

RADIATION SENSITIVE COMPOSITION FOR FORMING A COLORED LAYER,
COLOR FILTER AND COLOR LIQUID CRYSTAL DISPLAY PANEL

Field of the Invention

5 The present invention relates to a radiation sensitive composition for forming a colored layer, a color filter and a color liquid crystal display panel. More specifically, it relates to a radiation sensitive composition used to form a colored layer, e.g., pixels and a black matrix useful for
10 the manufacture of a color filter for use in transmission and reflection color liquid crystal displays and color image pick-up devices, a color filter comprising a colored layer made of the radiation sensitive composition and a color liquid crystal display panel comprising the color filter.

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Description of the Prior Art

 As means of manufacturing a color filter by using a colored radiation sensitive composition, there is known a method in which a colored radiation sensitive composition
20 is applied to a substrate or a substrate comprising a light screening layer having a desired pattern and dried and then the dried coating film is exposed to radiation in a desired pattern (to be referred to as "exposure" hereinafter) and developed to obtain color pixels (see JP-A 2-144502 and JP-A
25 3-53201) (the term "JP-A" as used herein means an "unexamined published Japanese patent application").

 Although the tact time is generally shortened by reducing the amount of exposure in the technical field of color filters, it is difficult to obtain an excellent pixel
30 pattern and black matrix pattern when the tact time is shortened because the edge of a pattern obtained from the colored radiation sensitive composition of the prior art is apt to be partially missing or undercut during development.

Summary of the Invention

It is an object of the present invention to provide a radiation sensitive composition for forming a colored layer, which exhibits excellent developability, more specifically
5 a novel radiation sensitive composition for forming a colored layer, which does not produce an undissolved product or scum on the pattern edge at the time of development and can provide pixels and a black matrix without a missing part or undercut of the pattern edge even when the amount of exposure is small.

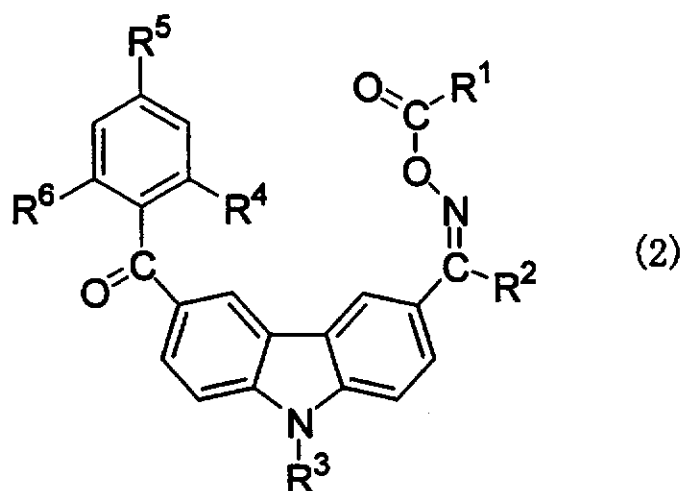
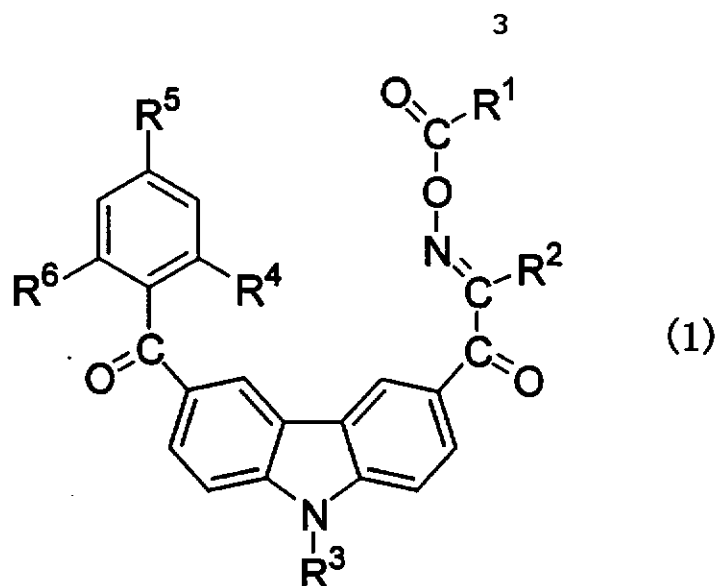
10 It is another object of the present invention to provide a color filter comprising a colored layer made of the above composition.

It is still another object of the present invention to provide a color liquid crystal display panel comprising
15 the above color filter.

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

According to the present invention, firstly, the above objects and advantages of the present invention are attained
20 by a radiation sensitive composition for forming a colored layer, comprising (A) a colorant, (B) an alkali-soluble resin, (C) a polyfunctional monomer or a combination of a polyfunctional monomer and a monofunctional monomer, and (D) at least one optical radical generator selected from the
25 group consisting of compounds represented by each of the following formulas (1) and (2).

The term "colored layer" as used herein means a colored layer composed of pixels and/or a black matrix used for color filters.



In the formulas (1) and (2), R^1 is a linear, branched or cyclic alkyl group having 1 to 12 carbon atoms or phenyl group, R^2 is a hydrogen atom, linear, branched or cyclic alkyl group having 1 to 12 carbon atoms or phenyl group, R^3 is a hydrogen atom, or linear, branched or cyclic alkyl group having 1 to 12 carbon atoms, and R^4 , R^5 and R^6 are each independently a hydrogen atom, or linear, branched or cyclic alkyl group having 1 to 6 carbon atoms, with the proviso that the alkyl group represented by R^1 , R^2 , R^3 , R^4 , R^5 and R^6 may be substituted by a substituent selected from the group consisting of a linear, branched or cyclic alkoxy group having 1 to 6 carbon atoms, phenyl group and halogen atom, and the phenyl group represented by R^1 and R^2 may be

substituted by a substituent selected from the group consisting of a linear, branched or cyclic alkyl group having 1 to 6 carbon atoms, linear, branched or cyclic alkoxy group having 1 to 6 carbon atoms, phenyl group and halogen atom.

5 According to the present invention, secondly, the above objects and advantages of the present invention are attained by a color filter comprising a colored layer made of the above radiation sensitive composition for forming a colored layer.

10 According to the present invention, thirdly, the above objects and advantages of the present invention are attained by a color liquid crystal display panel comprising the color filter.

15 The present invention will be described in detail hereinunder.

Detailed Description of the Preferred Embodiments

Radiation sensitive composition for forming a colored layer

20 (A) Colorant

The color of the colorant in the present invention is not particularly limited and is suitably selected according to the application purpose of the obtained color filter. It may be a pigment, dye or natural coloring matter.

25 Since the development of a high-definition color and heat resistance are required for a color filter, a colorant having high color developability and high heat resistance, especially a colorant having high thermal decomposition resistance is preferred as the colorant in the present
30 invention. Therefore, a pigment is preferred, and an organic pigment and carbon black are particularly preferred.

Examples of the above organic pigment are compounds classified into a group of pigments according to color index (C.I.; issued by The Society of Dyers and Colourists),

specifically compounds having the following color index (C.I.) numbers:

C.I. Pigment Yellow 1, C.I. Pigment Yellow 3, C.I. Pigment Yellow 12, C.I. Pigment Yellow 13, C.I. Pigment Yellow 14,
5 C.I. Pigment Yellow 15, C.I. Pigment Yellow 16, 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 60, C.I. Pigment Yellow 61, C.I. Pigment Yellow 65, C.I. Pigment Yellow 71, C.I. Pigment Yellow 73, C.I. Pigment
10 Yellow 74, C.I. Pigment Yellow 81, C.I. Pigment Yellow 83, C.I. Pigment Yellow 93, C.I. Pigment Yellow 95, C.I. Pigment Yellow 97, C.I. Pigment Yellow 98, C.I. Pigment Yellow 100, C.I. Pigment Yellow 101, C.I. Pigment Yellow 104, C.I. Pigment Yellow 106, C.I. Pigment Yellow 108, C.I. Pigment
15 Yellow 109, C.I. Pigment Yellow 110, C.I. Pigment Yellow 113, C.I. Pigment Yellow 114, C.I. Pigment Yellow 116, C.I. Pigment Yellow 117, C.I. Pigment Yellow 119, C.I. Pigment Yellow 120, C.I. Pigment Yellow 126, C.I. Pigment Yellow 127, C.I. Pigment Yellow 128, C.I. Pigment Yellow 129, C.I.
20 Pigment Yellow 138, C.I. Pigment Yellow 139, C.I. Pigment Yellow 150, C.I. Pigment Yellow 151, C.I. Pigment Yellow 152, C.I. Pigment Yellow 153, C.I. Pigment Yellow 154, C.I. Pigment Yellow 155, C.I. Pigment Yellow 156, C.I. Pigment Yellow 166, C.I. Pigment Yellow 168, C.I. Pigment Yellow 175,
25 C.I. Pigment Yellow 180 and C.I. Pigment Yellow 185;
C.I. Pigment Orange 1, C.I. Pigment Orange 5, C.I. Pigment Orange 13, C.I. Pigment Orange 14, C.I. Pigment Orange 16, C.I. Pigment Orange 17, C.I. Pigment Orange 24, C.I. Pigment Orange 34, C.I. Pigment Orange 36, C.I. Pigment Orange 38,
30 C.I. Pigment Orange 40, C.I. Pigment Orange 43, C.I. Pigment Orange 46, C.I. Pigment Orange 49, C.I. Pigment Orange 51, C.I. Pigment Orange 61, C.I. Pigment Orange 63, C.I. Pigment Orange 64, C.I. Pigment Orange 71 and C.I. Pigment Orange 73;

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 Red 1, C.I. Pigment Red 2, C.I. Pigment Red 3,
 5 C.I. Pigment Red 4, C.I. Pigment Red 5, C.I. Pigment Red 6,
 C.I. Pigment Red 7, C.I. Pigment Red 8, C.I. Pigment Red 9,
 C.I. Pigment Red 10, C.I. Pigment Red 11, C.I. Pigment Red
 12, C.I. Pigment Red 14, C.I. Pigment Red 15, C.I. Pigment
 Red 16, C.I. Pigment Red 17, C.I. Pigment Red 18, C.I. Pigment
 10 Red 19, C.I. Pigment Red 21, C.I. Pigment Red 22, C.I. Pigment
 Red 23, C.I. Pigment Red 30, C.I. Pigment Red 31, C.I. Pigment
 Red 32, C.I. Pigment Red 37, C.I. Pigment Red 38, C.I. Pigment
 Red 40, C.I. Pigment Red 41, C.I. Pigment Red 42, C.I. Pigment
 Red 48:1, C.I. Pigment Red 48:2, C.I. Pigment Red 48:3, C.I.
 15 Pigment Red 48:4, C.I. Pigment Red 49:1, C.I. Pigment Red
 49:2, C.I. Pigment Red 50:1, C.I. Pigment Red 52:1, C.I.
 Pigment Red 53:1, C.I. Pigment Red 57, C.I. Pigment Red 57:1,
 C.I. Pigment Red 57:2, C.I. Pigment Red 58:2, C.I. Pigment
 Red 58:4, C.I. Pigment Red 60:1, C.I. Pigment Red 63:1, C.I.
 20 Pigment Red 63:2, C.I. Pigment Red 64:1, C.I. Pigment Red
 81:1, C.I. Pigment Red 83, C.I. Pigment Red 88, C.I. Pigment
 Red 90:1, C.I. Pigment Red 97, C.I. Pigment Red 101, C.I.
 Pigment Red 102, C.I. Pigment Red 104, C.I. Pigment Red 105,
 C.I. Pigment Red 106, C.I. Pigment Red 108, C.I. Pigment Red
 25 112, C.I. Pigment Red 113, C.I. Pigment Red 114, C.I. Pigment
 Red 122, C.I. Pigment Red 123, C.I. Pigment Red 144, C.I.
 Pigment Red 146, C.I. Pigment Red 149, C.I. Pigment Red 150,
 C.I. Pigment Red 151, C.I. Pigment Red 166, C.I. Pigment Red
 168, C.I. Pigment Red 170, C.I. Pigment Red 171, C.I. Pigment
 30 Red 172, C.I. Pigment Red 174, 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 188, C.I. Pigment
 Red 190, C.I. Pigment Red 193, C.I. Pigment Red 194, C.I.

Pigment Red 202, C.I. Pigment Red 206, C.I. Pigment Red 207, C.I. Pigment Red 208, C.I. Pigment Red 209, C.I. Pigment Red 215, C.I. Pigment Red 216, C.I. Pigment Red 220, C.I. Pigment Red 224, C.I. Pigment Red 226, C.I. Pigment Red 242, C.I. Pigment Red 243, C.I. Pigment Red 245, C.I. Pigment Red 254, C.I. Pigment Red 255, C.I. Pigment Red 264 and C.I. Pigment Red 265;

C.I. Pigment Blue 15, C.I. Pigment Blue 15:3, C.I. Pigment Blue 15:4, C.I. Pigment Blue 15:6 and C.I. Pigment Blue 60; C.I. Pigment Green 7 and C.I. Pigment Green 36; 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 may be purified by sulfuric acid re-crystallization, solvent cleaning or a combination thereof before use.

Examples of the above inorganic pigment include titanium oxide, barium sulfate, calcium carbonate, zinc white, lead sulfate, yellow lead, zinc yellow, red iron oxide (red iron oxide (III)), cadmium red, ultramarine, Prussian blue, chromium oxide green, cobalt green, amber, titanium black, synthetic iron black and carbon black.

In the present invention, the above organic pigments and inorganic pigments may be used alone or in combination of two or more, respectively, or both may be used in combination. For example, to form pixels, one or more organic pigments are preferably used and to form a black matrix, two or more organic pigments and/or carbon black are preferably used.

In the present invention, the surface of the particle of the pigment may be optionally modified by a polymer before use. Examples of the polymer used to modify the surface of the particle of the pigment include polymers disclosed by JP-A 8-259876 and commercially available polymers and oligomers for dispersing a pigment.

In the present invention, optionally, the colorant may be used in conjunction with a dispersant. The dispersant is, for example, a cationic, anionic, nonionic, amphoteric, silicone-based or fluorine-based surfactant.

5 Examples of the dispersant include polyoxyethylene alkyl ethers such as polyoxyethylene lauryl ether, polyoxyethylene stearyl ether and polyoxyethylene oleyl ether; polyoxyethylene alkylphenyl ethers such as polyoxyethylene n-octylphenyl ether and polyoxyethylene
10 n-nonylphenyl ether; polyethylene glycol diesters such as polyethylene glycol dilaurate and polyethylene glycol distearate; sorbitan fatty acid esters; fatty acid modified polyesters; tertiary amine modified polyurethanes; and polyethylene imines. These surfactants are available on the
15 market under the trade names of KP (of Shin-Etsu Chemical, Co., Ltd.), Polyflow (of Kyoeisha Kagaku Co., Ltd.), F Top (of Tokem Products Co., Ltd.), Megafac (of Dainippon Ink and Chemicals, Inc.), Florade (of Sumitomo 3M Limited), Asahi Guard and Surflon (of Asahi Glass Co., Ltd.), Disperbyk (of
20 BYK Chemie Japan Co., Ltd.), and Solsperse (of Avecia Co., Ltd.).

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

25 The amount of the surfactant is preferably 50 parts or less by weight, more preferably 0 to 30 parts by weight based on 100 parts by weight of the colorant.

(B) alkali-soluble resin

30 Any alkali-soluble resin may be used as the alkali-soluble resin in the present invention if it serves as a binder for the colorant (A) and has solubility in a developer which is used in the development step of a color filter production process, particularly preferably an alkali developer. It is preferably an alkali-soluble resin having

a carboxyl group, particularly preferably a copolymer (to be referred to as "carboxyl group-containing copolymer" hereinafter) of an ethylenically unsaturated monomer having at least one carboxyl group (to be referred to as "carboxyl group-containing unsaturated monomer" hereinafter) and
5 other copolymerizable ethylenically unsaturated monomer (to be referred to as "copolymerizable unsaturated monomer" hereinafter).

Examples of the carboxyl group-containing unsaturated
10 monomer include unsaturated monocarboxylic acids such as (meth)acrylic acid, crotonic acid, α -chloroacrylic acid and cinnamic acid; unsaturated dicarboxylic acids and anhydrides thereof such as maleic acid, maleic anhydride, fumaric acid, itaconic acid, itaconic anhydride, citraconic acid,
15 citraconic anhydride and mesaconic acid; unsaturated polycarboxylic acids having three or more carboxyl groups and anhydrides thereof; mono[(meth)acryloyloxyalkyl]esters of a polycarboxylic acid having two or more carboxyl groups such as mono[2-(meth)acryloyloxyethyl]succinate and
20 mono[2-(meth)acryloyloxyethyl]phthalate; and mono(meth)acrylates of a polymer having a carboxyl group and a hydroxyl group at both terminals such as ω -carboxypolycaprolactone mono(meth)acrylate.

Out of these carboxyl group-containing unsaturated
25 monomers, mono(2-acryloyloxyethyl)succinate and mono(2-acryloyloxyethyl)phthalate are available on the market under the trade names of M-5300 and M-5400 (of Toagosei Chemical Industry Co., Ltd.), respectively.

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

Examples of the copolymerizable unsaturated monomer include aromatic vinyl compounds such as styrene, α -methylstyrene, o-vinyltoluene, m-vinyltoluene, p-vinyltoluene, p-chlorostyrene, o-methoxystyrene,

m-methoxystyrene, p-methoxystyrene, o-vinylbenzylmethyl
 ether, m-vinylbenzylmethyl ether, p-vinylbenzylmethyl
 ether, o-vinylbenzylglycidyl ether, m-vinylbenzylglycidyl
 ether and p-vinylbenzylglycidyl ether; indenenes such as
 5 indene and 1-methylindene; unsaturated carboxylates 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-hydroxyethyl
 10 (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
 15 (meth)acrylate, 2-methoxyethyl (meth)acrylate,
 2-phenoxyethyl (meth)acrylate, methoxydiethylene glycol
 (meth)acrylate, methoxytriethylene glycol (meth)acrylate,
 methoxypropylene glycol (meth)acrylate, methoxydipropylene
 glycol (meth)acrylate, isobornyl (meth)acrylate,
 20 dicyclopentadienyl (meth)acrylate,
 2-hydroxy-3-phenoxypropyl (meth)acrylate and glycerol
 mono(meth)acrylate; unsaturated aminoalkyl carboxylates
 such as 2-aminoethyl (meth)acrylate, 2-dimethylaminoethyl
 (meth)acrylate, 2-aminopropyl (meth)acrylate,
 25 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
 30 cyanide; unsaturated amides such as (meth)acrylamide,
 α -chloroacrylamide and N-2-hydroxyethyl (meth)acrylamide;
 unsaturated imides such as maleimide, N-phenylmaleimide and
 N-cyclohexylmaleimide; 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 a terminal of a polymer molecular chain such as polystyrene, polymethyl (meth)acrylate, poly-n-butyl (meth)acrylate and polysiloxane.

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

The carboxyl group-containing copolymer in the present invention is preferably a copolymer (to be referred to as "carboxyl group-containing copolymer (B1)" hereinafter) of (a) a carboxyl group-containing unsaturated monomer component comprising (meth)acrylic acid as an essential ingredient and optionally at least one compound selected from the group consisting of mono[2-(meth)acryloyloxyethyl]succinate and ω -carboxypolycaprolactone mono(meth)acrylate and (b) at least one selected from the group consisting of styrene, methyl (meth)acrylate, 2-hydroxyethyl (meth)acrylate, allyl (meth)acrylate, benzyl (meth)acrylate, glycerol mono(meth)acrylate, N-phenylmaleimide, polystyrene macromonomer and polymethyl methacrylate macromonomer.

Illustrative examples of the carboxyl group-containing copolymer (B1) include a copolymer of (meth)acrylic acid and methyl (meth)acrylate, copolymer of (meth)acrylic acid and benzyl (meth)acrylate, copolymer of (meth)acrylic acid, 2-hydroxyethyl (meth)acrylate and benzyl (meth)acrylate, copolymer of (meth)acrylic acid, methyl (meth)acrylate and polystyrene macromonomer, copolymer of (meth)acrylic acid, methyl (meth)acrylate and polymethyl methacrylate macromonomer, copolymer of (meth)acrylic acid, benzyl (meth)acrylate and polystyrene macromonomer, copolymer of (meth)acrylic acid, benzyl

(meth)acrylate and polymethyl methacrylate macromonomer, copolymer of (meth)acrylic acid, 2-hydroxyethyl (meth)acrylate, benzyl (meth)acrylate and polystyrene macromonomer, copolymer of (meth)acrylic acid,

- 5 2-hydroxyethyl (meth)acrylate, benzyl (meth)acrylate and polymethyl methacrylate macromonomer, copolymer of (meth)acrylic acid, styrene, benzyl (meth)acrylate and N-phenylmaleimide, copolymer of (meth)acrylic acid, mono[2-(meth)acryloyloxyethyl]succinate, styrene, benzyl
- 10 (meth)acrylate and N-phenylmaleimide, copolymer of (meth)acrylic acid, mono[2-(meth)acryloyloxyethyl]succinate, styrene, allyl (meth)acrylate and N-phenylmaleimide, copolymer of (meth)acrylic acid, styrene, benzyl (meth)acrylate,
- 15 glycerol mono(meth)acrylate and N-phenylmaleimide, and copolymer of (meth)acrylic acid, ω -carboxypolycaprolactone mono(meth)acrylate, styrene, benzyl (meth)acrylate, glycerol mono(meth)acrylate and N-phenylmaleimide.

The content of the carboxyl group-containing

- 20 unsaturated monomer in the carboxyl group-containing copolymer is preferably 5 to 50 wt%, more preferably 10 to 40 wt%. When the above content is lower than 5 wt%, the solubility in an alkali developer of the obtained radiation sensitive composition may lower and when the content is
- 25 higher than 50 wt%, the solubility in an alkali developer of the radiation sensitive composition may become too high. As a result, when the composition is developed with an alkali developer, the colored layer may fall off from the substrate and the film surface of the colored layer may be roughened.

- 30 The weight average molecular weight in terms of polystyrene (to be referred to as "Mw" hereinafter) measured by gel permeation chromatography (GPC, eluting solvent: tetrahydrofuran) of the alkali-soluble resin in the present invention is preferably 3,000 to 300,000, more preferably

5,000 to 100,000.

The number average molecular weight in terms of polystyrene (to be referred to as "Mn" hereinafter) measured by gel permeation chromatography (GPC, eluting solvent: 5 tetrahydrofuran) of the alkali-soluble resin in the present invention is preferably 3,000 to 60,000, more preferably 5,000 to 25,000.

In the present invention, by using this alkali-soluble resin having specific Mw and Mn, a radiation sensitive 10 composition having excellent developability is obtained. This composition can provide pixels and a black matrix having a sharp pattern edge and hardly produces the residue, stain or film residue on the substrate and light screening layer of an unexposed portion during development.

15 The Mw/Mn ratio of the alkali-soluble resin in the present invention is preferably 1 to 5, more preferably 1 to 4.

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

20 The amount of the alkali-soluble resin in the present invention is preferably 10 to 1,000 parts by weight, more preferably 20 to 500 parts by weight based on 100 parts by weight of the colorant (A). When the amount of the alkali-soluble resin is smaller than 10 parts by weight, 25 alkali developability may lower, or a stain or the film residue may be produced on the substrate and light screening layer of an unexposed portion. When the amount is larger than 1,000 parts by weight, the concentration of the colorant becomes relatively low, whereby it may be difficult to 30 achieve the target color depth of a thin film.

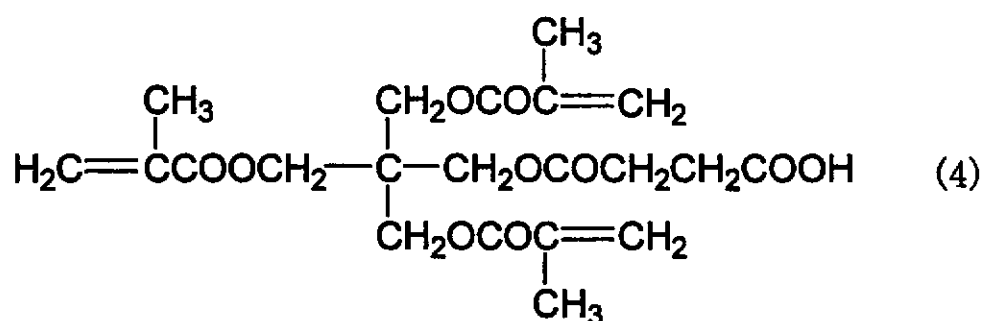
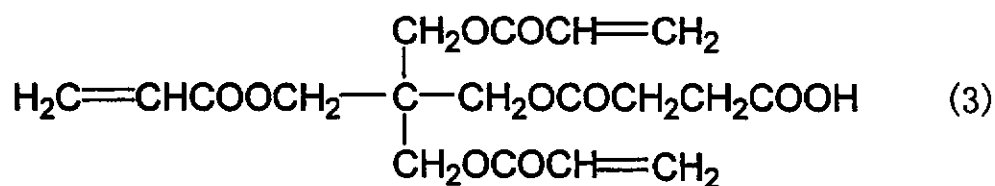
(C) polyfunctional monomer or a combination of polyfunctional monomer and monofunctional monomer

The polyfunctional monomer in the present invention

is a monomer having two or more polymerizable unsaturated bonds.

Examples of the polyfunctional monomer include di(meth)acrylates of an alkylene glycol such as ethylene glycol and propylene glycol; di(meth)acrylates of a
 5 polyalkylene glycol such as polyethylene glycol and polypropylene glycol; poly(meth)acrylates of a polyhydric alcohol having 3 or more hydroxyl groups and dicarboxylic acid modified products thereof such as glycerin,
 10 trimethylolpropane, pentaerythritol and dipentaerythritol; oligo(meth)acrylates such as polyester, epoxy resin, urethane resin, alkyd resin, silicone resin and spiran resin; di(meth)acrylates of a polymer having a hydroxyl group at both terminals such as poly-1,3-butadiene having a hydroxyl
 15 group at both terminals, polyisoprene having a hydroxyl group at both terminals and polycaprolactone having a hydroxyl group at both terminals; and tris[2-(meth)acryloyloxyethyl]phosphate.

Out of these polyfunctional monomers,
 20 poly(meth)acrylates of a polyhydric alcohol having 3 or more hydroxyl groups and dicarboxylic acid modified products thereof are preferred, as exemplified by trimethylolpropane triacrylate, trimethylolpropane trimethacrylate, pentaerythritol triacrylate, pentaerythritol
 25 trimethacrylate, pentaerythritol tetraacrylate, pentaerythritol tetramethacrylate, dipentaerythritol pentaacrylate, dipentaerythritol pentamethacrylate, dipentaerythritol hexaacrylate, dipentaerythritol hexamethacrylate and compounds represented by the following
 30 formulas (3) and (4).



5 Out of these, trimethylolpropane triacrylate,
 pentaerythritol triacrylate and dipentaerythritol
 hexaacrylate are particularly preferred because they provide
 a colored layer having excellent strength and surface
 smoothness and rarely produces a stain or the film residue
 10 on the substrate and light screening layer of an unexposed
 portion.

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

The amount of the polyfunctional monomer in the present
 15 invention is preferably 5 to 500 parts by weight, more
 preferably 20 to 300 parts by weight based on 100 parts by
 weight of the alkali-soluble resin (B). When the amount of
 the polyfunctional monomer is smaller than 5 parts by weight,
 the strength and surface smoothness of the colored layer may
 20 deteriorate and when the amount is larger than 500 parts by
 weight, alkali developability may lower, or a stain or the
 film residue may be produced on the substrate and light
 screening layer of an unexposed portion.

In the present invention, a combination of the
 25 polyfunctional monomer and a monofunctional monomer having

one polymerizable unsaturated bond may be used.

Examples of the above monofunctional monomer include the above carboxyl group-containing unsaturated monomers and copolymerizable unsaturated monomers enumerated for the
5 above alkali-soluble resin (B), N-(meth)acryloylmorpholine, N-vinylpyrrolidone, N-vinyl-ε-caprolactam and commercially available M-5600 (of Toagosei Chemical Industry Co., Ltd.).

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

10 The amount of the monofunctional monomer is preferably 90 wt% or less, more preferably 50 wt% or less based on the total weight of the polyfunctional monomer and the monofunctional monomer. When the amount of the monofunctional monomer is larger than 90 wt%, the strength
15 and surface smoothness of the obtained colored layer may become unsatisfactory.

The total amount of the polyfunctional monomer and the monofunctional monomer in the present invention is preferably 5 to 500 parts by weight, more preferably 20 to
20 300 parts by weight based on 100 parts by weight of the alkali-soluble resin (B). When the above total amount is smaller than 5 parts by weight, the strength and surface smoothness of the colored layer may deteriorate and when the total amount is larger than 500 parts by weight, alkali
25 developability may lower, or a stain or the film residue may be produced on the substrate and light screening layer of an unexposed portion.

(D) optical radical generator

30 The component (D) in the present invention is at least one optical radical generator selected from the group consisting of compounds represented by the above formulas (1) and (2) (to be referred to as "carbazole compound (D1)" hereinafter). The component (D) is a component which forms

a radical capable of initiating the polymerization of the above component (C) through exposure to radiation such as visible radiation, ultraviolet radiation, far ultraviolet radiation, charged corpuscular rays or X-rays.

5 Examples of the linear, branched or cyclic alkyl group having 1 to 12 carbon atoms represented by R^1 , R^2 and R^3 in the formulas (1) and (2) include methyl group, ethyl group, n-propyl group, i-propyl group, n-butyl group, i-butyl group, sec-butyl group, t-butyl group, n-pentyl group, n-hexyl
10 group, n-heptyl group, n-octyl group, n-nonyl group, n-decyl group, n-undecyl group, n-dodecyl group, cyclopentyl group and cyclohexyl group.

 Examples of the linear, branched or cyclic alkyl group having 1 to 6 carbon atoms represented by R^4 , R^5 and R^6 include
15 methyl group, ethyl group, n-propyl group, i-propyl group, n-butyl group, i-butyl group, sec-butyl group, t-butyl group, n-pentyl group, n-hexyl group, cyclopentyl group and cyclohexyl group.

 Examples of the linear, branched or cyclic alkoxy
20 group having 1 to 6 carbon atoms out of the substituents for the alkyl group represented by R^1 , R^2 , R^3 , R^4 , R^5 and R^6 and the substituents for the phenyl group represented by R^1 and R^2 include methoxy group, ethoxy group, n-propoxy group, i-propoxy group, n-butoxy group and t-butoxy group.

25 Examples of the halogen atom include fluorine atom and chlorine atom.

 Examples of the linear, branched or cyclic alkyl group having 1 to 6 carbon atoms out of the substituents for the phenyl group represented by R^1 and R^2 include methyl group,
30 ethyl group, n-propyl group, i-propyl group, n-butyl group and t-butyl group.

 These substituents may be existent alone or in combination in each alkyl group and each phenyl group.

R^1 in the above formulas (1) and (2) is preferably a

methyl group, ethyl group, n-propyl group, i-propyl group, n-butyl group or phenyl group. R^2 is preferably a hydrogen atom, methyl group, ethyl group, n-propyl group, i-propyl group, n-butyl group, n-pentyl group, n-hexyl group,

- 5 n-heptyl group or n-octyl group. R^3 is preferably a hydrogen atom, methyl group, ethyl group, n-propyl group, i-propyl group or n-butyl group. Further, R^4 , R^5 and R^6 are each preferably a hydrogen atom, methyl group, ethyl group, n-propyl group, i-propyl group or n-butyl group.

10 Preferred examples of the carbazole compound (D1) in the present invention include

1-[9-ethyl-6-benzoyl-9.H.-carbazol-3-yl]-nonane-1,2-nonane-2-oxime-O-benzoate,

- 15 1-[9-ethyl-6-benzoyl-9.H.-carbazol-3-yl]-nonane-1,2-nonane-2-oxime-O-acetate,

1-[9-ethyl-6-benzoyl-9.H.-carbazol-3-yl]-pentane-1,2-pentane-2-oxime-O-acetate,

1-[9-ethyl-6-benzoyl-9.H.-carbazol-3-yl]-octane-1-oneoxime-O-acetate,

- 20 1-[9-ethyl-6-(2-methylbenzoyl)-9.H.-carbazol-3-yl]-ethane-1-oneoxime-O-benzoate,

1-[9-ethyl-6-(2-methylbenzoyl)-9.H.-carbazol-3-yl]-ethane-1-oneoxime-O-acetate,

- 25 1-[9-ethyl-6-(1,3,5-trimethylbenzoyl)-9.H.-carbazol-3-yl]-ethane-1-oneoxime-O-benzoate and

1-[9-n-butyl-6-(2-ethylbenzoyl)-9.H.-carbazol-3-yl]-ethane-1-oneoxime-O-benzoate.

Out of these carbazole compounds (D1),

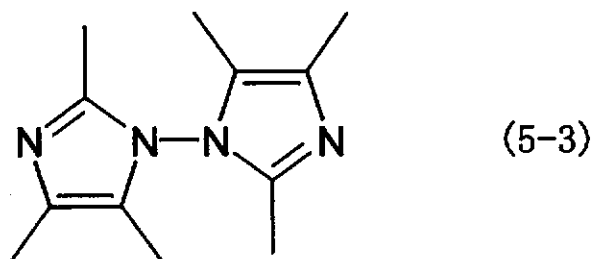
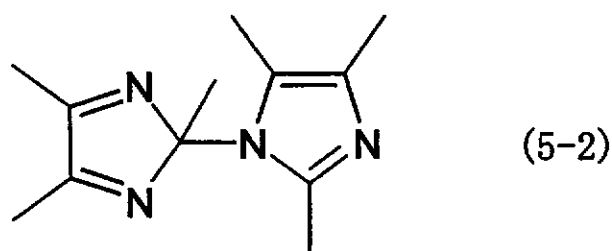
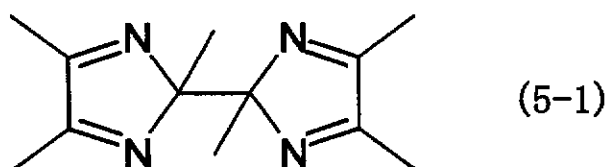
- 30 1-[9-ethyl-6-(2-methylbenzoyl)-9.H.-carbazol-3-yl]-ethane-1-oneoxime-O-acetate is particularly preferred.

In the present invention, the above carbazole compounds (D1) may be used alone or in combination of two or more.

In the present invention, the carbazole compound (D1)

may be used in conjunction with other optical radical generator.

Examples of the above other optical radical generator include a biimidazole compound having at least one main
 5 skeleton represented by the following formula (5-1), (5-2) or (5-3), benzoin compound, acetophenone compound, benzophenone compound, α -diketone compound, polynuclear quinone compound, xanthone compound, phosphine compound and triazine compound.



10

Examples of the above biimidazole compound include
 2,2'-bis(2-chlorophenyl)-4,4',5,5'-tetrakis(4-
 ethoxycarbonylphenyl)-1,2'-biimidazole,
 2,2'-bis(2-bromophenyl)-4,4',5,5'-tetrakis(4-
 15 ethoxycarbonylphenyl)-1,2'-biimidazole,
 2,2'-bis(2-chlorophenyl)-4,4',5,5'-tetraphenyl-1,2'-
 biimidazole,
 2,2'-bis(2,4-dichlorophenyl)-4,4',5,5'-tetraphenyl-1,2'-
 biimidazole,
 20 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'-
5 biimidazole and
2,2'-bis(2,4,6-tribromophenyl)-4,4',5,5'-tetraphenyl-
1,2'-biimidazole.

Out of these biimidazole compounds,
2,2'-bis(2-chlorophenyl)-4,4',5,5'-tetraphenyl-1,2'-
10 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, and
15 2,2'-bis(2-chlorophenyl)-4,4',5,5'-tetraphenyl-1,2'-
biimidazole is particularly preferred.

The above biimidazole compounds have excellent
solubility in a solvent, do not produce foreign matter such
as an undissolved product and a precipitate, have high
20 sensitivity and high contrast, fully promote a curing
reaction by exposure with a small amount of energy and do
not cause a curing reaction in an unexposed portion.
Therefore, the coating film after exposure is clearly divided
into a cured portion insoluble in a developer and an uncured
25 portion having high solubility in a developer. Therefore,
it is possible to form a high-definition pattern array having
a predetermined pixel pattern and black matrix pattern
without an undercut.

30 -hydrogen donor-

When the biimidazole compound is used as the optical
radical generator in the present invention, it is preferably
used in combination with the following hydrogen donor to
further improve sensitivity.

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

The hydrogen donor is preferably a mercaptan compound
5 defined hereinbelow or an amine compound defined hereinbelow.

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

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

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

A detailed description is subsequently given of these
20 hydrogen donors.

The mercaptan hydrogen donor may have at least one benzene ring or hetero ring, or both of them. When it has two or more of the rings, a fused ring may or may not be formed.

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

Further, the mercaptan hydrogen donor may be

substituted by a carboxyl group, substituted or nonsubstituted alkoxy carbonyl group, substituted or nonsubstituted phenoxy carbonyl group or nitrile group at a position other than the mercapto group(s).

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

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

 The amine hydrogen donor may have at least one benzene
15 ring or hetero ring, or both of them. When it has two or more of the rings, a fused ring may or may not be formed.

 At least one amino group of the amine hydrogen donor may be substituted by an alkyl group or substituted alkyl group. The amine hydrogen donor may be substituted by a
20 carboxyl group, substituted or nonsubstituted alkoxy carbonyl group, substituted or nonsubstituted phenoxy carbonyl group or nitrile group at a position other than the amino group(s).

 Examples of the above amine hydrogen donor include
25 4,4'-bis(dimethylamino)benzophenone, 4,4'-bis(diethylamino)benzophenone, 4-diethylaminoacetophenone, 4-dimethylaminopropiophenone, ethyl 4-dimethylaminobenzoate, i-amyl 4-dimethylaminobenzoate, 4-dimethylaminobenzoic acid and
30 4-dimethylaminobenzonitrile.

 Out 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. 4,4'-bis(dimethylamino)benzophenone and 4,4'-bis(diethylamino)benzophenone can serve as an optical radical initiator by itself even when the biimidazole compound is not existent.

5 In the present invention, the above hydrogen donors may be used alone or in combination of two or more. A combination of at least one mercaptan hydrogen donor and at least one amine hydrogen donor is preferably used because the formed colored layer hardly falls off from the substrate
10 during development and has high strength and sensitivity.

Preferred examples of the combination of the mercaptan hydrogen donor and the amine hydrogen donor include a combination of 2-mercaptobenzothiazole/
4,4'-bis(dimethylamino)benzophenone, combination of
15 2-mercaptobenzothiazole/
4,4'-bis(diethylamino)benzophenone, combination of
2-mercaptobenzoxazole/
4,4'-bis(dimethylamino)benzophenone, and combination of
2-mercaptobenzoxazole/ 4,4'-bis(diethylamino)benzophenone.
20 A combination of 2-mercaptobenzothiazole/
4,4'-bis(diethylamino)benzophenone and a combination of
2-mercaptobenzoxazole/ 4,4'-bis(diethylamino)benzophenone
are more preferred, and a combination of
2-mercaptobenzothiazole/
25 4,4'-bis(diethylamino)benzophenone is particularly
preferred.

The weight ratio of the mercaptan hydrogen donor to the amine hydrogen donor in the combination of the mercaptan hydrogen donor and the amine hydrogen donor is preferably
30 1:1 to 1:4, more preferably 1:1 to 1:3.

Examples of the above benzoin compound include benzoin, benzoin methyl ether, benzoin ethyl ether, benzoin isopropyl ether, benzoin isobutyl ether and methyl 2-benzoylbenzoate.

Examples of the acetophenone compound include

2,2-diemthoxyacetophenone, 2,2-diethoxyacetophenone,
 2,2-dimethoxy-2-phenylacetophenone,
 2-hydroxy-2-methyl-1-phenylpropan-1-one,
 1-(4-1-propylphenyl)-2-hydroxy-2-methylpropan-1-one,
 5 2-methyl-(4-methylthiophenyl)-2-morpholino-1-propan-1-
 one, 4-(2-hydroxyethoxy)phenyl-(2-hydroxy-2-propyl)ketone,
 2-benzyl-2-dimethylamino-1-(4-morpholinophenyl)butan-1-
 one, 1-hydroxycyclohexylphenyl ketone and
 2,2-dimethoxy-1,2-diphenylethan-1-one.

10 Examples of the above benzophenone compound include
 4,4'-bis(dimethylamino)benzophenone and
 4,4'-bis(diethylamino)benzophenone.

 Examples of the above α -diketone compound include
 diacetyl, dibenzoyl and methyl benzoyl formate.

15 Examples of the above polynuclear quinone compound
 include anthraquinone, 2-ethylanthraquinone,
 2-t-butylanthraquinone and 1,4-naphthoquinone.

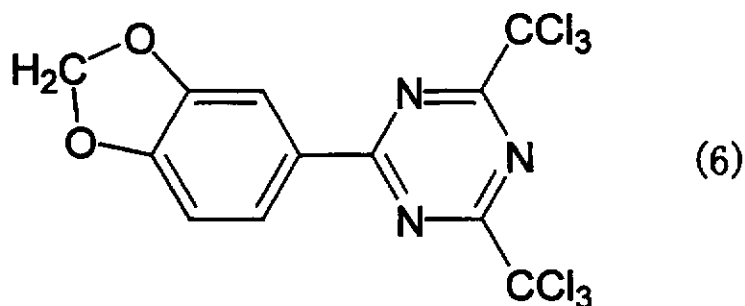
 Examples of the above xanthone compound include
 xanthone, thioxanthone and 2-chlorothioxanthone.

20 Examples of the above phosphine compound include
 bis(2,4,6-trimethylbenzoyl)phenylphosphine oxide and
 2,4,6-trimethylbenzoyldiphenylphosphine oxide.

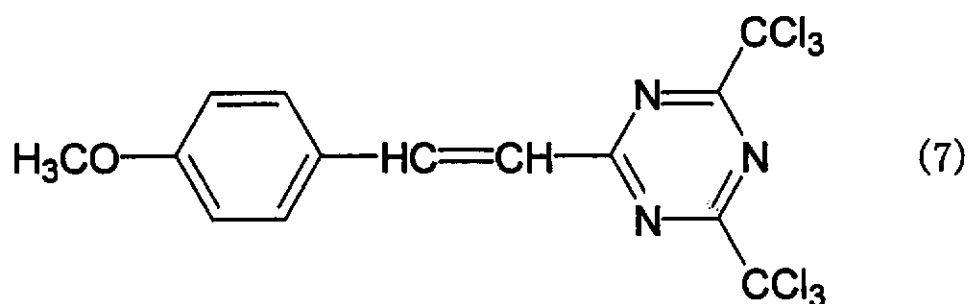
 Examples of the above triazine compound include
 compounds having a halomethyl group such as

25 2,4,6-tris(trichloromethyl)-s-triazine,
 2-methyl-4,6-bis(trichloromethyl)-s-triazine,
 2-[2-(furan-2-yl)ethenyl]-4,6-bis(trichloromethyl)-s-
 triazine, 2-[2-(5-methylfuran-2-yl)ethenyl]-4,6-bis
 (trichloromethyl)-s-triazine,
 30 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,
 2-(4-n-butoxyphenyl)-4,6-bis(trichloromethyl)-s-triazine,
 and compounds represented by the following formulas (6) and
 (7).



5



The above other optical radical generators may be used
 alone or in combination of two or more.

10 The amount of the other optical radical generator is
 preferably 50 wt% or less, more preferably 1 to 30 wt% based
 on the total of the carbazole compound (D1) and the other
 optical radical generator. When the amount of the other
 optical radical generator is larger than 50 wt%, the
 15 predetermined effect of the present invention may be
 impaired.

 The total amount of the optical radical generators in
 the present invention is preferably 0.01 to 200 parts by
 weight, more preferably 1 to 120 parts by weight,
 20 particularly preferably 1 to 100 parts by weight based on
 100 parts by weight of the component (C). When the total
 amount of the optical radical generators is smaller than 0.01

part by weight, it may be difficult to obtain a pattern array having a predetermined pixel pattern or black matrix pattern due to incomplete curing by exposure. When the total amount is larger than 200 parts by weight, the formed colored layer
5 may fall off from the substrate during development and a stain or the film residue may be produced on the substrate and light screening layer of an unexposed portion.

The above optical radical generator may be used in conjunction with at least one of a sensitizer, curing
10 accelerator and polymer crosslinking/sensitizing agent as required.

- additives -

The radiation sensitive composition for forming a
15 colored layer of the present invention may contain various additives as required.

The above additives include an organic acid or an organic amino compound (excluding the above hydrogen donor) which serves to further improve the solubility in an alkali
20 developer of the radiation sensitive composition and suppress the production of the undissolved product residue after development.

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

Examples of the aliphatic carboxylic acid include monocarboxylic acids such as formic acid, acetic acid, propionic acid, butyric acid, valeric acid, pivalic acid, caproic acid, diethylacetic acid, ethantonic acid and caprylic
30 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.

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

10 Examples of the phenyl group-containing carboxylic acid 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 and terephthalic acid;
15 aromatic polycarboxylic acids having 3 or more carboxyl groups such as trimellitic acid, trimesic acid, mellophanic acid and pyromellitic acid; and phenylacetic acid, hydroatropic acid, hydrocinnamic acid, mandelic acid, phenylsuccinic acid, atropic acid, cinnamic acid,
20 cinnamylidenic acid, coumaric acid and umbellic acid.

 Out of these organic acids, aliphatic dicarboxylic acids are preferred, and malonic acid, adipic acid, itaconic acid, citraconic acid, fumaric acid and mesaconic acid are particularly preferred as the aliphatic carboxylic acid from
25 the viewpoints of alkali solubility, solubility in a solvent which will be described hereinafter and the prevention of a stain or the film residue on the substrate and light screening layer of an unexposed portion. Aromatic dicarboxylic acids are preferred, and phthalic acid is
30 particularly preferred as the phenyl group-containing carboxylic acid.

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

 The amount of the organic acid is preferably 15 wt%

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

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

Examples of the above aliphatic amine include mono(cyclo)alkylamines such as n-propylamine,
 10 1-propylamine, n-butylamine, i-butylamine, sec-butylamine, t-butylamine, n-pentylamine, n-hexylamine, n-heptylamine, n-octylamine, n-nonylamine, n-decylamine, n-undecylamine, n-dodcylamine, cyclohexylamine, 2-methylcyclohexylamine, 3-methylcyclohexylamine, 4-methylcyclohexylamine,
 15 2-ethylcyclohexylamine, 3-ethylcyclohexylamine and 4-ethylcyclohexylamine; di(cyclo)alkylamines such as methyl·ethylamine, diethylamine, methyl·n-propylamine, ethyl·n-propylamine, di-n-propylamine, di-i-propylamine, di-n-butylamine, di-i-butylamine, di-sec-butylamine,
 20 di-t-butylamine, di-n-pentylamine, di-n-hexylamine, methylcyclohexylamine, ethylcyclohexylamine and dicyclohexylamine; tri(cyclo)alkylamines such as dimethyl·ethylamine, methyl·diethylamine, triethylamine, dimethyl·n-propylamine, diethyl·n-propylamine,
 25 methyl·di-n-propylamine, ethyl·di-n-propylamine, tri-n-propylamine, tri-i-propylamine, tri-n-butylamine, tri-i-butylamine, tri-sec-butylamine, tri-t-butylamine, tri-n-pentylamine, tri-n-hexylamine, dimethylcyclohexylamine, diethylcyclohexylamine,
 30 methyldicyclohexylamine, ethyldicyclohexylamine and tricyclohexylamine; mono(cyclo)alkanolamines such as 2-aminoethanol, 3-amino-1-propanol, 1-amino-2-propanol, 4-amino-1-butanol, 5-amino-1-pentanol, 6-amino-1-hexanol and 4-amino-1-cyclohexanol; di(cyclo)alkanolamines such as

- diethanolamine, di-n-propanolamine, di-i-propanolamine, di-n-butanolamine, di-i-butanolamine, di-n-pentanolamine, di-n-hexanolamine and di(4-cyclohexanol)amine; tri(cyclo)alkanolamines such as triethanolamine,
- 5 tri-n-propanolamine, tri-i-propanolamine, tri-n-butanolamine, tri-i-butanolamine, tri-n-pentanolamine, tri-n-hexanolamine and tri(4-cyclohexanol)amine; amino(cyclo)alkanediols such as 3-amino-1,2-propanediol, 2-amino-1,3-propanediol,
- 10 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-diethylamino-1,2-propanediol, 2-dimethylamino-1,3-propanediol and
- 15 2-diethylamino-1,3-propanediol; amino group-containing cycloalkane methanols such as 1-aminocyclopentane methanol, 4-aminocyclopentane methanol, 1-aminocyclohexane methanol, 4-aminocyclohexane methanol, 4-dimethylaminocyclopentane methanol, 4-diethylaminocyclopentane methanol,
- 20 4-dimethylaminocyclohexane methanol and 4-diethylaminocyclohexane methanol; 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,
- 25 5-aminovaleric acid, 6-aminocaproic acid, 1-aminocyclopropanecarboxylic acid, 1-aminocyclohexanecarboxylic acid and 4-aminocyclohexanecarboxylic acid.

The above phenyl group-containing amine is, for

30 example, a compound having an amino group directly bonded to a phenyl group or a compound having an amino group bonded to a phenyl group through a carbon chain.

Examples of the phenyl group-containing amine 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-butyylaniline, 1-naphthylamine, 2-naphthylamine,
 N,N-dimethylaniline, N,N-diethylaniline and
 5 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,
 10 4-dimethylaminophenol and 4-diethylaminophenol.

Out of these organic amino compounds,
 mono(cyclo)alkanolamines and amino(cyclo)alkanediols are
 preferred, and 2-aminoethanol, 3-amino-1-propanol,
 5-amino-1-pentanol, 3-amino-1,2-propanediol,
 15 2-amino-1,3-propanediol and 4-amino-1,2-butanediol are
 particularly preferred as the aliphatic amine from the
 viewpoints of solubility in a solvent which will be described
 hereinafter and the prevention of a stain or the film residue
 on the substrate and light screening layer of an unexposed
 20 portion. Aminophenols are preferred, and 2-aminophenol,
 3-aminophenol and 4-aminophenol are particularly preferred
 as the phenol group-containing amine.

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

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

30 Additives other than the above organic acid and organic
 amino compound include a dispersion aid such as a blue pigment
 derivative or yellow pigment derivative, e.g., a copper
 phthalocyanine derivative; filler such as glass or alumina;
 polymer compound such as polyvinyl alcohol, polyethylene

glycol monoalkyl ether or poly(fluoroalkylacrylate);
 nonionic, cationic or anionic surfactant; adhesion
 accelerator such as vinyl trimethoxysilane, vinyl
 triethoxysilane, vinyl tris(2-methoxyethoxy)silane,
 5 N-(2-aminoethyl)-3-aminopropyl·methyl·dimethoxysilane,
 N-(2-aminoethyl)-3-aminopropyltrimethoxysilane,
 3-aminopropyltriethoxysilane,
 3-glycidoxypropyltrimethoxysilane,
 3-glycidoxypropyl·methyl·dimethoxysilane,
 10 2-(3,4-epoxycyclohexyl)ethyltrimethoxysilane,
 3-chloropropyl·methyl·dimethoxysilane,
 3-chloropropyltrimethoxysilane,
 3-methacryloxypropyltrimethoxysilane or
 3-mercaptopropyltrimethoxysilane; antioxidant such as
 15 2,2'-thiobis(4-methyl-6-t-butylphenol) or
 2,6-di-t-butylphenol; ultraviolet light absorber such as
 2-(3-t-butyl-5-methyl-2-hydroxyphenyl)-5-
 chlorobenzotriazole or alkoxybenzophenone; cohesion
 inhibitor such as sodium polyacrylate; and heat radical
 20 generator such as 1,1'-azobis(cyclohexane-1-carbonitrile)
 or 2-phenylazo-4-methoxy-2,4-dimethylvaleronitrile.

Solvent

The radiation sensitive composition for forming a
 25 colored layer of the present invention comprises the above
 components (A) to (D) as essential ingredients and optionally
 the above additives and is preferably mixed with a solvent
 to be prepared as a liquid composition.

A suitable solvent may be selected and used as the
 30 solvent as far as it disperses or dissolves the components
 (A) to (D) and additives constituting the radiation sensitive
 composition, does not react with these and has suitable
 volatility.

Examples of the solvent 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
- 5 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,
- 10 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; (poly)alkylene glycol
- 15 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;
- 20 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; alkyl lactates such as methyl lactate and ethyl lactate;
- 25 other esters such as ethyl 2-hydroxy-2-methylpropionate, methyl 3-methoxypropionate, ethyl 3-methoxypropionate, methyl 3-ethoxypropionate, ethyl 3-ethoxypropionate, ethyl ethoxyacetate, ethyl hydroxyacetate, methyl
- 2-hydroxy-3-methylbutanoate,
- 30 3-methyl-3-methoxybutylacetate, 3-methyl-3-methoxybutylpropionate, 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 and lactams such as N,N-dimethylformamide, 5 N,N-dimethylacetamide and N-methylpyrrolidone.

Out of these solvents, propylene glycol monomethyl ether, ethylene glycol monomethyl ether acetate, propylene glycol monomethyl ether acetate, propylene glycol monoethyl ether acetate, diethylene glycol dimethyl ether, diethylene 10 glycol methyl ethyl ether, cyclohexanone, 2-heptanone, 3-heptanone, ethyl lactate, ethyl 3-methoxypropionate, methyl 3-ethoxypropionate, ethyl 3-ethoxypropionate, 3-methyl-3-methoxybutylpropionate, n-butyl acetate, 1-butyl acetate, n-amyl formate, i-amyl acetate, n-butyl 15 propionate, ethyl butyrate, i-propyl butyrate, n-butyl butyrate and ethyl pyruvate are particularly preferred from the viewpoints of solubility, pigment dispersibility and coatability.

The above solvents may be used alone or in combination 20 of two or more.

Further, a high-boiling 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, 25 diethyl maleate, γ -butyrolactone, ethylene carbonate, propylene carbonate or ethylene glycol monophenyl ether acetate may be used in conjunction with the above solvent.

These high-boiling solvents may be used alone or in combination of two or more.

30 The amount of the solvent is not particularly limited but desirably a value which ensures that the total amount of all the components excluding the solvent of the composition is preferably 5 to 50 wt%, particularly preferably 10 to 40 wt% from the viewpoints of the coatability

and stability of the obtained radiation sensitive composition.

Color filter

5 The color filter of the present invention comprises a colored layer made of the radiation sensitive composition for forming a colored layer of the present invention.

A description is subsequently given of the method of forming the color filter of the present invention.

10 A light screening layer is optionally formed on the surface of a substrate to define a portion for forming pixels, and a liquid radiation sensitive composition comprising, for example, a red pigment dispersed therein is applied to the substrate and prebaked to evaporate the solvent so as to form
15 a coating film. This coating film is then exposed to radiation through a photomask, developed with an alkali developer to dissolve and remove an unexposed portion of the coating film and post-baked to form a pixel array having a predetermined red pixel pattern.

20 Thereafter, the application, prebaking, exposure, development and post-baking of liquid radiation sensitive compositions comprising green and blue pigments dispersed therein are carried out likewise to form a green pixel array and a blue pixel array on the same substrate sequentially
25 so as to obtain a color filter having red, green and blue pixel arrays on the substrate. As a matter of course, the order of forming the color pixels is not limited to the above in the present invention.

30 The black matrix may be formed likewise by using the radiation sensitive composition for forming a colored layer of the present invention.

The substrate used to form pixels and/or a black matrix is made of glass, silicon, polycarbonate, polyester, aromatic polyamide, polyamide-imide or polyimide.

The substrate may be optionally subjected to a suitable pre-treatment such as chemical treatment with a silane coupling agent, plasma treatment, ion plating, sputtering, gas-phase reaction or vacuum deposition.

5 To apply the liquid radiation sensitive composition to the substrate, a suitable coating technique such as spray coating, roll coating, rotational coating (spin coating), slit die coating, bar coating or ink jet coating may be employed. Out of these, spin coating and split die coating
10 are preferred.

The thickness of the coating film after drying is preferably 0.1 to 10 μm , more preferably 0.2 to 8.0 μm , particularly preferably 0.2 to 6.0 μm .

The radiation used to form pixels and/or a black matrix
15 is selected from visible radiation, ultraviolet radiation, far ultraviolet radiation, electron beam and X-rays. Out of these, radiation having a wavelength of 190 to 450 nm is preferred.

The dose of the radiation is preferably 10 to 10,000
20 J/m².

The above alkali developer is preferably an aqueous solution of an alkaline compound such as sodium carbonate, sodium hydroxide, potassium hydroxide, tetramethylammonium hydroxide, choline, 1,8-diazabicyclo-[5.4.0]-7-undecene or
25 1,5-diazabicyclo-[4.3.0]-5-nonene.

A suitable amount of a water-soluble organic solvent such as methanol or ethanol, or a surfactant may be added to the above alkali developer. The coating film is generally rinsed after alkali development.

30 Shower development, spray development, dip (immersion) development, puddle development or the like may be employed. As for development conditions, the coating film is preferably developed at normal temperature for 5 to 300 sec.

The thus obtained color filter of the present invention is extremely useful for transmission and reflection color liquid crystal displays, color image pick-up devices, color sensors, etc.

5

Color liquid crystal display panel

The color liquid crystal display panel of the present invention comprises the color filter of the present invention.

10 As an example of the color liquid crystal display panel of the present invention, a color liquid crystal display panel having excellent characteristic properties can be manufactured by using the radiation sensitive composition for forming a colored layer of the present invention to form
15 pixels and/or a black matrix on a thin film transistor substrate array.

The radiation sensitive composition for forming a colored layer of the present invention comprises the above components (A) to (D) as essential ingredients.

20 Particularly preferred examples of the composition are given below.

- (1) a radiation sensitive composition for forming a colored layer comprising a carboxyl group-containing copolymer (B1) as the alkali-soluble resin (B)
- 25 (2) the radiation sensitive composition for forming a colored layer (1) comprising at least one selected from the group consisting of trimethylolpropane triacrylate, pentaerythritol triacrylate and dipentaerythritol hexaacrylate as the polyfunctional
30 monomer (C)
- (3) the radiation sensitive composition for forming a colored layer (2) comprising
1-[9-ethyl-6-(2-methylbenzoyl)-9.H.-carbazol-3-yl]
ethan-1-oneoxime-O-acetate as the carbazole compound

(D1)

(4) the radiation sensitive composition for forming a colored layer (1), (2) or (3) comprising an organic pigment and/or carbon black as the colorant (A)

5 The preferred color filter (5) of the present invention comprises pixels and/or a black matrix made of the radiation sensitive composition for forming a colored layer (1), (2), (3) or (4).

The preferred color liquid crystal display panel (6)
10 of the present invention comprises the above color filter (5) and the more preferred color liquid crystal display panel (7) of the present invention comprises pixels and/or a black matrix made of the radiation sensitive composition for forming a colored layer (1), (2), (3) or (4) on a thin film
15 transistor substrate array.

As described above, when the radiation sensitive composition for forming a colored layer of the present invention comprises an optical radical generator which contains a carbazole compound (D1) having high sensitivity
20 to radiation as an essential ingredient, even if it contains a pigment in a high concentration, an undissolved product does not remain on the substrate and light screening layer of an unexposed portion during development, scum is not produced on the edges of the pixel pattern and the black matrix
25 pattern, and an excellent pixel pattern and black matrix pattern without a missing part of the edge or an undercut can be formed with a small amount of exposure.

Further, the pixels and black matrix made of the radiation sensitive composition for forming a colored layer
30 of the present invention have high surface smoothness and excellent adhesion to the substrate.

Therefore, the radiation sensitive composition for forming a colored layer of the present invention can be extremely advantageously used for the manufacture of a color

filter such as a color filter for color liquid crystal display panels in the field of the electronic industry.

Examples

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

 "Parts" and "%" in the following examples are based on weight.

10

<(B) preparation of alkali-soluble resin>

Synthetic Example 1

 1 part of 2,2'-azobis(2,4-dimethylvaleronitrile) and 200 parts of propylene glycol monomethyl ether acetate were
15 fed to a flask equipped with a cooling tube and a stirrer, 15 parts of methacrylic acid, 15 parts of styrene, 35 parts of benzyl methacrylate, 10 parts of glycerol monomethacrylate, 25 parts of N-phenylmaleimide and 2.5
20 parts of α -methylstyrene dimer as a chain transfer agent were then fed to the flask, the inside of the flask was substituted by nitrogen, the resulting solution was stirred gently, and the reaction solution was heated at 80°C to be polymerized by maintaining that temperature for 3 hours. Thereafter, the reaction solution was further heated at 100°C, 0.5 part
25 of 2,2'-azobis(2,4-dimethylvaleronitrile) was added, and polymerization was carried out for another 1 hour to obtain a resin solution (solid content of 33.0 %).

 The obtained resin had an Mw of 17,000 and an Mn of 8,000. This resin was designated as resin (B-1).

30

Synthetic Example 2

 1 part of 2,2'-azobis(2,4-dimethylvaleronitrile) and 200 parts of propylene glycol monomethyl ether acetate were fed to a flask equipped with a cooling tube and a stirrer,

15 parts of methacrylic acid, 15 parts of styrene, 30 parts of benzyl methacrylate, 15 parts of glycerol monomethacrylate, 25 parts of N-phenylmaleimide and 2.5 parts of α -methylstyrene dimer as a chain transfer agent were then fed to the flask, the inside of the flask was substituted by nitrogen, the resulting solution was stirred gently, and the reaction solution was heated at 80°C to be polymerized by maintaining that temperature for 3 hours. Thereafter, the reaction solution was further heated 100°C, 0.5 part of 2,2'-azobis(2,4-dimethylvaleronitrile) was added, and polymerization was carried out for another 1 hour to obtain a resin solution (solid content of 32.9 %).

The obtained resin had an Mw of 19,000 and an Mn of 9,000. This resin was designated as resin (B-2).

Synthetic Example 3

1 part of 2,2'-azobis(2,4-dimethylvaleronitrile) and 200 parts of propylene glycol monomethyl ether acetate were fed to a flask equipped with a cooling tube and a stirrer, 15 parts of methacrylic acid, 15 parts of styrene, 30 parts of benzyl methacrylate, 10 parts of glycerol monomethacrylate, 30 parts of N-phenylmaleimide and 2.5 parts of α -methylstyrene dimer as a chain transfer agent were then fed to the flask, the inside of the flask was substituted by nitrogen, the resulting solution was stirred gently, and the reaction solution was heated at 80°C to be polymerized by maintaining that temperature for 3 hours. Thereafter, the reaction solution was further heated at 100°C, 0.5 part of 2,2'-azobis(2,4-dimethylvaleronitrile) was added, and polymerization was carried out for another 1 hour to obtain a resin solution (solid content of 33.2 %).

The obtained resin had an Mw of 15,000 and an Mn of 7,000. This resin was designated as resin (B-3).

Synthetic Example 4

3 parts of 2,2'-azobis(2,4-dimethylvaleronitrile) and 200 parts of propylene glycol monomethyl ether acetate were fed to a flask equipped with a cooling tube and a stirrer, 5 15 parts of methacrylic acid, 30 parts of acenaphthylene, 35 parts of benzyl methacrylate, 10 parts of 2-hydroxyethyl methacrylate, 10 parts of ω -carboxypolycaprolactone monoacrylate and 5 parts of α -methylstyrene dimer as a chain transfer agent were then fed to the flask, the inside of the 10 flask was substituted by nitrogen, the resulting solution was stirred gently, and the reaction solution was heated at 80°C to be polymerized by maintaining that temperature for 3 hours. Thereafter, the reaction solution was further heated at 100°C, 0.5 part of 15 2,2'-azobis(2,4-dimethylvaleronitrile) was added, and polymerization was carried out for another 1 hour to obtain a resin solution (solid content of 31.0 %).

The obtained resin had an Mw of 10,000 and an Mn of 6,000. This resin was designated as resin (B-4).

20

Example 1

<preparation of liquid composition>

85 parts of a mixture of C.I. Pigment Red 254 and C.I. Pigment Red 177 in a weight ratio of 80/20 as a colorant (A), 25 80 parts of resin (B-1) as an alkali-soluble resin (B), 80 parts of dipentaerythritol hexaacrylate as a polyfunctional monomer (C), 20 parts of 1-[9-ethyl-6-(2-methylbenzoyl)-9.H.-carbazol-3-yl]-ethan-1-oneoxime-O-acetate (trade name of CGI-242, manufactured 30 by Ciba Specialty Chemicals Co., Ltd., the same shall apply hereinafter) as an optical radical generator (D), and 1,000 parts of a mixture of ethyl 3-ethoxypropionate and propylene glycol monomethyl ether acetate in a weight ratio of 70/30 as a solvent were mixed together to prepare a liquid radiation

sensitive composition (R1).

<formation of color filter>

5 This liquid composition (R1) was applied to a soda-lime glass substrate having an SiO_2 film for preventing the elution of sodium ions on the surface with a spin coater and prebaked on a hot plate heated at 90°C for 2 minutes to form a $1.7\text{ }\mu\text{m}$ -thick coating film.

10 Thereafter, this substrate was cooled to room temperature and exposed to ultraviolet radiation having wavelengths of 365 nm, 405 nm and 436 nm through a photomask (slit width of $30\text{ }\mu\text{m}$) with a high-pressure mercury lamp. The dose of the radiation was 400 J/m^2 . The substrate was then immersed in a 0.04 wt% aqueous solution of potassium
15 hydroxide at 23°C for 1 minute to be developed, rinsed with super pure water and dried with air. Thereafter, the substrate was post-baked in a clean oven heated at 220°C for 30 minutes to form a pixel array having a striped red pixel pattern on the substrate.

20

<evaluation>

When the pixel array on the substrate was observed through an optical microscope, the development residue was not seen on the substrate of an unexposed portion, and no
25 scum and no missing part were seen on the edge of the pixel pattern.

When the section of the pixel pattern was observed through a scanning electron microscope (SEM), no undercut was seen.

30

Comparative Example 1

<preparation of liquid composition and formation of color filter>

A radiation sensitive composition (r1) was prepared

in the same manner as in Example 1 except that 20 parts of 2-benzyl-2-dimethylamino-1-(4-morpholinophenyl)butanone-1 was used as an optical radical generator.

5 Thereafter, a pixel array having a striped red pixel pattern was formed on the substrate in the same manner as in Example 1 except that the liquid composition (r1) was used in place of the liquid composition (R1).

<evaluation>

10 When the pixel array on the substrate was observed through an optical microscope, the development residue was not seen on the substrate of an unexposed portion but a missing part was seen on the edge of the pixel pattern.

15 When the section of the pixel pattern was observed through a scanning electron microscope (SEM), an undercut was seen.

Example 2

20 <preparation of liquid composition and formation of color filter>

95 parts of a mixture of C.I. Pigment Green 36 and C.I. Pigment Yellow 150 in a weight ratio of 60/40 as a colorant (A), 70 parts of resin (B-2) as an alkali-soluble resin (B), 80 parts of dipentaerythritol hexaacrylate as a
25 polyfunctional monomer (C), 25 parts of 1-[9-ethyl-6-(2-methylbenzoyl)-9.H.-carbazol-3-yl]-ethan-1-oneoxime-O-acetate as an optical radical generator (D), 1 part of malonic acid as an additive and 900 parts of a mixture
30 of 3-methoxybutyl acetate and propylene glycol monomethyl ether acetate in a weight ratio of 50/50 as a solvent were mixed together to prepare a liquid radiation sensitive composition (G1).

A pixel array having a striped green pixel pattern was formed on the substrate in the same manner as in Example 1

except that the liquid composition (G1) was used in place of the liquid composition (R1).

<evaluation>

5 When the pixel array on the substrate was observed through an optical microscope, the development residue was not seen on the substrate of an unexposed portion, and no scum and no missing part were seen on the edge of the pixel pattern.

10 When the section of the pixel pattern was observed through a scanning electron microscope (SEM), no undercut was seen.

Comparative Example 2

15 <preparation of liquid composition and formation of color filter>

 A radiation sensitive composition (g1) was prepared in the same manner as in Example 2 except that 35 parts of 2-benzyl-2-dimethylamino-1-(4-morpholinophenyl)butanone-
20 1 was used as an optical radical generator.

 Thereafter, a pixel array having a striped green pixel pattern was formed on the substrate in the same manner as in Example 1 except that the liquid composition (g1) was used in place of the liquid composition (R1).

25

<evaluation>

 When the pixel array on the substrate was observed through an optical microscope, the development residue was not seen on the substrate of an unexposed portion but a missing
30 part was seen on the edge of the pixel pattern.

 When the section of the pixel pattern was observed through a scanning electron microscope (SEM), an undercut was seen.

Example 3

<preparation of liquid composition and formation of color filter>

70 parts of a mixture of C.I. Pigment Blue 15:6 and
5 C.I. Pigment Violet 23 in a weight ratio of 95/5 as a colorant
(A), 60 parts of resin (B-3) as an alkali-soluble resin (B),
90 parts of dipentaerythritol hexaacrylate as a
polyfunctional monomer (C), 40 parts of
1-[9-ethyl-6-(2-methylbenzoyl)-9.H.-carbazol-3-yl]-ethan
10 -1-oneoxime-O-acetate as an optical radical generator (D),
5 parts of A-60 (trade name, nonionic surfactant manufactured
by Kao Corporation) as an additive and 900 parts of a mixture
of ethyl 3-ethoxypropionate and propylene glycol monomethyl
ether acetate in a weight ratio of 60/40 as a solvent were
15 mixed together to prepare a liquid radiation sensitive
composition (B1).

Thereafter, a pixel array having a striped blue pixel
pattern was formed on the substrate in the same manner as
in Example 1 except that the liquid composition (B1) was used
20 in place of the liquid composition (R1).

<evaluation>

When the pixel array on the substrate was observed
through an optical microscope, the development residue was
25 not seen on the substrate of an unexposed portion, and no
scum and no missing part were seen on the edge of the pixel
pattern.

When the section of the pixel pattern was observed
through a scanning electron microscope (SEM), no undercut
30 was seen.

Comparative Example 3

<preparation of liquid composition and formation of color filter>

A radiation sensitive composition (b1) was prepared in the same manner as in Example 3 except that 20 parts of 2-benzyl-2-dimethylamino-1-(4-morpholinophenyl)butanone-1 was used as an optical radical generator.

5 Thereafter, a pixel array having a striped blue pixel pattern was formed on the substrate in the same manner as in Example 1 except that the liquid composition (b1) was used in place of the liquid composition (R1).

10 <evaluation>

When the section of the pixel pattern was observed through a scanning electron microscope (SEM), an undercut was seen.

15 Example 4

<preparation of liquid composition and formation of color filter>

250 parts of carbon black (manufactured by Mikuni Shikiso Co., Ltd.) as a colorant (A), 75 parts of resin (B-4)
20 as an alkali-soluble resin (B), 75 parts of dipentaerythritol hexaacrylate as a polyfunctional monomer (C), 20 parts of 1-[9-ethyl-6-(2-methylbenzoyl)-9.H.-carbazol-3-yl]-ethan-1-oneoxime-O-acetate as an optical radical generator (D), and 1,000 parts of a mixture of propylene glycol monomethyl
25 ether acetate and cyclohexanone in a weight ratio of 50/50 as a solvent were mixed together to prepare a liquid radiation sensitive composition (BK1).

30 Thereafter, a pixel array having a striped black pixel pattern was formed on the substrate in the same manner as in Example 1 except that the liquid composition (BK1) was used in place of the liquid composition (R1).

<evaluation>

When the obtained pixel array was observed through an

optical microscope, the development residue was not observed on the substrate of an unexposed portion, and no scum and no missing part were observed on the edge of the pixel pattern.

When the section of the pixel pattern was observed
5 through a scanning electron microscope (SEM), no undercut was seen.

Comparative Example 4

<preparation of liquid composition and formation of color
10 filter>

A radiation sensitive composition (bk1) was prepared in the same manner as in Example 4 except that 30 parts of 2-benzyl-2-dimethylamino-1-(4-morpholinophenyl)butanone-1 and 12 parts of
15 2,2'-bis(2-chlorophenyl)-4,4',5,5'-tetraphenyl-1,2'-biimidazole as optical radical generators, 12 parts of 4,4'-bis(diethylamino)benzophenone as an amine-based hydrogen donor and 6 parts of 2-mercaptobenzothiazole as a mercaptan-based hydrogen donor were used.

20 Thereafter, a pixel array having a striped black pixel pattern was formed on the substrate in the same manner as in Example 1 except that the liquid composition (bk1) was used in place of the liquid composition (R1).

25 <evaluation>

When the obtained pixel array was observed through an optical microscope, the development residue was not seen on the substrate of an unexposed portion but a missing part was seen on the edge of the pixel pattern.

30 When the section of the pixel pattern was observed through a scanning electron microscope (SEM), an undercut was seen.

Example 5

<preparation of liquid composition and formation of color filter>

5 A radiation sensitive composition (R2) was prepared in the same manner as in Example 1 except that 1,500 parts of a mixture of ethyl 3-ethoxypropionate and propylene glycol monomethyl ether acetate in a weight ratio of 70/30 was used as a solvent.

10 Thereafter, a pixel array having a striped red pixel pattern was formed on the substrate in the same manner as in Example 1 except that the liquid composition (R2) was used in place of the liquid composition (R1) and applied with a slit die coater in place of the spin coater.

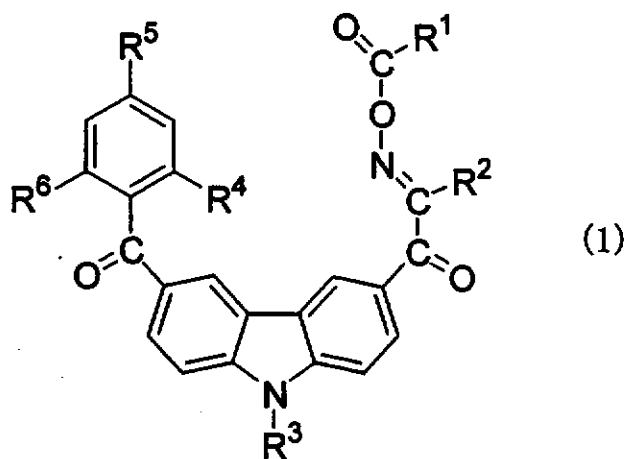
<evaluation>

15 When the pixel array on the substrate was observed through an optical microscope, the development residue was not observed on the substrate of an unexposed portion, and no scum and no missing part were observed on the edge of the pixel pattern.

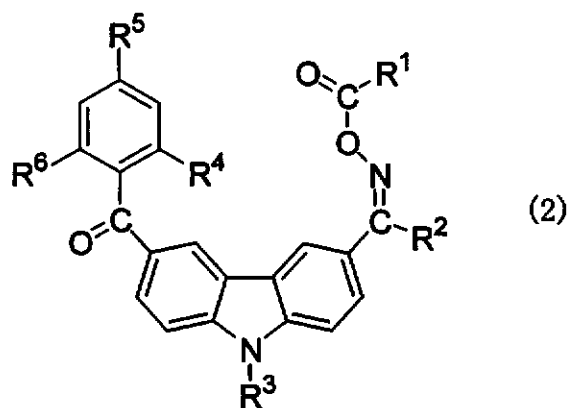
20 When the section of the pixel pattern was observed through a scanning electron microscope (SEM), no undercut was seen.

What is claimed is:

1. A radiation sensitive composition for forming a colored layer, comprising (A) a colorant, (B) an alkali-soluble resin, (C) a polyfunctional monomer or a combination of a polyfunctional monomer and a monofunctional monomer, and (D) at least one optical radical generator selected from the group consisting of compounds represented by each of the following formulas (1) and (2):



10



- wherein R¹ is a linear, branched or cyclic alkyl group having 1 to 12 carbon atoms or phenyl group, R² is a hydrogen atom, linear, branched or cyclic alkyl group having 1 to 12 carbon atoms or phenyl group, R³ is a hydrogen atom, or linear, branched or cyclic alkyl group having 1 to 12 carbon atoms, and R⁴, R⁵ and R⁶ are each independently a hydrogen atom, or linear, branched or cyclic alkyl group having 1 to 6 carbon

atoms, with the proviso that the alkyl group represented by R^1 , R^2 , R^3 , R^4 , R^5 and R^6 may be substituted by a substituent selected from the group consisting of a linear, branched or cyclic alkoxyl group having 1 to 6 carbon atoms, phenyl group and halogen atom, and the phenyl group represented by R^1 and R^2 may be substituted by a substituent selected from the group consisting of a linear, branched or cyclic alkyl group having 1 to 6 carbon atoms, linear, branched or cyclic alkoxyl group having 1 to 6 carbon atoms, phenyl group and halogen atom.

10

2. A color filter comprising a colored layer made of the radiation sensitive composition for forming a colored layer of claim 1.

15

3. A color liquid crystal display panel comprising the color filter of claim 2.