

Radiation-sensitive composition for forming a colored
layer, color filter and color liquid crystal display
device

5 Technical Field

This invention relates to a radiation-sensitive composition for forming a colored layer, a color filter and a color liquid crystal display device. More specifically, it relates to a radiation-sensitive
10 composition for forming a colored layer useful in a color filter for use in a transmissive type or reflective type color liquid crystal display device or color image-sensing device, a color filter having a colored layer formed from the above radiation-sensitive
15 composition and a color liquid crystal display device having the above color filter.

Technical Background

For producing a color filter from a colored
20 radiation-sensitive composition, there is conventionally known a method in which a colored radiation-sensitive composition is applied onto a substrate or a substrate pre-coated with a masking layer, a solvent is removed, a coating obtained after the solvent removal is irradiated
25 with radiation (to be referred to as "exposure" hereinafter) in a predetermined pattern, and developed to obtain pixels of each color (see JP-A 2-144502 and JP-A 3-53201).

In recent years, the main stream in the technical
30 filed of color filters is to decrease the exposure dose to decrease a tact time. When the exposure dose is decreased, however, conventional colored radiation-sensitive compositions are liable to result in a decrease in a film remaining ratio after development,

the occurrence of chipping or undercuts in a pattern or the separation of a pattern from a substrate. It has been therefore difficult to obtain pixels and a black matrix having an excellent pattern shape while
5 decreasing the tact time. Regarding display performances, further, there is strongly demanded a color liquid crystal display device that is free from such defects as sticking, after-image, etc., for a long period of time, and a colored layer is in turn more and more required to
10 be improved in the reliability of electric characteristics typified by voltage holding, and the like. In reality, however, it is very difficult to comply with such requirements with any conventional colored radiation-sensitive composition.

15

Disclosure of the Invention

It is an object of this invention to provide a novel radiation-sensitive composition for forming a colored layer, which can provide a colored filter that
20 is free of pattern failures such as chippings or undercuts in a pattern, that is excellent in adhesion to a substrate and that is also excellent in reliability of electric characteristics, and the like.

First, this invention includes a radiation-
25 sensitive composition for forming a colored layer, which comprises (A) a colorant, (B) an alkali-soluble resin, (C) a polyfunctional monomer and (D) a photopolymerization initiator, the (B) alkali-soluble resin containing a copolymer formed from (b1) at least
30 one selected from the group consisting of an unsaturated carboxylic acid, an unsaturated carboxylic anhydride and an unsaturated phenolic compound, (b2) an N-substituted maleimide, (b3) an unsaturated compound having an allyl group and (b4) at least one selected from the group

consisting of an aromatic vinyl compound, indene or a derivative thereof, an unsaturated carboxylic acid ester compound, an unsaturated carboxylic acid aminoalkyl ester compound, an unsaturated carboxylic acid glycidyl ester compound, a vinyl cyanide compound, an unsaturated amide compound, a carboxylic acid vinyl ester compound, a vinyl ether compound, an aliphatic conjugated diene compound and a macromonomer having a mono(meth)acryloyl group in its polymer molecular-chain terminal.

10 In this invention, the colored layer means "pixel(s) and/or black matrix".

Secondly, this invention includes a color filter having a colored layer formed from the above radiation-sensitive composition for forming a colored layer.

15 Thirdly, this invention includes a color liquid crystal display device having the above color filter.

This invention will be explained in detail below.

Preferred Embodiments of the Invention

20 Radiation-sensitive composition for colored layer

- (A) Colorant -

The colorant in this invention is not specially limited in color tone, and it is selected as required depending upon a use of a color filter to be obtained.

25 The colorant may be any one of a pigment, a dye or a natural dyestuff.

A color filter is required to have high-definition color development and heat resistance, and the colorant in this invention is hence preferably a colorant having

30 high color developability and high heat resistance or in particular a colorant having high resistance against thermal decomposition. The colorant is more preferably selected from organic pigments or inorganic pigments, particularly preferably from organic pigments or carbon

black.

The above organic pigments include, for example, compounds classified as Pigments in Color Index (C.I.; issued by The Society of Dyers and Colourists Corporation), specifically compounds that are assigned 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, 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 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 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. 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, C.I. Pigment Yellow 180, 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, 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, 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, C.I. Pigment Violet 38;

C.I. Pigment Red 1, C.I. Pigment Red 2, C.I. Pigment Red 3, 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 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. 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. 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 112, C.I. Pigment Red 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.
- 5 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 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
- 10 180, 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.
- 15 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, C.I. Pigment Red 265;
- 20 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 Violet 23; C.I. Pigment Green 7, C.I. Pigment Green 36;
- 25 C.I. Pigment Brown 23, C.I. Pigment Brown 25; C.I. Pigment Black 1, C.I. Pigment Black 7.

These organic pigments can be used after purified as required by a proper method such as a sulfuric acid recrystallization method, a solvent washing method or a

30 combination of these methods.

Further, examples of the inorganic pigments include titanium oxide, barium sulfate, calcium carbonate, zinc oxide, lead sulfate, chrome yellow, zinc chromate, colcothar (red iron oxide (III)), cadmium red,

ultramarine blue, Prussian blue, chromium oxide green, cobalt green, amber, titanium black, synthetic iron black, carbon black and the like.

In this invention, the above organic pigments and
5 inorganic pigments may be used singly, or they may be used in combination. Further, organic pigment(s) and inorganic pigment(s) may be used in combination. For forming the pixels, preferably, one or more organic pigments are used. For forming the black matrix,
10 preferably, two or more organic pigments and/or carbon black are/is used.

In this invention, the above pigments as particles may be surface-modified with a polymer as required before they are used as such. The polymer for surface-
15 modifying grains of the pigments is selected, for example, from polymers described in JP 8-259876A, etc., or commercially available polymers or oligomers for dispersing pigments.

In this invention, further, the colorant may be
20 used together with a dispersant as required.

Examples of the above dispersant include cationic, anionic, nonionic, amphoteric, silicon-containing and fluorine-containing surfactants.

Examples of the above surfactants include
25 polyoxyethylene alkyl ethers such as polyoxyethylene lauryl ether, polyoxyethylene stearyl ether, polyoxyethylene oleyl ether, etc.; polyoxyethylene alkylphenyl ethers such as polyoxyethylene n-octylphenyl ether, polyoxyethylene n-nonylphenyl ether, etc.;
30 polyethylene glycol diesters such as polyethylene glycol dilaurate, polyethylene glycol distearate, etc.; sorbitan fatty acid esters; fatty acid modified polyesters; tertiary amine-modified polyurethane; polyethylene imine and products having the following

trade names such as KP (supplied by The Shin-Etsu Chemical Co., Ltd.), POLYFLOW (supplied by KYOEISHA CHEMICAL Co., LTD.), "F-Top" (supplied by Tochem Products K.K.), MEGAFAC (supplied by DAINIPPON INK AND
5 CHEMICALS, INCORPORATED), FLUORAD (supplied by Sumitomo 3M Ltd.), Asahi Guard and Surflon (both supplied by Asahi Glass Co., Ltd.), BYK and Disperbyk (both supplied by BIGCHEME JAPAN) and Solsperse (supplied by Zeneca K.K.).

10 These surfactants may be used singly or in combination.

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

15 In this invention, the radiation-sensitive resin composition can be prepared by a proper method. When a pigment is used as a colorant, preferably, the radiation-sensitive resin composition is prepared in a manner in which the pigment is milled, for example, with
20 a bead mill or roll mill and at the same time mixed and dispersed in a solvent in the presence of a dispersant to obtain a pigment dispersion, and the pigment dispersion is mixed with a (B) component, a (C) component and a (D) component to be described later,
25 optionally together with an additional solvent and other additive to be described later.

 The amount of the dispersing agent for the preparation of the pigment dispersion, per 100 parts by weight of the pigment, is preferably 100 parts by weight
30 or less, more preferably 0.5 to 100 parts by weight, still more preferably 1 to 70 parts by weight, particularly preferably 10 to 50 parts by weight. In this case, when the amount of the dispersing agent exceeds 100 parts by weight, the developability may be

impaired.

The solvent for the preparation of the pigment dispersion can be selected, for example, from those which will be described later as examples with regard to the radiation-sensitive resin composition as a liquid composition to be described later.

The amount of the solvent for the preparation of the pigment dispersion, per 100 parts by weight of the pigment, is preferably 200 to 1,000 parts by weight, more preferably 300 to 800 parts by weight.

When the pigment dispersion is prepared with a bead mill, for example, glass beads or titania beads having a diameter of approximately 0.5 to 10 mm are used and a pigment mixture containing a pigment, a solvent and a dispersing agent is mixed and dispersed, preferably, with cooling it with cooling water, or the like.

In this case, the filling factor of the beads is preferably 50 to 80 % based on a mill capacity, and the charging amount of the pigment mixture is preferably approximately 20 to 50 % based on the mill capacity. Further, the time period for the treatment is preferably 2 to 50 hours, preferably 2 to 25 hours.

When the preparation is carried out with a roll mill, for example, a three-roll mill or two-roll mill is used, and the pigment mixture can be treated preferably with cooling it with cooling water or the like.

In this case, the inter-roll distance is preferably 10 μm or less, and the shearing force is preferably approximately 10^8 dyn/second. The time period for the treatment is preferably 2 to 50 hours, more preferably 2 to 25 hours.

-(B) Alkali-soluble resin-

The alkali-soluble resin in this invention contains a copolymer (to be referred to as "copolymer (BI)"

hereinafter) formed from (b1) at least one selected from the group consisting of an unsaturated carboxylic acid, an unsaturated carboxylic anhydride and an unsaturated phenolic compound (these compounds will be generically referred to as "unsaturated compound (b1)" hereinafter), (b2) an N-substituted maleimide, (b3) an unsaturated compound having an allyl group (to be referred to as "unsaturated compound (b3)" hereinafter) and (b4) at least one (to be referred to as "unsaturated compound (b4)" hereinafter) selected from the group consisting of an aromatic vinyl compound, indene or a derivative thereof, an unsaturated carboxylic acid ester compound, an unsaturated carboxylic acid aminoalkyl ester compound, an unsaturated carboxylic acid glycidyl ester compound, a vinyl cyanide compound, an unsaturated amide compound, a carboxylic acid vinyl ester compound, a vinyl ether compound, an aliphatic conjugated diene compound and a macromonomer having a mono(meth)acryloyl group in its polymer molecular-chain terminal. The alkali-soluble resin is a component that works as a binder for the (A) colorant and that has solubility in an alkali developing solution which is used in a developing step for forming a colored layer.

Regarding the above unsaturated compound (b1), examples of the above unsaturated carboxylic acid or unsaturated carboxylic anhydrides include; unsaturated monocarboxylic acids such as (meth)acrylic acid, crotonic acid, α -chloroacrylic acid, cinnamic acid, etc.; unsaturated dicarboxylic acids such as maleic acid, maleic anhydride, fumaric acid, itaconic acid, itaconic anhydride, citraconic acid, citraconic anhydride, mesaconic acid, etc. or anhydrides thereof; trivalent or higher unsaturated polyvalent carboxylic

acids or anhydrides thereof;
mono[(meth)acryloyloxyalkyl]esters of divalent or higher
polyvalent carboxylic acids such as mono[2-
(meth)acryloyloxyethyl]succinate, mono-[2-
5 (meth)acryloyloxyethyl]phthalate, etc.; and
mono(meth)acrylates having a carboxy group and a
hydroxyl group on each of their two terminal ends such
as ω -carboxylpolycaprolactone mono(meth)acrylate, etc.

Of these unsaturated carboxylic acids and
10 unsaturated carboxylic anhydrides, mono(2-
acryloyloxyethyl)succinate and mono(2-
acryloyloxyethyl)phthalate are commercially available
under the trade names of LIGHT-ESTER HOA-MS and LIGHT-
ESTER HOA-MPE (both supplied by KYOEISHA CHEMICAL Co.,
15 LTD.).

Further, examples of the above unsaturated phenol
compound include
unsaturated phenol compounds such as o-vinylphenol, m-
vinylphenol, p-vinylphenol, 2-methyl-4-vinylphenol, 3-
20 methyl-4-vinylphenol, o-isopropenylphenol, m-
isopropenylphenol, p-isopropenylphenol, etc.; and
unsaturated naphthol compounds such as 2-vinyl-1-
naphthol, 3-vinyl-1-naphthol, 1-vinyl-2-naphthol, 3-
vinyl-2-naphthol, 2-isopropenyl-1-naphthol, 3-
25 isopropenyl-1-naphthol, etc.

In this invention, as an unsaturated compound (b1),
(meth)acrylic acid, mono[2-
(meth)acryloyloxyethyl]succinate, ω -
carboxylpolycaprolactone mono(meth)acrylate, p-
30 vinylphenol, etc., are preferred and (meth)acrylic acid
is particularly preferred.

Examples of the N-substituted maleimide include N-
methylemaleimide, N-ethylmaleimide, N-n-propylmaleimide,
N-i-propylmaleimide, N-n-butylmaleimide, N-t-

butylmaleimide, N-n-hexylmaleimide, N-cyclopentylmaleimide, N-cyclohexylmaleimide, N-phenylmaleimide, N-1-naphthylmaleimide, etc.

In this invention, as an N-substituted maleimide,
5 N-cyclohexylmaleimide, N-phenylmaleimide, etc., are preferred, and N-phenylmaleimide is particularly preferred.

The above N-substituted maleimides may be used singly or in combination.

10 The unsaturated compound (b3) includes a compound having an ally group alone as a polymerizable unsaturated bond and a compound having an allyl group and other polymerizable unsaturated bond as polymerizable unsaturated bonds (to be referred to as
15 "unsaturated compound (b3-I)" hereinafter), and the unsaturated compound (b3-I) is preferred.

Examples of the unsaturated compound (b3) include unsaturated compounds (b3-I) such as allyl
(meth)acrylate, allyl crotonate, allyl α -chloroacrylate,
20 allyl cinnamate, monoallyl maleate, monoallyl fumarate, etc., allyl acetate, allyl propionate, allyl butyrate, allyl benzoate, monoallyl succinate, monoallyl phthalate, allyl methyl ether, allyl ethyl ether, allyl glycidyl ether, p-allyl benzyl methyl ether, p-allyl benzyl
25 glycidyl ether and the like.

In this invention, as an unsaturated compound (b3), allyl (meth)acrylate is particularly preferred.

The above unsaturated compounds (b3) may be used singly or in combination.

30 As specific examples of the unsaturated compound (b4), the above aromatic vinyl compound includes, for example, styrene, α -methylstyrene, o-vinyltoluene, m-vinyltoluene, p-vinyltoluene, p-chlorostyrene, o-methoxystyrene, m-methoxystyrene, p-methoxystyrene, o-

vinyl benzyl methyl ether, m-vinyl benzyl methyl ether, p-vinyl benzyl methyl ether, o-vinyl benzyl glycidyl ether, m-vinylbenzyl glycidyl ether, p-vinylbenzyl glycidyl ether, etc.;

5 the above indene derivative includes, for example, 1-methyindene, etc.;

the above unsaturated carboxylic ester compound includes, for example, methyl (meth)acrylate, ethyl (meth)acrylate, n-propyl (meth)acrylate, i-propyl (meth)acrylate, n-
 10 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-
 15 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, methoxydiethylene glycol (meth)acrylate, methoxytriethylene glycol (meth)acrylate,
 20 methoxypropylene glycol (meth)acrylate, methoxydipropylene glycol (meth)acrylate, isobornyl (meth)acrylate, dicyclopentadiethyl (meth)acrylate, 2-hydroxy-3-phenoxypropyl (meth)acrylate, glycerol
 25 mono(meth)acrylate, etc.;

the above unsaturated carboxylic acid aminoalkyl ester compound includes, for example, 2-aminoethyl (meth)acrylate, 2-dimethylaminoethyl (meth)acrylate, 2-aminopropyl (meth)acrylate, 2-dimethylaminopropyl
 30 (meth)acrylate, 3-aminopropyl (meth)acrylate, 3-dimethylaminopropyl (meth)acrylate, etc.;

the above unsaturated carboxylic acid glycidyl ester compound includes, for example, glycidyl (meth)acrylate, etc.;

the above vinyl cyanide compound includes, for example, (meth)acrylonitrile, α -chloroacrylonitrile, vinylidene cyanide, etc.;

the above unsaturated amide compound includes, for
5 example, (meth)acrylamide, α -chloroacrylamide, N-2-hydroxyethyl (meth)acrylamide, etc.;

the above carboxylic acid vinyl ester compound includes, for example, vinyl acetate, vinyl propionate, vinyl butyrate, vinyl benzoate, etc.;

10 the above vinyl ether compound includes, for example, vinyl methyl ether, vinyl ethyl ether, etc.;

the above aliphatic conjugated diene compound includes, for example, 1,3-butadiene, isoprene, chloroprene, etc.; and

15 the above macromonomer having a mono(meth)acryloyl group on its polymer molecular-chain terminal includes, for example, a macromonomer having a mono(meth)acryloyl group on the terminal of a polymer such as polystyrene, polymethyl (meth)acrylate, poly-n-butyl (meth)acrylate,
20 polysiloxane, etc.

In this invention, as an unsaturated compound (b4), the aromatic vinyl compound, the unsaturated carboxylic acid ester compound, the macromonomer, etc., are preferred, and styrene, methyl (meth)acrylate, n-butyl
25 (meth)acrylate, 2-ethylhexyl (meth)acrylate, 2-hydroxyethyl (meth)acrylate, benzyl (meth)acrylate, glycerol mono(meth)acrylate, polystyrene macromonomer, polymethyl methacrylate macromonomer, etc., are particularly preferred.

30 The above unsaturated compounds (b4) may be used singly or in combination.

In this invention, the copolymer (BI) is preferably a copolymer (to be referred to as "copolymer (BII)" hereinafter) obtained from at least one unsaturated

compound (b1) containing (meth)acrylic acid as a main component, at least one N-substituted maleimide selected from the group consisting of N-cyclohexylmaleimide and N-phenylmaleimide, at least one unsaturated compound

5 (b3) selected from the group consisting of allyl acrylate and allyl methacrylate and at least one unsaturated compound (b4) selected from the group consisting of styrene, methyl (meth)acrylate, n-butyl (meth)acrylate, 2-ethylhexyl (meth)acrylate, 2-

10 hydroxyethyl (meth)acrylate, benzyl (meth)acrylate, phenyl (meth)acrylate, glycerol mono(meth)acrylate, a polystyrene macromonomer and polymethyl methacrylate macromonomer.

Specific examples of the copolymer (BII) include

15 a (meth)acrylic acid/N-phenylmaleimide/allyl methacrylate/styrene copolymer,
 a (meth)acrylic acid/N-phenylmaleimide/allyl methacrylate/styrene/2-hydroxyethyl (meth)acrylate copolymer,

20 a (meth)acrylic acid/N-phenylmaleimide/allyl methacrylate/styrene/methyl (meth)acrylate/n-butyl (meth)acrylate copolymer,
 a (meth)acrylic acid/N-phenylmaleimide/allyl methacrylate/styrene/methyl (meth)acrylate/2-ethylhexyl

25 (meth)acrylate copolymer,
 a (meth)acrylic acid/N-phenylmaleimide/allyl methacrylate/styrene/methyl (meth)acrylate/2-hydroxyethyl (meth)acrylate copolymer,
 a (meth)acrylic acid/N-phenylmaleimide/allyl

30 methacrylate/styrene/n-butyl (meth)acrylate/2-hydroxyethyl (meth)acrylate copolymer,
 a (meth)acrylic acid/N-phenylmaleimide/allyl methacrylate/styrene/n-butyl (meth)acrylate/benzyl (meth)acrylate copolymer,

- a (meth)acrylic acid/N-phenylmaleimide/allyl
methacrylate/styrene/2-ethylhexyl (meth)acrylate/benzyl
(meth)acrylate copolymer,
- 5 a (meth)acrylic acid/N-phenylmaleimide/allyl
methacrylate/styrene/2-hydroxyethyl
(meth)acrylate/benzyl (meth)acrylate copolymer,
- a (meth)acrylic acid/N-phenylmaleimide/allyl
methacrylate/styrene/benzyl (meth)acrylate/glycerol
mono(meth)acrylate copolymer,
- 10 a (meth)acrylic acid/N-phenylmaleimide/allyl
methacrylate/styrene/n-butyl (meth)acrylate/benzyl
(meth)acrylate/glycerol mono(meth)acrylate copolymer,
- a (meth)acrylic acid/N-phenylmaleimide/allyl
methacrylate/methyl (meth)acrylate copolymer,
- 15 a (meth)acrylic acid/N-phenylmaleimide/allyl
methacrylate/2-hydroxyethyl (meth)acrylate copolymer,
- a (meth)acrylic acid/N-phenylmaleimide/allyl
methacrylate/benzyl (meth)acrylate copolymer,
- a (meth)acrylic acid/N-phenylmaleimide/allyl
- 20 methacrylate/2-hydroxyethyl (meth)acrylate/phenyl
(meth)acrylate copolymer,
- a (meth)acrylic acid/N-phenylmaleimide/allyl
methacrylate/benzyl (meth)acrylate/glycerol
mono(meth)acrylate copolymer,
- 25 a (meth)acrylic acid/N-phenylmaleimide/allyl
methacrylate/n-butyl (meth)acrylate/2-hydroxyethyl
(meth)acrylate/benzyl (meth)acrylate copolymer,
- a (meth)acrylic acid/N-phenylmaleimide/allyl
methacrylate/n-butyl (meth)acrylate/2-hydroxyethyl
- 30 (meth)acrylate/phenyl (meth)acrylate copolymer,
- a (meth)acrylic acid/N-phenylmaleimide/allyl
methacrylate/n-butyl (meth)acrylate/benzyl
(meth)acrylate/glycerol mono(meth)acrylate copolymer,
- a (meth)acrylic acid/N-phenylmaleimide/allyl

- methacrylate/2-hydroxyethyl (meth)acrylate/phenyl
(meth)acrylate/polystyrene macromonomer copolymer,
a (meth)acrylic acid/N-phenylmaleimide/allyl
methacrylate/styrene/2-hydroxyethyl
- 5 (meth)acrylate/phenyl (meth)acrylate/polymethyl
methacrylate macromonomer copolymer,
a (meth)acrylic acid/N-phenylmaleimide/allyl
methacrylate/styrene/n-butyl (meth)acrylate/2-
hydroxyethyl (meth)acrylate/phenyl
- 10 (meth)acrylate/polystyrene macromonomer copolymer,
a (meth)acrylic acid/N-phenylmaleimide/allyl
methacrylate/styrene/n-butyl (meth)acrylate/2-
hydroxyethyl (meth)acrylate/phenyl
(meth)acrylate/polymethyl methacrylate macromonomer
- 15 copolymer,
a (meth)acrylic acid/N-phenylmaleimide/allyl
methacrylate/methyl (meth)acrylate/polystyrene
macromonomer copolymer,
a (meth)acrylic acid/N-phenylmaleimide/allyl
- 20 methacrylate/methyl (meth)acrylate/polymethyl
methacrylate macromonomer copolymer,
a (meth)acrylic acid/N-phenylmaleimide/allyl
methacrylate/benzyl (meth)acrylate/polystyrene
macromonomer copolymer,
- 25 a (meth)acrylic acid/N-phenylmaleimide/allyl
methacrylate/benzyl (meth)acrylate/polymethyl
(meth)acrylate macromonomer copolymer,
a (meth)acrylic acid/N-phenylmaleimide/allyl
methacrylate/methyl (meth)acrylate/n-methyl
- 30 (meth)acrylate/polystyrene macromonomer copolymer,
a (meth)acrylic acid/N-phenylmaleimide/allyl
methacrylate/methyl (meth)acrylate/n-butyl
(meth)acrylate/polymethyl methacrylate macromonomer
copolymer,

- a (meth)acrylic acid/N-phenylmaleimide/allyl
methacrylate/n-butyl (meth)acrylate/benzyl
(meth)acrylate/polystyrene macromonomer copolymer,
a (meth)acrylic acid/N-phenylmaleimide/allyl
5 methacrylate/n-butyl (meth)acrylate/benzyl
(meth)acrylate/polymethyl (meth)acrylate macromonomer
copolymer,
a (meth)acrylic acid/N-phenylmaleimide/allyl
methacrylate/2-hydroxyethyl (meth)acrylate/benzyl
10 (meth)acrylate/polystyrene macromonomer copolymer,
a (meth)acrylic acid/N-phenylmaleimide/allyl
methacrylate/2-hydroxyethyl (meth)acrylate/benzyl
(meth)acrylate/polymethyl (meth)acrylate macromonomer
copolymer,
15 a (meth)acrylic acid/N-phenylmaleimide/allyl
methacrylate/n-butyl (meth)acrylate/2-hydroxyethyl
(meth)acrylate/benzyl (meth)acrylate/polystyrene
macromonomer copolymer,
a (meth)acrylic acid/N-phenylmaleimide/allyl
20 methacrylate/n-butyl (meth)acrylate/2-hydroxyethyl
(meth)acrylate/benzyl (meth)acrylate/polymethyl
(meth)acrylate macromonomer copolymer,
a (meth)acrylic acid/mono[2-(meth)acryloyloxyethyl]
succinate/N-cyclohexylmaleimide/allyl
25 methacrylate/styrene copolymer,
a (meth)acrylic acid/mono[2-(meth)acryloyloxyethyl]
succinate/N-cyclohexylmaleimide/allyl
methacrylate/styrene/n-butyl (meth)acrylate copolymer,
a (meth)acrylic acid/mono[2-(meth)acryloyloxyethyl]
30 succinate/N-cyclohexylmaleimide/allyl
methacrylate/styrene/benzyl (meth)acrylate copolymer,
a (meth)acrylic acid/mono[2-(meth)acryloyloxyethyl]
succinate/N-cyclohexylmaleimide/allyl
methacrylate/styrene/n-butyl (meth)acrylate/benzyl

- (meth)acrylate copolymer,
 a (meth)acrylic acid/mono[2-(meth)acryloyloxyethyl]
 succinate/N-cyclohexylmaleimide/allyl
 methacrylate/benzyl (meth)acrylate/glycerol
- 5 mono(meth)acrylate copolymer,
 a (meth)acrylic acid/mono[2-(meth)acryloyloxyethyl]
 succinate/N-phenylmaleimide/allyl methacrylate/styrene
 copolymer,
 a (meth)acrylic acid/mono[2-(meth)acryloyloxyethyl]
 10 succinate/N-phenylmaleimide/allyl
 methacrylate/styrene/n-butyl (meth)acrylate copolymer,
 a (meth)acrylic acid/mono[2-(meth)acryloyloxyethyl]
 succinate/N-phenylmaleimide/allyl
 methacrylate/styrene/2-hydroxyethyl (meth)acrylate
 15 copolymer,
 a (meth)acrylic acid/mono[2-(meth)acryloyloxyethyl]
 succinate/N-phenylmaleimide/allyl methacrylate/styrene/
 benzyl (meth)acrylate copolymer,
 a (meth)acrylic acid/mono[2-(meth)acryloyloxyethyl]
 20 succinate/N-phenylmaleimide/allyl methacrylate/
 styrene/methyl (meth)acrylate/n-butyl (meth)acrylate
 copolymer,
 a (meth)acrylic acid/mono[2-(meth)acryloyloxyethyl]
 succinate/N-phenylmaleimide/allyl methacrylate/
 25 styrene/methyl (meth)acrylate/2-ethylhexyl
 (meth)acrylate copolymer,
 a (meth)acrylic acid/mono[2-(meth)acryloyloxyethyl]
 succinate/N-phenylmaleimide/allyl
 methacrylate/styrene/n-butyl (meth)acrylate/benzyl
 30 (meth)acrylate copolymer,
 a (meth)acrylic acid/mono[2-(meth)acryloyloxyethyl]
 succinate/N-phenylmaleimide/allyl
 methacrylate/styrene/2-ethylhexyl (meth)acrylate/benzyl
 (meth)acrylate copolymer,

- a (meth)acrylic acid/mono[2-(meth)acryloyloxyethyl]
succinate/N-phenylmaleimide/allyl
methacrylate/styrene/2-hydroxyethyl
(meth)acrylate/benzyl (meth)acrylate copolymer,
- 5 a (meth)acrylic acid/mono[2-(meth)acryloyloxyethyl]
succinate/N-phenylmaleimide/allyl methacrylate/styrene/
methyl (meth)acrylate/n-butyl (meth)acrylate/2-
hydroxyethyl (meth)acrylate copolymer,
- 10 a (meth)acrylic acid/mono[2-(meth)acryloyloxyethyl]
succinate/N-phenylmaleimide/allyl methacrylate/styrene/
methyl (meth)acrylate/2-ethylhexyl (meth)acrylate/2-
hydroxyethyl (meth)acrylate copolymer,
- 15 a (meth)acrylic acid/mono[2-(meth)acryloyloxyethyl]
succinate/N-phenylmaleimide/allyl methacrylate/styrene/
/n-butyl (meth)acrylate/2-hydroxyethyl
(meth)acrylate/benzyl (meth)acrylate copolymer,
- 20 a (meth)acrylic acid/mono[2-(meth)acryloyloxyethyl]
succinate/N-phenylmaleimide/allyl methacrylate/styrene/
/2-ethylhexyl (meth)acrylate/2-hydroxyethyl
(meth)acrylate/benzyl (meth)acrylate copolymer,
- 25 a (meth)acrylic acid/mono[2-(meth)acryloyloxyethyl]
succinate/N-phenylmaleimide/allyl methacrylate/benzyl
(meth)acrylate/glycerol mono (meth)acrylate copolymer,
- 30 a (meth)acrylic acid/mono[2-(meth)acryloyloxyethyl]
succinate/N-phenylmaleimide/allyl methacrylate/n-butyl
(meth)acrylate/benzyl (meth)acrylate/glycerol mono
(meth)acrylate copolymer,
- a (meth)acrylic acid/ ω -carboxypolycaprolactone
mono(meth)acrylate/N-cyclohexylmaleimide/allyl
methacrylate/styrene/benzyl (meth)acrylate/glycerol mono
(meth)acrylate copolymer,
- a (meth)acrylic acid/ ω -carboxypolycaprolactone
mono(meth)acrylate/N-phenylmaleimide/allyl
methacrylate/styrene/benzyl (meth)acrylate/glycerol mono

- (meth)acrylate copolymer,
 a (meth)acrylic acid/ ω -carboxylpolycaprolactone
 mono(meth)acrylate/N-phenylmaleimide/allyl
 methacrylate/styrene/n-butyl (meth)acrylate/glycerol
 5 mono (meth)acrylate copolymer, and
 a copolymer obtained by replacing the allyl methacrylate
 of each of these copolymers with ally acrylate.

Of the above copolymers (BII), preferred are:

- a (meth)acrylic acid/N-phenylmaleimide/allyl
 10 methacrylate/styrene copolymer,
 a (meth)acrylic acid/N-phenylmaleimide/allyl
 methacrylate/styrene/2-hydroxyethyl (meth)acrylate
 copolymer,
 a (meth)acrylic acid/N-phenylmaleimide/allyl
 15 methacrylate/styrene/2-hydroxyethyl
 (meth)acrylate/benzyl (meth)acrylate copolymer,
 a (meth)acrylic acid/mono[2-(meth)acryloyloxyethyl]
 succinate/N-phenylmaleimide/allyl methacrylate/styrene
 copolymer,
 20 a (meth)acrylic acid/mono[2-(meth)acryloyloxyethyl]
 succinate/N-phenylmaleimide/allyl
 methacrylate/styrene/2-hydroxyethyl (meth)acrylate
 copolymer,
 a (meth)acrylic acid/mono[2-(meth)acryloyloxyethyl]
 25 succinate/N-phenylmaleimide/allyl methacrylate/styrene/
 benzyl (meth)acrylate copolymer,
 a (meth)acrylic acid/mono[2-(meth)acryloyloxyethyl]
 succinate/N-phenylmaleimide/allyl
 methacrylate/styrene/2-hydroxyethyl
 30 (meth)acrylate/benzyl (meth)acrylate copolymer and the
 like.

In the copolymer (BI), the copolymerization amount
 ratio of the unsaturated compound (b1) is preferably 1
 to 40 % by weight, particularly preferably 5 to 30 % by

weight, the copolymerization amount ratio of the N-substituted maleimide (b2) is preferably 1 to 50 % by weight, particularly preferably 5 to 40 % by weight, the copolymerization amount ratio of the unsaturated
5 compound (b3) is preferably 1 to 70 % by weight, particularly preferably 5 to 40 % by weight, and the copolymerization amount ratio of the unsaturated compound (b4) is preferably 1 to 80 % by weight, particularly preferably 5 to 60 % by weight.

10 In this invention, the copolymerization amount ratios of the unsaturated compounds in the copolymer (BI) are brought into the above ranges, whereby there can be obtained a radiation-sensitive composition excellent in sensitivity, adhesion to a substrate and
15 solvent resistance.

In this invention, other alkali-soluble resin may be used in combination with the copolymer (BI).

The above "other" alkali-soluble resin is not specially limited so long as it acts on the (A) colorant
20 as a binder and has solubility in an alkali developing solution for use in the step of development for forming a colored layer. For example, an alkali-soluble resin having a carboxyl group is preferred, and as an example thereof, there is a copolymer obtained from at least at
25 least one selected from the group consisting of those unsaturated carboxylic acids and unsaturated carboxylic anhydrides which are described as examples with regard to the copolymer (BI) and at least one selected from the group consisting of those N-substituted maleimides and
30 unsaturated compounds (b4) which are described as examples with regard to the copolymer (BI).

As "other" alkali-soluble resin preferred, more specifically, there is a copolymer obtained from (i) at least one unsaturated carboxylic acid containing

(meth)acrylic acid as an essential component and (ii) at least one selected from the group consisting of N-cyclohexylmaleimide, N-phenylmaleimide, styrene, methyl (meth)acrylate, n-butyl (meth)acrylate, 2-ethylhexyl (meth)acrylate, 2-hydroxyethyl (meth)acrylate, benzyl (meth)acrylate, phenyl (meth)acrylate, glycerol mono(meth)acrylate, a polystyrene macromonomer and a polymethyl methacrylate macromonomer.

In this invention, the copolymer (BI) and the "other" alkali-soluble resin respectively have a weight average molecular weight (to be referred to as "Mw" hereinafter), as a polystyrene, of 2,000 to 300,000, more preferably 3,000 to 100,000 when measured by gel permeation chromatography (GPC, elution solvent: tetrahydrofuran).

Further, the copolymer (BI) and the "other" alkali-soluble resin respectively have a number average molecular weight (to be referred to as "Mn" hereinafter), as a polystyrene, of 3,000 to 60,000, more preferably 5,000 to 25,000, when measured by gel permeation chromatography (GPC, elution solvent: tetrahydrofuran).

In this invention, the copolymer (BI) having the above-specified Mw and Mn is used, or this copolymer (BI) is used in combination with the above "other" alkali-soluble resin having the above-specified Mw and Mn, whereby a radiation-sensitive composition excellent in developability can be obtained, so that a colored layer having a sharp pattern edge can be formed and that the occurrence of a residue, a ground soiling, a remaining film, etc., on a non-exposed portion of a substrate and on a masking layer is suppressed during development.

The ratio of Mw and Mn (M_w/M_n) of each of the copolymer (BI) and the "other" alkali-soluble resin is

preferably from 1 to 5, more preferably from 1 to 4.

In this invention, the above copolymers (BI) may be used singly or in combination, and this is also applicable to the "other" alkali-soluble resins.

5 In this invention, the total amount of the alkali-soluble resins per 100 parts by weight of the (A) colorant is preferably 10 to 1,000 parts by weight, more preferably 20 to 500 parts by weight. In this case, when the total amount of the alkali-soluble resins is less
10 than 10 parts by weight, for example, alkali developability may be decreased and a ground soiling or a remaining film may occur on a non-exposed portion of a substrate or on a masking layer. When it exceeds 1,000 parts by weight, the concentration of the colorant is
15 relatively low, and it may be hence difficult to attain the color density intended as a thin film.

Further, the amount of the copolymer (BI) in the alkali-soluble resin is preferably 10 to 100 % by weight, particularly preferably 20 to 100 % by weight. In this
20 case, when the amount of the copolymer (BI) is less than 10 % by weight, the intended effect of this invention may be impaired.

-(C) Polyfunctional monomer-

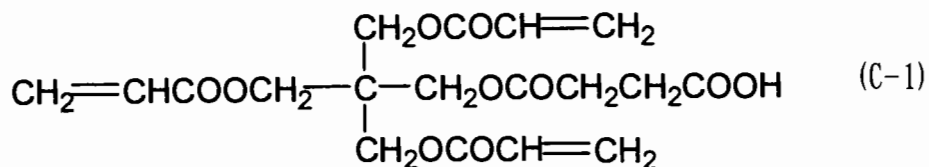
The polyfunctional monomer in this invention refers
25 to a monomer having two or more polymerizable unsaturated bonds per molecule.

Examples of the polyfunctional monomer include;
di(meth)acrylates of alkylene glycols such as ethylene glycol, propylene glycol, etc.;
30 di(meth)acrylates of polyalkylene glycols such as polyethylene glycol, polypropylene glycol, etc.;
poly(meth)acrylates of trihydric or higher polyhydric alcohols such as glycerin, trimethylol propane, pentaerythritol, dipentaerythritol, etc., and

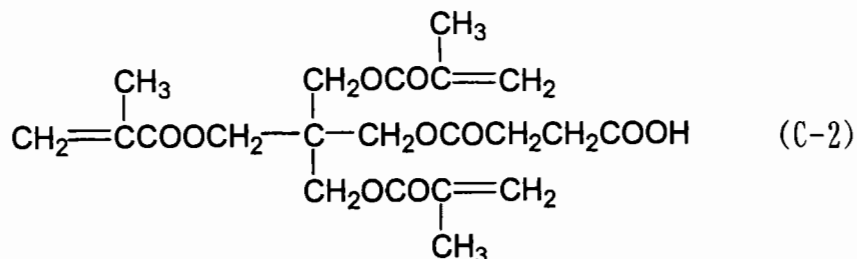
dicarboxylic-acid-modified products of these;
 oligo(meth)acrylates of a polyester, an epoxy resin, a
 urethane resin, an alkyd resin, a silicone resin, a
 spiran resin, etc.;

- 5 di(meth)acrylates of both-terminals-hydroxylated
 polymers such as both-terminals-hydroxypoly-1,3-
 butadiene, both-terminals-hydroxypolyisoprene, both-
 terminals-hydroxypolycaprolactone, etc.; and
 tris[2-(meth)acryloyloxyethyl]phosphate.

- 10 Of these polyfunctional monomers,
 poly(meth)acrylates of trihydric or higher polyhydric
 alcohols or dicarboxylic-acid-modified products of these
 are preferred. Specifically, preferred are
 trimethylolpropane triacrylate, trimethylolpropane
 15 trimethacrylate, pentaerythritol triacrylate,
 pentaerythritol trimethacrylate, pentaerythritol
 tetraacrylate, pentaerythritol tetramethacrylate,
 dipentaerythritol pentaacrylate, dipentaerythritol
 pentamethacrylate, dipentaerythritol hexaacrylate,
 20 dipentaerythritol hexamethacrylate, a compound of the
 following formula (C-1),



a compound of the following formula (C-2),



- 25 and the like. Above all, trimethylolpropane triacrylate,
 pentaerythritol triacrylate and dipentaerythritol

hexaacrylate are particularly preferred in that a colored layer has high strength and excellent surface smoothness and that the occurrence of a ground soiling, a remaining film, etc., on a non-exposed portion of a substrate and on a masking layer is suppressed.

The above polyfunctional monomers may be used singly or in combination.

The amount of the polyfunctional monomer in this invention per 100 parts by weight of the (B) alkali-soluble resin is preferably 5 to 500 parts by weight, more preferably 20 to 300 parts by weight. In this case, when the amount of the polyfunctional monomer is less than 5 parts by weight, the intensity and surface smoothness of a colored layer are liable to decrease. When it exceeds 500 parts by weight, for example, the alkali developability is liable to decrease or a ground soiling, a remaining film, etc., are liable to occur on a non-exposed portion of a substrate or on a masking layer.

In this invention, further, some quantity of the polyfunctional monomer may be replaced with a monofunctional monomer having one polymerizable unsaturated bond.

Examples of the above monofunctional monomer include compounds similar to those compounds described as examples of the unsaturated compound (b1), the N-position-substituted maleimide and the unsaturated compound (b4) with regard to the (B) alkali-soluble resin, N-(meth)acryloylmorpholine, N-vinylpyrrolidone, N-vinyl-ε-caprolactam and other commercially available product M-5600 (trade name, supplied by TOAGOSEI CO., LTD.).

These monofunctional monomers may be used singly or in combination.

The amount of the monofunctional monomer based on the total amount of the polyfunctional monomer and the monofunctional monomer is preferably 90 % by weight or less, more preferably 50 % by weight or less. When the
5 amount of the monofunctional monomer exceeds 90 % by weight, the strength and surface smoothness of an obtained colored layer may be insufficient.

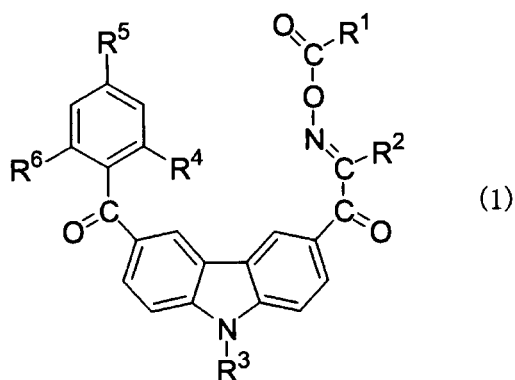
The total amount of the polyfunctional monomer and the monofunctional monomer in this invention per 100
10 parts by weight of the (B) alkali-soluble resin is preferably 5 to 500 parts by weight, more preferably 20 to 300 parts by weight. When the above total amount is less than 5 % by weight, the strength and surface smoothness of a colored layer are liable to decrease.
15 When it exceeds 500 parts by weight, for example, the alkali developability is liable to decrease or a ground soiling, a remaining film, etc., are liable to occur on a non-exposed portion of a substrate and on a masking layer.

20 - (D) Photopolymerization initiator-

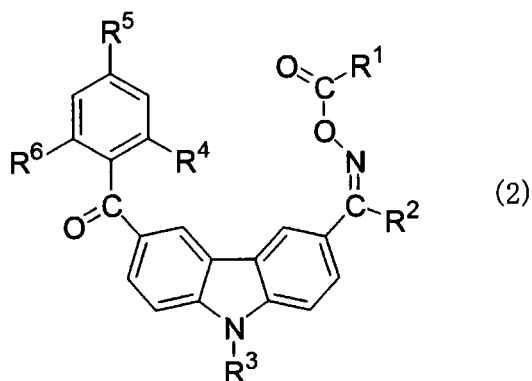
The photopolymerization initiator in this invention refers to a component that generates an active species capable of initiating polymerization of the above (C) polyfunctional monomer and the optional monofunctional
25 monomer by exposure to radiation such as visible light, ultraviolet light, far ultraviolet light, charged particle ray, X-ray or the like.

In this invention, examples of the photopolymerization initiator include a compound of the
30 following formula (I) (to be referred to as "oxime compound (D1)" hereinafter, a compound of the following formula (2) (to be referred to as "oxime compound (D2)" hereinafter), a biimidazole compound having at least one of main structures of the following formulae (3-1), (3-

2) and (3-3), a benzoin compound, an acetophenone compound, a benzophenone compound, an α -diketone compound, a polynuclear quinone compound, a xanthone compound, a phosphine compound and a triazine compound.



5

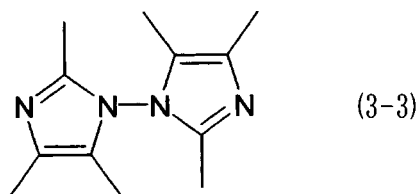
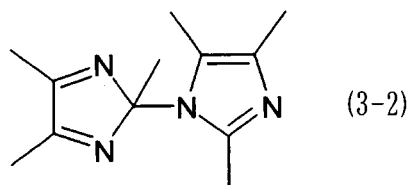
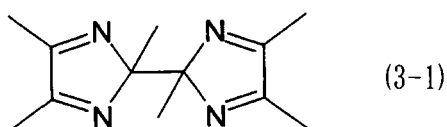


10 In the formulae (1) and (2), each R^1 is independently a linear, branched or cyclic alkyl group having 1 to 12 carbon atoms or a phenyl group, each R^2 is independently a hydrogen atom, a linear, branched or cyclic alkyl group having 1 to 12 carbon atoms or a phenyl group, R^3 is a hydrogen atom or a linear, branched or cyclic alkyl group having 1 to 12 carbon atoms, and each of R^4 , R^5 and R^6 is independently a hydrogen atom or a linear, branched or cyclic alkyl group having 1 to 6 carbon atoms, provided that the alkyl group represented

15

20 by each of R^1 , R^2 , R^3 , R^4 , R^5 and R^6 may be substituted

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



10

In the formulae (1) and (2), examples of the linear, branched or cyclic alkyl group having 1 to 12 carbon atoms, represented by R^1 , R^2 and R^3 , 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 group, n-heptyl group, n-octyl group, n-nonyl group, n-decyl group, n-undecyl group, n-dodecyl group, cyclopentyl group, cyclohexyl group, etc.

Further, 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 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

20

group, cyclopentyl group, cyclohexyl group, etc.

Of the substituents on alkyl groups represented by R^1 , R^2 , R^3 , R^4 , R^5 and R^6 and on phenyl groups represented by R^1 and R^2 , the linear, branched or cyclic alkoxyl group having 1 to 6 carbon atoms includes, for example, methoxyl group, ethoxyl group, n-propoxyl group, i-propoxyl group, n-butoxyl group, t-butoxyl group, etc., and the halogen atom includes, for example, a fluorine atom, a chlorine atom, etc.

Of the substituents on phenyl groups represented by R^1 and R^2 , the linear, branched or cyclic alkyl group having 1 to 6 carbon atoms includes, for example, methyl group, ethyl group, n-propyl group, i-propyl group, n-butyl group, t-butyl group, etc.

On each of the above alkyl groups and phenyl groups, one or more substituents may exist, or different substituents may exist.

In the formulae (1) and (2), R^1 is preferably 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, 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, and each of R^4 , R^5 and R^6 is preferably a hydrogen atom, methyl group, ethyl group, n-propyl group, i-propyl group or n-butyl group.

Specific examples of the oxime compound (D1) preferably include 1-[4-(phenylthio)phenyl]-octan-1-one-2-one oxime-O-acetate, 1-[4-(2-methylphenylthio)phenyl]-octan-1-one-2-one oxime-O-acetate, 1-[4-(2,4,6-trimethylphenylthio)phenyl]-octan-1-one-2-one oxime-O-acetate, 1-[4-(2-ethylphenylthio)phenyl]-octan-1-one-2-

one oxime-O-acetate, 1-[4-(phenylthio)phenyl]-octan-1-one-2-one oxime-O-benzoate, 1-[4-(2-methylphenylthio)phenyl]-octan-1-one-2-one oxime-O-benzoate, 1-[4-(2,4,6-trimethylphenylthio)phenyl]-octan-1-one-2-one oxime-O-benzoate and 1-[4-(2-ethylphenylthio)phenyl]-octan-1-one-2-one oxime-O-benzoate, etc.

Further, specific examples of the oxime compound (D2) preferably include 1-[9-ethyl-6-benzoyl-9.H.-carbazol-3-yl]-octan-1-one oxime-O-acetate, 1-[9-ethyl-6-(2-methylbenzoyl)-9.H.-carbazol-3-yl]-ethan-1-one oxime-O-acetate, 1-[9-ethyl-6-(2-methylbenzoyl)-9.H.-carbazol-3-yl]-ethan-1-one oxime-O-benzoate, 1-[9-ethyl-6-(2,4,6-trimethylbenzoyl)-9.H.-carbazol-3-yl]-ethan-1-one oxime-O-benzoate, 1-[9-n-butyl-6-(2-ethylbenzoyl)-9.H.-carbazol-3-yl]-ethan-1-one oxime-O-benzoate, etc.

Of these oxime compounds (D1) and oxime compounds (D2), oxime compounds (D2) are more preferred, and 1-[9-ethyl-6-(2-methylbenzoyl)-9.H.-carbazol-3-yl]-ethan-1-one oxime-O-acetate is particularly preferred.

Examples of the above imidazole 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-ethoxycarbonylphenyl)-1,2'-biimidazole, 2,2'-bis(2-chlorophenyl)-4,4',5,5'-tetrakis(4-ethoxycarbonylphenyl)-1,2'-biimidazole, 2,2'-bis(2,4-dichlorophenyl)-4,4',5,5'-tetrakis(4-ethoxycarbonylphenyl)-1,2'-biimidazole, 2,2'-bis(2,4,6-trichlorophenyl)-4,4',5,5'-tetrakis(4-ethoxycarbonylphenyl)-1,2'-biimidazole, 2,2'-bis(2-bromophenyl)-4,4',5,5'-tetrakis(4-ethoxycarbonylphenyl)-1,2'-biimidazole, 2,2'-bis(2,4-dibromophenyl)-4,4',5,5'-tetrakis(4-ethoxycarbonylphenyl)-1,2'-biimidazole and 2,2'-bis(2,4,6-tribromophenyl)-4,4',5,5'-tetrakis(4-ethoxycarbonylphenyl)-1,2'-biimidazole.

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,
 5 and 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 and do not generate foreign
 matters such as an undissolved matter, a precipitate,
 10 etc., and they have high sensitivity and cause a curing
 reaction to fully proceed under exposure at a low energy
 level. Further, they have high contrast and do not cause
 a curing reaction in a non-exposed portion. In a coating
 film after exposure, therefore, a cured portion
 15 insoluble in a developing solution and an uncured
 portion having high solubility in the developing
 solution are distinctly divided, whereby there can be
 formed a high-definition pattern array in which a pixel
 pattern free of an undercut and a black matrix pattern
 20 are arranged according to a predetermined array.

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

25 Examples of the above acetophenone compound
 includes 2,2-dimethoxyacetophenone, 2,2-
 diethoxyacetophenone, 2,2-dimethoxy-2-phenylacetophenone,
 2-hydroxy-2-methyl-1-phenylpropan-1-one, 1-(4-i-
 propylphenyl)-2-hydroxy-2-methylpropan-1-one, 2-methyl-
 30 (4-methylthiophenyl)-2-morpholino-1-propan-1-one, 4-(2-
 hydroxyethoxy)phenyl-2-(hydroxyl-2-propyl) ketone, 2-
 benzyl-2-dimethylamino-1-(4-morpholinophenyl)butan-1-one,
 1-hydroxycyclohexyl phenyl ketone and 2,2-dimethoxy-1,2-
 diphenylethan-1-one.

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

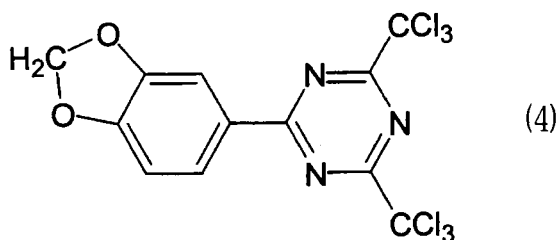
Examples of the above α -diketone compound include 5 diacetyl, dibenzoyl and methylbenzoyl formate.

Examples of the above polynuclear quinone compound includes anthraquinone, 2-ethylanthraquinone, 2-t-butylantrhaquinone and 1,4-naphthoquinone.

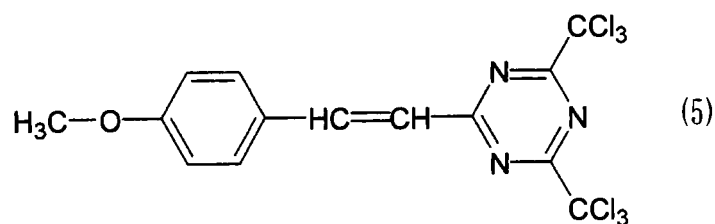
Examples of the above xanthone compound include 10 xanthone, thioxanthone and 2-chloroxanthone.

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 15 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-(furan-2-yl)ethenyl]-4,6-bis(trichloromethyl)-s-triazine, 2-[2-(5-methylfuran-2-yl)ethenyl]-4,6-bis(trichloromethyl)-s-
20 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)-
25 4,6-bis(trichloromethyl)-s-triazine, 2-(4-n-butoxyphenyl)-4,6-bis(trichloromethyl)-s-triazine, a compound of the following formula (4),



and a compound of the following formula (5).



In this invention, as a photopolymerization initiator, the oxime compound (D1), the oxime compound (D2), the biimidazole compound, the acetophenone compound and the triazine compound are preferred, and the oxime compound (D1) and the oxime compound (D2) are more preferred.

In this invention, the photopolymerization initiators may be used singly or in combination.

In this invention, the amount of the photopolymerization initiator per 100 parts by weight of total of the (C) polyfunctional monomer and the optional monofunctional monomer is preferably 0.01 to 200 parts by weight, more preferably 1 to 120 parts by weight, particularly preferably 1 to 100 parts by weight. When the amount of the photopolymerization initiator is less than 0.01 part by weight, curing by exposure is insufficient and it may be difficult to obtain a pattern array a pixel pattern or black matrix pattern arranged in a predetermined array. When it exceeds 200 parts by weight, a formed color layer is liable to come off a substrate during development or a ground soiling, a remaining film, etc., are liable to occur on a non-exposed portion of a substrate and on a masking layer.

In this invention, further, at least one of a sensitizer, a curing promoter and a polymer optical crosslinking agent-sensitizer may be used as required together with the above photopolymerization initiator.

-Additives-

The radiation-sensitive composition for forming a

colored layer, provided by this invention, may contain various additives as required.

Examples of the above additives include organic acids or organic amino compounds that work to more
5 improve the solubility of the radiation-sensitive composition in an alkali developing solution and that work to more suppress an undissolved matter that remains after development.

The above organic acids are preferably aliphatic
10 carboxylic acids or phenyl-group-containing carboxylic acids having at least one carboxylic group per molecule. Examples of the above aliphatic carboxylic acids include;
monocarboxylic acids such as formic acid, acetic acid,
15 propionic acid, butyric acid, valeric acid, pivalic acid, caproic acid, diethylacetic acid, enanthic acid, caprylic acid, etc.;
dicarboxylic acids such as oxalic acid, malonic acid, succinic acid, glutaric acid, adipic acid, pimelic acid,
20 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, mesaconic acid, etc.;
25 and
tricarboxylic acids such as tricarballylic acid, aconitic acid, camphoronic acid, etc.

Further, examples of the above phenyl-group-containing carboxylic acid include compounds in which a
30 carboxyl group is bonded directly to a phenyl group and carboxylic acids in which a carboxyl group is bonded to a phenyl group through a carbon chain.

Examples of the phenyl-group-containing carboxylic acid include;

aromatic monocarboxylic acids such as benzoic acid, toluic acid, cumic acid, hemellitic acid, mesitylenic acid, etc.;

aromatic dicarboxylic acids such as phthalic acid,
5 isophthalic acid, terephthalic acid, etc.;
trivalent or higher aromatic polycarboxylic acids such as trimellitic acid, trimesic acid, mellophanic acid, pyromellitic acid, etc.;
phenylacetic acid, hydroatropic acid, hydrocinnamic acid,
10 mandelic acid, phenylsuccinic acid, atropic acid, cinnamic acid, cinnamylidene acid, coumaric acid, umbellic acid and the like.

Of these organic acids, in view of alkali solubility, solubility in a solvent to be described
15 later and prevention of a ground soiling and a remaining film on a non-exposed portion of a substrate or on a masking layer, aliphatic dicarboxylic acids are preferred, and malonic acid, adipic acid, itaconic acid, citraconic acid, fumaric acid, mesaconic acid, etc., are
20 particularly preferred. And, as a phenyl-group-containing carboxylic acid, aromatic dicarboxylic acids are preferred, and phthalic acid is particularly preferred.

The above organic acids may be used singly or in
25 combination.

The amount of the organic acid based on the entire radiation-sensitive composition is preferably 15 % by weight or less, more preferably 10 % by weight or less. When the amount of the organic acid exceeds 15 % by
30 weight, the adhesion of a formed colored layer to a substrate is liable to decrease.

The above organic amino compound is preferably an aliphatic amine or phenyl-group-containing amine having one or more amino groups per molecule.

Examples of the above aliphatic amine include;
 mono(cyclo)alkylamines such as n-propylamine, i-propylamine, n-butylamine, i-butylamine, sec-butylamine, t-butylamine, n-pentylamine, n-hexylamine, n-heptylamine,
 5 n-octylamine, n-nonylamine, n-decylamine, n-undecylamine, n-dodecylamine, cyclohexylamine, 2-methylcyclohexylamine, 3-methylcyclohexylamine, 4-methylcyclohexylamine, 2-ethylcyclohexylamine, 3-ethylcyclohexylamine, 4-ethylcyclohexylamine, etc.;

10 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,
 15 ethylcyclohexylamine, dicyclohexylamine, etc.;

tri(cyclo)alkylamines such as dimethylethylamine, methyldiethylamine, triethylamine, dimethyl-n-propylamine, diethyl-n-propylamine, methyl di-n-propylamine, ethyl di-n-propylamine, tri-n-propylamine,
 20 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, tricyclohexylamine, etc.;

25 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, 4-amino-1-cyclohexanol, etc.;

di(cyclo)alkanolamines such as diethanolamine, di-n-propanolamine, di-i-propanolamine, di-n-butanolamine,
 30 di-i-butanolamine, di-n-pentanolamine, di-n-hexanolamine, di(4-cyclohexanol)amine, etc.;

tri(cyclo)alkanolamines such as triethanolamine, tri-n-propanolamine, tri-i-propanolamine, tri-n-butanolamine,

- tri-*i*-butanolamine, tri-*n*-pentanolamine, tri-*n*-hexanolamine, tri(4-cyclohexanol)amine, etc.; 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-diethylamino-1,2-propanediol, 2-dimethylamino-1,3-propanediol, 2-diethylamino-1,3-propandiol, etc.;
- 10 amino-group-containing cycloalkanemethanols such as 1-aminocyclopentanemethanol, 4-aminocyclopentanemethanol, 1-aminocyclohexanemethanol, 4-aminocyclohexanemethanol, 4-dimethylaminocyclopentanemethanol, 4-diethylaminocyclopentanemethanol, 4-
- 15 dimethylaminocyclohexanemethanol, 4-diethylaminocyclohexanemethanol, etc.; and aminocarboxylic acids such as β -alanine, 2-aminobutyric acid, 3-aminobutyric acid, 4-aminobutyric acid, 2-aminoisobutyric acid, 3-aminoisobutyric acid, 2-
- 20 aminovaleric acid, 5-aminovaleric acid, 6-aminocaproic acid, 1-aminocyclopropanecarboxylic acid, 1-aminocyclohexanecarboxylic acid, 4-aminocyclohexanecarboxylic acid, etc.

Further, examples of the above phenyl-group-

25 containing amine include compounds in which an amino group is bonded directly to a phenyl group and compounds in which an amino group is bonded to a phenyl group through a carbon chain.

Examples of the phenyl-group-containing amine

30 include;

aromatic amines such as aniline, 2-methylaniline, 3-methylaniline, 4-methylaniline, 4-ethylaniline, 4-*n*-propylaniline, 4-*i*-propylaniline, 4-*n*-butylaniline, 4-*t*-butylaniline, 1-naphthylamine, 2-naphthylamine, *N,N*-

dimethylaniline, N,N-diethylaniline, 4-methyl-N,N-dimethylaniline, etc.;

aminobenzyl alcohols such as 2-aminobenzyl alcohol, 3-aminobenzyl alcohol, 4-aminobenzyl alcohol, 4-

5 dimethylaminobenzyl alcohol, 4-diethylaminobenzyl alcohol, etc.; and

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

10 Of these organic amino compounds, in view of solubility in a solvent to be described later and prevention of a ground soiling and a remaining film on a non-exposed portion of a substrate or on a masking layer, mono(cyclo)alkanolamines and amino(cyclo)alkanediols are
15 preferred, and 2-aminoethanol, 3-amino-1-propanol, 5-amino-1-pentanol, 3-amino-1,2-propanediol, 2-amino-1,3-propanediol, 4-amino-1,2-butanediol, etc., are particularly preferred, as aliphatic amines. And, as phenyl-group-containing amines, aminophenols are
20 preferred, and 2-aminophenol, 3-aminophenol, 4-aminophenol, etc., are particularly preferred.

The above organic amino compounds may be used singly or in combination.

The amount of the organic amino compound based on
25 the entire radiation-sensitive composition is preferably 15 % by weight or less, more preferably 10 % by weight or less. In this case, when the amount of the organic amino compound exceeds 15 % by weight, the adhesion of a formed colored layer to a substrate is liable to be low.

30 Examples of additives other than the above-described organic acids and organic amino compounds include;

dispersing aids such as a blue pigment derivative like a copper phthalocyanine derivative, a yellow

pigment derivative, etc.;
 fillers such as glass, alumina, etc.;
 polymer compounds such as polyvinyl alcohol,
 polyethylene glycol monoalkyl ether, poly(fluoroalkyl
 5 acrylate), etc.;
 surfactants such as nonionic, cationic and anionic
 surfactants, etc.;
 adhesion promoters such as vinyltrimethoxysilane,
 vinyltriethoxysilane, vinyltris(2-methoxyethoxy)silane,
 10 N-(2-aminoethyl)-3-aminopropylmethyldimethoxysilane, N-
 (2-aminoethyl)-3-aminopropyltrimethoxysilane, 3-
 aminopropyltriethoxysilane, 3-
 glycidoxypropyltrimethoxysilane, 3-
 glycidoxypropylmethyldimethoxysilane, 2-(3,4-
 15 epoxycyclohexyl)ethyltrimethoxysilane, 3-
 chloropropylmethyldimethoxysilane, 3-
 chloropropyltrimethoxysilane, 3-
 methacryloyloxypropyltrimethoxysilane, 3-
 mercaptopropyltrimethoxysilane, etc.;
 20 antioxidants such as 2,6-di-t-butylphenol, etc.;
 ultraviolet absorbents such as 2-(3-t-butyl-5-methyl-2-
 hydroxyphenyl)-5-chlorobenzotriazole, alkoxybenzophenone,
 etc.;
 aggregation inhibitors such as sodium polyacrylate, and
 25 thermal radical generating agents such as 1,1'-
 azobis(cyclohexane-1-carbonitrile), 2-phenylazo-4-
 methoxy-2,4-dimethylvaleronitrile, etc.

Solvent

The radiation-sensitive composition for forming a
 30 colored layer, provided by this invention, contains the
 above (A) to (D) components as essential components and
 contains the above additive component(s) as required.
 Preferably, it is prepared in the form of a liquid
 composition by adding a solvent.

The above solvent can be selected, as required, from those solvents which disperse or dissolve the (A) to (D) components and the additive components for constituting the radiation sensitive composition, which
5 do not react with these components and which exhibit proper volatility.

Examples of the above solvent include;
(poly)alkylene glycol monoalkyl ethers such as ethylene glycol monomethyl ether, ethylene glycol monoethyl ether,
10 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
15 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
20 mono-n-propyl ether, dipropylene glycol mono-n-butyl ether, tripropylene glycol monomethyl ether, tripropylene glycol monoethyl ether, etc.;
(poly)alkylene glycol monoalkyl ether acetates such as ethylene glycol monomethyl ether acetate, ethylene
25 glycol monoethyl ether acetate, diethylene glycol monomethyl ether acetate, diethylene glycol monoethyl ether acetate, propylene glycol monomethyl ether acetate, propylene glycol monoethyl ether acetate, etc.;
other ethers such as diethylene glycol dimethyl ether,
30 diethylene glycol methyl ethyl ether, diethylene glycol diethyl ether, tetrahydrofuran, etc.;
ketones such as methyl ethyl ketone, cyclohexanone, 2-heptanone, 3-heptanone, etc.;
alkyl lactates such as methyl lactate, ethyl lactate,

etc.;

other esters such as ethyl 2-hydroxy-2-methylpropionate, methyl 3-methoxypropionate, ethyl 3-methoxypropionate, methyl 3-ethoxypropionate, ethyl 3-ethoxypropionate,

5 ethyl ethoxyacetate, ethyl hydroxyacetate, methyl 2-hydroxy-3-methylbutanoate, 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,

10 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, ethyl 2-oxobutanoate, etc.;

aromatic hydrocarbons such as toluene, xylene, etc.;

15 amide compounds or lactam compounds such as N,N-dimethylformamide, N,N-dimethylacetamide, N-methylpyrrolidone, etc., and the like.

Of these solvents, in view of solubility, pigment dispersibility, application performance, etc., preferred

20 are 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-

25 heptanone, ethyl lactate, ethyl 3-methoxypropionate, methyl 3-ethoxypropionate, ethyl 3-ethoxypropionate, 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

30 butyrate, ethyl pyruvate, etc.

The above solvents may be used singly or in combination.

In combination with the above solvent, there may be used high-boiling-point solvents such as benzyl ethyl

ether, di-n-hexyl ether, acetonyl acetone, isophorone, caproic acid, caprylic acid, 1-octanol, 1-nonanol, benzyl alcohol, benzyl acetate, ethyl benzoate, diethyl oxalate, diethyl maleate, γ -butyrolactone, ethylene
5 carbonate, propylene carbonate, ethylene glycol monophenyl ether acetate, etc.

These high-boiling-point solvents may be used singly or in combination.

Although not specially limited, the amount of the
10 solvent is desirably such an amount that the total concentration of components of a composition excluding the solvent is preferably 5 to 50 % by weight, more preferably 10 to 40 % by weight, in view of coatability and stability of the radiation sensitive composition
15 obtained.

When the high-boiling-point solvent is used in combination, the content of the high-boiling-point solvent in the entire solvent amount is preferably 50 % by weight or less, more preferably 30 % by weight or
20 less.

Color Filter

The color filter of this invention has a colored layer formed from the radiation-sensitive composition for forming a colored layer, provided by this invention.

25 The method for forming a colored layer in the color filter of this invention will be explained below.

First, a masking layer is formed on the surface of a substrate as required for comparting a portion where pixels are to be formed, a liquid composition that is a
30 radiation-sensitive composition containing, for example, a red pigment dispersed therein is applied onto the substrate, an applied liquid composition is pre-baked to volatilize a solvent and form a coating film.

Then, the coating film is subjected to exposure

through a photomask, followed by development with an alkali developing solution to dissolve and remove a non-exposed portion of the coating film and post-baking, whereby a pixel array is formed in which a pixel pattern
5 in red is arranged in a predetermined array.

Thereafter, using a liquid composition that is a radiation-sensitive composition containing a green or blue pigment dispersed therein, application of the liquid composition, pre-baking, exposure, development
10 and post-baking are carried out in the same manner as above, and a green pixel array and a blue pixel array are consecutively formed on the same substrate in the above manner, whereby there is obtained a color filter having pixel arrays of three primary colors of red,
15 green and blue arranged on the substrate. In this invention, however, the order of forming pixels of the colors shall not be limited to the above-described order.

Further, a black matrix can be formed from a liquid composition that is a radiation-sensitive composition
20 containing, for example, a black pigment dispersed therein in the same manner as in the formation of the above pixels.

Examples of the substrate that is used for the formation of pixels and/or a black matrix include a
25 glass substrate, a silicon substrate, a polycarbonate substrate, a polyester substrate, an aromatic polyamide substrate, a polyamideimide substrate and a polyimide substrate.

Further, these substrates may be subjected to pre-
30 treatment such as chemical treatment with a silane coupling agent or the like, plasma treatment, ion plating, sputtering, a gaseous phase reaction method, vacuum vapor deposition, or the like as required.

For applying a liquid composition of the radiation

sensitive composition to a substrate, there may be employed a spray method, a roll coating method, a spin coating method, a slit die application method, a bar coating method, an ink jet method, or the like as
5 required, while a spin coating method and a slit die application method are preferred.

The thickness of the coating film, as a thickness obtained after the removal of a solvent, is preferably 0.1 to 10 μm , more preferably 0.2 to 8.0 μm , particularly
10 preferably 0.2 to 6.0 μm .

The radiation to be used for forming pixels and/or a black matrix can be selected, for example, from visible light, ultraviolet light, far ultraviolet light, electron beam, X-ray or the like. A radiation having a
15 wavelength in the range of 190 to 450 nm is preferred.

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

Further, the above alkali developing solution is preferably selected, for example, from aqueous solutions
20 of sodium carbonate, sodium hydroxide, potassium hydroxide, tetramethylammonium hydroxide, choline, 1,8-diazabicyclo-[5.4.0]-7-undecene, 1,5-diazabicyclo[4.3.0]-5-nonene and the like.

The above alkali developing solution may contain a
25 proper amount, for example, of a water-soluble organic solvent such as methanol or ethanol or a surfactant. In addition, alkali development is preferably followed by washing with water.

As a developing method, a shower developing method,
30 a spray developing method, a dip (immersion) developing method, a paddle (liquid mounding) method or the like can be employed. Regarding developing conditions, ordinary temperature and 5 to 300 seconds are preferred.

The color filter of this invention, obtained in the

above manner, is remarkably useful for a transmission type or reflection type color liquid crystal display device, a color image-sensing device, a color sensor and the like.

5 Color liquid crystal display device

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

According to one aspect of the color liquid crystal display device of this invention, pixels and/or a black
10 matrix are/is formed on a thin film transistor substrate array from the radiation sensitive composition for forming a colored layer, provided by this invention, in the above-described manner, whereby a color liquid crystal display device having particularly excellent
15 characteristics can be produced.

Particularly Preferred Embodiments of this invention

The radiation sensitive composition for forming a colored layer, provided by this invention, contains the above (A) to (D) components as essential components.
20 Specifically, the following compositions (1) to (4) are particularly preferred.

(1) A radiation-sensitive composition for forming a colored layer, in which the (B) alkali-soluble resin contains the copolymer (BII).

25 (2) A radiation-sensitive composition for forming a colored layer as recited in the above (1), in which the (C) polyfunctional monomer is at least one selected from the group consisting of trimethylolpropane triacrylate, pentaerythritol triacrylate and dipentaerythritol
30 hexaacrylate.

(3) A radiation-sensitive composition for forming a colored layer, as recited in the above (1) or (2), in which the photopolymerization initiator is at least one selected from the group consisting of the oxime compound

(D1), the oxime compound (D2), the biimidazole compound, the acetophenone compound and the triazine compound.

(4) A radiation-sensitive composition for forming a colored layer as recited in the above (1), (2) or (3),
5 in which the (A) colorant is an organic pigment or carbon black.

Further, a preferred color filter of this invention (5) has pixels and/or a black matrix formed from the above radiation-sensitive composition for forming a
10 colored layer as recited in (1), (2), (3) or (4).

Further, a preferred color liquid crystal display device of this invention (6) has the above color filter (5), and a more preferred color liquid crystal display device of
15 this invention

(7) has the above color filter (6) on a thin-film transistor substrate array.

As described above, the radiation-sensitive composition for forming a colored layer, provided by
20 this invention, is free from pattern failures such as chippings or undercuts in a pattern and is excellent in adhesion to a substrate. Moreover, it is excellent in electric characteristics such as voltage holding ratio and can give a color filter having high reliability.

25 The radiation sensitive composition for forming a colored layer, provided by this invention, can be therefore remarkably suitably used for producing various color filters including a color filter for a color liquid crystal display device in the field of
30 electronics industries.

Examples

This invention will be more specifically explained with reference to Examples hereinafter, while this

invention shall not be limited to these Examples.

Each of resins obtained in the following Synthesis Examples was measured for Mw and Mn by gel permeation chromatography (GPC) based on the following
5 specification.

Apparatus: GPC-101 (supplied by Showa Denko K.K.)

Columns: GPC-KF-801, GPC-KF-802, GPC-KF-803 and GPC-KF-804 were used in a state of being combined.

Mobile phase: Tetrahydrofuran containing 0.5 % by
10 weight of phosphoric acid.

Synthesis Example 1

A flask having a cooling tube and a stirrer was charged with 5 parts by weight of 2,2'-
15 azobisvaleronitrile and 200 parts by weight of propylene glycol monomethyl ether acetate and then charged with 20 parts by weight of methacrylic acid, 10 parts by weight of mono(2-methacryloyloxyethyl)succinate, 31.2 parts by weight of N-phenylmaleimide, 20 parts by weight of allyl
20 methacrylate, 18.8 parts by weight of styrene and 7 parts by weight of α -methylstyrene dimer as a chain transfer agent, followed by replaced by N₂. Then, with stirring moderately, the temperature of a reaction mixture was increased to 70°C and this temperature was
25 maintained for 2 hours to carry out polymerization. Then, 2 parts by weight of 2,2'-azobisvaleronitrile was once again added, and the polymerization was further continued for 2 hours to give a resin solution (solid content = 32.8 % by weight). This resin had an Mw of
30 12,000 and an MW/Mn of 2.8.

This resin solution will be referred to as "resin solution (Poly s-1)" and this resin will be referred to as "resin (Poly a-1)".

Synthesis Example 2

A flask having a cooling tube and a stirrer was charged with 5 parts by weight of 2,2'-azobisvaleronitrile and 200 parts by weight of propylene glycol monomethyl ether acetate and then charged with 20 parts by weight of methacrylic acid, 5 parts by weight of mono(2-methacryloyloxyethyl)succinate, 31.2 parts by weight of N-phenylmaleimide, 20 parts by weight of allyl methacrylate, 18.8 parts by weight of styrene, 5.0 parts by weight of benzyl methacrylate and 7 parts by weight of α -methylstyrene dimer, followed by replaced by N₂. Then, with stirring moderately, the temperature of a reaction mixture was increased to 70°C and this temperature was maintained for 2 hours to carry out polymerization. Then, 2 parts by weight of 2,2'-azobisvaleronitrile was once again added, and the polymerization was further continued for 2 hours to give a resin solution (solid content = 32.8 % by weight). This resin had an Mw of 11,000 and an MW/Mn of 2.6.

This resin solution will be referred to as "resin solution (Poly s-2)" and this resin will be referred to as "resin (Poly a-2)".

Synthesis Example 3

A flask having a cooling tube and a stirrer was charged with 5 parts by weight of 2,2'-azobisvaleronitrile and 200 parts by weight of propylene glycol monomethyl ether acetate and then charged with 10 parts by weight of methacrylic acid, 31.2 parts by weight of N-phenylmaleimide, 20 parts by weight of allyl methacrylate, 18.8 parts by weight of styrene, 15 parts by weight of 2-hydroxyethyl methacrylate, 5.0 parts by weight of benzyl methacrylate and 5 parts by weight of α -methylstyrene dimer, followed by replaced by N₂. Then,

with stirring moderately, the temperature of a reaction mixture was increased to 70°C and this temperature was maintained for 2 hours to carry out polymerization. Then, 2 parts by weight of 2,2'-azobisvaleronitrile was once again added, and the polymerization was further continued for 2 hours to give a resin solution (solid content = 32.5 % by weight). This resin had an Mw of 11,000 and an MW/Mn of 2.9.

This resin solution will be referred to as "resin solution (Poly s-3)" and this resin will be referred to as "resin (Poly a-3)".

Synthesis Example 4

A flask having a cooling tube and a stirrer was charged with 5 parts by weight of 2,2'-azobisvaleronitrile and 200 parts by weight of propylene glycol monomethyl ether acetate and then charged with 10 parts by weight of methacrylic acid, 31.2 parts by weight of N-phenylmaleimide, 30 parts by weight of allyl methacrylate, 18.8 parts by weight of styrene, 10 parts by weight of 2-hydroxyethyl methacrylate and 7 parts by weight of α -methylstyrene dimer, followed by replaced by N₂. Then, with stirring moderately, the temperature of a reaction mixture was increased to 70°C and this temperature was maintained for 2 hours to carry out polymerization. Then, 2 parts by weight of 2,2'-azobisvaleronitrile was once again added, and the polymerization was further continued for 2 hours to give a resin solution (solid content = 31.9 % by weight). This resin had an Mw of 12,000 and an MW/Mn of 2.8.

This resin solution will be referred to as "resin solution (Poly s-4)" and this resin will be referred to as "resin (Poly a-4)".

Synthesis Example 5

A flask having a cooling tube and a stirrer was charged with 5 parts by weight of 2,2'-azobisvaleronitrile and 200 parts by weight of propylene glycol monomethyl ether acetate and then charged with 20 parts by weight of methacrylic acid, 10 parts by weight of mono(2-methacryloyloxyethyl)succinate, 31.2 parts by weight of N-phenylmaleimide, 20 parts by weight of benzyl methacrylate, 18.8 parts by weight of styrene and 7 parts by weight of α -methylstyrene dimer, followed by replaced by N₂. Then, with stirring moderately, the temperature of a reaction mixture was increased to 70°C and this temperature was maintained for 2 hours to carry out polymerization. Then, 2 parts by weight of 2,2'-azobisvaleronitrile was once again added, and the polymerization was further continued for 2 hours to give a resin solution (solid content = 32.8 % by weight). This resin had an Mw of 12,000 and an MW/Mn of 2.8.

This resin solution will be referred to as "resin solution (Poly s-5)" and this resin will be referred to as "resin (Poly a-5)".

Synthesis Example 6

A flask having a cooling tube and a stirrer was charged with 5 parts by weight of 2,2'-azobisvaleronitrile and 200 parts by weight of propylene glycol monomethyl ether acetate and then charged with 20 parts by weight of methacrylic acid, 10 parts by weight of mono(2-methacryloyloxyethyl)succinate, 20 parts by weight of allyl methacrylate, 18.8 parts by weight of styrene, 31.2 parts by weight of benzyl methacrylate and 7 parts by weight of α -methylstyrene dimer, followed by replaced by N₂. Then, with stirring moderately, the temperature of a reaction mixture was increased to 80°C

and this temperature was maintained for 2 hours to carry out polymerization. Then, the reaction mixture was temperature-increased to 100°C, 2 parts by weight of 2,2'-azobisvaleronitrile was once again added, and the
5 polymerization was further continued for 2 hours to give a resin solution (solid content = 32.8 % by weight). This resin had an Mw of 15,000 and an MW/Mn of 3.0.

This resin solution will be referred to as "resin solution (Poly s-6)" and this resin will be referred to
10 as "resin (Poly a-6)".

Synthesis Example 7

A flask having a cooling tube and a stirrer was charged with 5 parts by weight of 2,2'-
15 azobisvaleronitrile and 200 parts by weight of propylene glycol monomethyl ether acetate and then charged with 20 parts by weight of methacrylic acid, 10 parts by weight of mono(2-methacryloyloxyethyl)succinate, 18.8 parts by weight of styrene, 51.2 parts by weight of benzyl
20 methacrylate and 7 parts by weight of α -methylstyrene dimer, followed by replaced by N₂. Then, with stirring moderately, the temperature of a reaction mixture was increased to 70°C and this temperature was maintained for 2 hours to carry out polymerization. Then, 2 parts by
25 weight of 2,2'-azobisvaleronitrile was once again added, and the polymerization was further continued for 2 hours to give a resin solution (solid content = 32.8 % by weight). This resin had an Mw of 12,000 and an MW/Mn of 2.8.

30 This resin solution will be referred to as "resin solution (Poly s-7)" and this resin will be referred to as "resin (Poly a-7)".

[Evaluation for chippings and adhesion]

Example 1

A mixture containing 40 parts by weight of a mixture of C.I. Pigment Red 254 with C.I. Pigment Yellow 139 at a ratio of 50/50 (weight ratio) as an (A) pigment, 10 parts by weight of Disperbyk 2001 (supplied by BIGCHEME JAPAN) as a dispersing agent and 100 parts by weight of ethyl 3-ethoxypropionate as a solvent was mixed and dispersed with a Diamond Fine Mill (trade name, bead mill (bead diameter 1.0 mm) supplied by Mitsubishi Material Corporation) for 12 hours to prepare a pigment dispersion.

Then, 100 parts by weight of the above pigment dispersion, the resin solution (Poly s-1) in an amount corresponding to a resin (Poly a-1) content of 70 parts by weight, as a (B) alkali-soluble resin, 80 parts by weight of dipentaerythritol hexaacrylate as a (C) polyfunctional monomer, 50 parts by weight of 1-[9-ethyl-6-(2-methylbenzoyl)-9.H.-carbazol-3-yl]-ethan-1-oneoxime-O-acetate as a (D) photopolymerization initiator and 1,000 parts by weight of propylene glycol monomethyl ether acetate were mixed to prepare a liquid composition (r-1).

Then, the liquid composition (r-1) was applied onto a soda glass substrate and an applied liquid composition was pre-baked at 80°C for 2 minutes to form a coating film. Then, the coating film was irradiated through a 90 micron-wide-stripe pattern photomask with radiation including wavelengths of 365 nm, 405 nm and 436 nm at an exposure dose of 5,000 J/m² by means of a high-pressure mercury lamp. Then, the substrate was immersed in a developing solution that was a 0.04 wt% potassium hydroxide aqueous solution, at 23°C for 1 minute to carry out development, and then the substrate was washed with ultrapure water and air-dried.

Then, the resultant stripe pattern was observed through a scanning electron microscope to show that no chipping was found in the pattern and that the adhesion of the coating film to the substrate was excellent.

5

Example 2

A liquid composition (r-2) was prepared in the same manner as in Example 1 except that the resin solution (Poly s-1) was replaced with the resin solution (Poly s-
10 2) in an amount corresponding to a resin (Poly a-2) content of 70 parts by weight and a coating film of the above composition was formed on a soda glass in the same manner as in Example 1.

Then, the coating film was irradiated through a 90
15 micron-wide-stripe pattern photomask with radiation including wavelengths of 365 nm, 405 nm and 436 nm at an exposure dose of $5,000 \text{ J/m}^2$ by means of a high-pressure mercury lamp. Then, the substrate was immersed in a developing solution that was a 0.04 wt% potassium
20 hydroxide aqueous solution, at 23°C for 1 minute to carry out development, and then the substrate was washed with ultrapure water and air-dried.

Then, the resultant stripe pattern was observed through a scanning electron microscope to show that no
25 chipping was found in the pattern and that the adhesion of the coating film to the substrate was excellent.

Example 3

A liquid composition (r-3) was prepared in the same
30 manner as in Example 1 except that the resin solution (Poly s-1) was replaced with the resin solution (Poly s-3) in an amount corresponding to a resin (Poly a-3) content of 70 parts by weight and a coating film of the above composition was formed on a soda glass in the same

manner as in Example 1.

Then, the coating film was irradiated through a 90 micron-wide-stripe pattern photomask with radiation including wavelengths of 365 nm, 405 nm and 436 nm at an exposure dose of 5,000 J/m² by means of a high-pressure mercury lamp. Then, the substrate was immersed in a developing solution that was a 0.04 wt% potassium hydroxide aqueous solution, at 23°C for 1 minute to carry out development, and then the substrate was washed with ultrapure water and air-dried.

Then, the resultant stripe pattern was observed through a scanning electron microscope to show that no chipping was found in the pattern and that the adhesion of the coating film to the substrate was excellent.

15

Example 4

A liquid composition (r-4) was prepared in the same manner as in Example 1 except that the resin solution (Poly s-1) was replaced with the resin solution (Poly s-4) in an amount corresponding to a resin (Poly a-4) content of 70 parts by weight and a coating film of the above composition was formed on a soda glass in the same manner as in Example 1.

Then, the coating film was irradiated through a 90 micron-wide-stripe pattern photomask with radiation including wavelengths of 365 nm, 405 nm and 436 nm at an exposure dose of 5,000 J/m² by means of a high-pressure mercury lamp. Then, the substrate was immersed in a developing solution that was a 0.04 wt% potassium hydroxide aqueous solution, at 23°C for 1 minute to carry out development, and then the substrate was washed with ultrapure water and air-dried.

Then, the resultant stripe pattern was observed through a scanning electron microscope to show that no

chipping was found in the pattern and that the adhesion of the coating film to the substrate was excellent.

Comparative Example 1

5 A liquid composition (r-5) was prepared in the same manner as in Example 1 except that the resin solution (Poly s-1) was replaced with the resin solution (Poly s-5) in an amount corresponding to a resin (Poly a-5) content of 70 parts by weight and a coating film of the
10 above composition was formed on a soda glass in the same manner as in Example 1.

 Then, the coating film was irradiated through a 90 micron-wide-stripe pattern photomask with radiation including wavelengths of 365 nm, 405 nm and 436 nm at an
15 exposure dose of 5,000 J/m² by means of a high-pressure mercury lamp. Then, the substrate was immersed in a developing solution that was a 0.04 wt% potassium hydroxide aqueous solution, at 23°C for 1 minute to carry out development, and then the substrate was washed with
20 ultrapure water and air-dried.

 Then, the resultant stripe pattern was observed through a scanning electron microscope to show that no chipping was found in the pattern and that the adhesion of the coating film to the substrate was excellent.

25

Example 5

 A mixture containing 40 parts by weight of a mixture of C.I. Pigment Blue 15:6 with C.I. Pigment Violet 23 at a ratio of 90/10 (weight ratio) as an (A)
30 pigment, 10 parts by weight of Disperbyk 2001 (supplied by BIGCHEME JAPAN) as a dispersing agent and 100 parts by weight of ethyl 3-ethoxypropionate as a solvent was mixed and dispersed with a Diamond Fine Mill (trade name, bead mill (bead diameter 1.0 mm) supplied by Mitsubishi

Material Corporation) for 12 hours to prepare a pigment dispersion.

Then, 100 parts by weight of the above pigment dispersion, the resin solution (Poly s-1) in an amount
5 corresponding to a resin (Poly a-1) content of 80 parts by weight, as a (B) alkali-soluble resin, 70 parts by weight of dipentaerythritol hexaacrylate as a (C) polyfunctional monomer, 30 parts by weight of 1-[9-ethyl-6-(2-methylbenzoyl)-9.H.-carbazol-3-yl]-ethan-1-
10 oneoxime-O-acetate as a (D) photopolymerization initiator and 1,000 parts by weight of propylene glycol monomethyl ether acetate were mixed to prepare a liquid composition (r-6).

Then, the liquid composition (r-6) was applied onto
15 a soda glass substrate and an applied liquid composition was pre-baked at 80°C for 2 minutes to form a coating film. Then, the coating film was irradiated through a 90 micron-wide-stripe pattern photomask with radiation including wavelengths of 365 nm, 405 nm and 436 nm at an
20 exposure dose of 5,000 J/m² by means of a high-pressure mercury lamp. Then, the substrate was immersed in a developing solution that was a 0.04 wt% potassium hydroxide aqueous solution, at 23°C for 1 minute to carry out development, and then the substrate was washed with
25 ultrapure water and air-dried.

Then, the resultant stripe pattern was observed through a scanning electron microscope to show that no chipping was found in the pattern and that the adhesion of the coating film to the substrate was excellent.

30

Example 6

A liquid composition (r-7) was prepared in the same manner as in Example 5 except that the resin solution (Poly s-1) was replaced with the resin solution (Poly s-

2) in an amount corresponding to a resin (Poly a-2) content of 80 parts by weight and a coating film of the above composition was formed on a soda glass in the same manner as in Example 5.

5 Then, the coating film was irradiated through a 90 micron-wide-stripe pattern photomask with radiation including wavelengths of 365 nm, 405 nm and 436 nm at an exposure dose of 5,000 J/m² by means of a high-pressure mercury lamp. Then, the substrate was immersed in a
10 developing solution that was a 0.04 wt% potassium hydroxide aqueous solution, at 23°C for 1 minute to carry out development, and then the substrate was washed with ultrapure water and air-dried.

 Then, the resultant stripe pattern was observed
15 through a scanning electron microscope to show that no chipping was found in the pattern and that the adhesion of the coating film to the substrate was excellent.

Example 7

20 A liquid composition (r-8) was prepared in the same manner as in Example 5 except that the resin solution (Poly s-1) was replaced with the resin solution (Poly s-3) in an amount corresponding to a resin (Poly a-3) content of 80 parts by weight and a coating film of the
25 above composition was formed on a soda glass in the same manner as in Example 5.

 Then, the coating film was irradiated through a 90 micron-wide-stripe pattern photomask with radiation including wavelengths of 365 nm, 405 nm and 436 nm at an
30 exposure dose of 5,000 J/m² by means of a high-pressure mercury lamp. Then, the substrate was immersed in a developing solution that was a 0.04 wt% potassium hydroxide aqueous solution, at 23°C for 1 minute to carry out development, and then the substrate was washed with

ultrapure water and air-dried.

Then, the resultant stripe pattern was observed through a scanning electron microscope to show that no chipping was found in the pattern and that the adhesion
5 of the coating film to the substrate was excellent.

Example 8

A liquid composition (r-9) was prepared in the same manner as in Example 5 except that the resin solution
10 (Poly s-1) was replaced with the resin solution (Poly s-4) in an amount corresponding to a resin (Poly a-4) content of 80 parts by weight and a coating film of the above composition was formed on a soda glass in the same manner as in Example 5.

15 Then, the coating film was irradiated through a 90 micron-wide-stripe pattern photomask with radiation including wavelengths of 365 nm, 405 nm and 436 nm at an exposure dose of 5,000 J/m² by means of a high-pressure mercury lamp. Then, the substrate was immersed in a
20 developing solution that was a 0.04 wt% potassium hydroxide aqueous solution, at 23°C for 1 minute to carry out development, and then the substrate was washed with ultrapure water and air-dried.

Then, the resultant stripe pattern was observed
25 through a scanning electron microscope to show that no chipping was found in the pattern and that the adhesion of the coating film to the substrate was excellent.

Comparative Example 2

30 A liquid composition (r-10) was prepared in the same manner as in Example 5 except that the resin solution (Poly s-1) was replaced with the resin solution (Poly s-5) in an amount corresponding to a resin (Poly a-5) content of 80 parts by weight and a coating film of

the above composition was formed on a soda glass in the same manner as in Example 5.

Then, the coating film was irradiated through a 90 micron-wide-stripe pattern photomask with radiation
5 including wavelengths of 365 nm, 405 nm and 436 nm at an exposure dose of 5,000 J/m² by means of a high-pressure mercury lamp. Then, the substrate was immersed in a developing solution that was a 0.04 wt% potassium hydroxide aqueous solution, at 23°C for 1 minute to carry
10 out development, and then the substrate was washed with ultrapure water and air-dried.

Then, the resultant stripe pattern was observed through a scanning electron microscope to show that no chipping was found in the pattern and that the adhesion
15 of the coating film to the substrate was excellent.

Example 9

A mixture containing 40 parts by weight of a mixture of C.I. Pigment Green 36 with C.I. Pigment
20 Yellow 150 at a ratio of 50/50 (weight ratio), 10 parts by weight of Disperbyk 2001 (supplied by BIGCHEME JAPAN) as a dispersing agent and 100 parts by weight of ethyl 3-ethoxypropionate as a solvent was mixed and dispersed with a diamond fine mill (trade name, bead mill (bead
25 diameter 1.0 mm) supplied by Mitsubishi Material Corporation) for 12 hours to prepare a pigment dispersion.

Then, 100 parts by weight of the above pigment dispersion, the resin solution (Poly s-1) in an amount
30 corresponding to a resin (Poly a-1) content of 80 parts by weight, as a (B) alkali-soluble resin, 80 parts by weight of dipentaerythritol hexaacrylate as a (C) polyfunctional monomer, 30 parts by weight of 1-[9-ethyl-6-(2-methylbenzoyl)-9.H.-carbazol-3-yl]-ethan-1-

oneoxime-O-acetate as a (D) photopolymerization initiator and 1,000 parts by weight of propylene glycol monomethyl ether acetate were mixed to prepare a liquid composition (r-11).

5 Then, the liquid composition (r-11) was applied onto a soda glass substrate and an applied liquid composition was pre-baked at 80°C for 2 minutes to form a coating film. Then, the coating film was irradiated through a 90 micron-wide-stripe pattern photomask with
10 radiation including wavelengths of 365 nm, 405 nm and 436 nm at an exposure dose of 5,000 J/m² by means of a high-pressure mercury lamp. Then, the substrate was immersed in a developing solution that was a 0.04 wt% potassium hydroxide aqueous solution, at 23°C for 1
15 minute to carry out development, and then the substrate was washed with ultrapure water and air-dried.

 Then, the resultant stripe pattern was observed through a scanning electron microscope to show that no chipping was found in the pattern and that the adhesion
20 of the coating film to the substrate was excellent.

Example 10

 A liquid composition (r-12) was prepared in the same manner as in Example 9 except that the resin
25 solution (Poly s-1) was replaced with the resin solution (Poly s-2) in an amount corresponding to a resin (Poly a-2) content of 80 parts by weight and a coating film of the above composition was formed on a soda glass in the same manner as in Example 9.

30 Then, the coating film was irradiated through a 90 micron-wide-stripe pattern photomask with radiation including wavelengths of 365 nm, 405 nm and 436 nm at an exposure dose of 5,000 J/m² by means of a high-pressure mercury lamp. Then, the substrate was immersed in a

developing solution that was a 0.04 wt% potassium hydroxide aqueous solution, at 23°C for 1 minute to carry out development, and then the substrate was washed with ultrapure water and air-dried.

5 Then, the resultant stripe pattern was observed through a scanning electron microscope to show that no chipping was found in the pattern and that the adhesion of the coating film to the substrate was excellent.

10 Example 11

 A liquid composition (r-13) was prepared in the same manner as in Example 9 except that the resin solution (Poly s-1) was replaced with the resin solution (Poly s-3) in an amount corresponding to a resin (Poly
15 a-3) content of 80 parts by weight and a coating film of the above composition was formed on a soda glass in the same manner as in Example 9.

 Then, the coating film was irradiated through a 90 micron-wide-stripe pattern photomask with radiation
20 including wavelengths of 365 nm, 405 nm and 436 nm at an exposure dose of 5,000 J/m² by means of a high-pressure mercury lamp. Then, the substrate was immersed in a developing solution that was a 0.04 wt% potassium hydroxide aqueous solution, at 23°C for 1 minute to carry
25 out development, and then the substrate was washed with ultrapure water and air-dried.

 Then, the resultant stripe pattern was observed through a scanning electron microscope to show that no chipping was found in the pattern and that the adhesion
30 of the coating film to the substrate was excellent.

Example 12

 A liquid composition (r-14) was prepared in the same manner as in Example 9 except that the resin

solution (Poly s-1) was replaced with the resin solution (Poly s-4) in an amount corresponding to a resin (Poly a-4) content of 80 parts by weight and a coating film of the above composition was formed on a soda glass in the same manner as in Example 9.

Then, the coating film was irradiated through a 90 micron-wide-stripe pattern photomask with radiation including wavelengths of 365 nm, 405 nm and 436 nm at an exposure dose of 5,000 J/m² by means of a high-pressure mercury lamp. Then, the substrate was immersed in a developing solution that was a 0.04 wt% potassium hydroxide aqueous solution, at 23°C for 1 minute to carry out development, and then the substrate was washed with ultrapure water and air-dried.

Then, the resultant stripe pattern was observed through a scanning electron microscope to show that no chipping was found in the pattern and that the adhesion of the coating film to the substrate was excellent.

Comparative Example 3

A liquid composition (r-15) was prepared in the same manner as in Example 9 except that the resin solution (Poly s-1) was replaced with the resin solution (Poly s-5) in an amount corresponding to a resin (Poly a-5) content of 80 parts by weight and a coating film of the above composition was formed on a soda glass in the same manner as in Example 9.

Then, the coating film was irradiated through a 90 micron-wide-stripe pattern photomask with radiation including wavelengths of 365 nm, 405 nm and 436 nm at an exposure dose of 5,000 J/m² by means of a high-pressure mercury lamp. Then, the substrate was immersed in a developing solution that was a 0.04 wt% potassium hydroxide aqueous solution, at 23°C for 1 minute to carry

out development, and then the substrate was washed with ultrapure water and air-dried.

Then, the resultant stripe pattern was observed through a scanning electron microscope to show that no
5 chipping was found in the pattern and that the adhesion of the coating film to the substrate was excellent.

Comparative Example 4

A liquid composition (r-16) was prepared in the
10 same manner as in Example 1 except that the resin solution (Poly s-1) was replaced with the resin solution (Poly s-6) in an amount corresponding to a resin (Poly a-6) content of 70 parts by weight and a coating film of the above composition was formed on a soda glass in the
15 same manner as in Example 1.

Then, the coating film was irradiated through a 90 micron-wide-stripe pattern photomask with radiation including wavelengths of 365 nm, 405 nm and 436 nm at an exposure dose of 5,000 J/m² by means of a high-pressure
20 mercury lamp. Then, the substrate was immersed in a developing solution that was a 0.04 wt% potassium hydroxide aqueous solution, at 23°C for 1 minute to carry out development, and then the substrate was washed with ultrapure water and air-dried.

25 Then, the resultant stripe pattern was observed through a scanning electron microscope to show that a number of chippings were found in the pattern and that there were places where pattern was partly peeled off the substrate.

30

Comparative Example 5

A liquid composition (r-17) was prepared in the same manner as in Example 1 except that the resin solution (Poly s-1) was replaced with the resin solution

(Poly s-7) in an amount corresponding to a resin (Poly a-7) content of 70 parts by weight and a coating film of the above composition was formed on a soda glass in the same manner as in Example 1.

5 Then, the coating film was irradiated through a 90 micron-wide-stripe pattern photomask with radiation including wavelengths of 365 nm, 405 nm and 436 nm at an exposure dose of 5,000 J/m² by means of a high-pressure mercury lamp. Then, the substrate was immersed in a
10 developing solution that was a 0.04 wt% potassium hydroxide aqueous solution, at 23°C for 1 minute to carry out development, and then the substrate was washed with ultrapure water and air-dried.

 Then, the resultant stripe pattern was observed
15 through a scanning electron microscope to show that a number of chippings were found in the pattern and that there were places where pattern was partly peeled off the substrate.

20 Comparative Example 6

 A liquid composition (r-18) was prepared in the same manner as in Example 5 except that the resin solution (Poly s-1) was replaced with the resin solution (Poly s-6) in an amount corresponding to a resin (Poly
25 a-6) content of 80 parts by weight and a coating film of the above composition was formed on a soda glass in the same manner as in Example 5.

 Then, the coating film was irradiated through a 90 micron-wide-stripe pattern photomask with radiation
30 including wavelengths of 365 nm, 405 nm and 436 nm at an exposure dose of 5,000 J/m² by means of a high-pressure mercury lamp. Then, the substrate was immersed in a developing solution that was a 0.04 wt% potassium hydroxide aqueous solution, at 23°C for 1 minute to carry

out development, and then the substrate was washed with ultrapure water and air-dried.

Then, the resultant stripe pattern was observed through a scanning electron microscope to show that a
5 number of chippings were found in the pattern and that there were places where pattern was partly peeled off the substrate.

Comparative Example 7

10 A liquid composition (r-19) was prepared in the same manner as in Example 5 except that the resin solution (Poly s-1) was replaced with the resin solution (Poly s-7) in an amount corresponding to a resin (Poly a-7) content of 80 parts by weight and a coating film of
15 the above composition was formed on a soda glass in the same manner as in Example 5.

Then, the coating film was irradiated through a 90 micron-wide-stripe pattern photomask with radiation including wavelengths of 365 nm, 405 nm and 436 nm at an
20 exposure dose of $5,000 \text{ J/m}^2$ by means of a high-pressure mercury lamp. Then, the substrate was immersed in a developing solution that was a 0.04 wt% potassium hydroxide aqueous solution, at 23°C for 1 minute to carry out development, and then the substrate was washed with
25 ultrapure water and air-dried.

Then, the resultant stripe pattern was observed through a scanning electron microscope to show that a number of chippings were found in the pattern and that there were places where pattern was partly peeled off
30 the substrate.

Comparative Example 8

A liquid composition (r-20) was prepared in the same manner as in Example 9 except that the resin

solution (Poly s-1) was replaced with the resin solution (Poly s-6) in an amount corresponding to a resin (Poly a-6) content of 80 parts by weight and a coating film of the above composition was formed on a soda glass in the same manner as in Example 9.

Then, the coating film was irradiated through a 90 micron-wide-stripe pattern photomask with radiation including wavelengths of 365 nm, 405 nm and 436 nm at an exposure dose of 5,000 J/m² by means of a high-pressure mercury lamp. Then, the substrate was immersed in a developing solution that was a 0.04 wt% potassium hydroxide aqueous solution, at 23°C for 1 minute to carry out development, and then the substrate was washed with ultrapure water and air-dried.

Then, the resultant stripe pattern was observed through a scanning electron microscope to show that a number of chippings were found in the pattern and that there were a number of places where pattern was partly peeled off the substrate.

20

Comparative Example 9

A liquid composition (r-21) was prepared in the same manner as in Example 9 except that the resin solution (Poly s-1) was replaced with the resin solution (Poly s-7) in an amount corresponding to a resin (Poly a-7) content of 80 parts by weight and a coating film of the above composition was formed on a soda glass in the same manner as in Example 9.

Then, the coating film was irradiated through a 90 micron-wide-stripe pattern photomask with radiation including wavelengths of 365 nm, 405 nm and 436 nm at an exposure dose of 5,000 J/m² by means of a high-pressure mercury lamp. Then, the substrate was immersed in a developing solution that was a 0.04 wt% potassium

hydroxide aqueous solution, at 23°C for 1 minute to carry out development, and then the substrate was washed with ultrapure water and air-dried.

Then, the resultant stripe pattern was observed through a scanning electron microscope to show that a number of chippings were found in the pattern and that there were a number of places where pattern was partly peeled off the substrate.

10 [Evaluation for voltage holding ratio]

The liquid resin compositions obtained in Examples 1 to 12 and Comparative Examples 1 to 9 were applied, with a spin coater, on soda glass substrates on each surface of which an SiO₂ film had been formed for prevention of sodium ion elution and an ITO (indium-tin oxide alloy) electrode having a predetermined form had been vapor-deposited. The thus-applied compositions were pre-baked in a clean oven at 90°C for 10 minutes to form coating films having a thickness of 1.8 μm each.

20 Then, the coating films were irradiated with radiation including wavelengths of 365 nm, 405 nm and 436 nm at an exposure dose of 5,000 J/m² by means of a high-pressure mercury lamp without using any photomask. Then, the substrates were immersed in a developing solution that was a 0.04 wt% potassium hydroxide aqueous solution, at 23°C for 1 minute to carry out development, and then the substrates were washed with ultrapure water and air-dried. Further, post-baking was carried out at 230°C for 30 minutes to cure the coating films, whereby red pixels were formed on the substrates. The pixels had a thickness of 1.5 μm.

These substrates having the pixels formed thereon and substrates having only ITO electrodes vapor-deposited in a predetermined form thereon were attached

and bonded with a sealing agent containing glass beads having a size of 0.018 mm, and then, liquid crystal MLC6608 (trade name) supplied by Merck & Co., Inc.) was injected to produce liquid crystal cells.

5 Then, each of the liquid crystal cells was placed in a constant-temperature chamber at 60°C and measured for a voltage holding ratio with a liquid crystal voltage holding ratio measuring system VHR-1A model (trade name) supplied by Toyo Corporation under
10 conditions where the applied voltage was 5.0 V square wave and the measurement frequency was 60 Hz.

 The voltage holding ratio as used herein refers to a value calculated by (potential difference of liquid crystal cell in 16.7 milliseconds after application of
15 voltage)/(voltage immediately after application of voltage).

 Table 1 shows results of measurements of voltage holding ratios together with the presence (Yes) or absence (No) of N-phenylmaleimide and allyl methacrylate
20 in the alkali-soluble resins and results of evaluations for chipping and adhesion. When the voltage holding ratio of a liquid crystal cell is less than 90 %, it means that the liquid crystal cell cannot maintain the applied voltage at a predetermined level and cannot
25 fully twist liquid crystal.

Table 1

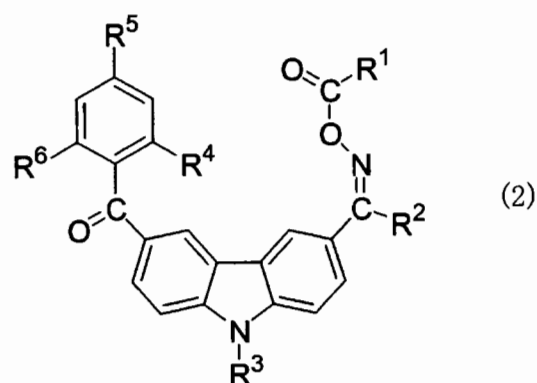
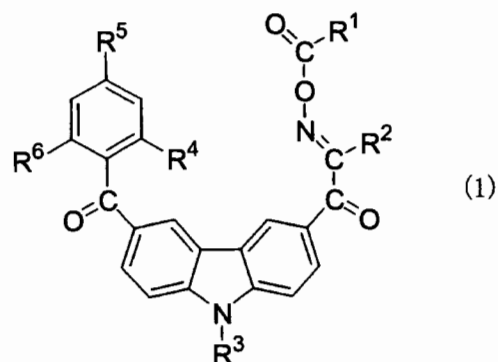
	Liquid composition	N-phenylmaleimide	Allyl methacrylate	chipping in pattern	Adhesion	Voltage holding ratio (%)
Ex. 1	r-1	yes	yes	no	excellent	91
Ex. 2	r-2	yes	yes	no	excellent	90
Ex. 3	r-3	yes	yes	no	excellent	93
Ex. 4	r-4	yes	yes	no	excellent	91
C.Ex. 1	r-5	yes	no	no	excellent	82
Ex. 5	r-6	yes	yes	no	excellent	92
Ex. 6	r-7	yes	yes	no	excellent	91
Ex. 7	r-8	yes	yes	no	excellent	93
Ex. 8	r-9	yes	yes	no	excellent	90
C.Ex. 2	r-10	yes	no	no	excellent	81
Ex. 9	r-11	yes	yes	no	excellent	93
Ex. 10	r-12	yes	yes	no	excellent	92
Ex. 11	r-13	yes	yes	no	excellent	92
Ex. 12	r-14	yes	yes	no	excellent	91
C.Ex. 3	r-15	yes	no	no	excellent	76
C.Ex. 4	r-16	no	yes	numerous	peeled	93
C.Ex. 5	r-17	no	no	numerous	peeled	75
C.Ex. 6	r-18	no	yes	numerous	peeled	91
C.Ex. 7	r-19	no	No	numerous	peeled	73
C.Ex. 8	r-20	no	yes	numerous	numerously peeled	92
C.Ex. 9	r-21	no	No	numerous	numerously peeled	74

Ex.: Example C.Ex.: Comparative Example

CLAIMS

1. A radiation-sensitive composition for forming a colored layer, which comprises (A) a colorant, (B) an alkali-soluble resin, (C) a polyfunctional monomer and (D) a photopolymerization initiator, the (B) alkali-soluble resin containing a copolymer formed from (b1) at least one selected from the group consisting of an unsaturated carboxylic acid, an unsaturated carboxylic anhydride and an unsaturated phenol compound, (b2) an N-substituted maleimide, (b3) an unsaturated compound having an allyl group and (b4) at least one selected from the group consisting of an aromatic vinyl compound, indene or a derivative thereof, an unsaturated carboxylic acid ester compound, an unsaturated carboxylic acid aminoalkyl ester compound, an unsaturated carboxylic acid glycidyl ester compound, a vinyl cyanide compound, an unsaturated amide compound, a carboxylic acid vinyl ester compound, a vinyl ether compound, an aliphatic conjugated diene compound and a macromonomer having a mono(meth)acryloyl group in its polymer molecular-chain terminal.

2. The radiation-sensitive composition for forming a colored layer according to claim 1, wherein (D) photopolymerization initiator contains a compound of the following formula (1) and/or a compound of the following formula (2),



5 in which each R^1 is independently a linear, branched or cyclic alkyl group having 1 to 12 carbon atoms or a phenyl group, each R^2 is independently a hydrogen atom, a linear, branched or cyclic alkyl group having 1 to 12 carbon atoms or a phenyl group, R^3 is a

10 hydrogen atom or a linear, branched or cyclic alkyl group having 1 to 12 carbon atoms, and each of R^4 , R^5 and R^6 is independently a hydrogen atom or a linear, branched or cyclic alkyl group having 1 to 6 carbon atoms, provided that the alkyl group represented by each of R^1 ,

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

20 substituted with a linear, branched or cyclic alkyl group having 1 to 6 carbon atoms, a linear, branched or

cyclic alkoxyl group having 1 to 6 carbon atoms, a phenyl group and a halogen atom.

3. A color filter having a colored layer formed from
5 the radiation-sensitive composition for forming a color filter according to claim 1 or 2.

4. A liquid crystal display device having the color filter of claim 3.