

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

Field of the Invention

5 The present invention relates to a radiation sensitive composition for forming a colored layer, a color filter and a color liquid crystal display device. More specifically, it relates to a radiation sensitive composition used to form a colored layer useful for color filters for use in
10 transmission and reflection type color liquid crystal displays and color image pick-up devices, a color filter having a colored layer formed from the radiation sensitive composition and a color liquid crystal display device comprising the color filter.

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Description of the Prior Art

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

 In the technical field of color filters, the requirements for the formed pixels and black matrix and the colored radiation sensitive composition are becoming severer. That is, in addition to the sensitivity, resolution and
30 pattern shape of the colored radiation sensitive composition, resistance to a wide variety of solvents and adhesion to a substrate are strongly required for the pixels and black matrix and excellent storage stability is strongly required for the colored radiation sensitive composition used to form

a color filter as a liquid composition containing a solvent from the viewpoint of the production control of color filters. However, conventional colored radiation sensitive compositions cannot satisfy these requirements fully.

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Summary of the Invention

It is an object of the present invention to provide a novel radiation sensitive composition for forming a colored layer which has excellent storage stability as a liquid
10 composition containing a solvent and provides pixels and a black matrix having excellent resistance to a wide variety of solvents and excellent adhesion to a substrate.

It is another object of the present invention to provide a color filter and a color liquid crystal display
15 device.

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

According to the present invention, firstly, the above objects and advantages of the present invention are attained
20 by a radiation sensitive composition comprising (A) a colorant, (B) an alkali-soluble resin, (C) a polyfunctional monomer and (D) a photopolymerization initiator, wherein
the alkali-soluble resin (B) is a copolymer of (b1) at least one first unsaturated compound selected from the
25 group consisting of an unsaturated carboxylic acid, an unsaturated carboxylic anhydride and an unsaturated phenolic compound and at least one second unsaturated compound selected from the group consisting of (b2) an unsaturated compound having an oxetane skeleton and (b3) an unsaturated
30 compound having a tetrahydrofuran skeleton, and the radiation sensitive composition is used to form a colored layer.

In the present invention, the colored layer means pixels and/or a black matrix.

According to the present invention, secondly, the above objects and advantages of the present invention are attained by a color filter having a colored layer formed from the radiation sensitive composition of the present invention.

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

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Best Mode For Embodiments of The Invention

The present invention will be described in detail hereinunder.

Radiation sensitive composition

15 - (A) colorant -

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

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

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

C.I. Pigment Yellow 1, C.I. Pigment Yellow 3, C.I. Pigment Yellow 12, C.I. Pigment Yellow 13, C.I. Pigment Yellow 14,

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,
 5 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.
 10 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,
 15 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
 20 Yellow 166, C.I. Pigment Yellow 168, C.I. Pigment Yellow 175,
 C.I. Pigment Yellow 180 and C.I. Pigment Yellow 185;
 C.I. Pigment Orange 1, C.I. Pigment Orange 5, C.I. Pigment
 Orange 13, C.I. Pigment Orange 14, C.I. Pigment Orange 16,
 C.I. Pigment Orange 17, C.I. Pigment Orange 24, C.I. Pigment
 25 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 and C.I. Pigment Orange
 30 73;
 C.I. Pigment Violet 1, C.I. Pigment Violet 19, C.I. Pigment
 Violet 23, C.I. Pigment Violet 29, C.I. Pigment Violet 32,
 C.I. Pigment Violet 36 and C.I. Pigment Violet 38;
 C.I. Pigment Red 1, C.I. Pigment Red 2, C.I. Pigment Red 3,

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
5 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
10 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
15 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,
20 C.I. Pigment Red 106, C.I. Pigment Red 108, 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. Pigment Red 151, C.I. Pigment Red 166, C.I. Pigment Red
25 168, 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 180, C.I. Pigment Red
185, C.I. Pigment Red 187, C.I. Pigment Red 188, C.I. Pigment
30 Red 190, C.I. Pigment Red 193, C.I. Pigment Red 194, C.I.
Pigment Red 202, C.I. Pigment Red 206, C.I. Pigment Red 207,
C.I. Pigment Red 208, C.I. Pigment Red 209, C.I. Pigment Red
215, C.I. Pigment Red 216, C.I. Pigment Red 220, C.I. Pigment
Red 224, C.I. Pigment Red 226, C.I. Pigment Red 242, C.I.

Pigment Red 243, C.I. Pigment Red 245, C.I. Pigment Red 254, C.I. Pigment Red 255, C.I. Pigment Red 264 and C.I. Pigment Red 265;

C.I. Pigment Blue 15, C.I. Pigment Blue 15:3, C.I. Pigment Blue 15:4, C.I. Pigment Blue 15:6 and C.I. Pigment Blue 60; C.I. Pigment Green 7 and C.I. Pigment Green 36; C.I. Pigment Brown 23 and C.I. Pigment Brown 25; and C.I. Pigment Black 1 and C.I. Pigment Black 7.

These organic pigments may be purified by sulfuric acid re-crystallization, solvent cleaning or a combination thereof before use.

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

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

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

In the present invention, optionally, the colorant may be used in conjunction with a dispersant.

The above dispersant is, for example, a cationic, anionic, nonionic, ampholytic, silicone-based or fluorine-based surfactant.

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

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

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

In the present invention, the radiation sensitive resin composition can be prepared by a suitable method. For
25 example, it can be prepared by mixing together the components (A) to (D) optionally with a solvent and an additive which will be described hereinafter. When a pigment is used as the colorant, it is preferably mixed with and dispersed into a solvent optionally together with part of the component (B)
30 in the presence of a dispersant while it is ground by a bead mill or roll mill to prepare a pigment dispersion which is then mixed with the components (B), (C) and (D) and optionally with an additional solvent and an additive to prepare the radiation sensitive resin composition.

The amount of the dispersant for the preparation of the pigment dispersion is preferably 100 parts or less by weight, more preferably 0.5 to 100 parts by weight, much more preferably 1 to 70 parts by weight, particularly preferably 10 to 50 parts by weight based on 100 parts by weight of the pigment. When the amount of the dispersant is larger than 100 parts by weight, developability may be impaired.

The solvent used for the preparation of the pigment dispersion may be identical to the solvent used to prepare the liquid radiation sensitive resin composition which will be described hereinafter.

The amount of the solvent for the preparation of the pigment dispersion is preferably 500 to 1,000 parts by weight, more preferably 700 to 900 parts by weight based on 100 parts by weight of the pigment.

To prepare the pigment dispersion by using a bead mill, glass beads or titania beads having a diameter of about 0.5 to 10 mm are used to mix and disperse a pigment mixed solution comprising a pigment, a solvent and a dispersant preferably while it is cooled with cooling water or the like.

The filling rate of the beads is preferably 50 to 80 % of the capacity of the mill, and the amount of the pigment mixed solution injected is preferably about 20 to 50 % of the capacity of the mill. The treating time is preferably 2 to 50 hours, more preferably 2 to 25 hours.

To prepare the pigment dispersion by using a roll mill, a three-roll mill or a two-roll mill is used to mix and disperse the pigment mixed solution preferably while it is cooled with cooling water or the like.

The interval between rolls is preferably 10 μm or less, and the shearing force is preferably about 10^8 dyn/sec. The treating time is preferably 2 to 50 hours, more preferably 2 to 25 hours.

- (B) alkali-soluble resin -

The alkali-soluble resin in the present invention is a copolymer of (b1) at least one first unsaturated compound selected from the group consisting of an unsaturated
5 carboxylic acid, an unsaturated carboxylic anhydride and an unsaturated phenolic compound (to be referred to as "acid unsaturated compound" hereinafter) and at least one second unsaturated compound selected from the group consisting of
10 (b2) an unsaturated compound having an oxetane skeleton and (b3) an unsaturated compound having a tetrahydrofuran skeleton and is a component which serves as a binder for the colorant (A) and has solubility in an alkali developer which is used in a developing step for forming a colored layer.

Specific examples of the alkali-soluble resin (B)
15 include (B1) a copolymer of an acid unsaturated compound and an unsaturated compound having an oxetane skeleton (to be referred to as "oxetane unsaturated compound" hereinafter), (B2) a copolymer of an acid unsaturated compound and an unsaturated compound having a tetrahydrofuran skeleton (to
20 be referred to as "tetrahydrofuran unsaturated compound" hereinafter) and (B3) a copolymer of an acid unsaturated compound, an oxetane unsaturated compound and a tetrahydrofuran unsaturated compound.

Examples of the above unsaturated carboxylic acid and
25 unsaturated carboxylic acid anhydride out of the acid unsaturated compounds in the copolymers (B1), (B2) and (B3) include unsaturated monocarboxylic acids such as (meth)acrylic acid, crotonic acid, α -chloroacrylic acid and cinnamic acid; unsaturated dicarboxylic acids and anhydrides
30 thereof such as maleic acid, maleic anhydride, fumaric acid, itaconic acid, itaconic anhydride, citraconic acid, citraconic anhydride and mesaconic acid; unsaturated polycarboxylic acids having three or more carboxyl groups and anhydrides thereof; mono[(meth)acryloyloxyalkyl]esters

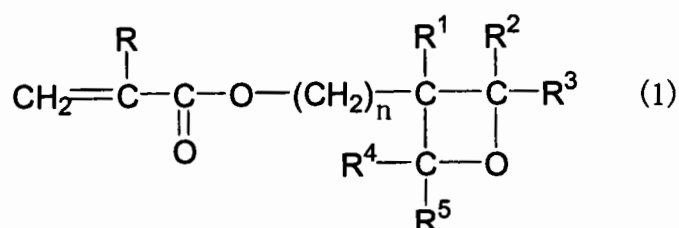
of a polycarboxylic acid having two or more carboxyl groups such as mono[2-(meth)acryloyloxyethyl]succinate and mono[2-(meth)acryloyloxyethyl]phthalate; and
5 a hydroxyl group at both terminals such as ω -carboxypolycaprolactone mono(meth)acrylate.

Out of these unsaturated carboxylic acids and unsaturated carboxylic acid anhydrides, mono(2-acryloyloxyethyl)succinate and
10 mono(2-acryloyloxyethyl)phthalate are available on the market under the trade names of Light Ester HOA-MS and Light Ester HOA-MPE (of Kyoeisha Kagaku Co., Ltd.), respectively.

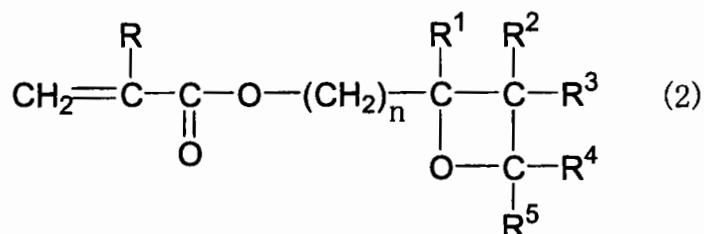
Examples of the above unsaturated phenolic compound out of the acid unsaturated compounds include unsaturated
15 phenols such as o-vinylphenol, m-vinylphenol, p-vinylphenol, 2-methyl-4-vinylphenol, 3-methyl-4-vinylphenol, o-isopropenylphenol, m-isopropenylphenol and p-isopropenylphenol; and unsaturated naphthols such as 2-vinyl-1-naphthol, 3-vinyl-1-naphthol,
20 1-vinyl-2-naphthol, 3-vinyl-2-naphthol, 2-isopropenyl-1-naphthol and 3-isopropenyl-1-naphthol.

In the present invention, (meth)acrylic acid and p-vinylphenol are preferred, and (meth)acrylic acid is particularly preferred as the acid unsaturated compound.

25 In the copolymers (B1) and (B3), the oxetane unsaturated compound is preferably a compound represented by the following formula (1) (to be referred to as "oxetane unsaturated compound (1)" hereinafter) or a compound represented by the following formula (2) (to be referred to
30 as "oxetane unsaturated compound (2)" hereinafter).



(in the formula (1), R is a hydrogen atom or alkyl group having 1 to 4 carbon atoms, R¹ is a hydrogen atom or alkyl group having 1 to 4 carbon atoms, R², R³, R⁴ and R⁵ are each
 5 independently a hydrogen atom, fluorine atom, alkyl group having 1 to 4 carbon atoms, fluoroalkyl group having 1 to 4 carbon atoms or aryl group having 6 to 20 carbon atoms, and n is an integer of 0 to 6.)



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(in the formula (2), R, R¹, R², R³, R⁴, R⁵ and n are as defined in the above formula (1).)

In the above formulas (1) and (2), examples of the alkyl group having 1 to 4 carbon atoms represented by R, R¹, R²,
 15 R³, R⁴ and R⁵ include methyl group, ethyl group, n-propyl group, i-propyl group, n-butyl group, i-butyl group, sec-butyl group and t-butyl group.

Examples of the fluoroalkyl group having 1 to 4 carbon atoms represented by R², R³, R⁴ and R⁵ include fluoromethyl
 20 group, difluoromethyl group, trifluoromethyl group, 1-fluoroethyl group, 2-fluoroethyl group, 1,1-difluoroethyl group, 2,2,2-trifluoroethyl group, pentafluoroethyl group, heptafluoro-n-propyl group, heptafluoro-1-propyl group, nonafluoro-n-butyl group,
 25 nonafluoro-i-butyl group, nonafluoro-sec-butyl group and nonafluoro-t-butyl group.

Examples of the aryl group having 6 to 20 carbon atoms represented by R^2 , R^3 , R^4 and R^5 include phenyl group, o-tolyl group, m-tolyl group and p-tolyl group.

Examples of the oxetane unsaturated compound (1)

- 5 include (meth)acrylic esters such as
- 3-[(meth)acryloyloxymethyl]oxetane,
 - 3-[(meth)acryloyloxymethyl]-2-methyloxetane,
 - 3-[(meth)acryloyloxymethyl]-3-methyloxetane,
 - 3-[(meth)acryloyloxymethyl]-2-ethyloxetane,
 - 10 3-[(meth)acryloyloxymethyl]-3-ethyloxetane,
 - 3-[(meth)acryloyloxymethyl]-2-trifluoromethyloxetane,
 - 3-[(meth)acryloyloxymethyl]-2-pentafluoroethyloxetane,
 - 3-[(meth)acryloyloxymethyl]-2-phenyloxetane,
 - 3-[(meth)acryloyloxymethyl]-2,2-difluorooxetane,
 - 15 3-[(meth)acryloyloxymethyl]-2,2,4-trifluorooxetane,
 - 3-[(meth)acryloyloxymethyl]-2,2,4,4-tetrafluorooxetane,
 - 3-[2-(meth)acryloyloxyethyl]oxetane,
 - 3-[2-(meth)acryloyloxyethyl]-2-methyloxetane,
 - 3-[2-(meth)acryloyloxyethyl]-3-methyloxetane,
 - 20 3-[2-(meth)acryloyloxyethyl]-2-ethyloxetane,
 - 3-[2-(meth)acryloyloxyethyl]-3-ethyloxetane,
 - 3-[2-(meth)acryloyloxyethyl]-2-trifluoromethyloxetane,
 - 3-[2-(meth)acryloyloxyethyl]-2-pentafluoroethyloxetane,
 - 3-[2-(meth)acryloyloxyethyl]-2-phenyloxetane,
 - 25 3-[2-(meth)acryloyloxyethyl]-2,2-difluorooxetane,
 - 3-[2-(meth)acryloyloxyethyl]-2,2,4-trifluorooxetane and
 - 3-[2-(meth)acryloyloxyethyl]-2,2,4,4-tetrafluorooxetane.

Examples of the oxetane unsaturated compound (2)

- include (meth)acrylic esters such as
- 30 2-[(meth)acryloyloxymethyl]oxetane,
 - 2-[(meth)acryloyloxymethyl]-2-methyloxetane,
 - 2-[(meth)acryloyloxymethyl]-3-methyloxetane,
 - 2-[(meth)acryloyloxymethyl]-4-methyloxetane,
 - 2-[(meth)acryloyloxymethyl]-2-ethyloxetane,

- 2-[(meth)acryloyloxymethyl]-3-ethyloxetane,
 2-[(meth)acryloyloxymethyl]-4-ethyloxetane,
 2-[(meth)acryloyloxymethyl]-2-trifluoromethyloxetane,
 2-[(meth)acryloyloxymethyl]-3-trifluoromethyloxetane,
 5 2-[(meth)acryloyloxymethyl]-4-trifluoromethyloxetane,
 2-[(meth)acryloyloxymethyl]-2-pentafluoroethyloxetane,
 2-[(meth)acryloyloxymethyl]-3-pentafluoroethyloxetane,
 2-[(meth)acryloyloxymethyl]-4-pentafluoroethyloxetane,
 2-[(meth)acryloyloxymethyl]-2-phenyloxetane,
 10 2-[(meth)acryloyloxymethyl]-3-phenyloxetane,
 2-[(meth)acryloyloxymethyl]-4-phenyloxetane,
 2-[(meth)acryloyloxymethyl]-2,3-difluorooxetane,
 2-[(meth)acryloyloxymethyl]-2,4-difluorooxetane,
 2-[(meth)acryloyloxymethyl]-3,3-difluorooxetane,
 15 2-[(meth)acryloyloxymethyl]-3,4-difluorooxetane,
 2-[(meth)acryloyloxymethyl]-4,4-difluorooxetane,
 2-[(meth)acryloyloxymethyl]-3,3,4-trifluorooxetane,
 2-[(meth)acryloyloxymethyl]-3,4,4-trifluorooxetane,
 2-[(meth)acryloyloxymethyl]-3,3,4,4-tetrafluorooxetane,
 20 2-[2-(meth)acryloyloxyethyl]oxetane,
 2-[2-(meth)acryloyloxyethyl]-2-methyloxetane,
 2-[2-(meth)acryloyloxyethyl]-3-methyloxetane,
 2-[2-(meth)acryloyloxyethyl]-4-methyloxetane,
 2-[2-(meth)acryloyloxyethyl]-2-ethyloxetane,
 25 2-[2-(meth)acryloyloxyethyl]-3-ethyloxetane,
 2-[2-(meth)acryloyloxyethyl]-4-ethyloxetane,
 2-[2-(meth)acryloyloxyethyl]-2-trifluoromethyloxetane,
 2-[2-(meth)acryloyloxyethyl]-3-trifluoromethyloxetane,
 2-[2-(meth)acryloyloxyethyl]-4-trifluoromethyloxetane,
 30 2-[2-(meth)acryloyloxyethyl]-2-pentafluoroethyloxetane,
 2-[2-(meth)acryloyloxyethyl]-3-pentafluoroethyloxetane,
 2-[2-(meth)acryloyloxyethyl]-4-pentafluoroethyloxetane,
 2-[2-(meth)acryloyloxyethyl]-2-phenyloxetane,
 2-[2-(meth)acryloyloxyethyl]-3-phenyloxetane,

2-[2-(meth)acryloyloxyethyl]-4-phenyloxetane,
 2-[2-(meth)acryloyloxyethyl]-2,3-difluorooxetane,
 2-[2-(meth)acryloyloxyethyl]-2,4-difluorooxetane,
 2-[2-(meth)acryloyloxyethyl]-3,3-difluorooxetane,
 5 2-[2-(meth)acryloyloxyethyl]-3,4-difluorooxetane,
 2-[2-(meth)acryloyloxyethyl]-4,4-difluorooxetane,
 2-[2-(meth)acryloyloxyethyl]-3,3,4-trifluorooxetane,
 2-[2-(meth)acryloyloxyethyl]-3,4,4-trifluorooxetane, and
 2-[2-(meth)acryloyloxyethyl]-3,3,4,4-tetrafluorooxetane.

10 Out of these oxetane unsaturated compounds (1) and
 these oxetane unsaturated compounds (2),
 3-[(meth)acryloyloxymethyl]oxetane,
 3-[(meth)acryloyloxymethyl]-3-ethyloxetane,
 3-[(meth)acryloyloxymethyl]-2-trifluoromethyloxetane,
 15 3-[(meth)acryloyloxymethyl]-2-phenyloxetane,
 2-[(meth)acryloyloxymethyl]oxetane and
 2-[(meth)acryloyloxymethyl]-4-trifluoromethyloxetane are
 preferred. 3-(methacryloyloxymethyl)oxetane,
 3-(methacryloyloxymethyl)-3-ethyloxetane,
 20 3-(methacryloyloxymethyl)-2-trifluoromethyloxetane,
 3-(methacryloyloxymethyl)-2-phenyloxetane,
 2-(methacryloyloxymethyl)oxetane and
 2-(methacryloyloxymethyl)-4-trifluoromethyloxetane are
 particularly preferred because the development margin of the
 25 obtained radiation sensitive composition is wide and the
 chemical resistance of the obtained colored layer is
 improved.

In the present invention, (oxetanylalkyl)ethers of a
 vinyl phenol such as (3-oxetanylmethoxy)-p-vinylbenzene,
 30 [2-(3-oxetanyl)ethoxy]-p-vinylbenzene,
 (2-oxetanylmethoxy)-p-vinylbenzene and
 [2-(2-oxetanyl)ethoxy]-p-vinylbenzene; and
 (oxetanylalkyl)vinyl ethers such as
 (3-oxetanylmethyl)vinyl ether, [2-(3-oxetanyl)ethyl]vinyl

ether, (2-oxetanylmethyl)vinyl ether and [2-(2-oxetanyl)ethyl]vinyl ether may also be used as the oxetane unsaturated compound besides the oxetane unsaturated compounds (1) and the oxetane unsaturated compounds (2).

5 The above oxetane unsaturated compounds may be used alone or in combination of two or more.

 Examples of the tetrahydrofuran unsaturated compound in the copolymers (B2) and (B3) include tetrahydrofuran esters of (meth)acrylic acid such as tetrahydrofuran-2-yl
 10 (meth)acrylate and tetrahydrofuran-3-yl (meth)acrylate; tetrahydrofurfuryl group-containing esters of (meth)acrylic acid such as tetrahydrofurfuryl (meth)acrylate, 3-tetrahydrofurfuryl (meth)acrylate, 2-(tetrahydrofurfuryloxy)ethyl (meth)acrylate and
 15 2-(3-tetrahydrofurfuryloxy)ethyl (meth)acrylate; tetrahydrofurfuryl group-containing esters of 2-(meth)acryloyloxypropionic acid such as tetrahydrofurfuryl 2-(meth)acryloyloxypropionate, 3-tetrahydrofurfuryl 2-(meth)acryloyloxypropionate,
 20 2-(tetrahydrofurfuryloxy)ethyl 2-(meth)acryloyloxypropionate and 2-(3-tetrahydrofurfuryloxy)ethyl 2-(meth)acryloyloxypropionate; vinylbenzene derivatives such as (tetrahydrofuran-2-yl)oxy-p-vinylbenzene,
 25 (tetrahydrofurfuryl)oxy-p-vinylbenzene and 2-(tetrahydrofurfuryloxy)ethoxy-p-vinylbenzene; and vinyl ethers such as (tetrahydrofuran-2-yl)vinyl ether, (tetrahydrofurfuryl)vinyl ether and [2-(tetrahydrofurfuryloxy)ethyl]vinyl ether.

30 In the present invention, tetrahydrofurfuryl group-containing esters of (meth)acrylic acid are preferred, and tetrahydrofurfuryl (meth)acrylate and [2-(meth)acryloyloxyethyl](tetrahydrofurfuryl)succinate are particularly preferred as the tetrahydrofuran

unsaturated compound.

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

The copolymers (B1), (B2) and (B3) may optionally
 5 further contain an unsaturated compound (to be referred to as "other unsaturated compound" hereinafter) other than the acid unsaturated compound, oxetane unsaturated compound and tetrahydrofuran unsaturated compound as a constituent component.

10 Examples of the other unsaturated compound include aromatic vinyl compounds such as styrene, α -methylstyrene, o-vinyltoluene, m-vinyltoluene, p-vinyltoluene, p-chlorostyrene, o-methoxystyrene, m-methoxystyrene, p-methoxystyrene, o-vinylbenzylmethyl ether,
 15 m-vinylbenzylmethyl ether, p-vinylbenzylmethyl ether, o-vinylbenzylglycidyl ether, m-vinylbenzylglycidyl ether and p-vinylbenzylglycidyl ether; indenenes such as indene and 1-methylindene; unsaturated imides such as maleimide, N-cyclohexylmaleimide, N-phenylmaleimide, itaconimide and
 20 citraconimide; unsaturated carboxylates such as methyl (meth)acrylate, ethyl (meth)acrylate, n-propyl (meth)acrylate, i-propyl (meth)acrylate, n-butyl (meth)acrylate, i-butyl (meth)acrylate, sec-butyl (meth)acrylate, t-butyl (meth)acrylate, 2-hydroxyethyl
 25 (meth)acrylate, 2-hydroxypropyl (meth)acrylate, 3-hydroxypropyl (meth)acrylate, 2-hydroxybutyl (meth)acrylate, 3-hydroxybutyl (meth)acrylate, 4-hydroxybutyl (meth)acrylate, allyl (meth)acrylate, benzyl (meth)acrylate, cyclohexyl (meth)acrylate, phenyl
 30 (meth)acrylate, 2-methoxyethyl (meth)acrylate, 2-phenoxyethyl (meth)acrylate, methoxydiethylene glycol (meth)acrylate, methoxytriethylene glycol (meth)acrylate, methoxypropylene glycol (meth)acrylate, methoxydipropylene glycol (meth)acrylate, isobornyl (meth)acrylate,

dicyclopentadienyl (meth)acrylate,
 2-hydroxy-3-phenoxypropyl (meth)acrylate and glycerol
 mono(meth)acrylate; unsaturated aminoalkyl carboxylates
 such as 2-aminoethyl (meth)acrylate, 2-dimethylaminoethyl
 5 (meth)acrylate, 2-aminopropyl (meth)acrylate,
 2-dimethylaminopropyl (meth)acrylate, 3-aminopropyl
 (meth)acrylate and 3-dimethylaminopropyl (meth)acrylate;
 unsaturated glycidyl carboxylates such as glycidyl
 (meth)acrylate; vinyl cyanide compounds such as
 10 (meth)acrylonitrile, α -chloroacrylonitrile and vinylidene
 cyanide; unsaturated amides such as (meth)acrylamide,
 α -chloroacrylamide and N-2-hydroxyethyl (meth)acrylamide;
 vinyl carboxylates such as vinyl acetate, vinyl propionate,
 vinyl butyrate and vinyl benzoate; unsaturated ethers such
 15 as vinyl methyl ether, vinyl ethyl ether and allyl glycidyl
 ether; aliphatic conjugated dienes such as 1,3-butadiene,
 isoprene and chloroprene; and macromonomers having a
 mono(meth)acryloyl group at a terminal of a polymer molecular
 chain such as polystyrene, polymethyl (meth)acrylate,
 20 poly-n-butyl (meth)acrylate and polysiloxane.

These other unsaturated compounds may be used alone
 or in combination of two or more.

In the present invention, the copolymer (B1) is
 preferably a copolymer (to be referred to as "copolymer (BI)"
 25 hereinafter) of (b1) at least one acid unsaturated compound
 essentially composed of (meth)acrylic acid and (b2) at least
 one oxetane unsaturated compound selected from the group
 consisting of 3-(methacryloyloxymethyl)oxetane,
 3-(methacryloyloxymethyl)-3-ethyloxetane,
 30 3-(methacryloyloxymethyl)-2-trifluoromethyloxetane,
 3-(methacryloyloxymethyl)-2-phenyloxetane,
 2-(methacryloyloxymethyl)oxetane and
 2-(methacryloyloxymethyl)-4-trifluoromethyloxetane, and
 optionally (b4) at least one other unsaturated compound

selected from the group consisting of styrene,
 N-phenylmaleimide, methyl (meth)acrylate, 2-hydroxyethyl
 (meth)acrylate, allyl (meth)acrylate, benzyl
 (meth)acrylate, glycerol mono(meth)acrylate, polystyrene
 5 macromonomer and polymethyl methacrylate macromonomer.

More specifically, the copolymer (BI) is, for example,
 a copolymer (BI-1) of (b1) an acid unsaturated compound
 composed of (meth)acrylic acid and (b2) an oxetane
 unsaturated compound composed of
 10 3-[(meth)acryloyloxymethyl]oxetane and optionally (b4) at
 least one other unsaturated compound selected from the group
 consisting of styrene, N-phenylmaleimide, methyl
 (meth)acrylate, 2-hydroxyethyl (meth)acrylate, allyl
 (meth)acrylate, benzyl (meth)acrylate, glycerol
 15 mono(meth)acrylate, polystyrene macromonomer and
 polymethyl methacrylate macromonomer; a copolymer (BI-2) of
 (b1) an acid unsaturated compound composed of (meth)acrylic
 acid and (b2) an oxetane unsaturated compound composed of
 3-[(meth)acryloyloxymethyl]-3-ethyloxetane and optionally
 20 (b4) at least one other unsaturated compound selected from
 the group consisting of styrene, N-phenylmaleimide, methyl
 (meth)acrylate, 2-hydroxyethyl (meth)acrylate, allyl
 (meth)acrylate, benzyl (meth)acrylate, glycerol
 mono(meth)acrylate, polystyrene macromonomer and
 25 polymethyl methacrylate macromonomer; a copolymer (BI-3) of
 (b1) an acid unsaturated compound composed of (meth)acrylic
 acid and (b2) an oxetane unsaturated compound composed of
 3-[(meth)acryloyloxymethyl]-2-trifluoromethyloxetane and
 optionally (b4) at least one other unsaturated compound
 30 selected from the group consisting of styrene,
 N-phenylmaleimide, methyl (meth)acrylate, 2-hydroxyethyl
 (meth)acrylate, allyl (meth)acrylate, benzyl
 (meth)acrylate, glycerol mono(meth)acrylate, polystyrene
 macromonomer and polymethyl methacrylate macromonomer; a

copolymer (BI-4) of (b1) an acid unsaturated compound composed of (meth)acrylic acid and (b2) an oxetane unsaturated compound composed of 3-[(meth)acryloyloxymethyl]-2-phenyloxetane and optionally (b4) at least one other unsaturated compound selected from the group consisting of styrene, N-phenylmaleimide, methyl (meth)acrylate, 2-hydroxyethyl (meth)acrylate, allyl (meth)acrylate, benzyl (meth)acrylate, glycerol mono(meth)acrylate, polystyrene macromonomer and polymethyl methacrylate macromonomer; a copolymer (BI-5) of (b1) an acid unsaturated compound composed of (meth)acrylic acid and (b2) an oxetane unsaturated compound composed of 2-[(meth)acryloyloxymethyl]oxetane and optionally (b4) at least one other unsaturated compound selected from the group consisting of styrene, N-phenylmaleimide, methyl (meth)acrylate, 2-hydroxyethyl (meth)acrylate, allyl (meth)acrylate, benzyl (meth)acrylate, glycerol mono(meth)acrylate, polystyrene macromonomer and polymethyl methacrylate macromonomer; or a copolymer (BI-6) of (b1) an acid unsaturated compound composed of (meth)acrylic acid and (b2) an oxetane unsaturated compound composed of 2-[(meth)acryloyloxymethyl]-4-trifluoromethyloxetane and optionally (b4) at least one other unsaturated compound selected from the group consisting of styrene, N-phenylmaleimide, methyl (meth)acrylate, 2-hydroxyethyl (meth)acrylate, allyl (meth)acrylate, benzyl (meth)acrylate, glycerol mono(meth)acrylate, polystyrene macromonomer and polymethyl methacrylate macromonomer.

Out of these copolymers (BI), the copolymers (BI-1) and (BI-2) are particularly preferred.

In the copolymer (BI), the copolymerization amount of the acid unsaturated compound is preferably 1 to 40 wt%,

particularly preferably 5 to 30 wt%, the copolymerization amount of the oxetane unsaturated compound is preferably 1 to 60 wt%, particularly preferably 10 to 45 wt%, and the copolymerization amount of the other unsaturated compound is preferably 0 to 70 wt%, more preferably 1 to 70 wt%, particularly preferably 1 to 50 wt%.

In the present invention, when the copolymerization amounts of the above unsaturated compounds contained in the copolymer (BI) are set within the above ranges, a radiation sensitive composition which is excellent in the storage stabilities of the pigment dispersion and the liquid composition containing a solvent as well as sensitivity, solvent resistance and adhesion to the substrate even when the content of the pigment is high can be obtained.

The copolymer (B2) is preferably a copolymer (to be referred to as "copolymer (BII)" hereinafter) of (b1) at least one acid unsaturated compound composed of (meth)acrylic acid and (b3) at least one tetrahydrofuran unsaturated compound selected from the group consisting of tetrahydrofurfuryl (meth)acrylate and [2-(meth)acryloyloxyethyl] (tetrahydrofurfuryl)succinate and optionally (b4) at least one other unsaturated compound selected from the group consisting of styrene, N-phenylmaleimide, methyl (meth)acrylate, 2-hydroxyethyl (meth)acrylate, allyl (meth)acrylate, benzyl (meth)acrylate, glycerol mono(meth)acrylate, polystyrene macromonomer and polymethyl methacrylate macromonomer.

More specifically, the copolymer (BII) is, for example, a copolymer (to be referred to as "copolymer BII-1" hereinafter) of (b1) at least one acid unsaturated compound composed of (meth)acrylic acid and (b3) at least one tetrahydrofuran unsaturated compound composed of tetrahydrofurfuryl (meth)acrylate and optionally (b4) at least one other unsaturated compound selected from the group

consisting of styrene, N-phenylmaleimide, methyl (meth)acrylate, 2-hydroxyethyl (meth)acrylate, allyl (meth)acrylate, benzyl (meth)acrylate, glycerol mono(meth)acrylate, polystyrene macromonomer and
5 polymethyl methacrylate macromonomer; or a copolymer (to be referred to as "copolymer (BII-2)" hereinafter) of (b1) at least one acid unsaturated compound composed of (meth)acrylic acid and (b3) at least one tetrahydrofuran unsaturated compound composed of
10 [2-(meth)acryloyloxyethyl] (tetrahydrofurfuryl) succinate and optionally (b4) at least one other unsaturated compound selected from the group consisting of styrene, N-phenylmaleimide, methyl (meth)acrylate, 2-hydroxyethyl (meth)acrylate, allyl (meth)acrylate, benzyl
15 (meth)acrylate, glycerol mono(meth)acrylate, polystyrene macromonomer and polymethyl methacrylate macromonomer.

In the copolymer (B2), the copolymerization amount of the acid unsaturated compound is preferably 1 to 40 wt%, particularly preferably 5 to 30 wt%, the copolymerization
20 amount of the tetrahydrofuran unsaturated compound is preferably 1 to 70 wt%, particularly preferably 5 to 50 wt%, and the copolymerization amount of the other unsaturated compound is preferably 0 to 80 wt%, more preferably 1 to 80 wt%, particularly preferably 1 to 50 wt%.

25 In the present invention, when the copolymerization amounts of the above unsaturated compounds in the copolymer (B2) are set within the above ranges, a radiation sensitive composition which is excellent in the storage stabilities of the pigment dispersion and the liquid composition
30 containing a solvent as well as sensitivity, solvent resistance and adhesion to the substrate even when the content of the pigment is high can be obtained.

The copolymer (B3) is preferably a copolymer (to be referred to as "copolymer (BIII)" hereinafter) of (b1) at

least one acid unsaturated compound composed of (meth)acrylic acid, (b3) at least one tetrahydrofuran unsaturated compound selected from the group consisting of tetrahydrofurfuryl (meth)acrylate and

5 [2-(meth)acryloyloxyethyl] (tetrahydrofurfuryl) succinate and (b2) at least one oxetane unsaturated compound selected from the group consisting of

3-(methacryloyloxymethyl)oxetane,
 3-(methacryloyloxymethyl)-3-ethyloxetane,
 10 3-(methacryloyloxymethyl)-2-trifluoromethyloxetane,
 3-(methacryloyloxymethyl)-2-phenyloxetane,
 2-(methacryloyloxymethyl)oxetane and
 2-(methacryloyloxymethyl)-4-trifluoromethyloxetane and optionally (b4) at least one other unsaturated compound

15 selected from the group consisting of styrene, N-phenylmaleimide, methyl (meth)acrylate, 2-hydroxyethyl (meth)acrylate, allyl (meth)acrylate, benzyl (meth)acrylate, glycerol mono(meth)acrylate, polystyrene macromonomer and polymethyl methacrylate macromonomer.

20 More specifically, the copolymer (III) is, for example, a copolymer (BIII-1) of (b1) an acid unsaturated compound composed of (meth)acrylic acid, (b3) a tetrahydrofuran unsaturated compound composed of tetrahydrofurfuryl (meth)acrylate and (b2) an oxetane unsaturated compound

25 composed of 3-[(meth)acryloyloxymethyl]oxetane and optionally (b4) at least one other unsaturated compound selected from the group consisting of styrene, N-phenylmaleimide, methyl (meth)acrylate, 2-hydroxyethyl (meth)acrylate, allyl (meth)acrylate, benzyl

30 (meth)acrylate, glycerol mono(meth)acrylate, polystyrene macromonomer and polymethyl methacrylate macromonomer; a copolymer (BIII-2) of (b1) an acid unsaturated compound composed of (meth)acrylic acid, (b3) a tetrahydrofuran unsaturated compound composed of tetrahydrofurfuryl

(meth)acrylate and (b2) an oxetane unsaturated compound composed of 3-[(meth)acryloyloxymethyl]-3-ethyloxetane and optionally (b4) at least one other unsaturated compound selected from the group consisting of styrene,

5 N-phenylmaleimide, methyl (meth)acrylate, 2-hydroxyethyl (meth)acrylate, allyl (meth)acrylate, benzyl (meth)acrylate, glycerol mono(meth)acrylate, polystyrene macromonomer and polymethyl methacrylate macromonomer; a copolymer (BIII-3) of (b1) an acid unsaturated compound

10 composed of (meth)acrylic acid, (b3) a tetrahydrofuran unsaturated compound composed of tetrahydrofurfuryl (meth)acrylate and (b2) an oxetane unsaturated compound composed of

3-[(meth)acryloyloxymethyl]-2-trifluoromethyloxetane and

15 optionally (b4) at least one other unsaturated compound selected from the group consisting of styrene, N-phenylmaleimide, methyl (meth)acrylate, 2-hydroxyethyl (meth)acrylate, allyl (meth)acrylate, benzyl (meth)acrylate, glycerol mono(meth)acrylate, polystyrene

20 macromonomer and polymethyl methacrylate macromonomer; a copolymer (BIII-4) of (b1) an acid unsaturated compound composed of (meth)acrylic acid, (b3) a tetrahydrofuran unsaturated compound composed of tetrahydrofurfuryl (meth)acrylate and (b2) an oxetane unsaturated compound

25 composed of 3-[(meth)acryloyloxymethyl]-2-phenyloxetane and optionally (b4) at least one other unsaturated compound selected from the group consisting of styrene, N-phenylmaleimide, methyl (meth)acrylate, 2-hydroxyethyl (meth)acrylate, allyl (meth)acrylate, benzyl

30 (meth)acrylate, glycerol mono(meth)acrylate, polystyrene macromonomer and polymethyl methacrylate macromonomer; a copolymer (BIII-5) of (b1) an acid unsaturated compound composed of (meth)acrylic acid, (b3) a tetrahydrofuran unsaturated compound composed of tetrahydrofurfuryl

(meth)acrylate and (b2) an oxetane unsaturated compound composed of 2-[(meth)acryloyloxymethyl]oxetane and optionally (b4) at least one other unsaturated compound selected from the group consisting of styrene,
 5 N-phenylmaleimide, methyl (meth)acrylate, 2-hydroxyethyl (meth)acrylate, allyl (meth)acrylate, benzyl (meth)acrylate, glycerol mono(meth)acrylate, polystyrene macromonomer and polymethyl methacrylate macromonomer; or a copolymer (BIII-6) of (b1) an acid unsaturated compound
 10 composed of (meth)acrylic acid, (b3) a tetrahydrofuran unsaturated compound composed of tetrahydrofurfuryl (meth)acrylate and (b2) an oxetane unsaturated compound composed of
 2-[(meth)acryloyloxymethyl]-4-trifluoromethyloxetane and
 15 optionally (b4) at least one other unsaturated compound selected from the group consisting of styrene, N-phenylmaleimide, methyl (meth)acrylate, 2-hydroxyethyl (meth)acrylate, allyl (meth)acrylate, benzyl (meth)acrylate, glycerol mono(meth)acrylate, polystyrene
 20 macromonomer and polymethyl methacrylate macromonomer.

Out of these copolymers (BIII), the copolymers (BIII-1) and (BIII-2) are particularly preferred.

In the copolymer (BIII), the copolymerization amount of the acid unsaturated compound is preferably 1 to 40 wt%,
 25 particularly preferably 5 to 30 wt%, the copolymerization amount of the tetrahydrofuran unsaturated compound is preferably 1 to 70 wt%, particularly preferably 1 to 40 wt%, the copolymerization amount of the oxetane unsaturated compound is preferably 1 to 60 wt%, particularly preferably
 30 1 to 40 wt%, and the copolymerization amount of the other unsaturated compound is preferably 0 to 70 wt%, more preferably 1 to 60 wt%.

In the present invention, when the copolymerization amounts of the above unsaturated compounds in the copolymer

(BIII) are set within the above ranges, a radiation sensitive composition for forming a colored layer which is excellent in sensitivity, solvent resistance and adhesion to the substrate can be obtained.

5 In the present invention, other alkali-soluble resin may be used in combination with the copolymers (B1), (B2) and (B3).

 The above other alkali-soluble resin is not particularly limited as long as it serves as a binder for
10 the colorant (A) and has solubility in an alkali developer which is used in a developing step for forming a colored layer. For example, it is preferably an alkali-soluble resin having a carboxyl group (to be referred to as "other carboxyl group-containing alkali-soluble resin" hereinafter).

15 An example of the other carboxyl group-containing alkali-soluble resin is a copolymer of at least one of the carboxyl group-containing unsaturated compounds enumerated for the copolymers (B1), (B2) and (B3) and at least one of the other unsaturated compounds enumerated for the
20 copolymers (B1), (B2) and (B3).

 A preferred example of the other carboxyl group-containing alkali-soluble resin is a copolymer of (i) a carboxyl group-containing unsaturated compound composed of (meth)acrylic acid and (ii) at least one selected from
25 the group consisting of styrene, N-phenylmaleimide, methyl (meth)acrylate, 2-hydroxyethyl (meth)acrylate, allyl (meth)acrylate, benzyl (meth)acrylate, glycerol mono(meth)acrylate, polystyrene macromonomer and polymethyl methacrylate macromonomer.

30 In the present invention, the weight average molecular weights in terms of polystyrene (to be referred to as "Mw" hereinafter) measured by gel permeation chromatography (GPC, eluting solvent: tetrahydrofuran) of the copolymers (B1), (B2) and (B3) and the other alkali-soluble resin are each

preferably 3,000 to 300,000, more preferably 5,000 to 100,000.

The number average molecular weights in terms of polystyrene (to be referred to as "Mn" hereinafter) measured
5 by gel permeation chromatography (GPC, eluting solvent: tetrahydrofuran) of the copolymers (B1), (B2) and (B3) and the other alkali-soluble resin are each preferably 3,000 to 60,000, more preferably 5,000 to 25,000.

In the present invention, by using a combination of
10 the above copolymer (B1) and copolymer (B2) having specific Mw and Mn or the above copolymer (B3) having specific Mw and Mn and optionally the above other alkali-soluble resin having specific Mw and Mn, a radiation sensitive composition having excellent developability is obtained. It is thereby
15 possible to form pixels and a black matrix having a sharp pattern edge and difficult to produce the residue, stain or film residue on the substrate or light screening layer of an unexposed portion at the time of development.

The Mw/Mn ratios of the copolymers (B1), (B2) and (B3)
20 and the other alkali-soluble resin are each preferably 1 to 5, more preferably 1 to 4.

In the present invention, the copolymers (B1), (B2) and (B3) and the other alkali-soluble resins may be used alone or in combination of two or more.

25 In the present invention, the total amount of the alkali-soluble resins is preferably 10 to 1,000 parts by weight, more preferably 20 to 500 parts by weight based on 100 parts by weight of the colorant (A). When the total amount of the alkali-soluble resins is smaller than 10 parts
30 by weight, alkali developability may lower, or a stain or the film residue may be produced on the substrate or light screening layer of an unexposed portion. When the total amount is larger than 1,000 parts by weight, the concentration of the colorant becomes relatively low,

whereby it may be difficult to achieve the target color density of a thin film.

The total amount of the copolymers (B1) and (B2) or the amount of the copolymer (B3) in the alkali-soluble resin is preferably 5 to 100 wt%, more preferably 10 to 100 wt%, particularly preferably 30 to 100 wt%. When the total amount is smaller than 5 wt%, the intended effect of the present invention may be impaired.

The amount of the copolymer (B1) is preferably 1 to 90 wt%, particularly preferably 5 to 80 wt% based on the total of the copolymers (B1) and (B2). When the amount of the copolymer (B1) is smaller than 1 wt%, solvent resistance may lower and when the amount is larger than 90 wt%, storage stability may lower.

15

- (C) polyfunctional monomer -

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

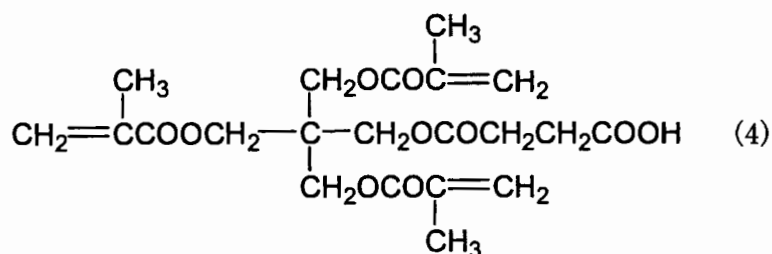
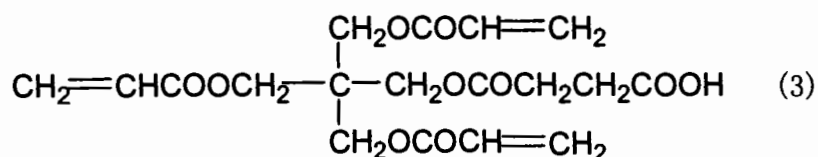
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Examples of the polyfunctional monomer include di(meth)acrylates of an alkylene glycol such as ethylene glycol and propylene glycol; di(meth)acrylates of a polyalkylene glycol such as polyethylene glycol and polypropylene glycol; poly(meth)acrylates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

30

tris[2-(meth)acryloyloxyethyl]phosphate.

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



15

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

20

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

25

The amount of the polyfunctional monomer in the present invention is preferably 5 to 500 parts by weight, more

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

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

Examples of the above monofunctional monomer include the above compounds enumerated for the acid unsaturated compound, N-substituted maleimide or other unsaturated compound in the above alkali-soluble resin (B), N-(meth)acryloylmorpholine, N-vinylpyrrolidone, N-vinyl- ϵ -caprolactam and commercially available M-5600 (trade name of Toagosei Chemical Industry Co., Ltd.).

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

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

The total amount of the polyfunctional monomer and the monofunctional monomer in the present invention is preferably 5 to 500 parts by weight, more preferably 20 to 300 parts by weight based on 100 parts by weight of the alkali-soluble resin. When the total amount is smaller than 5 parts by weight, the strength and surface smoothness of the colored layer may deteriorate and when the total amount is larger than 500 parts by weight, alkali developability

may lower, or a stain or the film residue may be produced on the substrate or light screening layer of an unexposed portion.

5 - (D) photopolymerization initiator -

The photopolymerization initiator in the present invention is a compound which forms active species capable of initiating the polymerization of the above polyfunctional monomer (C) and the optionally used monofunctional monomer
10 upon exposure to radiation such as visible radiation, ultraviolet radiation, far ultraviolet radiation, electron radiation or X-radiation.

The photopolymerization initiator is, for example, an acetophenone compound, biimidazole compound, triazine
15 compound, benzoin compound, benzophenone compound, α -diketone compound, polynuclear quinone compound, xanthone compound, diazo compound, O-acyloxime compound, onium salt compound or imidosulfonato compound. These compounds form an active radical, an active acid or both of them upon
20 exposure.

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

In the present invention, the amount of the photopolymerization initiator is preferably 0.01 to 120
30 parts by weight, more preferably 1 to 100 parts by weight based on 100 parts by weight of the polyfunctional monomer (C) or the total of the polyfunctional monomer and the monofunctional monomer. When the amount of the photopolymerization initiator is smaller than 0.01 part by

weight, it may be difficult to obtain a color filter having a predetermined colored layer pattern due to incomplete curing by exposure and when the amount is larger than 120 parts by weight, the formed colored layer may fall off from the substrate during development.

Examples of the acetophenone compound out of the preferred photopolymerization initiators in the present invention include 2-hydroxy-2-methyl-1-phenylpropan-1-one, 2-methyl-1-[4-(methylthio)phenyl]-2-morpholinopropan-1-one, 2-benzyl-2-dimethylamino-1-(4-morpholinophenyl)butan-1-one, 1-hydroxycyclohexyl-phenyl ketone, 2,2-dimethoxy-1,2-diphenylethan-1-one and 1,2-octanedione.

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

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

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

Examples of the above biimidazole compound include
 2,2'-bis(2-chlorophenyl)-4,4',5,5'-tetrakis(4-
 ethoxycarbonylphenyl)-1,2'-biimidazole,
 2,2'-bis(2-bromophenyl)-4,4',5,5'-tetrakis(4-
 5 ethoxycarbonylphenyl)-1,2'-biimidazole,
 2,2'-bis(2-chlorophenyl)-4,4',5,5'-tetraphenyl-1,2'-
 biimidazole,
 2,2'-bis(2,4-dichlorophenyl)-4,4',5,5'-tetraphenyl-1,2'-
 biimidazole,
 10 2,2'-bis(2,4,6-trichlorophenyl)-4,4',5,5'-tetraphenyl-1,
 2'-biimidazole,
 2,2'-bis(2-bromophenyl)-4,4',5,5'-tetraphenyl-1,2'-
 biimidazole,
 2,2'-bis(2,4-dibromophenyl)-4,4',5,5'-tetraphenyl-1,2'-
 15 biimidazole and
 2,2'-bis(2,4,6-tribromophenyl)-4,4',5,5'-tetraphenyl-
 1,2'-biimidazole.

Out of these biimidazole compounds,
 2,2'-bis(2-chlorophenyl)-4,4',5,5'-tetraphenyl-1,2'-
 20 biimidazole,
 2,2'-bis(2,4-dichlorophenyl)-4,4',5,5'-tetraphenyl-1,2'-
 biimidazole and
 2,2'-bis(2,4,6-trichlorophenyl)-4,4',5,5'-tetraphenyl-1,
 2'-biimidazole are preferred, and
 25 2,2'-bis(2,4-dichlorophenyl)-4,4',5,5'-tetraphenyl-1,2'-
 biimidazole is particularly preferred.

These biimidazole compounds have excellent solubility
 in a solvent, do not form foreign matter such as an
 undissolved product and a precipitate, have high sensitivity,
 30 fully promote a curing reaction by exposure with a small
 amount of energy and do not cause a curing reaction in an
 unexposed portion. Therefore, the coating film obtained
 after exposure is clearly divided into a cured portion
 insoluble in a developer and an uncured portion having high

solubility in a developer, thereby making it possible to form a high-definition color filter having a predetermined colored layer pattern which is not undercut.

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

When the biimidazole compound is used as the photopolymerization initiator in the present invention, the amount of the biimidazole compound is preferably 0.01 to 40 parts by weight, more preferably 1 to 30 parts by weight, 10 particularly preferably 1 to 20 parts by weight based on 100 parts by weight of the polyfunctional monomer (C) or the total of the polyfunctional monomer and the monofunctional monomer. When the amount of the biimidazole compound is smaller than 0.01 part by weight, it may be difficult to obtain a color 15 filter having a predetermined colored layer pattern due to incomplete curing by exposure. When the amount is larger than 40 parts by weight, the formed colored layer may fall off from the substrate and the film surface of the colored layer may be roughened during development.

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

The term "hydrogen donor" as used herein means a 25 compound which can provide a hydrogen atom to a radical formed from the biimidazole compound upon exposure.

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

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

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

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

A detailed description is subsequently given of these hydrogen donors.

10 The mercaptan hydrogen donor may have at least one benzene ring or hetero ring, or both of them. When it has two or more of the rings, a fused ring may be formed.

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

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

Examples of this mercaptan hydrogen donor include 2-mercaptobenzothiazole, 2-mercaptobenzoxazole,
30 2-mercaptobenzoimidazole,
2,5-dimercapto-1,3,4-thiadiazole and
2-mercapto-2,5-dimethylaminopyridine.

Out of these mercaptan hydrogen donors, 2-mercaptobenzothiazole and 2-mercaptobenzoxazole are

preferred, and 2-mercaptobenzothiazole is particularly preferred.

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

At least one amino group of the amine hydrogen donor may be substituted by an alkyl group or substituted alkyl group. The amine hydrogen donor may be substituted by a carboxyl group, alkoxycarbonyl group, substituted
10 alkoxycarbonyl group, phenoxycarbonyl group, substituted phenoxycarbonyl group or nitrile group at a position other than the amino group(s).

Examples of the above amine hydrogen donor include 4,4'-bis(dimethylamino)benzophenone,
15 4,4'-bis(diethylamino)benzophenone,
4-diethylaminoacetophenone, 4-dimethylaminopropiophenone, ethyl-4-dimethylaminobenzoate, 4-dimethylaminobenzoic acid and 4-dimethylaminobenzonitrile.

Out of these amine hydrogen donors,
20 4,4'-bis(dimethylamino)benzophenone and
4,4'-bis(diethylamino)benzophenone are preferred, and
4,4'-bis(diethylamino)benzophenone is particularly preferred.

The amine hydrogen donor serves as a sensitizer even
25 when a photopolymerization initiator other than a biimidazole compound is used.

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

Preferred examples of the combination of the mercaptan hydrogen donor and the amine hydrogen donor include a

combination of 2-mercaptobenzothiazole and
4,4'-bis(dimethylamino)benzophenone, combination of
2-mercaptobenzothiazole and
4,4'-bis(diethylamino)benzophenone, combination of
5 2-mercaptobenzoxazole and
4,4'-bis(dimethylamino)benzophenone, and combination of
2-mercaptobenzoxazole and
4,4'-bis(diethylamino)benzophenone. Out of these
combinations, a combination of 2-mercaptobenzothiazole and
10 4,4'-bis(diethylamino)benzophenone and a combination of
2-mercaptobenzoxazole and
4,4'-bis(diethylamino)benzophenone are more preferred, and
a combination of 2-mercaptobenzothiazole and
4,4'-bis(diethylamino)benzophenone is particularly
15 preferred.

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

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

Examples of the above triazine compound include
triazine compounds having a halomethyl group such as
2,4,6-tris(trichloromethyl)-s-triazine,

2-methyl-4,6-bis(trichloromethyl)-s-triazine,
 2-[2-(5-methylfuran-2-yl)ethenyl]-4,6-
 bis(trichloromethyl)-s-triazine,
 2-[2-(furan-2-yl)ethenyl]-4,6-bis(trichloromethyl)-s-
 5 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,
 10 2-(4-methoxyphenyl)-4,6-bis(trichloromethyl)-s-triazine,
 2-(4-ethoxystyryl)-4,6-bis(trichloromethyl)-s-triazine
 and 2-(4-n-butoxyphenyl)-4,6-bis(trichloromethyl)-s-
 triazine.

Out of these triazine compounds,
 15 2-[2-(3,4-dimethoxyphenyl)ethenyl]-4,6-
 bis(trichloromethyl)-s-triazine is particularly preferred.

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

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

Examples of the above O-acyloxime compound include
 1-[4-(phenylthio)phenyl]-heptane-1,2-dione
 2-(O-benzoyloxime),

1-[4-(phenylthio)phenyl]-octane-1,2-dione
 2-(O-benzoyloxime),
 1-[4-(benzoyl)phenyl]-octane-1,2-dione 2-(O-benzoyloxime),
 1-[9-ethyl-6-(2-methylbenzoyl)-9H-carbazol-3-yl]-
 5 ethanone 1-(O-acetyloxime),
 1-[9-ethyl-6-(3-methylbenzoyl)-9H-carbazol-3-yl]-
 ethanone 1-(O-acetyloxime) and
 1-[9-ethyl-6-benzoyl-9H-carbazol-3-yl]-ethanone
 1-(O-acetyloxime).

10 Out of these O-acyloxime compounds,
 1-[4-(phenylthio)phenyl]-octane-1,2-dione
 2-(O-benzoyloxime) and
 1-[9-ethyl-6-(2-methylbenzoyl)-9H-carbazol-3-yl]-
 ethanone 1-(O-acetyloxime) are particularly preferred.

15 The above O-acyloxime compounds may be used alone or
 in combination of two or more.

When the O-acyloxime compound is used as the
 photopolymerization initiator in the present invention, the
 amount of the O-acyloxime compound is preferably 0.01 to 40
 20 parts by weight, more preferably 1 to 30 parts by weight,
 particularly preferably 1 to 20 parts by weight based on 100
 parts by weight of the polyfunctional monomer (C) or the total
 of the polyfunctional monomer and the monofunctional monomer.
 When the amount of the O-acetyloxime compound is smaller than
 25 0.01 part by weight, it may be difficult to obtain a color
 filter having a predetermined colored layer pattern due to
 incomplete curing by exposure. When the amount is larger
 than 40 parts by weight, the formed colored layer may fall
 off from the substrate during development.

30 The above onium salt compound is, for example, a diaryl
 iodonium salt, triaryl sulfonium salt or diaryl phosphonium
 salt.

Examples of the above diaryl iodonium salt include
 diphenyliodonium tetrafluoroborate, diphenyliodonium

hexafluorophosphonate, diphenyliodonium
 hexafluoroarsenate, diphenyliodonium trifluoromethane
 sulfonate, diphenyliodonium trifluoroacetate,
 diphenyliodonium-p-toluene sulfonate,
 5 4-methoxyphenylphenyliodonium tetrafluoroborate,
 4-methoxyphenylphenyliodonium hexafluorophosphonate,
 4-methoxyphenylphenyliodonium hexafluoroarsenate,
 4-methoxyphenylphenyliodonium trifluoromethane sulfonate,
 4-methoxyphenylphenyliodonium trifluoroacetate,
 10 4-methoxyphenylphenyliodonium-p-toluene sulfonate,
 bis(4-tert-butylphenyl)iodonium tetrafluoroborate,
 bis(4-tert-butylphenyl)iodonium hexafluoroarsenate,
 bis(4-tert-butylphenyl)iodonium trifluoromethane
 sulfonate, bis(4-tert-butylphenyl)iodonium
 15 trifluoroacetate and
 bis(4-tert-butylphenyl)iodonium-p-toluene sulfonate.

Examples of the above triaryl sulfonium salt include
 triphenylsulfonium tetrafluoroborate, triphenylsulfonium
 hexafluorophosphonate, triphenylsulfonium
 20 hexafluoroarsenate, triphenylsulfonium trifluoromethane
 sulfonate, triphenylsulfonium trifluoroacetate,
 triphenylsulfonium-p-toluene sulfonate,
 4-methoxyphenyldiphenylsulfonium tetrafluoroborate,
 4-methoxyphenyldiphenylsulfonium hexafluorophosphonate,
 25 4-methoxyphenyldiphenylsulfonium hexafluoroarsenate,
 4-methoxyphenyldiphenylsulfonium trifluoromethane
 sulfonate, 4-methoxyphenyldiphenylsulfonium
 trifluoroacetate,
 4-methoxyphenyldiphenylsulfonium-p-toluene sulfonate,
 30 4-phenylthiophenyldiphenylsulfonium tetrafluoroborate,
 4-phenylthiophenyldiphenylsulfonium hexafluorophosphonate,
 4-phenylthiophenyldiphenylsulfonium hexafluoroarsenate,
 4-phenylthiophenyldiphenylsulfonium trifluoromethane
 sulfonate, 4-phenylthiophenyldiphenylsulfonium-p-

toluene sulfonate and

4-phenylthiophenyldiphenylsulfonium-p-toluene sulfonate.

Examples of the above diaryl phosphonium salt include
(1-6- η -cumene) (η -cyclopentadienyl) iron

5 hexafluorophosphate.

Out of these onium salt compounds, diphenyliodonium
hexafluorophosphate and triphenylsulfonium
trifluoromethane sulfonate are particularly preferred.

The above onium salt compounds may be used alone or
10 in combination of two or more.

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

25 - additives -

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

The above additives include an organic acid, an organic
30 amino compound (excluding the above hydrogen donor), a curing
agent and a curing aid.

The above organic acid and organic amino compound serve
to further improve the solubility in an alkali developer of
the radiation sensitive composition and further suppress the

production of the residual undissolved product after development.

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

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

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

Examples of the phenyl group-containing carboxylic
25 acid include aromatic monocarboxylic acids such as benzoic acid, toluic acid, cuminic acid, hemellitic acid and mesitylenic acid; aromatic dicarboxylic acids such as phthalic acid, isophthalic acid and terephthalic acid; aromatic polycarboxylic acids having 3 or more carboxyl
30 groups such as trimellitic acid, trimesic acid, mellophanic acid and pyromellitic acid; and phenylacetic acid, hydroatropic acid, hydrocinnamic acid, mandelic acid, phenylsuccinic acid, atropic acid, cinnamic acid, cinnamylidenic acid, coumaric acid and umbellic acid.

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

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

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

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

Examples of the above aliphatic amine include mono(cyclo)alkylamines such as n-propylamine, i-propylamine, n-butylamine, i-butylamine, sec-butylamine, t-butylamine, n-pentylamine, n-hexylamine, n-heptylamine, n-octylamine, n-nonylamine, n-decylamine, n-undecylamine, n-dodecylamine, cyclohexylamine, 2-methylcyclohexylamine, 3-methylcyclohexylamine, 4-methylcyclohexylamine, 2-ethylcyclohexylamine, 3-ethylcyclohexylamine and 4-ethylcyclohexylamine; di(cyclo)alkylamines such as methyl·ethylamine, diethylamine, methyl·n-propylamine, ethyl·n-propylamine, di-n-propylamine, di-i-propylamine, di-n-butylamine, di-i-butylamine, di-sec-butylamine,

di-t-butylamine, di-n-pentylamine, d-n-hexylamine,
 methylcyclohexylamine, ethylcyclohexylamine and
 dicyclohexylamine; tri(cyclo)alkylamines such as
 dimethyl·ethylamine, methyl·diethylamine, triethylamine,
 5 dimethyl·n-propylamine, diethyl·n-propylamine,
 methyl·di-n-propylamine, ethyl·di-n-propylamine,
 tri-n-propylamine, tri-i-propylamine, tri-n-butylamine,
 tri-i-butylamine, tri-sec-butylamine, tri-t-butylamine,
 tri-n-pentylamine, tri-n-hexylamine,
 10 dimethylcyclohexylamine, diethylcyclohexylamine,
 methyldicyclohexylamine, ethyldicyclohexylamine and
 tricyclohexylamine; mono(cyclo)alkanolamines such as
 2-aminoethanol, 3-amino-1-propanol, 1-amino-2-propanol,
 4-amino-1-butanol, 5-amino-1-pentanol, 6-amino-1-hexanol
 15 and 4-amino-1-cyclohexanol; di(cyclo)alkanolamines such as
 diethanolamine, di-n-propanolamine, di-i-propanolamine,
 di-n-butanolamine, di-i-butanolamine, di-n-pentanolamine,
 di-n-hexanolamine and di(4-cyclohexanol)amine;
 tri(cyclo)alkanolamines such as triethanolamine,
 20 tri-n-propanolamine, tri-i-propanolamine,
 tri-n-butanolamine, tri-i-butanolamine,
 tri-n-pentanolamine, tri-n-hexanolamine and
 tri(4-cyclohexanol)amine; amino(cyclo)alkanediols such as
 3-amino-1,2-propanediol, 2-amino-1,3-propanediol,
 25 4-amino-1,2-butanediol, 4-amino-1,3-butanediol,
 4-amino-1,2-cyclohexanediol, 4-amino-1,3-cyclohexanediol,
 3-dimethylamino-1,2-propanediol,
 3-diethylamino-1,2-propanediol,
 2-dimethylamino-1,3-propanediol and
 30 2-diethylamino-1,3-propanediol; amino group-containing
 cycloalkane methanols such as 1-aminocyclopentane methanol,
 4-aminocyclopentane methanol, 1-aminocyclohexane methanol,
 4-aminocyclohexane methanol, 4-dimethylaminocyclopentane
 methanol, 4-diethylaminocyclopentane methanol,

4-dimethylaminocyclohexane methanol and
 4-diethylaminocyclohexane methanol; and aminocarboxylic
 acids such as β -alanine, 2-aminobutyric acid, 3-aminobutyric
 acid, 4-aminobutyric acid, 2-aminoisobutyric acid,
 5 3-aminoisobutyric acid, 2-aminovaleric acid,
 5-aminovaleric acid, 6-aminocaproic acid,
 1-aminocyclopropanecarboxylic acid,
 1-aminocyclohexanecarboxylic acid and
 4-aminocyclohexanecarboxylic acid.

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

 Examples of the phenyl group-containing amine include
 15 aromatic amines such as aniline, 2-methylaniline,
 3-methylaniline, 4-methylaniline, 4-ethylaniline,
 4-n-propylaniline, 4-i-propylaniline, 4-n-butyylaniline,
 4-t-butyylaniline, 1-naphthylamine, 2-naphthylamine,
 N,N-dimethylaniline, N,N-diethylaniline and
 20 4-methyl-N,N-dimethylaniline; aminobenzyl alcohols such as
 2-aminobenzyl alcohol, 3-aminobenzyl alcohol,
 4-aminobenzyl alcohol, 4-dimethylaminobenzyl alcohol and
 4-diethylaminobenzyl alcohol; and aminophenols such as
 2-aminophenol, 3-aminophenol, 4-aminophenol,
 25 4-dimethylaminophenol and 4-diethylaminophenol.

 Out of these organic amino compounds,
 mono(cyclo)alkanolamines and amino(cyclo)alkanediols are
 preferred, and 2-aminoethanol, 3-amino-1-propanol,
 5-amino-1-pentanol, 3-amino-1,2-propanediol,
 30 2-amino-1,3-propanediol and 4-amino-1,2-butanediol are
 particularly preferred as the aliphatic amine from the
 viewpoints of solubility in a solvent which will be described
 hereinafter and the prevention of a stain or the film residue
 on the substrate or light screening layer of an unexposed

portion. Aminophenols are preferred, and 2-aminophenol, 3-aminophenol and 4-aminophenol are particularly preferred as the phenyl group-containing amine.

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

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

The above curing agent is a component which reacts with a carboxyl group and/or an oxetane ring contained in the copolymers (B1) and (B3) or a carboxyl group contained in 15 the copolymer (B2) to cure these copolymers.

The curing agent is, for example, an epoxy compound or an oxetane compound.

The above epoxy compound is preferably a polyfunctional epoxy compound as exemplified by aromatic 20 epoxy resins such as bisphenol A epoxy resin, hydrogenated bisphenol A epoxy resin, bisphenol F epoxy resin, hydrogenated bisphenol F epoxy resin and novolak epoxy resin; alicyclic epoxy resins, heterocyclic epoxy resins and other epoxy resins such as glycidyl ester-based resins, glycidyl 25 amine-based resins and epoxylated oil; and brominated derivatives of these epoxy resins, epoxylated products of butadiene (co)polymers, epoxylated products of isoprene (co)polymers, (co)polymers of glycidyl group-containing unsaturated compounds, and triglycidyl isocyanurate.

30 An epoxy group-containing unsaturated compound is also preferred as the above epoxy compound, as exemplified by glycidyl (meth)acrylate, 3,4-epoxybutyl (meth)acrylate, 6,7-epoxyheptyl (meth)acrylate, o-vinylbenzyl glycidyl ether, m-vinylbenzyl glycidyl ether and p-vinylbenzyl

glycidyl ether.

The above oxetane compound is preferably a polyfunctional oxetane compound as exemplified by low molecular weight compounds such as bisoxetanyl carbonate, bisoxetanyl adipate, bisoxetanyl terephthalate, bisoxetanyl p-xylylenedicarboxylate and bisoxetanyl 1,4-cyclohexanedicarboxylate, and polymer compounds such as an oxetane etherified product of phenol novolak resin and (co)polymer of an unsaturated compound having an oxetane skeleton (excluding the copolymers (B1) and (B3)).

A compound having both an oxetane ring structure and an unsaturated double bond is also preferred as the oxetane compound, as exemplified by the above oxetane unsaturated compounds.

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

The amount of the curing agent is preferably 30 wt% or less, more preferably 20 wt% or less based on the total solid content of the radiation sensitive composition. When the amount of the curing agent is larger than 30 wt%, the storage stability of the obtained radiation sensitive composition may lower.

The above curing aid is a component which promotes a curing reaction by the above curing agent by ring-opening the epoxy group and/or oxetane ring of the curing agent.

The curing aid is, for example, a polycarboxylic acid, polycarboxylic anhydride, amino compound or thermal acid generator.

Examples of the above polycarboxylic acid include the above compounds having two or more carboxyl groups out of the above organic acids. Examples of the amino compound include the above organic amino compounds.

Examples of the above polycarboxylic anhydride include aromatic polycarboxylic anhydrides such as phthalic

anhydride, pyromellitic anhydride, trimellitic anhydride and 3,3',4,4'-benzophenonetetracarboxylic dianhydride; aliphatic polycarboxylic anhydrides such as itaconic anhydride, succinic anhydride, citraconic anhydride, 5 dodecenylsuccinic anhydride, tricarballic anhydride, maleic anhydride and 1,2,3,4-butanetetracarboxylic dianhydride; alicyclic polycarboxylic anhydrides such as hexahydrophthalic anhydride, 3,4-dimethyltetrahydrophthalic anhydride, 10 1,2,4-cyclopentanetricarboxylic anhydride, 1,2,4-cyclohexanetricarboxylic anhydride, cyclopentanetetracarboxylic dianhydride, 1,2,4,5-cyclohexanetetracarboxylic dianhydride, hymic anhydride and nadic anhydride; ester group-containing 15 carboxylic anhydrides such as ethylene glycol bistrimellitate anhydride and glycerin tristrimellitate anhydride; and epoxy resin curing agents commercially available under the trade names of Adeca Hardener EH-700 (of Asahi Denka Kogyo K.K.), Rikacid HH (of Shin Nippon Rika Co., 20 Ltd.) and MH-700 (of Shin Nippon Rika Co., Ltd.).

Examples of the above thermal acid generator include sulfonium salts (excluding triaryl sulfonium salts enumerated for the above photopolymerization initiator (D)), benzothiazonium salts, ammonium salts, phosphonium salts, 25 sulfonate compounds, sulfonimide compounds and diazomethane compounds. Out of these, sulfonium salts, benzothiazonium salts, sulfonate compounds, sulfonimide compounds and diazomethane compounds are preferred.

The above sulfonium salts include alkylsulfonium salts 30 such as 4-acetophenyldimethylsulfonium hexafluoroantimonate, 4-acetoxypenyldimethylsulfonium hexafluoroarsenate, dimethyl-4-(benzyloxycarbonyloxy)phenylsulfonium hexafluoroantimonate,

- dimethyl-4- (benzoyloxy)phenylsulfonium
hexafluoroantimonate,
dimethyl-4- (benzoyloxy)phenylsulfonium hexafluoroarsenate,
and dimethyl-3-chloro-4-acetoxyphenylsulfonium
- 5 hexafluoroantimonate; benzylsulfonium salts such as
benzyl-4-hydroxyphenylmethylsulfonium
hexafluoroantimonate,
benzyl-4-hydroxyphenylmethylsulfonium hexafluorophosphate,
4-acetoxyphenylbenzylmethylsulfonium hexafluoroantimonate,
- 10 benzyl-4-methoxyphenylmethylsulfonium
hexafluoroantimonate,
benzyl-2-methyl-4-hydroxyphenylmethylsulfonium
hexafluoroantimonate,
benzyl-3-chloro-4-hydroxyphenylmethylsulfonium
- 15 hexafluoroarsenate and
4-methoxybenzyl-4-hydroxyphenylmethylsulfonium
hexafluorophosphate; dibenzylsulfonium salts such as
dibenzyl-4-hydroxyphenylsulfonium hexafluoroantimonate,
dibenzyl-4-hydroxyphenylsulfonium hexafluorophosphate,
- 20 4-acetoxyphenyldibenzylsulfonium hexafluoroantimonate,
dibenzyl-4-methoxyphenylsulfonium hexafluoroantimonate,
dibenzyl-3-chloro-4-hydroxyphenylsulfonium
hexafluoroarsenate,
dibenzyl-3-methyl-4-hydroxy-5-tert-butylphenylsulfonium
- 25 hexafluoroantimonate and
benzyl-4-methoxybenzyl-4-hydroxyphenylsulfonium
hexafluorophosphate; and substituted benzylsulfonium salts
such as p-chlorobenzyl-4-hydroxyphenylmethylsulfonium
hexafluoroantimonate,
- 30 p-nitrobenzyl-4-hydroxyphenylmethylsulfonium
hexafluoroantimonate,
p-chlorobenzyl-4-hydroxyphenylmethylsulfonium
hexafluorophosphate,
p-nitrobenzyl-3-methyl-4-hydroxyphenylmethylsulfonium

hexafluoroantimonate,
 3,5-dichlorobenzyl-4-hydroxyphenylmethylsulfonium
 hexafluoroantimonate and
 o-chlorobenzyl-3-chloro-4-hydroxyphenylmethylsulfonium
 5 hexafluoroantimonate.

The above benzothiazonium salts include
 benzylbenzothiazonium salts such as
 3-benzylbenzothiazonium hexafluoroantimonate,
 3-benzylbenzothiazonium hexafluorophosphate,
 10 3-benzylbenzothiazonium tetrafluoroborate,
 3-(p-methoxybenzyl)benzothiazonium hexafluoroantimonate,
 3-benzyl-2-methylthiobenzothiazonium hexafluoroantimonate
 and 3-benzyl-5-chlorobenzothiazonium
 hexafluoroantimonate.

15 The above sulfonate compounds include benzoin tosylate,
 α -methylolbenzoin tosylate, α -methylolbenzoin
 n-octanesulfonate,
 pyrogalloltris(trifluoromethanesulfonate),
 pyrogalloltris(nonafluoro-n-butanesulfonate),
 20 pyrogalloltris(methanesulfonate) and
 nitrobenzyl-9,10-diethoxyanthracene-2-sulfonate.

The above sulfonimide compounds include
 N-(trifluoromethanesulfonyloxy)succinimide,
 N-(trifluoromethanesulfonyloxy)bicyclo[2.2.1]hept-5-ene-
 25 2,3-dicarboxyimide, N-(10-camphorsulfonyloxy)succinimide,
 N-(10-camphorsulfonyloxy)bicyclo[2.2.1]hept-5-ene-2,3-
 dicarboxyimide and
 N[(5-methyl-5-carboxymethanebicyclo[2.2.1]hept-
 2-yl)sulfonyloxy]succinimide.

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

Out of these thermal acid generators,

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

10 The above curing aids may be used alone or in
 combination of two or more.

 The amount of the curing aid is preferably 15 wt% or
 less, more preferably 10 wt% or less based on the total solid
 content of the radiation sensitive composition. When the
 15 amount of the curing aid is larger than 15 wt%, the storage
 stability of the obtained radiation sensitive composition
 may lower or the formed colored layer may fall off from the
 substrate during development.

 Additives other than the above additives include a
 20 dispersion aid such as a blue pigment derivative or yellow
 pigment derivative, e.g., a copper phthalocyanine
 derivative; filler such as glass or alumina; polymer compound
 such as polyvinyl alcohol, polyethylene glycol monoalkyl
 ether or poly(fluoroalkylacrylate); nonionic, cationic or
 25 anionic surfactant; adhesion accelerator such as vinyl
 trimethoxysilane, vinyl triethoxysilane, vinyl
 tris(2-methoxyethoxy)silane,
 N-(2-aminoethyl)-3-aminopropyl·methyl·dimethoxysilane,
 N-(2-aminoethyl)-3-aminopropyltrimethoxysilane,
 30 3-aminopropyltriethoxysilane,
 3-glycidoxypropyltrimethoxysilane,
 3-glycidoxypropyl·methyl·dimethoxysilane,
 2-(3,4-epoxycyclohexyl)ethyltrimethoxysilane,
 3-chloropropyl·methyl·dimethoxysilane,

3-chloropropyltrimethoxysilane,
3-methacryloyloxypropyltrimethoxysilane or
3-mercaptopropyltrimethoxysilane; antioxidant such as
2,2'-thiobis(4-methyl-6-t-butylphenol) or
5 2,6-di-t-butylphenol; ultraviolet light absorber such as
2-(3-t-butyl-5-methyl-2-hydroxyphenyl)-5-
chlorobenzotriazole or alkoxybenzophenone; cohesion
inhibitor such as sodium polyacrylate; and heat radical
generator such as 1,1'-azobis(cyclohexane-1-carbonitrile)
10 or 2-phenylazo-4-methoxy-2,4-dimethylvaleronitrile.

Solvent

The radiation sensitive composition of the present
invention comprises the above components (A) to (D) as
15 essential components and optionally the above additives and
is generally mixed with a solvent to be prepared as a liquid
composition. A suitable solvent may be selected and used
as far as it disperses or dissolves the components (A) to
(D) and additives constituting the radiation sensitive
20 composition, does not react with these components and has
suitable volatility.

Examples of the solvent include (poly)alkylene glycol
monoalkyl ethers such as ethylene glycol monomethyl ether,
ethylene glycol monoethyl ether, ethylene glycol
25 mono-n-propyl ether, ethylene glycol mono-n-butyl ether,
diethylene glycol monomethyl ether, diethylene glycol
monoethyl ether, diethylene glycol mono-n-propyl ether,
diethylene glycol mono-n-butyl ether, triethylene glycol
monomethyl ether, triethylene glycol monoethyl ether,
30 propylene glycol monomethyl ether, propylene glycol
monoethyl ether, propylene glycol mono-n-propyl ether,
propylene glycol mono-n-butyl ether, dipropylene glycol
monomethyl ether, dipropylene glycol monoethyl ether,
dipropylene glycol mono-n-propyl ether, dipropylene glycol

mono-n-butyl ether, tripropylene glycol monomethyl ether and tripropylene glycol monoethyl ether; (poly)alkylene glycol monoalkyl ether acetates such as ethylene glycol monomethyl ether acetate, ethylene glycol monoethyl ether acetate, 5 diethylene glycol monomethyl ether acetate, diethylene glycol monoethyl ether acetate, propylene glycol monomethyl ether acetate and propylene glycol monoethyl ether acetate; other ethers such as diethylene glycol dimethyl ether, diethylene glycol methyl ethyl ether, diethylene glycol 10 diethyl ether and tetrahydrofuran; ketones such as methyl ethyl ketone, cyclohexanone, 2-heptanone and 3-heptanone; alkyl lactates such as methyl lactate and ethyl lactate; other esters such as ethyl 2-hydroxy-2-methylpropionate, methyl 3-methoxypropionate, ethyl 3-methoxypropionate, 15 methyl 3-ethoxypropionate, ethyl 3-ethoxypropionate, ethyl ethoxyacetate, ethyl hydroxyacetate, methyl 2-hydroxy-3-methylbutanoate, 3-methyl-3-methoxybutylacetate, 3-methyl-3-methoxybutylpropionate, ethyl acetate, n-propyl acetate, i-propyl acetate, n-butyl acetate, i-butyl acetate, 20 n-amyl formate, i-amyl acetate, n-butyl propionate, ethyl butyrate, n-propyl butyrate, i-propyl butyrate, n-butyl butyrate, methyl pyruvate, ethyl pyruvate, n-propyl pyruvate, methyl acetoacetate, ethyl acetoacetate and ethyl 25 2-oxobutanoate; aromatic hydrocarbons such as toluene and xylene; and amides and lactams such as N,N-dimethylformamide, N,N-dimethylacetamide and N-methylpyrrolidone.

Out of these solvents, propylene glycol monomethyl ether, ethylene glycol monomethyl ether acetate, propylene 30 glycol monomethyl ether acetate, propylene glycol monoethyl ether acetate, diethylene glycol dimethyl ether, diethylene glycol methyl ethyl ether, cyclohexanone, 2-heptanone, 3-heptanone, ethyl lactate, ethyl 3-methoxypropionate, methyl 3-ethoxypropionate, ethyl 3-ethoxypropionate,

3-methyl-3-methoxybutylpropionate, n-butyl acetate, i-butyl acetate, n-amyl formate, i-amyl acetate, n-butyl propionate, ethyl butyrate, i-propyl butyrate, n-butyl butyrate and ethyl pyruvate are particularly preferred from the viewpoints of solubility, pigment dispersibility and coatability.

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

Further, a high-boiling solvent such as benzyl ethyl ether, di-n-hexyl ether, acetonylacetone, isophorone, caproic acid, caprylic acid, 1-octanol, 1-nonanol, benzyl alcohol, benzyl acetate, ethyl benzoate, diethyl oxalate, diethyl maleate, γ -butyrolactone, ethylene carbonate, propylene carbonate or ethylene glycol monophenyl ether acetate may be used in conjunction with the above solvent.

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

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

Color filter

The color filter of the present invention has a colored layer formed from the radiation sensitive composition of the present invention.

A description is subsequently given of the method of forming a colored layer in the color filter of the present invention.

A light screening layer is optionally formed on the surface of a substrate to define a portion for forming pixels,

and a liquid radiation sensitive composition comprising, for example, a red pigment dispersed therein is applied to the substrate and prebaked to vaporize the solvent so as to form a coating film.

5 This coating film is then exposed to radiation through a photomask, developed with an alkali developer to dissolve and remove an unexposed portion of the coating film and post-baked to form a pixel array having a predetermined red pixel pattern.

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

 A black matrix can be formed likewise by using a liquid radiation sensitive composition comprising, for example, a
20 black pigment dispersed therein.

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

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

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

 The thickness of the coating film after drying is

preferably 0.1 to 10 μm , more preferably 0.2 to 8.0 μm , particularly preferably 0.2 to 6.0 μm .

The radiation used to form pixels and/or a black matrix is selected from visible radiation, ultraviolet radiation, 5 far ultraviolet radiation, electron radiation and X-radiation. Out of these, radiation having a wavelength of 190 to 450 nm is preferred.

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

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

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

Shower development, spray development, dip 20 (immersion) development or puddle development may be employed. As for development conditions, the coating film is preferably developed at normal temperature for 5 to 300 sec.

The thus obtained color filter of the present invention 25 is extremely useful for transmission and reflection color liquid crystal display devices, color image pick-up devices, color sensors, etc.

Color Liquid crystal display device

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

As an example of the color liquid crystal display device of the present invention, a color liquid crystal

display device having excellent characteristic properties can be manufactured by using the radiation sensitive composition of the present invention to form pixels and/or a black matrix on a thin film transistor substrate array as described above.

The radiation sensitive composition of the present invention comprises the above components (A) to (D) as essential components. Particularly preferred examples of the composition are given below.

- 10 (a) a radiation sensitive composition for forming a colored layer, wherein the copolymer (B1) comprises the copolymer (BI) and the copolymer (B2) comprises the copolymer (BII)
- 15 (b) the radiation sensitive composition (a) for forming a colored layer, wherein the copolymer (BI) comprises at least one selected from the group consisting of copolymers (BI-1) to (BI-6) and the copolymer (BII) comprises at least one selected from the group consisting of the copolymers (BII-1) and (BII-2)
- 20 (c) the radiation sensitive composition (a) or (b) for forming a colored layer, wherein the polyfunctional monomer (C) is at least one selected from the group consisting of trimethylolpropane triacrylate, pentaerythritol triacrylate and dipentaerythritol
25 hexaacrylate
- (d) the radiation sensitive composition (a), (b) or (c) for forming a colored layer, wherein the photopolymerization initiator (D) is at least one selected from the group consisting of an acetophenone
30 compound, biimidazole compound, triazine compound and O-acyloxime compound
- (e) the radiation sensitive composition (a), (b), (c) or (d) for forming a colored layer, wherein the colorant (A) is an organic pigment or carbon black

- (f) a radiation sensitive composition for forming a colored layer, wherein the alkali-soluble resin (B) comprises the copolymer (BII)
- 5 (g) the radiation sensitive composition (f) for forming a colored layer, wherein the copolymer (BII) comprises at least one selected from the group consisting of the copolymers (BII-1) and (BII-2)
- 10 (h) the radiation sensitive composition (f) or (g) for forming a colored layer, wherein the polyfunctional monomer (C) is at least one selected from the group consisting of trimethylolpropane triacrylate, pentaerythritol triacrylate and dipentaerythritol hexaacrylate
- 15 (i) the radiation sensitive composition (f), (g) or (h) for forming a colored layer, wherein the photopolymerization initiator (D) is at least one selected from the group consisting of an acetophenone compound, biimidazole compound and triazine compound
- 20 (j) the radiation sensitive composition (f), (g), (h) or (i) for forming a colored layer, wherein the colorant (A) is an organic pigment or carbon black.

The preferred color filter (k) of the present invention has pixels and/or a black matrix formed from the radiation sensitive composition (a), (b), (c), (d) or (e) for forming
25 a colored layer.

The preferred color filter (l) of the present invention has pixels and/or a black matrix formed from the radiation sensitive composition (f), (g), (h), (i) or (j) for forming a colored layer.

30 The preferred color liquid crystal display device (m) of the present invention comprises the above color filter (k) or (l), and the more preferred color liquid crystal display device (n) of the present invention comprises the above color filter (k) or (l) on a thin film transistor

substrate array.

As described above, the radiation sensitive composition of the present invention has excellent storage stability as a liquid composition while retaining excellent
5 sensitivity, resolution and pattern shape and can provide a pixel pattern and a black matrix pattern having excellent resistance to a wide variety of solvents and adhesion to a substrate.

Therefore, the radiation sensitive composition of the
10 present invention can be extremely advantageously used in the manufacture of a color filter such as a color filter for color liquid crystal display devices in the field of the electronic industry.

15 Examples

The following examples are provided for the purpose of further illustrating the present invention but are in no way to be taken as limiting. "Parts" and "%" are based on weight.

20

Synthesis of alkali-soluble copolymer

Synthesis Example 1

3 parts of 2,2'-azobisisobutyronitrile and 200 parts of propylene glycol monomethyl ether acetate were fed to a
25 flask equipped with a cooling tube and a stirrer, 15 parts of methacrylic acid, 25 parts of 3-(methacryloyloxymethyl)-3-ethyloxetane, 60 parts of benzyl methacrylate and 3 parts of α -methylstyrene dimer as a molecular weight control agent were then fed to the flask,
30 and the inside of the flask was substituted by nitrogen. The resulting mixture was stirred gently, and the obtained reaction solution was heated at 80°C to be polymerized by maintaining that temperature for 5 hours so as to obtain a resin solution. This resin was designated as an

alkali-soluble resin (B-1).

Synthesis Example 2

3 parts of 2,2'-azobisisobutyronitrile and 200 parts
5 of propylene glycol monomethyl ether acetate were fed to a
flask equipped with a cooling tube and a stirrer, 15 parts
of methacrylic acid, 25 parts of
3-(methacryloyloxymethyl)-3-ethyloxetane, 20 parts of
N-phenylmaleimide, 10 parts of styrene, 30 parts of benzyl
10 methacrylate and 3 parts of α -methylstyrene dimer as a
molecular weight control agent were then fed to the flask,
and the inside of the flask was substituted by nitrogen. The
resulting mixture was stirred gently, and the obtained
reaction solution was heated at 80°C to be polymerized by
15 maintaining that temperature for 5 hours so as to obtain a
resin solution. This resin was designated as an
alkali-soluble resin (B-2).

Synthesis Example 3

20 3 parts of 2,2'-azobisisobutyronitrile and 200 parts
of propylene glycol monomethyl ether acetate were fed to a
flask equipped with a cooling tube and a stirrer, 15 parts
of methacrylic acid, 25 parts of
3-(methacryloyloxymethyl)oxetane, 60 parts of benzyl
25 methacrylate and 3 parts of α -methylstyrene dimer as a
molecular weight control agent were then fed to the flask,
and the inside of the flask was substituted by nitrogen. The
resulting mixture was stirred gently, and the obtained
reaction solution was heated at 80°C to be polymerized by
30 maintaining that temperature for 5 hours so as to obtain a
resin solution. This resin was designated as an
alkali-soluble resin (B-3).

Synthesis Example 4

3 parts of 2,2'-azobisisobutyronitrile and 200 parts of propylene glycol monomethyl ether acetate were fed to a flask equipped with a cooling tube and a stirrer, 15 parts of methacrylic acid, 25 parts of tetrahydrofurfuryl methacrylate, 60 parts of benzyl methacrylate and 3 parts of α -methylstyrene dimer as a molecular weight control agent were then fed to the flask, and the inside of the flask was substituted by nitrogen. The resulting mixture was stirred gently, and the obtained reaction solution was heated at 80°C to be polymerized by maintaining that temperature for 5 hours so as to obtain a resin solution. This resin was designated as an alkali-soluble resin (B-4).

Synthesis Example 5

3 parts of 2,2'-azobisisobutyronitrile and 200 parts of propylene glycol monomethyl ether acetate were fed to a flask equipped with a cooling tube and a stirrer, 15 parts of methacrylic acid, 25 parts of tetrahydrofurfuryl methacrylate, 20 parts of N-phenylmaleimide, 10 parts of styrene, 30 parts of benzyl methacrylate and 3 parts of α -methylstyrene dimer as a molecular weight control agent were then fed to the flask, and the inside of the flask was substituted by nitrogen. The resulting mixture was stirred gently, and the obtained reaction solution was heated at 80°C to be polymerized by maintaining that temperature for 5 hours so as to obtain a resin solution. This resin was designated as an alkali-soluble resin (B-5).

Synthesis Example 6

3 parts of 2,2'-azobisisobutyronitrile and 200 parts of propylene glycol monomethyl ether acetate were fed to a flask equipped with a cooling tube and a stirrer, 15 parts of methacrylic acid, 60 parts of benzyl methacrylate, 25 parts of n-butyl methacrylate and 3 parts of α -methylstyrene

dimer as a molecular weight control agent were then fed to the flask, and the inside of the flask was substituted by nitrogen. The resulting mixture was stirred gently, and the obtained reaction solution was heated at 80°C to be
5 polymerized by maintaining that temperature for 5 hours so as to obtain a resin solution. This resin was designated as an alkali-soluble resin (B-6).

Synthesis Example 7

10 3 parts of 2,2'-azobisisobutyronitrile and 200 parts of propylene glycol monomethyl ether acetate were fed to a flask equipped with a cooling tube and a stirrer, 15 parts of methacrylic acid, 15 parts of tetrahydrofurfuryl methacrylate, 15 parts of
15 3-(methacryloyloxymethyl)-3-ethyloxetane, 55 parts of benzyl methacrylate and 3 parts of α -methylstyrene dimer as a molecular weight control agent were then fed to the flask, and the inside of the flask was substituted by nitrogen. The resulting mixture was stirred gently, and the obtained
20 reaction solution was heated at 80°C to be polymerized by maintaining that temperature for 5 hours so as to obtain a resin solution. This resin was designated as an alkali-soluble resin (B-7).

25 Synthesis Examples 8 to 14 and Comparative Synthesis Examples 1 to 6

Solutions of alkali-soluble resins (B-8) to (B-20) were obtained in the same manner as in Synthesis Example 7 except that the types and amounts of the unsaturated
30 compounds constituting the alkali-soluble resin were changed as shown in Table 1.

Table 1

	Synthesis Examples									
	7	8	9	10	11	12	13	14		
Alkali-soluble resin	B-7	B-8	B-9	B-10	B-11	B-12	B-13	B-14		
Acid unsaturated compound										
Methacrylic acid	15	15	15	15	15	15	15	15		
Tetrahydrofuran-based unsaturated compound										
Tetrahydrofurfuryl methacrylate	15	20	23	15	20	23	27	27		
Oxetane-based unsaturated compound										
3-(methacryloyloxymethyl)-3-ethyloxetane	15	10	7	-	-	-	3	-		
3-(methacryloyloxymethyl)oxetane	-	-	-	15	10	7	-	3		
other unsaturated compounds										
benzyl methacrylate	55	55	55	55	55	55	25	25		
N-phenylmaleimide	-	-	-	-	-	-	20	20		
Styrene	-	-	-	-	-	-	10	10		

Table 1-continued

	Comparative Synthesis Examples					
	1	2	3	4	5	6
Alkali-soluble resin	B-15	B-16	B-17	B-18	B-19	B-20
Acid unsaturated compound						
Methacrylic acid	15	15	15	15	15	15
Tetrahydrofuran-based unsaturated compound						
Tetrahydrofurfuryl methacrylate	-	-	30	-	-	-
Oxetane-based unsaturated compound						
3-(methacryloyloxymethyl)-3-ethyloxetane	30	-	-	3	3	-
3-(methacryloyloxymethyl)oxetane	-	30	-	-	-	-
other unsaturated compounds						
benzyl methacrylate	55	55	55	52	52	85
N-phenylmaleimide	-	-	-	20	20	-
Styrene	-	-	-	10	10	-

Preparation of pigment dispersion

Preparation Example 1

20 parts of a mixture of C.I. Pigment Red 254 and C.I.
5 Pigment Red 177 in a weight ratio of 80/20 as the colorant
(A), 5 parts (solid content) of BYK-2001 as a dispersant and
75 parts of propylene glycol monomethyl ether acetate as a
solvent were mixed together by a bead mill to prepare a
pigment dispersion (R).

10 Preparation Example 2

20 parts of a mixture of C.I. Pigment Green 36 and C.I.
Pigment Yellow 150 in a weight ratio of 50/50 as the colorant
(A), 5 parts (solid content) of Solspers 24000 as a
dispersant and 75 parts of propylene glycol monomethyl ether
15 acetate as a solvent were mixed together by a bead mill to
prepare a pigment dispersion (G).

Example 1

100 parts of the pigment dispersion (R), 10 parts
20 (solid content) of the alkali-soluble resin (B-1) as the
solution obtained in Synthesis Example 1, 5 parts (solid
content) of the alkali-soluble resin (B-4) as the solution
obtained in Synthesis Example 4, 15 parts of
trimethylolpropane triacrylate as the polyfunctional
25 monomer (C), 5 parts of
2-methyl-1-[4-(methylthio)phenyl]-2-morpholinopropan-1-
one and 3 parts of diethylthioxanthone as the
photopolymerization initiators (D) and propylene glycol
monomethyl ether acetate as a solvent were mixed together
30 to prepare a liquid composition (R-1) having a solid content
of 25 % (see Table 2).

A pattern was formed from the liquid composition (R-1)
by the following procedure and evaluated. The evaluation
results are shown in Table 10.

Pattern formation

The liquid composition (R-1) was applied to the surface of a glass substrate with a spin coater and prebaked at 90°C for 4 minutes to form a 1.3 µm-thick coating film. Thereafter, 3 of the substrates were cooled to room temperature, and the coating films on the substrates were exposed to 2,000 J/m² of radiation through a photomask with a high-pressure mercury lamp. The coating films were shower developed with a 0.04 % aqueous solution of potassium hydroxide at a temperature of 23°C and a development pressure of 1 kgf/cm² (nozzle diameter of 1 mm) and post-baked at 220°C for 30 minutes to form a 200 x 200 µm dot pattern.

Evaluation of solvent resistance

After the three substrates exposed to 2,000 J/m² of radiation were immersed in N-methylpyrrolidone (expressed as NMP in Tables 10 to 13), a 18 % aqueous solution of HCl (expressed as HCl in Tables 10 to 13) and a 5 % aqueous solution of KOH (expressed as KOH in Tables 10 to 13) at 25°C for 30 minutes, respectively, the dot patterns before and after immersion were observed through a scanning electron microscope. ○ means that the pattern was formed well and the film thickness ratio before and after immersion (film thickness after immersion x 100/film thickness before immersion) is 95 % or more, △ means that the film thickness ratio before and after immersion is less than 95 % or part of the pattern is missing, and × means that all the pattern peels off from the substrate after immersion.

Evaluation of adhesion

The liquid composition (R-1) was applied to the surface of a glass substrate with a spin coater and prebaked at 90°C for 4 minutes to form a 1.3 µm-thick coating film. Thereafter,

this substrate was cooled to room temperature, and the coating film was exposed to 2,000 J/m² of radiation with a high-pressure mercury lamp. The coating film was then shower developed with a 0.04 % aqueous solution of potassium hydroxide at a temperature of 23°C and a development pressure of 1 kgf/cm² (nozzle diameter of 1 mm) and post-baked at 220°C for 30 minutes. Thereafter, the coating film was cross cut into 100 squares in accordance with JIS K5400 to make an adhesion test. ○ means that no squares do not peel off, △ means that 1 to 10 squares peel off, and × means that more than 10 squares peel off.

Evaluation of storage stability of liquid composition

When the liquid composition (R-1) was put into a glass bottle and kept in a thermo-hydrostat at 40°C for 1 week, the viscosity of the liquid composition before and after storage was measured to calculate the change rate of viscosity (viscosity after storage x 100/viscosity before storage). The viscosity of the pigment dispersion (R), the viscosity of the solution of the alkali-soluble resin (B-1) and the viscosity of the solution of the alkali-soluble resin (B-4) remained unchanged after they were kept under the same conditions as above.

Examples 2 to 22

Liquid compositions (R-2) to (R-22) were prepared in the same manner as in Example 1 except that the types and amounts of the constituent components were changed as shown in Tables 2 and 3.

Evaluations were made in the same manner as in Example 1 except that the liquid compositions (R-2) to (R-22) were used in place of the liquid composition (R-1). The viscosity of the solution of the alkali-soluble resin (B-5) used in Examples 8 to 10, the viscosity of the solution of the

alkali-soluble resin (B-2) used in Examples 11 to 16 and the viscosity of the solution of the alkali-soluble resin (B-3) used in Examples 17 to 22 remained unchanged even when they were kept under the same conditions as when the storage stability of the above liquid composition was evaluated. The evaluation results are shown in Table 10.

Example 23

100 parts of the pigment dispersion (G), 10 parts (solid content) of the alkali-soluble resin (B-1) as the solution obtained in Synthesis Example 1, 5 parts (solid content) of the alkali-soluble resin (B-4) as the solution obtained in Synthesis Example 4, 12 parts of dipentaerythritol hexaacrylate as the polyfunctional monomer (C), 5 parts of 2-benzyl-2-dimethylamino-1-(4-moprholinophenyl)-butan-1-one and 3 parts of 4,4'-bis(diethylamino)benzophenone as the photopolymerization initiators (D) and propylene glycol monomethyl ether acetate as a solvent were mixed together to prepare a liquid composition (G-1) having a solid content of 25 % (see Table 4).

A pattern was formed from the liquid composition (G-1) in the same manner as in Example 1 except that the liquid composition (G-1) was used in place of the liquid composition (R-1) and evaluated. The viscosity of the pigment dispersion (G) used herein remained unchanged even when it was kept under the same conditions as when the storage stability of the above liquid composition was evaluated. The evaluation results are shown in Table 11.

30

Examples 24 to 44

Liquid compositions (G-2) to (G-22) were prepared in the same manner as in Example 23 except that the types and amounts of the constituent components were changed as shown

in Table 4 or Table 5.

Evaluations were made in the same manner as in Example 1 except that the liquid compositions (G-2) to (G-22) were used in place of the liquid composition (R-1). The
5 evaluation results are shown in Table 11.

Comparative Examples 1 to 19

Liquid compositions (R-23) to (R-41) were prepared in the same manner as in Example 1 except that the types and
10 amounts of the constituent components were changed as shown in Table 6 or Table 7.

Evaluations were made in the same manner as in Example 1 except that the liquid compositions (R-23) to (R-41) were used in place of the liquid composition (R-1). The
15 evaluation results are shown in Table 12.

Comparative Examples 20 to 38

Liquid compositions (G-23) to (G-41) were prepared in the same manner as in Example 23 except that the types and
20 amounts of the constituent components were changed as shown in Table 8 or Table 9.

Evaluations were made in the same manner as in Example 1 except that the liquid compositions (G-23) to (G-41) were used in place of the liquid composition (R-1). The
25 evaluation results are shown in Table 13.

The polyfunctional monomers, photopolymerization initiators and additives in Tables 2 to 9 are given below.

Polyfunctional monomers

- C-1: trimethylolpropane triacrylate
30 C-2: dipentaerythritol hexaacrylate

Photopolymerization initiators

D-1:

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

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

D-3:

2-benzyl-2-dimethylamino-1-(4-morpholinophenyl)butan-1-

5 one

D-4: 2,4-diethylthioxanthone

D-5: 4,4'-bis(diethylamino)benzophenone

Additives

E-1: bisphenol A novolak epoxy resin (trade name:157S65 of
10 Japan Epoxy Resin Co., Ltd.)

E-2: trimellitic anhydride

E-3:

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

Table 2

	Liquid composition	pigment dispersion (parts)	alkali-soluble resin (parts)	polyfunctional monomer (parts)	photopolymerization initiator (parts)	Additive (parts)
Ex. 1	R-1	R (100)	B-1 (10) B-4 (5)	C-1 (15)	D-1 (5) D-4 (3)	-
Ex. 2	R-2	R (100)	B-1 (10) B-4 (5)	C-1 (15)	D-2 (5) D-4 (3)	-
Ex. 3	R-3	R (100)	B-1 (10) B-4 (5)	C-1 (15)	D-1 (5) D-4 (3)	E-1 (4)
Ex. 4	R-4	R (100)	B-1 (10) B-4 (5)	C-1 (15)	D-1 (5) D-4 (3)	E-2 (2)
Ex. 5	R-5	R (100)	B-1 (10) B-4 (5)	C-1 (15)	D-1 (5) D-4 (3)	E-3 (2)
Ex. 6	R-6	R (100)	B-1 (5) B-4 (10)	C-1 (15)	D-1 (5) D-4 (3)	-
Ex. 7	R-7	R (100)	B-1 (2) B-4 (13)	C-1 (15)	D-1 (5) D-4 (3)	-
Ex. 8	R-8	R (100)	B-1 (10) B-5 (5)	C-1 (15)	D-1 (5) D-4 (3)	-
Ex. 9	R-9	R (100)	B-1 (5) B-5 (10)	C-1 (15)	D-1 (5) D-4 (3)	-
Ex. 10	R-10	R (100)	B-1 (2) B-5 (13)	C-1 (15)	D-1 (5) D-4 (3)	-

Ex.: Example

Table 3

	Liquid composition	pigment dispersion (parts)	alkali-soluble resin (parts)	polyfunctional monomer (parts)	photopolymerization initiator (parts)	Additive (parts)
Ex.11	R-11	R (100)	B-2 (10) B-4 (5)	C-1 (15)	D-1 (5) D-4 (3)	-
Ex.12	R-12	R (100)	B-2 (5) B-4 (10)	C-1 (15)	D-1 (5) D-4 (3)	-
Ex.13	R-13	R (100)	B-2 (2) B-4 (13)	C-1 (15)	D-1 (5) D-4 (3)	-
Ex.14	R-14	R (100)	B-2 (10) B-5 (5)	C-1 (15)	D-1 (5) D-4 (3)	-
Ex.15	R-15	R (100)	B-2 (5) B-5 (10)	C-1 (15)	D-1 (5) D-4 (3)	-
Ex.16	R-16	R (100)	B-2 (2) B-5 (13)	C-1 (15)	D-1 (5) D-4 (3)	-
Ex.17	R-17	R (100)	B-3 (10) B-4 (5)	C-1 (15)	D-1 (5) D-4 (3)	-
Ex.18	R-18	R (100)	B-3 (5) B-4 (10)	C-1 (15)	D-1 (5) D-4 (3)	-
Ex.19	R-19	R (100)	B-3 (2) B-4 (13)	C-1 (15)	D-1 (5) D-4 (3)	-
Ex.20	R-20	R (100)	B-3 (10) B-5 (5)	C-1 (15)	D-1 (5) D-4 (3)	-
Ex.21	R-21	R (100)	B-3 (5) B-5 (10)	C-1 (15)	D-1 (5) D-4 (3)	-
Ex.22	R-22	R (100)	B-3 (2) B-5 (13)	C-1 (15)	D-1 (5) D-4 (3)	-

Ex.: Example

Table 4

	Liquid composition	pigment dispersion (parts)	alkali-soluble resin (parts)	polyfunctional monomer (parts)	photopolymerization initiator (parts)	Additive (parts)
Ex. 23	G-1	G (100)	B-1 (10) B-4 (5)	C-2 (12)	D-3 (5) D-5 (3)	-
Ex. 24	G-2	G (100)	B-1 (10) B-4 (5)	C-2 (12)	D-2 (5) D-5 (3)	-
Ex. 25	G-3	G (100)	B-1 (10) B-4 (5)	C-2 (12)	D-3 (5) D-5 (3)	E-1 (4)
Ex. 26	G-4	G (100)	B-1 (10) B-4 (5)	C-2 (12)	D-3 (5) D-5 (3)	E-2 (2)
Ex. 27	G-5	G (100)	B-1 (10) B-4 (5)	C-2 (12)	D-3 (5) D-5 (3)	E-3 (2)
Ex. 28	G-6	G (100)	B-1 (5) B-4 (10)	C-2 (12)	D-3 (5) D-5 (3)	-
Ex. 29	G-7	G (100)	B-1 (2) B-4 (13)	C-2 (12)	D-3 (5) D-5 (3)	-
Ex. 30	G-8	G (100)	B-1 (10) B-5 (5)	C-2 (12)	D-3 (5) D-5 (3)	-
Ex. 31	G-9	G (100)	B-1 (5) B-5 (10)	C-2 (12)	D-3 (5) D-5 (3)	-
Ex. 32	G-10	G (100)	B-1 (2) B-5 (13)	C-2 (12)	D-3 (5) D-5 (3)	-

Ex.: Example

Table 5

	Liquid composition	pigment dispersion (parts)	alkali-soluble resin (parts)	polyfunctional monomer (parts)	photopolymerization initiator (parts)	Additive (parts)
Ex. 33	R-11	G (100)	B-2 (10) B-4 (5)	C-2 (12)	D-3 (5) D-5 (3)	-
Ex. 34	R-12	G (100)	B-2 (5) B-4 (10)	C-2 (12)	D-2 (5) D-5 (3)	-
Ex. 35	R-13	G (100)	B-2 (2) B-4 (13)	C-2 (12)	D-3 (5) D-5 (3)	-
Ex. 36	R-14	G (100)	B-2 (10) B-5 (5)	C-2 (12)	D-3 (5) D-5 (3)	-
Ex. 37	R-15	G (100)	B-2 (5) B-5 (10)	C-2 (12)	D-3 (5) D-5 (3)	-
Ex. 38	R-16	G (100)	B-2 (2) B-5 (13)	C-2 (12)	D-3 (5) D-5 (3)	-
Ex. 39	R-17	G (100)	B-3 (10) B-4 (5)	C-2 (12)	D-3 (5) D-5 (3)	-
Ex. 40	R-18	G (100)	B-3 (5) B-4 (10)	C-2 (12)	D-3 (5) D-5 (3)	-
Ex. 41	R-19	G (100)	B-3 (2) B-4 (13)	C-2 (12)	D-3 (5) D-5 (3)	-
Ex. 42	R-20	G (100)	B-3 (10) B-5 (5)	C-2 (12)	D-3 (5) D-5 (3)	-
Ex. 43	R-21	G (100)	B-3 (5) B-5 (10)	C-2 (12)	D-3 (5) D-5 (3)	-
Ex. 44	R-22	G (100)	B-3 (2) B-5 (13)	C-2 (12)	D-3 (5) D-5 (3)	-

Ex.: Example

Table 6

	Liquid composition	pigment dispersion (parts)	alkali-soluble resin (parts)	polyfunctional monomer (parts)	photopolymerization initiator (parts)	Additive (parts)
C.Ex.1	R-23	R (100)	B-1 (10) B-6 (5)	C-1 (15)	D-1 (5) D-4 (3)	-
C.Ex.2	R-24	R (100)	B-1 (10) B-6 (5)	C-1 (15)	D-2 (5) D-4 (3)	-
C.Ex.3	R-25	R (100)	B-1 (10) B-6 (5)	C-1 (15)	D-1 (5) D-4 (3)	E-1 (4)
C.Ex.4	R-26	R (100)	B-1 (10) B-6 (5)	C-1 (15)	D-1 (5) D-4 (3)	E-2 (2)
C.Ex.5	R-27	R (100)	B-1 (10) B-6 (5)	C-1 (15)	D-1 (5) D-4 (3)	E-3 (2)
C.Ex.6	R-28	R (100)	B-1 (5) B-6 (10)	C-1 (15)	D-1 (5) D-4 (3)	-
C.Ex.7	R-29	R (100)	B-1 (2) B-6 (13)	C-1 (15)	D-1 (5) D-4 (3)	-
C.Ex.8	R-30	R (100)	B-2 (10) B-6 (5)	C-1 (15)	D-1 (5) D-4 (3)	-
C.Ex.9	R-31	R (100)	B-2 (5) B-6 (10)	C-1 (15)	D-1 (5) D-4 (3)	-
C.Ex.10	R-32	R (100)	B-2 (2) B-6 (13)	C-1 (15)	D-1 (5) D-4 (3)	-
C.Ex.11	R-33	R (100)	B-3 (10) B-6 (5)	C-1 (15)	D-1 (5) D-4 (3)	-
C.Ex.12	R-34	R (100)	B-3 (5) B-6 (10)	C-1 (15)	D-1 (5) D-4 (3)	-
C.Ex.13	R-35	R (100)	B-3 (2) B-6 (13)	C-1 (15)	D-1 (5) D-4 (3)	-

C.Ex.: Comparative Example

Table 7

	Liquid composition	pigment dispersion (parts)	alkali-soluble resin (parts)	polyfunctional monomer (parts)	photopolymerization initiator (parts)	Additive (parts)
C.Ex. 14	R-36	R (100)	B-1 (15)	C-1 (15)	D-1 (5) D-4 (3)	-
C.Ex. 15	R-37	R (100)	B-2 (15)	C-1 (15)	D-1 (5) D-4 (3)	-
C.Ex. 16	R-38	R (100)	B-3 (15)	C-1 (15)	D-1 (5) D-4 (3)	-
C.Ex. 17	R-39	R (100)	B-4 (15)	C-1 (15)	D-1 (5) D-4 (3)	-
C.Ex. 18	R-40	R (100)	B-5 (15)	C-1 (15)	D-1 (5) D-4 (3)	-
C.Ex. 19	R-41	R (100)	B-6 (15)	C-1 (15)	D-1 (5) D-4 (3)	-

Table 8

	Liquid composition	pigment dispersion (parts)	alkali-soluble resin (parts)	polyfunctional monomer (parts)	photopolymerization initiator (parts)	Additive (parts)
C.Ex. 20	G-23	G (100)	B-1 (10) B-6 (5)	C-2 (12)	D-3 (5) D-5 (3)	-
C.Ex. 21	G-24	G (100)	B-1 (10) B-6 (5)	C-2 (12)	D-2 (5) D-5 (3)	-
C.Ex. 22	G-25	G (100)	B-1 (10) B-6 (5)	C-2 (12)	D-3 (5) D-5 (3)	E-1 (4)
C.Ex. 23	G-26	G (100)	B-1 (10) B-6 (5)	C-2 (12)	D-3 (5) D-5 (3)	E-2 (2)
C.Ex. 24	G-27	G (100)	B-1 (10) B-6 (5)	C-2 (12)	D-3 (5) D-5 (3)	E-3 (2)
C.Ex. 25	G-28	G (100)	B-1 (5) B-6 (10)	C-2 (12)	D-3 (5) D-5 (3)	-
C.Ex. 26	G-29	G (100)	B-1 (2) B-6 (13)	C-2 (12)	D-3 (5) D-5 (3)	-
C.Ex. 27	G-30	G (100)	B-2 (10) B-6 (5)	C-2 (12)	D-3 (5) D-5 (3)	-
C.Ex. 28	G-31	G (100)	B-2 (5) B-6 (10)	C-2 (12)	D-3 (5) D-5 (3)	-
C.Ex. 29	G-32	G (100)	B-2 (2) B-6 (13)	C-2 (12)	D-3 (5) D-5 (3)	-
C.Ex. 30	G-33	G (100)	B-3 (10) B-6 (5)	C-2 (12)	D-3 (5) D-5 (3)	-
C.Ex. 31	G-34	G (100)	B-3 (5) B-6 (10)	C-2 (12)	D-3 (5) D-5 (3)	-
C.Ex. 32	G-35	G (100)	B-3 (2) B-6 (13)	C-2 (12)	D-3 (5) D-5 (3)	-

C.Ex.: Comparative Example

Table 9

	Liquid composition	pigment dispersion (parts)	alkali-soluble resin (parts)	polyfunctional monomer (parts)	photopolymerization initiator (parts)	Additive (parts)
C.Ex. 33	G-36	G (100)	B-1 (15)	C-2 (12)	D-3 (5) D-5 (3)	-
C.Ex. 34	G-37	G (100)	B-2 (15)	C-2 (12)	D-3 (5) D-5 (3)	-
C.Ex. 35	G-38	G (100)	B-3 (15)	C-2 (12)	D-3 (5) D-5 (3)	-
C.Ex. 36	G-39	G (100)	B-4 (15)	C-2 (12)	D-3 (5) D-5 (3)	-
C.Ex. 37	G-40	G (100)	B-5 (15)	C-2 (12)	D-3 (5) D-5 (3)	-
C.Ex. 38	G-41	G (100)	B-6 (15)	C-2 (12)	D-3 (5) D-5 (3)	-

C.Ex.: Comparative Example

Table 10

	Solvent resistance			adhesion	storage stability of liquid composition
	NMP	HCl	KOH		
Ex.1	○	○	○	○	100
Ex.2	○	○	○	○	100
Ex.3	○	○	○	○	100
Ex.4	○	○	○	○	100
Ex.5	○	○	○	○	100
Ex.6	○	○	○	○	100
Ex.7	○	○	○	○	100
Ex.8	○	○	○	○	100
Ex.9	○	○	○	○	100
Ex.10	○	○	○	○	100
Ex.11	○	○	○	○	100
Ex.12	○	○	○	○	100
Ex.13	○	○	○	○	100
Ex.14	○	○	○	○	100
Ex.15	○	○	○	○	100
Ex.16	○	○	○	○	100
Ex.17	○	○	○	○	100
Ex.18	○	○	○	○	100
Ex.19	○	○	○	○	100
Ex.20	○	○	○	○	100
Ex.21	○	○	○	○	100
Ex.22	○	○	○	○	100

Ex.:Example

Table 11

	Solvent resistance			adhesion	storage stability of liquid composition
	NMP	HCl	KOH		
Ex.23	○	○	○	○	100
Ex.24	○	○	○	○	100
Ex.25	○	○	○	○	100
Ex.26	○	○	○	○	100
Ex.27	○	○	○	○	100
Ex.28	○	○	○	○	100
Ex.29	○	○	○	○	100
Ex.30	○	○	○	○	100
Ex.31	○	○	○	○	100
Ex.32	○	○	○	○	100
Ex.33	○	○	○	○	100
Ex.34	○	○	○	○	100
Ex.35	○	○	○	○	100
Ex.36	○	○	○	○	100
Ex.37	○	○	○	○	100
Ex.38	○	○	○	○	100
Ex.39	○	○	○	○	100
Ex.40	○	○	○	○	100
Ex.41	○	○	○	○	100
Ex.42	○	○	○	○	100
Ex.43	○	○	○	○	100
Ex.44	○	○	○	○	100

Ex.:Example

Table 12

	Solvent resistance			adhesion	storage stability of liquid composition
	NMP	HCl	KOH		
C.Ex.1	×	×	△	×	100
C.Ex.2	×	×	△	×	100
C.Ex.3	△	△	△	×	100
C.Ex.4	△	△	△	×	100
C.Ex.5	△	△	△	×	100
C.Ex.6	×	△	×	×	100
C.Ex.7	×	×	×	×	100
C.Ex.8	△	△	△	×	100
C.Ex.9	△	△	△	×	100
C.Ex.10	△	×	×	×	100
C.Ex.11	×	△	△	×	100
C.Ex.12	×	△	×	×	100
C.Ex.13	×	×	×	×	100
C.Ex.14	○	○	○	○	304
C.Ex.15	○	○	○	○	300
C.Ex.16	○	○	○	○	405
C.Ex.17	×	×	×	×	100
C.Ex.18	×	×	×	×	100
C.Ex.19	×	×	×	×	100

C.Ex.: Comparative Example

Table 13

	Solvent resistance			adhesion	storage stability of liquid composition
	NMP	HCl	KOH		
C.Ex.20	×	×	×	×	100
C.Ex.21	×	×	×	×	100
C.Ex.22	△	△	△	×	100
C.Ex.23	△	×	△	×	100
C.Ex.24	×	△	△	×	100
C.Ex.25	×	×	×	×	100
C.Ex.26	×	×	×	×	100
C.Ex.27	△	△	△	×	100
C.Ex.28	△	×	△	×	100
C.Ex.29	△	×	×	×	100
C.Ex.30	×	×	×	×	100
C.Ex.31	×	×	×	×	100
C.Ex.32	×	×	×	×	100
C.Ex.33	○	○	○	○	405
C.Ex.34	○	○	○	○	387
C.Ex.35	○	○	○	○	504
C.Ex.36	×	×	×	×	100
C.Ex.37	×	×	×	×	100
C.Ex.38	×	×	×	×	100

Example 45

100 parts of the pigment dispersion (R), 15 parts (solid content) of the alkali-soluble resin (B-7) as the resin solution obtained in Synthesis Example 7, 10 parts of
5 dipentaerythritol hexaacrylate and 5 parts of trimethylolpropane triacrylate as the polyfunctional monomers (C), 5 parts of 2-methyl-1-[4-(methylthio)phenyl]-2-morpholinopropan-1-one and 3 parts of 4,4'-bis(diethylamino)benzophenone as the
10 photopolymerization initiators (D) and propylene glycol monomethyl ether acetate as a solvent were mixed together to prepare a liquid composition (R-42) having a solid content of 25 % (see Table 14).

A pattern was formed from the liquid composition (R-42)
15 by the following procedure and evaluated. The evaluation results are shown in Table 18.

Pattern formation

The liquid composition (R-42) was applied to the
20 surface of a glass substrate with a spin coater and prebaked at 90°C for 4 minutes to form a 1.3 µm-thick coating film. Thereafter, 3 of the substrates were cooled to room temperature, and the coating films on the substrates were exposed to 2,000 J/m² of radiation through a photomask with
25 a high-pressure mercury lamp. The coating films were shower developed with a 0.04 wt% aqueous solution of potassium hydroxide at a temperature of 23°C and a development pressure of 1 kgf/cm² (nozzle diameter of 1 mm) and post-baked at 220°C for 30 minutes to form a 200 x 200 µm dot pattern.

30

Evaluation of solvent resistance

After the three substrates exposed to 2,000 J/m² of radiation were immersed in N-methylpyrrolidone (expressed

as NMP in Tables 18 and 19), a 18 % aqueous solution of HCl (expressed as HCl in Tables 18 and 19) and a 5 % aqueous solution of KOH (expressed as KOH in Tables 18 and 19) at 25°C for 30 minutes, respectively, the dot patterns before and after immersion were observed through a scanning electron microscope. ○ means that the pattern was formed well and the film thickness ratio before and after immersion (film thickness after immersion x 100/film thickness before immersion) is 95 % or more, △ means that the film thickness ratio before and after immersion is less than 95 % or part of the pattern is missing, and × means that all the pattern peels off from the substrate after immersion.

Evaluation of adhesion

The liquid composition (R-42) was applied to the surface of a glass substrate with a spin coater and prebaked at 90°C for 4 minutes to form a 1.3 μm-thick coating film. Thereafter, this substrate was cooled to room temperature, and the coating film was exposed to 2,000 J/m² of radiation with a high-pressure mercury lamp. The coating film was then shower developed with a 0.04 % aqueous solution of potassium hydroxide at a temperature of 23°C and a development pressure of 1 kgf/cm² (nozzle diameter of 1 mm) and post-baked at 220°C for 30 minutes. Thereafter, the coating film was cross cut into 100 squares in accordance with JIS K5400 to make an adhesion test. ○ means that no squares do not peel off, △ means that 1 to 10 squares peel off, and × means that more than 10 squares peel off.

Evaluation of storage stability of liquid composition

When the liquid composition (R-42) was put into a glass bottle and kept in a thermo-hydrostat at 40°C for 1 week, the viscosity of the liquid composition before and after storage was measured to calculate the change rate of

viscosity (viscosity after storage x 100/viscosity before storage). The viscosity of the pigment dispersion (R) and the viscosity of the solution of the alkali-soluble resin (B-7) remained unchanged after they were kept under the same conditions as above.

Examples 46 to 56

Liquid compositions (R-43) to (R-53) were prepared in the same manner as in Example 45 except that the constituent components were changed as shown in Table 14.

Evaluations were made in the same manner as in Example 45 except that the liquid compositions ((R-43) to (R-53) were used in place of the liquid composition (R-42). The viscosities of the solutions of the alkali-soluble resins (B-8) to (B-14) used in Examples 50 to 56 remained unchanged even when they were kept under the same conditions as when the storage stability of the above liquid composition was evaluated. The evaluation results are shown in Table 18.

Example 57

100 parts of the pigment dispersion (G), 15 parts (solid content) of the alkali-soluble resin (B-7) as the resin solution obtained in Synthesis Example 7, 5 parts of dipentaerythritol hexaacrylate and 10 parts of pentaerythritol tetraacrylate as the polyfunctional monomers (C), 5 parts of 2-benzyl-2-dimethylamino-1-(4-morpholinophenyl)-butan-1-one and 5 parts of diethylthioxanthone as the photopolymerization initiators (D) and propylene glycol monomethyl ether acetate as a solvent were mixed together to prepare a liquid composition (G-42) having a solid content of 25 %.

A pattern was formed and evaluated in the same manner as in Example 45 except that the liquid composition (G-42)

was used in place of the liquid composition (R-42). The viscosity of the pigment dispersion (G) used herein remained unchanged even when it was kept under the same conditions as when the storage stability of the above liquid composition was evaluated. The evaluation results are shown in Table 18.

Examples 58 to 68

Liquid compositions (G-43) to (G-53) were prepared in the same manner as in Example 57 except that the constituent components were changed as shown in Table 15.

Evaluations were made in the same manner as in Example 45 except that the liquid compositions (G-43) to (G-53) were used in place of the liquid composition (R-42). The evaluation results are shown in Table 18.

Comparative Examples 39 to 48

Liquid compositions (R-54) to (R-63) were prepared in the same manner as in Example 45 except that the constituent components were changed as shown in Table 16.

Evaluations were made in the same manner as in Example 45 except that the liquid compositions (R-54) to (R-63) were used in place of the liquid composition (R-42). The evaluation results are shown in Table 19.

Comparative Examples 49 to 58

Liquid compositions (G-54) to (G-63) were prepared in the same manner as in Example 57 except that the constituent components were changed as shown in Table 17.

Evaluations were made in the same manner as in Example 45 except that the liquid compositions (G-54) to (G-63) were used in place of the liquid composition (R-42). The evaluation results are shown in Table 19.

The polyfunctional monomers, photopolymerization

initiators and additives in Tables 14 to 17 are given below.

Polyfunctional monomers

C-1: dipentaerythritol hexaacrylate

C-2: trimethylolpropane triacrylate

5 C-3: pentaerythritol tetraacrylate

Photopolymerization initiators

D-1:

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

10 D-2:

2-benzyl-2-dimethylamino-1-(4-morpholinophenyl)butan-1-one

D-3: 4,4'-bis(diethylamino)benzophenone

D-4: 2,4-diethylthioxanthone

15 Additives

E-1: bisphenol A novolak epoxy resin (trade name:157S65 of Japan Epoxy Resin Co., Ltd.)

E-2: trimellitic anhydride

E-3:

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

Table 14

	Liquid composition	pigment dispersion (parts)	alkali-soluble resin (parts)	polyfunctional monomer (parts)	photopolymerization initiator (parts)	Additive (parts)
Ex. 45	R-42	R (100)	B-7 (15)	C-1 (10) C-2 (5)	D-1 (5) D-3 (3)	—
Ex. 46	R-43	R (100)	B-7 (15)	C-1 (10) C-2 (5)	D-1 (5) D-3 (3)	—
Ex. 47	R-44	R (100)	B-7 (15)	C-1 (10) C-2 (5)	D-1 (5) D-3 (3)	E-1 (4)
Ex. 48	R-45	R (100)	B-7 (15)	C-1 (10) C-2 (5)	D-1 (5) D-3 (3)	E-2 (2)
Ex. 49	R-46	R (100)	B-7 (15)	C-1 (10) C-2 (5)	D-1 (5) D-3 (3)	E-3 (2)
Ex. 50	R-47	R (100)	B-8 (15)	C-1 (10) C-2 (5)	D-1 (5) D-3 (3)	—
Ex. 51	R-48	R (100)	B-9 (15)	C-1 (10) C-2 (5)	D-1 (5) D-3 (3)	—
Ex. 52	R-49	R (100)	B-10 (15)	C-1 (10) C-2 (5)	D-1 (5) D-3 (3)	—
Ex. 53	R-50	R (100)	B-11 (15)	C-1 (10) C-2 (5)	D-1 (5) D-3 (3)	—
Ex. 54	R-51	R (100)	B-12 (15)	C-1 (10) C-2 (5)	D-1 (5) D-3 (3)	—
Ex. 55	R-52	R (100)	B-13 (15)	C-1 (10) C-2 (5)	D-1 (5) D-3 (3)	—
Ex. 56	R-53	R (100)	B-14 (15)	C-1 (10) C-2 (5)	D-1 (5) D-3 (3)	—

Ex. : Example

Table 15

	Liquid composition	pigment dispersion (parts)	alkali-soluble resin (parts)	polyfunctional monomer (parts)	photopolymerization initiator (parts)	Additive (parts)
Ex. 57	G-42	G (100)	B-7 (15)	C-1 (5) C-3 (10)	D-2 (5) D-4 (5)	—
Ex. 58	G-43	G (100)	B-7 (15)	C-1 (5) C-3 (10)	D-2 (5) D-4 (5)	—
Ex. 59	G-44	G (100)	B-7 (15)	C-1 (5) C-3 (10)	D-2 (5) D-4 (5)	E-1 (4)
Ex. 60	G-45	G (100)	B-7 (15)	C-1 (5) C-3 (10)	D-2 (5) D-4 (5)	E-2 (2)
Ex. 61	G-46	G (100)	B-7 (15)	C-1 (5) C-3 (10)	D-2 (5) D-4 (5)	E-3 (2)
Ex. 62	G-47	G (100)	B-8 (15)	C-1 (5) C-3 (10)	D-2 (5) D-4 (5)	—
Ex. 63	G-48	G (100)	B-9 (15)	C-1 (5) C-3 (10)	D-2 (5) D-4 (5)	—
Ex. 64	G-49	G (100)	B-10 (15)	C-1 (5) C-3 (10)	D-2 (5) D-4 (5)	—
Ex. 65	G-50	G (100)	B-11 (15)	C-1 (5) C-3 (10)	D-2 (5) D-4 (5)	—
Ex. 66	G-51	G (100)	B-12 (15)	C-1 (5) C-3 (10)	D-2 (5) D-4 (5)	—
Ex. 67	G-52	G (100)	B-13 (15)	C-1 (5) C-3 (10)	D-2 (5) D-4 (5)	—
Ex. 68	G-53	G (100)	B-14 (15)	C-1 (5) C-3 (10)	D-2 (5) D-4 (5)	—

Ex.: Example

Table 16

	Liquid composition	pigment dispersion (parts)	alkali-soluble resin (parts)	polyfunctional monomer (parts)	photopolymerization initiator (parts)	Additive (parts)
C.Ex. 39	R-54	R (100)	B-15 (15)	C-1 (10) C-2 (5)	D-1 (5) D-3 (3)	—
C.Ex. 40	R-55	R (100)	B-15 (15)	C-1 (10) C-2 (5)	D-1 (5) D-3 (3)	—
C.Ex. 41	R-56	R (100)	B-15 (15)	C-1 (10) C-2 (5)	D-1 (5) D-3 (3)	E-1 (4)
C.Ex. 42	R-57	R (100)	B-15 (15)	C-1 (10) C-2 (5)	D-1 (5) D-3 (3)	E-2 (2)
C.Ex. 43	R-58	R (100)	B-15 (15)	C-1 (10) C-2 (5)	D-1 (5) D-3 (3)	E-3 (2)
C.Ex. 44	R-59	R (100)	B-16 (15)	C-1 (10) C-2 (5)	D-1 (5) D-3 (3)	—
C.Ex. 45	R-60	R (100)	B-17 (15)	C-1 (10) C-2 (5)	D-1 (5) D-3 (3)	—
C.Ex. 46	R-61	R (100)	B-18 (15)	C-1 (10) C-2 (5)	D-1 (5) D-3 (3)	—
C.Ex. 47	R-62	R (100)	B-19 (15)	C-1 (10) C-2 (5)	D-1 (5) D-3 (3)	—
C.Ex. 48	R-63	R (100)	B-20 (15)	C-1 (10) C-2 (5)	D-1 (5) D-3 (3)	—

C.Ex.: Comparative Example

Table 17

	Liquid composition	pigment dispersion (parts)	alkali-soluble resin (parts)	polyfunctional monomer (parts)	photopolymerization initiator (parts)	Additive (parts)
C.Ex. 49	G-54	G (100)	B-15 (15)	C-1 (5) C-3 (10)	D-2 (5) D-4 (5)	—
C.Ex. 50	G-55	G (100)	B-15 (15)	C-1 (5) C-3 (10)	D-2 (5) D-4 (5)	—
C.Ex. 51	G-56	G (100)	B-15 (15)	C-1 (5) C-3 (10)	D-2 (5) D-4 (5)	E-1 (4)
C.Ex. 52	G-57	G (100)	B-15 (15)	C-1 (5) C-3 (10)	D-2 (5) D-4 (5)	E-2 (2)
C.Ex. 53	G-58	G (100)	B-15 (15)	C-1 (5) C-3 (10)	D-2 (5) D-4 (5)	E-3 (2)
C.Ex. 54	G-59	G (100)	B-16 (15)	C-1 (5) C-3 (10)	D-2 (5) D-4 (5)	—
C.Ex. 55	G-60	G (100)	B-17 (15)	C-1 (5) C-3 (10)	D-2 (5) D-4 (5)	—
C.Ex. 56	G-61	G (100)	B-18 (15)	C-1 (5) C-3 (10)	D-2 (5) D-4 (5)	—
C.Ex. 57	G-62	G (100)	B-19 (15)	C-1 (5) C-3 (10)	D-2 (5) D-4 (5)	—
C.Ex. 58	G-63	G (100)	B-20 (15)	C-1 (5) C-3 (10)	D-2 (5) D-4 (5)	—

C.Ex.: Comparative Example

Table 18

	Solvent resistance			adhesion	storage stability of liquid composition
	NMP	HCl	KOH		
Ex.45	○	○	○	○	100
Ex.46	○	○	○	○	100
Ex.47	○	○	○	○	100
Ex.48	○	○	○	○	100
Ex.49	○	○	○	○	100
Ex.50	○	○	○	○	100
Ex.51	○	○	○	○	100
Ex.52	○	○	○	○	100
Ex.53	○	○	○	○	100
Ex.54	○	○	○	○	100
Ex.55	○	○	○	○	100
Ex.56	○	○	○	○	100
Ex.57	○	○	○	○	100
Ex.58	○	○	○	○	100
Ex.59	○	○	○	○	100
Ex.60	○	○	○	○	100
Ex.61	○	○	○	○	100
Ex.62	○	○	○	○	100
Ex.63	○	○	○	○	100
Ex.64	○	○	○	○	100
Ex.65	○	○	○	○	100
Ex.66	○	○	○	○	100
Ex.67	○	○	○	○	100
Ex.68	○	○	○	○	100

Ex.:Example

Table 19

	Solvent resistance			adhesion	storage stability of liquid composition
	NMP	HCl	KOH		
C.Ex.39	○	○	○	○	280
C.Ex.40	○	○	○	○	304
C.Ex.41	○	○	○	○	334
C.Ex.42	○	○	○	○	456
C.Ex.43	○	○	○	○	345
C.Ex.44	○	○	○	○	298
C.Ex.45	×	×	×	×	100
C.Ex.46	×	△	×	×	100
C.Ex.47	×	△	×	×	100
C.Ex.48	×	×	×	×	100
C.Ex.49	○	○	○	○	350
C.Ex.50	○	○	○	○	460
C.Ex.51	○	○	○	○	315
C.Ex.52	○	○	○	○	316
C.Ex.53	○	○	○	○	317
C.Ex.54	○	○	○	○	406
C.Ex.55	×	×	×	×	100
C.Ex.56	×	△	×	×	100
C.Ex.57	×	×	×	×	100
C.Ex.58	×	×	×	×	100

C.Ex.: Comparative Example

What is claimed is:

1. A radiation sensitive composition comprising (A) a colorant, (B) an alkali-soluble resin, (C) a polyfunctional monomer and (D) a photopolymerization initiator, wherein
5 the alkali-soluble resin (B) is a copolymer of (b1) at least one first unsaturated compound selected from the group consisting of an unsaturated carboxylic acid, an unsaturated carboxylic anhydride and an unsaturated phenolic compound and at least one second unsaturated compound
10 selected from the group consisting of (b2) an unsaturated compound having an oxetane skeleton and (b3) an unsaturated compound having a tetrahydrofuran skeleton, and the radiation sensitive composition is used to form a colored layer.
15
2. The radiation sensitive composition according to claim 1, wherein the alkali-soluble resin (B) is a copolymer of the first unsaturated compound and the unsaturated compound having an oxetane skeleton as the second unsaturated compound,
20 or a copolymer of the first unsaturated compound and the unsaturated compound having a tetrahydrofuran skeleton as the second unsaturated compound.
3. The radiation sensitive composition according to claim
25 1, wherein the alkali-soluble resin (B) is a copolymer of the first unsaturated compound and the unsaturated compound having an oxetane skeleton and the unsaturated compound having a tetrahydrofuran skeleton as the second unsaturated compounds.
30
4. A color filter having a colored layer formed from the radiation sensitive composition for forming a colored layer of any one of claims 1 to 3.

5. A color liquid crystal display device comprising the color filter of claim 4.