexafluorophosphate; and substituted benzylsulfonium salts such as p-chlorobenzyl-4-hydroxyphenylmethylsulfonium hexafluoroantimonate, p-nitrobenzyl-4-hydroxyphenylmethylsulfonium hexafluoroantimonate, p-chlorobenzyl-4-

hydroxyphenylmethylsulfonium hexafluorophosphate, p-nitrobenzyl-3-methyl-4-hydroxyphenylmethylsulfonium hexafluoroantimonate, 3,5-dichlorobenzyl-4-hydroxyphenylmethylsulfonium hexafluoroantimonate, and o-chlorobenzyl-3-chloro-4-hydroxyphenylmethylsulfonium hexafluoroantimonate.

[0105]

Specific examples of the benzothiazonium salts may include benzylbenzothiazonium salts such as 3-benzylbenzothiazonium hexafluoroantimonate, 3-benzylbenzothiazonium hexafluorophosphate, 3-benzylbenzothiazonium tetrafluoroborate, 3-(p-methoxybenzyl)benzylbenzothiazonium hexafluoroantimonate, 3-benzyl-2-methylthiobenzylbenzothiazonium hexafluoroantimonate and 3-benzyl-5-chlorobenzothiazonium hexafluoroantimonate.

[0106]

Specific examples of the sulfonic acid ester may include benzointosylate, α -methylolbenzointosylate, α -methylolbenzoin-n-octanesulfonate, pyrogalloltris(trifluoromethanesulfonate), pyrogalloltris(nonafluoro-n-butanesulfonate), pyrogalloltris(methanesulfonate) and nitrobenzyl-9,10-diethoxyanthracene-2-sulfonate.

[0107]

Specific examples of the sulfonimide compound may include

N-(trifluoromethanesulfonyloxy)succinimide, N-(trifluoromethanesulfonyloxy)bicyclo[2.2.1]hept-5-ene-2,3-dicarboxyimide, N-(10-camphorsulfonyloxy)succinimide, N-(10-camphorsulfonyloxy)bicyclo[2.2.1]hept-5-ene-2,3-dicarboxyimide and N-[(5-methyl-5-carboxymethanebicyclo[2.2.1]hept-2-yl)sulfonyloxy]succinimide.

[0108]

Specific examples of the diazomethane compound may include

bis(cyclohexanesulfonyl)diazomethane, bis(t-butylsulfonyl)diazomethane and bis(1,4-dioxaspiro[4.5]decane-7-sulfonyl)diazomethane.

[0109]

Of them, particularly, 4-acetoxyphenyldimethylsulfonium hexafluoroarsenate, benzyl-4-hydroxyphenylmethylsulfonium hexafluoroantimonate, 4-acetoxyphenylbenzylmethylsulfonium hexafluoroantimonate, dibenzyl-4-hydroxyphenylsulfonium hexafluoroantimonate, 4-acetoxyphenylbenzylsulfonium hexafluoroantimonate, 3-benzylbenzothiazonium hexafluoroantimonate, and N-(trifluoromethanesulfonyloxy)bicyclo[2.2.1]hept-5-ene-2,3-dicarboxyimide are preferred.

[0110]

These curing aids can be used alone or as a mixture of two or more thereof.

The content of the curing aid is usually not more than 15% by mass, and preferably not more than 10% by mass based on the total solid content of a radiation-sensitive composition. When the content of the curing aid exceeds 15% by mass, the storage stability to the radiation-sensitive composition to be obtained decreases and the formed colored layer tends to peel off from a substrate during a developing process.

Note that the lower limits of the contents of the curing agent and the curing aid are usually 0.1 part by mass and preferably 0.5 parts by mass based on the total solid content of the radiation-sensitive composition.

[0111]

Examples of the additives other than the aforementioned additives may include dispersion aids such as a blue pigment derivative, e.g., a copper phthalocyanine derivative and a yellow pigment derivative;
fillers such as glass and alumina;
macromolecule compounds such as polyvinyl alcohol, polyethylene glycol monoalkyl ether and poly(fluoroalkylacrylate);
surfactants such as nonionic, cationic and anionic surfactants;
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 alkoxybenzophenone; aggregation inhibitors such as sodium polyacrylate; and thermal-radical generating agents such as 1,1'-azobis(cyclohexane-1-carbonitrile) and 2-phenylazo-4-methoxy-2,4-dimethyl valeronitrile.

[0112]

- Solvent -

The radiation-sensitive composition of the present invention, which contains the above (A) to (F) components as essential components and, if necessary, contains the additive components, is usually prepared in the form of a liquid composition by adding a solvent.

As the solvent, any solvent can be appropriately selected and used as long as it can disperse or dissolve (A) to (F) the components constituting the radiation-

sensitive composition and the additive components and as long as it does not react with these components and has proper volatility.

[0113]

Examples of the solvent may include

(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 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 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;

[0114]

(poly)alkylene 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 glycol monoethyl ether acetate;

other ethers such as diethylene glycol dimethyl ether, diethylene glycol methyl ethyl ether, diethylene glycol diethyl ether and tetrahydrofuran;

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

[0115]

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

other esters such as ethyl 2-hydroxy-2-methyl propionate, methyl 3-methoxypropionate, ethyl 3-methoxypropionate, methyl 3-ethoxypropionate, ethyl 3-ethoxypropionate, ethyl ethoxyacetate, ethyl hydroxyacetate, methyl 2-hydroxy-3-methyl butanoate, 3-methoxybutyl acetate, 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-amyl formate, i-amyl 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 or lactams such as N,N-dimethylformamide, N,N-dimethyl acetamide and N-methylpyrrolidone.

[0116]

Of these solvents, from the viewpoint of solubility, pigment dispersibility and coating properties, propylene

glycol monomethyl 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 lactate, ethyl 3-methoxypropionate, methyl 3-ethoxypropionate, ethyl 3-ethoxypropionate, 3-methoxybutyl acetate, 3-methyl-3-methoxybutyl propionate, n-butyl acetate, i-butyl acetate, n-amyl formate, i-amyl acetate, n-butyl propionate, ethyl butyrate, i-propyl butyrate, n-butyl butyrate, and ethyl pyruvate are preferred.

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

[0117]

Furthermore, the above solvents may be used in combination with a high-boiling point solvent 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 or ethylene glycol monophenyl ether acetate.

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

[0118]

The content of the solvent is not particularly limited; however, from the viewpoints of coating properties and stability of the radiation-sensitive composition to be obtained, it is desirable that the total concentration of the composition excluding the solvent is usually 5 to 50% by mass, and preferably 10 to 40% by mass.

[0119]

- Color Filter -

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

Next, a method for forming the colored layer of the color filter of the present invention will be described.

At first, a light shielding layer is formed on the surface of a substrate so as to section the parts to form pixels as required, and the radiation-sensitive composition in liquid form having, for example, the red pigment dispersed therein, is applied onto this substrate. Then, pre-baking is performed to evaporate a solvent and thereby a coating is formed.

Then, the coating is exposed to radiation through a photomask and developed with an alkaline developer to dissolve and remove unexposed portions of the coating. Thereafter, post-baking is performed to obtain a pixel

array in which a red pixel pattern is arranged in a predetermined array.

[0120]

Thereafter, using the liquid radiation-sensitive composition having the green pigment or the blue pigment dispersed therein, operations of applying each liquid composition, pre-baking, exposure to light, development and post-baking in the same manner as above are performed. In this way, green and blue pixel arrays are formed in this order on the same single substrate to obtain a colored filter having pixel arrays of the three primary colors (red, green and blue) arranged on the substrate. However, the order of forming pixels of individual colors in the present invention is not limited to the above order.

Furthermore, black matrix can be formed using a liquid radiation-sensitive composition having a black pigment dispersed therein in the same manner as in the above case of forming pixels.

[0121]

As a substrate material to be used in forming pixels and/or a black matrix, for example, glass, silicon, polycarbonate, polyester, aromatic polyamide, polyamide imide, and polyimide may be mentioned.

To these substrates, if desired, an appropriate pretreatment such as a chemical treatment with a silane coupling agent or the like, a plasma treatment, ion

plating, sputtering, gas phase reaction, or vacuum deposition, may be previously applied.

When the liquid radiation-sensitive composition is applied to the substrate, an appropriate coating method such as a spray method, a roll-coat method, a rotary coating method (spin coating method), a slit-die coating method, a bar coating method, or an ink-jet method may be employed; however, particularly, the spin coating method and the slit-die coating method are preferred.

The thickness of a coating is usually 0.1 to 10 μm , preferably 0.2 to 8.0 μm , and particularly preferably, 0.2 to 6.0 μm in terms of film-thickness after dry.

[0122]

As a radiation to be used for forming the colored layer, for example, visible rays, ultraviolet rays, far-ultraviolet rays, electron beams or X-rays can be used; however, radiation (radial ray) having a wavelength within the range of 190 to 450 nm is preferred.

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

As an alkaline developer, for example, aqueous solutions of compounds such as sodium carbonate, sodium hydroxide, potassium hydroxide, tetramethylammonium hydroxide, choline, 1,8-diazabicyclo-[5.4.0]-7-undecene or 1,5-diazabicyclo-[4.3.0]-5-nonene are preferred.

To the alkaline developer, for example, a water-miscible organic solvent such as methanol or ethanol and

a surfactant, etc., can be added in an appropriate amount. It is to be noted that the coating is usually rinsed with water after a developing process with the alkali developer.

As a developing process, a shower developing method, a spray developing method, a dip (immersion) developing method, and a puddle developing method can be applied. The developing process is preferably performed at an ordinary temperature for about 5 to 300 seconds.

[0123]

As a heating temperature in the post-baking, a temperature of about 200 to 250°C has been preferably employed in the art; however, in the radiation-sensitive composition for forming the colored layer of the present invention, a color filter having sufficient performance can be formed even if the post-baking is performed at a temperature of about 150 to 200°C. As heating time, a time period of about 20 to 40 minutes has been preferably employed for post-baking in the art; however, in the radiation-sensitive composition for forming the colored layer of the present invention, a color filter having sufficient performance can be obtained even if post-baking is performed for about 10 to 20 minutes at a heating temperature of 200°C or more and for about 20 to 30 minutes at a heating temperature of less than 200°C.

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

[0124]

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

[0125]

Liquid Crystal Display Device

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

An embodiment of the liquid crystal display device of the present invention, a color liquid crystal display device having particularly excellent characteristics can be manufactured by forming pixels and/or black matrices on thin-film transistor substrate arrays using the radiation-sensitive composition for forming the colored layer of the present invention in the manner as mentioned above.

[Examples]

[0126]

The present invention will be more specifically described by way of examples; however, the present invention is not limited to the examples below. It is to be noted that the "parts" and "%" described hereinafter are on the basis of mass if not otherwise specified.

The Mw and Mn of the resins obtained in the Synthesis Examples below 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.

Elution Solvent: Tetrahydrofuran containing 0.5% phosphoric acid.

[0127]

Dispersants, polyfunctional monomer, photopolymerization initiators and curing agents used in examples of the present invention will be described below.

Dispersant

b-1: Disperbyk-2001 (non-volatile content = 46%, amine value = 29, acid value = 19, manufactured by BYK Chemie (BYK)),

b-2: Solsperse 24000 (non-volatile content = 100%, amine value = 42, acid value = 25, manufactured by Lubrizol Corporation),

b-3: Disperbyk-192 (non-volatile content = 100%, amine value = 0, acid value = 0, manufactured by BYK Chemie (BYK)).

[0128]

Polyfunctional Monomer

d-1: dipentaerythritol hexaacrylate

[0129]

Polymerization Initiator

e-1: 2-methyl-1-[4-(methylthio)phenyl]-2-morpholinopropanon-1-one

e-2: ethanone, 1-[9-ethyl-6-(2-methylbenzoyl)-9H-carbazol-3-yl]-, 1-(O-acetyloxime),

e-3: 2-benzyl-2-dimethylamino-1-(4-morpholinophenyl)butanon-1-one

e-4: 2,4-diethylthioxanthone

e-5: 4,4'-bis(diethylamino)benzophenone
[0130]

Curing Agent

g-1: Bisphenol A Novolak epoxy resin (trade name: 157S65, manufactured by Japan Epoxy Resin Co., Ltd.)

g-2: Trimellitic anhydride

g-3: N-(trifluoromethanesulfonyloxy)bicyclo[2.2.1]hept-5-ene-2,3-dicarboxyimide
[0131]

Synthesis of (C) the Alkali-Soluble Resin

Synthesis Example 1

A flask equipped with a condenser and a stirrer was charged with 3 parts of 2,2'-azobisisobutyronitrile and 200 parts of propylene glycol monomethyl ether acetate, subsequently charged with 15 parts of methacrylic acid, 20 parts of N-phenylmaleimide, 10 parts of styrene, 55 parts of benzyl methacrylate and 5 parts of 2,4-diphenyl-4-methyl-1-pentene (trade name: Nofmer MSD, manufactured by NOF CORPORATION) serving as a molecular-weight controlling agent and purged with nitrogen gas.

Thereafter, the reaction solution was gently stirred while increasing the temperature thereof to 80°C. Polymerization was performed by maintaining the solution at this temperature for 5 hours to obtain a resin solution. This resin was referred to as "alkali-soluble resin (c-1)". The weight average molecular weight (in terms of polystyrene) of the alkaline-soluble resin measured by gel permeation chromatography was 11,000 and Mw/Mn was 2.6.

[0132]

Synthesis Example 2

A flask equipped with a condenser and a stirrer was charged with 3 parts of 2,2'-azobisisobutyronitrile and 200 parts of propylene glycol monomethyl ether acetate, subsequently charged with 15 parts of methacrylic acid, 85 parts of benzyl methacrylate and 5 parts of 2,4-diphenyl-4-methyl-1-pentene (trade name: Nofmer MSD, manufactured by NOF CORPORATION) serving as a molecular-weight controlling agent and purged with nitrogen gas. Thereafter, the reaction solution was gently stirred while increasing the temperature thereof to 80°C. Polymerization was performed by maintaining the solution at this temperature for 5 hours to obtain a resin solution. This resin was referred to as "alkali-soluble resin (c-2)". The weight average molecular weight (in terms of polystyrene) of the alkaline-soluble resin

measured by gel permeation chromatography was 13,000 and Mw/Mn was 2.8.

[0133]

Comparative Synthesis Example 1

A flask equipped with a condenser and a stirrer was charged with 3 parts of 2,2'-azobisisobutyronitrile and 200 parts of propylene glycol monomethyl ether acetate, subsequently charged with 15 parts of methacrylic acid, 70 parts of benzyl methacrylate, 15 parts of 3-[(meth)acryloyloxymethyl]-3-ethyloxetane and 5 parts of 2,4-diphenyl-4-methyl-1-pentene (trade name: Nofmer MSD, manufactured by NOF CORPORATION) serving as a molecular-weight controlling agent and purged with nitrogen gas. Thereafter, the reaction solution was gently stirred while increasing the temperature thereof to 80°C. Polymerization was performed by maintaining the solution at this temperature for 5 hours to obtain a resin solution. This resin was referred to as "alkali-soluble resin (c-3)". The weight average molecular weight (in terms of polystyrene) of the alkaline-soluble resin measured by gel permeation chromatography was 13,000 and Mw/Mn = 2.7.

[0134]

Synthesis of (F) the Polymer

Synthesis Example 3

A flask equipped with a condenser and a stirrer was charged with 3 parts of 2,2'-azobisisobutyronitrile and

200 parts of propylene glycol monomethyl ether acetate, subsequently charged with 100 parts of 3-[(meth)acryloyloxymethyl]-3-ethyloxetane and 5 parts of 2,4-diphenyl-4-methyl-1-pentene (trade name: Nofmer MSD, manufactured by NOF CORPORATION) serving as a molecular-weight controlling agent and purged with nitrogen gas. Thereafter, the reaction solution was gently stirred while increasing the temperature thereof to 80°C. Polymerization was performed by maintaining the solution at this temperature for 5 hours to obtain a resin solution. This resin was referred to as "polymer (f-1)". The weight average molecular weight (in terms of polystyrene) of the polymer measured by gel permeation chromatography was 12,000 and $M_w/M_n = 2.9$.

[0135]

Synthesis Example 4

A flask equipped with a condenser and a stirrer was charged with 3 parts of 2,2'-azobisisobutyronitrile and 200 parts of propylene glycol monomethyl ether acetate, subsequently charged with 100 parts of 3-[(meth)acryloyloxymethyl]-3-ethyloxetane and 7 parts of pentaerythritol tetrakis(3-mercaptopropionate) (trade name: PEMP, manufactured by Sakai Chemical Industry Co., Ltd) serving as a molecular-weight controlling agent and purged with nitrogen gas. Thereafter, the reaction solution was gently stirred while increasing the temperature thereof to 80°C. Polymerization was

performed by maintaining the solution at this temperature for 5 hours to obtain a resin solution. This resin was referred to as "polymer (f-2)". The weight average molecular weight (in terms of polystyrene) of the polymer measured by gel permeation chromatography was 7,000 and $M_w/M_n = 1.7$.

[0136]

Synthesis Example 5

A flask equipped with a condenser and a stirrer was charged with 3 parts of 4,4'-azobis(4-cyanovaleric acid) and 200 parts of propylene glycol monomethyl ether acetate, subsequently charged with 100 parts of 3-[(meth)acryloyloxymethyl]-3-ethyloxetane and 5 parts of 2,4-diphenyl-4-methyl-1-pentene (trade name: Nofmer MSD, manufactured by NOF CORPORATION) serving as a molecular-weight controlling agent and purged with nitrogen gas. Thereafter, the reaction solution was gently stirred while increasing the temperature thereof to 80°C. Polymerization was performed by maintaining the solution at this temperature for 5 hours to obtain a resin solution. This resin was referred to as "polymer (f-3)". The weight average molecular weight (in terms of polystyrene) of the polymer measured by gel permeation chromatography was 16,000 and $M_w/M_n = 2.8$.

[0137]

Synthesis Example 6

A flask equipped with a condenser and a stirrer was charged with 3 parts of 2,2'-azobisisobutyronitrile and 200 parts of propylene glycol monomethyl ether acetate, subsequently charged with 100 parts of 4-[3-(3-ethyloxetan-3-ylmethoxy)propoxy]styrene and 5 parts of 2,4-diphenyl-4-methyl-1-pentene (trade name: Nofmer MSD, manufactured by NOF CORPORATION) serving as a molecular-weight controlling agent and purged with nitrogen gas. Thereafter, the reaction solution was gently stirred while increasing the temperature thereof to 80°C. Polymerization was performed by maintaining the solution at this temperature for 5 hours to obtain a resin solution. This resin was referred to as "polymer (f-4)". The weight average molecular weight (in terms of polystyrene) of the polymer measured by gel permeation chromatography was 11,000 and $M_w/M_n = 2.6$.

[0138]

Synthesis Example 7

A flask equipped with a condenser and a stirrer was charged with 3 parts of 2,2'-azobisisobutyronitrile and 200 parts of propylene glycol monomethyl ether acetate, subsequently charged with 95 parts of 3-[(meth)acryloyloxymethyl]-3-ethyloxetane, 5 parts of benzyl methacrylate and 7 parts of pentaerythritol tetrakis(3-mercaptopropionate) (trade name: PEMP, manufactured by Sakai Chemical Industry Co., Ltd) serving as a molecular-weight controlling agent and purged with

nitrogen gas. Thereafter, the reaction solution was gently stirred while increasing the temperature thereof to 80°C. Polymerization was performed by maintaining the solution at this temperature for 5 hours to obtain a resin solution. This resin was referred to as "polymer (f-5)". The weight average molecular weight (in terms of polystyrene) of the polymer measured by gel permeation chromatography was 7,000 and $M_w/M_n = 1.7$.

[0139]

Synthesis Example 8

A flask equipped with a condenser and a stirrer was charged with 3 parts of 2,2'-azobisisobutyronitrile and 200 parts of propylene glycol monomethyl ether acetate, subsequently charged with 90 parts of 3-[(meth)acryloyloxymethyl]-3-ethyloxetane, 10 parts of benzyl methacrylate and 7 parts of pentaerythritol tetrakis(3-mercaptopropionate) (trade name: PEMP, manufactured by Sakai Chemical Industry Co., Ltd) serving as a molecular-weight controlling agent and purged with nitrogen gas. Thereafter, the reaction solution was gently stirred while increasing the temperature thereof to 80°C. Polymerization was performed by maintaining the solution at this temperature for 5 hours to obtain a resin solution. This resin was referred to as "polymer (f-6)". The weight average molecular weight (in terms of polystyrene) of the polymer measured by gel permeation chromatography was 7,000 and $M_w/M_n = 1.7$.

[0140]

Synthesis Example 9

A flask equipped with a condenser and a stirrer was charged with 3 parts of 2,2'-azobisisobutyronitrile and 200 parts of propylene glycol monomethyl ether acetate, subsequently charged with 80 parts of 3-[(meth)acryloyloxymethyl]-3-ethyloxetane, 20 parts of benzyl methacrylate and 7 parts of pentaerythritol tetrakis(3-mercaptopropionate) (trade name: PEMP, manufactured by Sakai Chemical Industry Co., Ltd) serving as a molecular-weight controlling agent and purged with nitrogen gas. Thereafter, the reaction solution was gently stirred while increasing the temperature thereof to 80°C. Polymerization was performed by maintaining the solution at this temperature for 5 hours to obtain a resin solution. This resin was referred to as "polymer (f-7)". The weight average molecular weight (in terms of polystyrene) of the polymer measured by gel permeation chromatography was 7,000 and $M_w/M_n = 1.7$.

[0141]

Synthesis Example 10

A flask equipped with a condenser and a stirrer was charged with 3 parts of 2,2'-azobisisobutyronitrile and 200 parts of propylene glycol monomethyl ether acetate, subsequently charged with 70 parts of 3-[(meth)acryloyloxymethyl]-3-ethyloxetane, 30 parts of benzyl methacrylate and 7 parts of pentaerythritol

tetrakis(3-mercaptopropionate) (trade name: PEMP, manufactured by Sakai Chemical Industry Co., Ltd) serving as a molecular-weight controlling agent and purged with nitrogen gas. Thereafter, the reaction solution was gently stirred while increasing the temperature thereof to 80°C. Polymerization was performed by maintaining the solution at this temperature for 5 hours to obtain a resin solution. This resin was referred to as "polymer (f-8)". The weight average molecular weight (in terms of polystyrene) of the polymer measured by gel permeation chromatography was 7,000 and $M_w/M_n = 1.7$.

[0142]

Comparative Synthesis Example 2

A flask equipped with a condenser and a stirrer was charged with 3 parts of 2,2'-azobisisobutyronitrile and 200 parts of propylene glycol monomethyl ether acetate, subsequently charged with 60 parts of 3-[(meth)acryloyloxymethyl]-3-ethyloxetane, 40 parts of benzyl methacrylate and 7 parts of pentaerythritol tetrakis(3-mercaptopropionate) (trade name: PEMP, manufactured by Sakai Chemical Industry Co., Ltd) serving as a molecular-weight controlling agent and purged with nitrogen gas. Thereafter, the reaction solution was gently stirred while increasing the temperature thereof to 80°C. Polymerization was performed by maintaining the solution at this temperature for 5 hours to obtain a resin solution. This resin was referred to as "polymer

(f-9)". The weight average molecular weight (in terms of polystyrene) of the polymer measured by gel permeation chromatography was 7,000 and $M_w/M_n = 1.7$.

[0143]

Preparation of Pigment Dispersion Solution

Preparation Example 1

As (A) the pigment, 20 parts of a mixture containing C.I. Pigment Red 254/C.I. Pigment Red 242/C.I. and Pigment Yellow 139 in a weight ratio of 45/30/25, 5 parts (in terms of solid content) of the dispersant (b-1) and 75 parts of propylene glycol monomethyl ether acetate as a solvent were processed with a beads mill to prepare a pigment dispersion solution (R).

[0144]

Preparation Example 2

As (A) the pigment, 20 parts of a mixture containing C.I. Pigment green 58/C.I. Pigment Yellow 150 in a massratio of 50/50, 5 parts (in terms of solid content) of the dispersant (b-2) and 75 parts of propylene glycol monomethyl ether acetate as a solvent were processed with a beads mill to prepare a pigment dispersion solution (S).

[0145]

Preparation Example 3

As (A) the pigment, 20 parts of a mixture containing C.I. Pigment green 58/C.I. Pigment Yellow 150 in a mass ratio of 50/50, 5 parts (in terms of solid content) of the dispersant (b-3) and 75 parts of propylene glycol

monomethyl ether acetate as a solvent were processed with a beads mill to prepare a pigment dispersion solution (T).
[0146]

Example 1

100 parts of the pigment dispersion solution (R), 10 parts (in terms of solid content) of the alkali-soluble resin solution (c-1), 3 parts (in terms of solid content) of the polymer (f-1), 17 parts of the polyfunctional monomer (d-1), 5 parts of the photopolymerization initiator (e-1) and 3 parts of the photopolymerization initiator (e-4), and propylene glycol monomethyl ether acetate as the solvent were mixed to prepare a liquid composition (R-1) having a solid-content concentration of 25%.

[0147]

The liquid composition (R-1) was processed to form a pattern and evaluated in accordance with the following procedure. The evaluation results are shown in Table 3.

[0148]

Pattern Formation

The liquid composition (R-1) was applied by using a spin coater onto the surface of a glass substrate and subjected to pre-baking performed at 90°C for 4 minutes to form a coating of 1.3 μm in thickness. Subsequently, three substrates thus prepared were cooled to room temperature and the coating formed on each of the substrates was exposed to light by using a high-pressure

mercury lamp through a photomask. The exposure amount on the coating of each substrate was $2,000 \text{ J/m}^2$. Thereafter, the coating of each substrate was sprayed with a 0.04% aqueous potassium hydroxide solution controlled at 23°C through a nozzle (1 mm in diameter) at a developing pressure of 1 kgf/cm^2 . After the shower developing was performed in this manner, post-baking was performed at 220°C or 180°C for 30 minutes to form a dot pattern of $200 \times 200 \text{ }\mu\text{m}$.

[0149]

Evaluation of Solvent Resistance

The three substrates prepared by performing post-baking at 220°C or 180°C for 30 minutes were soaked respectively in N-methylpyrrolidone (indicated by "NMP" in Tables 3 and 4), a 18% aqueous HCl solution (indicated by "HCl" in Tables 3 and 4) and an 5% aqueous KOH solution (indicated by "KOH" in Tables 3 and 4) at 25°C for 30 minutes. The dot patterns were observed before and after the soaking by a scanning electron microscope. Evaluation was performed by giving A to the case where a pattern is satisfactorily formed and a film-thickness ratio before and after soaking (the film thickness after soaking $\times 100$ /the film thickness before soaking) is 95% or more, giving B to the case where a film thickness before and after soaking is less than 95% or a defective part is observed in a pattern, and giving C to the case where a pattern is completely removed after soaking.

[0150]

Evaluation of Adhesiveness

The liquid composition (R-1) was applied by using a spin coater onto the surface of a glass substrate and subjected to pre-baking performed at 90°C for 4 minutes to form a coating of 1.3 μm in thickness. Subsequently, the substrate was cooled to room temperature and the coating was exposed to light by using a high-pressure mercury lamp. The exposure amount on the coating was 2,000 J/m^2 . Thereafter, the coating of the substrate was sprayed with a 0.04% aqueous potassium hydroxide solution controlled at 23°C through a nozzle (1 mm in diameter) at a developing pressure of 1 kgf/cm^2 . After the shower developing was performed in this manner, post-baking was performed at 180°C for 30 minutes. Next, the coating was cut into a 100 grid-pattern and subjected to a cross-cut adhesion test according to JIS K5400 standard.

Evaluation was performed by giving A to the case where none of the grids are removed, giving B to the case where 1 to 10 grids are removed, and giving C to the case where more than 10 grids are removed.

[0151]

Examples 2 to 16

Liquid compositions (R-2) to (R-16) were prepared in the same manner as in Example 1 except that the components and contents thereof were changed from those of R-1 as shown in Table 1.

Evaluation was performed in the same manner as in Example 1 except that liquid compositions (R-2) to (R-16) were used in place of the liquid composition (R-1). The evaluation results are shown in Table 3.

[0152]

Comparative Examples 1 to 4

Liquid compositions (R-17) to (R-20) were prepared in the same manner as in Example 1 except that the components and contents of the respective liquid compositions (R-17) to (R-20) were changed from those of R-1 as shown in Table 1.

Evaluation was performed in the same manner as in Example 1 except that liquid compositions (R-17) to (R-20) were used in place of the liquid composition (R-1). The evaluation results are shown in Table 3.

[0153]

[Table 1]

	Example																Comparative Example			
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	1	2	3	4
Pigment dispersion solution (R)	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
Alkali-soluble resin C-1	10	10	10	10	10	10	10	10					10	10	10	10	13			10
Alkali-soluble resin C-2									10	10	10	10						13		
Alkali-soluble resin C-3																			13	
Polymer f-1	3								3											
Polymer f-2		3								3			3	3	3	3				
Polymer f-3			3								3									
Polymer f-4				3								3								
Polymer f-5					3															
Polymer f-6						3														
Polymer f-7							3													
Polymer f-8								3												
Polymer f-9																				3
Polyfunctional monomer d-1	17	17	17	17	17	17	17	17	17	17	17	17	17	17	17	17	17	17	17	17
Photopolymerization initiator e-1	5	5	5	5	5	5	5	5	5	5	5	5		5	5	5	5	5	5	5
Photopolymerization initiator e-2													5							
Photopolymerization initiator e-4	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
Curing agent g-1														3						
Curing agent g-2															1					
Curing agent g-3																1				

[0154]

Example 17

One hundred parts of the pigment dispersion solution (S), 12 parts (in terms of solid content) of the alkali-soluble resin solution (c-1), 3 parts (in terms of solid content) of the polymer (f-1), 10 parts of the polyfunctional monomer (d-1), 5 parts of the photopolymerization initiator (e-3) and 1 part of the photopolymerization initiator (e-5) and propylene glycol monomethyl ether acetate as the solvent were mixed to prepare a liquid composition (S-1) having a solid-content concentration of 25%.

Subsequently, a pattern was formed and evaluated in the same manner as in Example 1 except that the liquid composition (S-1) was used in place of the liquid composition (R-1). The evaluation results are shown in Table 4.

[0155]

Examples 18 to 32

Liquid compositions (S-2) to (S-16) were prepared in the same manner as in Example 17 except that the component(s) and content(s) of the respective liquid compositions (S-2) to (S-16) were changed from those of S-1as shown in Table 2.

Evaluation was performed in the same manner as in Example 1 except that liquid compositions (S-2) to (S-16)

were used in place of the liquid composition (R-1). The evaluation results are shown in Table 4.

[0156]

Comparative Examples 5 to 9

Liquid compositions (S-17) to (S-20) and (T-1) were prepared in the same manner as in Example 17 except that the component(s) and content(s) of the respective liquid compositions (S-17) to (S-20) and (T-1) were changed from those of S-1as shown in Table 2.

Evaluation was performed in the same manner as in Example 1 except that liquid compositions (S-17) to (S-20) and (T-1) were used in place of the liquid composition (R-1). The evaluation results are shown in Table 4.

[0157]

[Table 2]

	Example																Comparative Example							
	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	5	6	7	8	9			
Pigment dispersion solution (S)	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100				
Pigment dispersion solution (T)																					100			
Alkali-soluble resin C-1	12	12	12	12	12	12	12	12					12	12	12	12	15			12	12			
Alkali-soluble resin C-2									12	12	12	12					15							
Alkali-soluble resin C-3																		15						
Polymer f-1	3								3												3			
Polymer f-2		3								3			3	3	3	3								
Polymer f-3			3								3													
Polymer f-4				3								3												
Polymer f-5					3																			
Polymer f-6						3																		
Polymer f-7							3																	
Polymer f-8								3																
Polymer f-9																				3				
Polyfunctional monomer d-1	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10			
Photopolymerization initiator e-3	5	5	5	5	5	5	5	5	5	5	5	5		5	5	5	5	5	5	5	5			
Photopolymerization initiator e-2													5											
Photopolymerization initiator e-5	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1			
Curing agent g-1														3										
Curing agent g-2															1									
Curing agent g-3																1								

[0158]

[Table 3]

	Liquid composition	Adhesiveness evaluation	Post-baking temperature 220°C			Post-baking temperature 180°C		
			NMP	HCl	KOH	NMP	HCl	KOH
Example 1	R-1	A	A	A	A	C	A	B
Example 2	R-2	A	A	A	A	A	A	A
Example 3	R-3	A	A	A	A	C	A	B
Example 4	R-4	A	A	A	A	C	A	B
Example 5	R-5	A	A	A	A	B	A	A
Example 6	R-6	A	A	A	A	B	A	B
Example 7	R-7	A	A	A	A	C	A	B
Example 8	R-8	A	A	A	A	C	A	B
Example 9	R-9	A	A	A	A	C	B	C
Example 10	R-10	A	A	A	A	A	A	A
Example 11	R-11	A	A	A	A	B	A	C
Example 12	R-12	A	A	A	A	C	B	C
Example 13	R-13	A	A	A	A	A	A	A
Example 14	R-14	A	A	A	A	A	A	A
Example 15	R-15	A	A	A	A	A	A	A
Example 16	R-16	A	A	A	A	A	A	A
Comparative Example 1	R-17	C	C	B	C	C	C	C
Comparative Example 2	R-18	C	C	B	C	C	C	C
Comparative Example 3	R-19	B	A	A	B	C	B	B
Comparative Example 4	R-20	B	A	B	B	C	B	B

[0159]

[Table 4]

	Liquid composition	Adhesiveness evaluation	Post-baking temperature 220°C			Post-baking temperature 180°C		
			NMP	HCl	KOH	NMP	HCl	KOH
Example 17	S-1	A	A	A	A	C	A	B
Example 18	S-2	A	A	A	A	A	A	A
Example 19	S-3	A	A	A	A	C	A	B
Example 20	S-4	A	A	A	A	C	A	B
Example 21	S-5	A	A	A	A	B	A	A
Example 22	S-6	A	A	A	A	B	A	B
Example 23	S-7	A	A	A	A	C	A	B
Example 24	S-8	A	A	A	A	C	A	B
Example 25	S-9	A	A	A	A	C	B	C
Example 26	S-10	A	A	A	A	A	A	A
Example 27	S-11	A	A	A	A	C	B	C
Example 28	S-12	A	A	A	A	C	B	C
Example 29	S-13	A	A	A	A	A	A	A
Example 30	S-14	A	A	A	A	A	A	A
Example 31	S-15	A	A	A	A	A	A	A
Example 32	S-16	A	A	A	A	A	A	A
Comparative Example 5	S-17	C	C	B	C	C	B	C
Comparative Example 6	S-18	C	C	B	C	C	C	C
Comparative Example 7	S-19	B	A	A	B	C	A	B
Comparative Example 8	S-20	B	A	B	B	C	A	B
Comparative Example 9	T-1	B	C	B	C	C	C	C

What is claimed is:

1. A radiation-sensitive composition for forming a colored layer, comprising (A) a pigment, (B) a dispersant having an acid value and an amine value either one of which exceeds 0, (C) an alkali-soluble resin, (D) a polyfunctional monomer, (E) a photopolymerization initiator and (F) a polymer in which a content of repeating units each having an oxetanyl group is not less than 70% by mass.
2. The radiation-sensitive composition for forming the colored layer according to claim 1, wherein a ratio (M_w/M_n) of a weight average molecular weight (M_w) to a number average molecular weight (M_n) in (F) the component is 1.0 to 2.5.
3. The radiation-sensitive composition for forming the colored layer according to claim 1, wherein (F) the component is a polymer obtained by polymerization in the presence of a polyvalent thiol compound.
4. A color filter formed by using the radiation-sensitive composition for forming the colored layer according to any one of claims 1 to 3.
5. A liquid crystal display device having the color filter according to claim 4.