

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.

15

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) (the term "JP-A" as used herein means an "unexamined published Japanese patent application").

 In the technical field of color filters, the tact time is now generally shortened by reducing the amount of exposure, and pixels and a black matrix formed with a small amount of
30 exposure need to have excellent pattern, solvent resistance and adhesion to a substrate. However, when the amount of exposure is small, a colored radiation sensitive composition of the prior art tends to have problems such as a reduction in film retention after exposure, a missing part of the

pattern, an undercut and the peeling of the pattern from the substrate. Therefore, it is difficult to obtain a satisfactory pixel pattern and black matrix pattern from the colored radiation sensitive composition of the prior art when the tact time is shortened. The radiation sensitive composition of the prior art is also unsatisfactory in terms of solvent resistance and adhesion to the substrate. Further, a colored radiation sensitive composition used to form a color filter has a high content of a pigment to obtain high color reproducibility. From the viewpoint of the production control of a color filter, the storage stability of an alkali-soluble resin itself needs to be high in addition to the storage stability of a pigment dispersion and the storage stability of a liquid composition containing a solvent. However, the colored radiation sensitive composition of the prior art could not be always satisfactory in these respects.

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 is excellent in the storage stability of an alkali-soluble resin itself, the storage stability of a pigment dispersion and the storage stability of a liquid composition even when the content of a pigment is high, is free from a reduction in film retention, a missing part of a pattern edge and an undercut even when the amount of exposure is small, and provides pixels and a black matrix having excellent solvent resistance and adhesion to a substrate.

It is another object of the present invention to provide a color filter having a colored layer formed from the above composition of the present invention and a color liquid crystal display device comprising the color filter.

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

According to the present invention, firstly, the above objects and advantages of the present invention are attained by a radiation sensitive composition for forming a colored layer, comprising (A) a colorant, (B) an alkali-soluble resin, 5 (C) a polyfunctional monomer and (D) a photopolymerization initiator, wherein

the alkali-soluble resin (B) is a copolymer comprising (b1) at least one selected from the group consisting of an unsaturated carboxylic acid, an unsaturated carboxylic anhydride and an unsaturated phenolic compound, (b2) an 10 unsaturated compound having an alicyclic carbon ring structure and (b3) an unsaturated compound having an oxetane ring structure.

In the present invention, the colored layer means 15 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 above radiation sensitive composition for forming a 20 colored layer.

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 above color filter.

25

Detailed Description of the Preferred Embodiments

The present invention will be described in detail hereinunder.

Radiation sensitive composition for forming a colored layer

30 - (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.

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.

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, C.I. Pigment Yellow 71, C.I. Pigment Yellow 73, C.I. Pigment Yellow 74, C.I. Pigment Yellow 81, C.I. Pigment Yellow 83, C.I. Pigment Yellow 93, C.I. Pigment Yellow 95, C.I. Pigment Yellow 97, C.I. Pigment Yellow 98, C.I. Pigment Yellow 100, C.I. Pigment Yellow 101, C.I. Pigment Yellow 104, C.I. Pigment Yellow 106, C.I. Pigment Yellow 108, C.I. Pigment Yellow 109, C.I. Pigment Yellow 110, C.I. Pigment Yellow 113, C.I. Pigment Yellow 114, C.I. Pigment Yellow 116, C.I. Pigment Yellow 117, C.I. Pigment Yellow 119, C.I. Pigment Yellow 120, C.I. Pigment Yellow 126, C.I. Pigment Yellow 127, C.I. Pigment Yellow 128, C.I. Pigment Yellow 129, C.I. Pigment Yellow 138, C.I. Pigment Yellow 139, C.I. Pigment Yellow 150, C.I. Pigment Yellow 151, C.I. Pigment Yellow 152, C.I. Pigment Yellow 153, C.I. Pigment Yellow 154, C.I. Pigment Yellow 155, C.I. Pigment Yellow 156, C.I. Pigment

Yellow 166, C.I. Pigment Yellow 168, C.I. Pigment Yellow 175,
 C.I. Pigment Yellow 180 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,
 5 C.I. Pigment Orange 17, C.I. Pigment Orange 24, C.I. Pigment
 Orange 34, C.I. Pigment Orange 36, C.I. Pigment Orange 38,
 C.I. Pigment Orange 40, C.I. Pigment Orange 43, C.I. Pigment
 Orange 46, C.I. Pigment Orange 49, C.I. Pigment Orange 51,
 C.I. Pigment Orange 61, C.I. Pigment Orange 63, C.I. Pigment
 10 Orange 64, C.I. Pigment Orange 71 and C.I. Pigment Orange
 73;
 C.I. Pigment Violet 1, C.I. Pigment Violet 19, C.I. Pigment
 Violet 23, C.I. Pigment Violet 29, C.I. Pigment Violet 32,
 C.I. Pigment Violet 36 and C.I. Pigment Violet 38;
 15 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
 20 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
 25 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
 30 Red 58:4, C.I. Pigment Red 60:1, C.I. Pigment Red 63:1, C.I.
 Pigment Red 63:2, C.I. Pigment Red 64:1, C.I. Pigment Red
 81:1, C.I. Pigment Red 83, C.I. Pigment Red 88, C.I. Pigment
 Red 90:1, C.I. Pigment Red 97, C.I. Pigment Red 101, C.I.
 Pigment Red 102, C.I. Pigment Red 104, C.I. Pigment Red 105,

C.I. Pigment Red 106, C.I. Pigment Red 108, C.I. Pigment Red 112, C.I. Pigment Red 113, C.I. Pigment Red 114, C.I. Pigment Red 122, C.I. Pigment Red 123, C.I. Pigment Red 144, C.I. Pigment Red 146, C.I. Pigment Red 149, C.I. Pigment Red 150, C.I. Pigment Red 151, C.I. Pigment Red 166, C.I. Pigment Red 168, C.I. Pigment Red 170, C.I. Pigment Red 171, C.I. Pigment Red 172, C.I. Pigment Red 174, C.I. Pigment Red 175, C.I. Pigment Red 176, C.I. Pigment Red 177, C.I. Pigment Red 178, C.I. Pigment Red 179, C.I. Pigment Red 180, C.I. Pigment Red 185, C.I. Pigment Red 187, C.I. Pigment Red 188, C.I. Pigment Red 190, C.I. Pigment Red 193, C.I. Pigment Red 194, C.I. Pigment Red 202, C.I. Pigment Red 206, C.I. Pigment Red 207, C.I. Pigment Red 208, C.I. Pigment Red 209, C.I. Pigment Red 215, C.I. Pigment Red 216, C.I. Pigment Red 220, C.I. Pigment Red 224, C.I. Pigment Red 226, C.I. Pigment Red 242, C.I. Pigment Red 243, C.I. Pigment Red 245, C.I. Pigment Red 254, C.I. Pigment Red 255, C.I. Pigment Red 264 and C.I. Pigment Red 265;

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

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

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

In the present invention, the above organic pigments and inorganic pigments may be used alone or in combination

of two or more, 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.

5 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
10 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.

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

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

 In the present invention, the radiation sensitive

resin composition can be prepared by a suitable method. When a pigment is used as the colorant, preferably, it is mixed with and dispersed into a solvent 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) which will be described hereinafter and optionally with an additional solvent and other additives which will be described hereinafter to prepare the radiation sensitive resin composition.

10 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 15 100 parts by weight, developability may be impaired.

 The solvent used for the preparation of the pigment dispersion may be identical to the solvent used for the liquid radiation sensitive resin composition which will be 20 described hereinafter.

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

25 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 the pigment mixed solution comprising a pigment, a solvent and a dispersant preferably while it is cooled with cooling water or the like.

30 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 200 hours, more preferably 2 to 100 hours.

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

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

10 - (B) alkali-soluble resin -

 The alkali-soluble resin in the present invention is a copolymer (to be referred to as "copolymer (BI)" hereinafter) comprising (b1) at least one selected from the group consisting of an unsaturated carboxylic acid, an
15 unsaturated carboxylic anhydride and an unsaturated phenolic compound (these compounds will be generically referred to as "acid unsaturated compound" hereinafter), (b2) an unsaturated compound having an alicyclic carbon ring structure (to be referred to as "alicyclic unsaturated
20 compound" hereinafter) and (b3) an unsaturated compound having an oxetane ring structure (to be referred to as "oxetane unsaturated compound" hereinafter). The component (B) serves as a binder for the colorant (A) and has solubility in an alkali developer which is used in a development step
25 for forming a colored layer.

 Examples of the above unsaturated carboxylic acid and unsaturated carboxylic anhydride include unsaturated monocarboxylic acids such as (meth)acrylic acid, crotonic acid, α -chloroacrylic acid and cinnamic acid; unsaturated
30 dicarboxylic acids and anhydrides 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 mono(meth)acrylates of a polymer having a carboxyl group and a hydroxyl group at both terminals such as ω -carboxypolycaprolactone mono(meth)acrylate.

Out of these unsaturated carboxylic acids and unsaturated carboxylic anhydrides,
 10 mono(2-acryloyloxyethyl)succinate and 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
 15 include unsaturated 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,
 20 3-vinyl-1-naphthol, 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
 25 particularly preferred as the acid unsaturated compound.

Examples of the above alicyclic unsaturated compound include (meth)acrylates such as cyclohexyl (meth)acrylate, isobornyl (meth)acrylate, tricyclo[5.2.1.0^{2,6}]decan-8-yl (meth)acrylate, tricyclo[5.2.1.0^{2,6}]decan-9-yl
 30 (meth)acrylate, tricyclo[5.2.1.0^{2,6}]decan-3-en-8-yl (meth)acrylate, tricyclo[5.2.1.0^{2,6}]decan-3-en-9-yl (meth)acrylate, 2-cyclohexyloxyethyl (meth)acrylate, 2-(tricyclo[5.2.1.0^{2,6}]decan-8-yloxy)ethyl (meth)acrylate, 2-(tricyclo[5.2.1.0^{2,6}]decan-9-yloxy)ethyl (meth)acrylate,

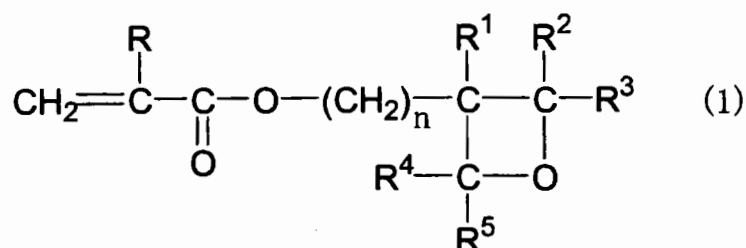
2- (tricyclo[5.2.1.0^{2,6}] decan-3-en-8-yloxy) ethyl
 (meth) acrylate,
 2- (tricyclo[5.2.1.0^{2,6}] decan-3-en-9-yloxy) ethyl
 (meth) acrylate,
 5 mono[2- (meth) acryloyloxyethyl] hexahydrophthalate,
 1-hydroxyethyl-2- (meth) acryloyloxyethyl
 hexahydrophthalate, 1-methyl-2- (meth) acryloyloxyethyl
 hexahydrophthalate and 1-ethyl-2- (meth) acryloyloxyethyl
 hexahydrophthalate; and vinyl ethers such as cyclohexyl
 10 vinyl ether, isobornyl vinyl ether,
 tricyclo[5.2.1.0^{2,6}] decan-8-ylvinyl ether,
 tricyclo[5.2.1.0^{2,6}] decan-9-ylvinyl ether,
 tricyclo[5.2.1.0^{2,6}] decan-3-en-8-ylvinyl ether,
 tricyclo[5.2.1.0^{2,6}] decan-3-en-9-ylvinyl ether,
 15 2-cyclohexyloxyethyl vinyl ether,
 2- (tricyclo[5.2.1.0^{2,6}] decan-8-yloxy) ethylvinyl ether,
 2- (tricyclo[5.2.1.0^{2,6}] decan-9-yloxy) ethylvinyl ether,
 2- (tricyclo[5.2.1.0^{2,6}] decan-3-en-8-yloxy) ethylvinyl ether,
 2- (tricyclo[5.2.1.0^{2,6}] decan-3-en-9-yloxy) ethylvinyl ether,
 20 mono[2-vinyloxyethyl] hexahydrophthalate,
 1-hydroxyethyl-2-vinyloxyethyl hexahydrophthalate,
 1-methyl-2-vinyloxyethyl hexahydrophthalate and
 1-ethyl-2-vinyloxyethyl hexahydrophthalate.

In the present invention, cyclohexyl (meth) acrylate,
 25 isobornyl (meth) acrylate, tricyclo[5.2.1.0^{2,6}] decan-8-yl
 (meth) acrylate, cyclohexyl vinyl ether, isobornyl vinyl
 ether and tricyclo[5.2.1.0^{2,6}] decan-8-ylvinyl ether are
 preferred, and cyclohexyl (meth) acrylate,
 tricyclo[5.2.1.0^{2,6}] decan-8-yl (meth) acrylate and isobornyl
 30 (meth) acrylate are particularly preferred as the alicyclic
 unsaturated compound.

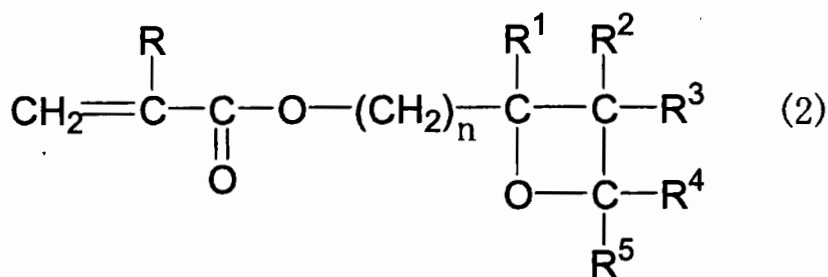
The above alicyclic unsaturated compounds may be used
 alone or in combination of two or more.

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 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 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.]



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

In the formulas (1) and (2), examples of the alkyl group having 1 to 4 carbon atoms represented by R, R¹, R², 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 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-i-propyl group, nonafluoro-n-butyl group, nonafluoro-i-butyl group,
 5 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)
 10 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,
 15 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,
 20 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,
 25 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,
 30 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

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

2-[2-(meth)acryloyloxyethyl]-2-pentafluoroethyloxetane,
 2-[2-(meth)acryloyloxyethyl]-3-pentafluoroethyloxetane,
 2-[2-(meth)acryloyloxyethyl]-4-pentafluoroethyloxetane,
 2-[2-(meth)acryloyloxyethyl]-2-phenyloxetane,
 5 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,
 10 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.

15 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,
 20 3-[(meth)acryloyloxymethyl]-2-phenyloxetane,
 2-[(meth)acryloyloxymethyl]oxetane and
 2-[(meth)acryloyloxymethyl]-4-trifluoromethyloxetane are
 preferred, and 3-(methacryloyloxymethyl)oxetane,
 3-(methacryloyloxymethyl)-3-ethyloxetane,
 25 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
 30 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,

[2-(3-oxetanyl)ethoxy]-p-vinylbenzene,
 (2-oxetanylmethoxy)-p-vinylbenzene and
 [2-(2-oxetanyl)ethoxy]-p-vinylbenzene; and
 (oxetanyllalkyl)vinyl ethers such as

5 (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).

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

The copolymer (B1) may further comprise an unsaturated
 compound as essential component (to be referred to as "other
 unsaturated compound" hereinafter) other than the acid
 15 unsaturated compounds, alicyclic unsaturated compounds and
 oxetane unsaturated compounds.

Examples of the other unsaturated compound include
 aromatic vinyl compounds such as styrene, α -methylstyrene,
 o-vinytoluene, m-vinytoluene, p-vinytoluene,
 20 p-chlorostyrene, o-methoxystyrene, m-methoxystyrene,
 p-methoxystyrene, o-vinylbenzylmethyl ether,
 m-vinylbenzylmethyl ether, p-vinylbenzylmethyl ether,
 o-vinylbenzylglycidyl ether, m-vinylbenzylglycidyl ether
 and p-vinylbenzylglycidyl ether; indenenes such as indene and
 25 1-methylindene; unsaturated imides such as maleimide,
 N-cyclohexylmaleimide, N-phenylmaleimide, itaconimide and
 citraconimide; unsaturated carboxylates such as methyl
 (meth)acrylate, ethyl (meth)acrylate, n-propyl
 (meth)acrylate, i-propyl (meth)acrylate, n-butyl
 30 (meth)acrylate, i-butyl (meth)acrylate, sec-butyl
 (meth)acrylate, t-butyl (meth)acrylate, 2-hydroxyethyl
 (meth)acrylate, 2-hydroxypropyl (meth)acrylate,
 3-hydroxypropyl (meth)acrylate, 2-hydroxybutyl
 (meth)acrylate, 3-hydroxybutyl (meth)acrylate,

4-hydroxybutyl (meth)acrylate, allyl (meth)acrylate, benzyl (meth)acrylate, cyclohexyl (meth)acrylate, phenyl (meth)acrylate, 2-methoxyethyl (meth)acrylate, 2-phenoxyethyl (meth)acrylate, 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 (meth)acrylate, 2-aminopropyl (meth)acrylate, 2-dimethylaminopropyl (meth)acrylate, 3-aminopropyl (meth)acrylate and 3-dimethylaminopropyl (meth)acrylate; unsaturated glycidyl carboxylates such as glycidyl (meth)acrylate; vinyl cyanide compounds such as (meth)acrylonitrile, α -chloroacrylonitrile and vinylidene cyanide; unsaturated amides such as (meth)acrylamide, α -chloroacrylamide and N-2-hydroxyethyl (meth)acrylamide; vinyl carboxylates such as vinyl acetate, vinyl propionate, vinyl butyrate and vinyl benzoate; unsaturated ethers such as vinyl methyl ether, vinyl ethyl ether and allyl glycidyl ether; aliphatic conjugated dienes such as 1,3-butadiene, isoprene and chloroprene; and macromonomers having a mono(meth)acryloyl group at a terminal of a polymer molecular chain such as polystyrene, polymethyl (meth)acrylate, 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 (BI) is preferably a copolymer (to be referred to as "copolymer (BII)" hereinafter) comprising as essential components (b1) at least one acid unsaturated compound essentially composed of (meth)acrylic acid, (b2) at least one alicyclic

unsaturated compound selected from the group consisting of cyclohexyl (meth)acrylate, isobornyl (meth)acrylate and tricyclo[5.2.1.0^{2,6}]decan-8-yl (meth)acrylate and (b3) at least one oxetane unsaturated compound selected from the group consisting of 3-[(meth)acryloyloxymethyl]oxetane, 3-[(meth)acryloyloxymethyl]-3-ethyloxetane, 3-[(meth)acryloyloxymethyl]-2-trifluoromethyloxetane, 3-[(meth)acryloyloxymethyl]-2-phenyloxetane, 2-[(meth)acryloyloxymethyl]oxetane and 2-[(meth)acryloyloxymethyl]-4-trifluoromethyloxetane, and optionally (b4) at least one other unsaturated compound selected from the group consisting of styrene, N-cyclohexylmaleimide, 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 (BII-1) comprising as essential components (b1) an acid unsaturated compound essentially composed of (meth)acrylic acid, (b2) an alicyclic unsaturated compound essentially composed of cyclohexyl (meth)acrylate and (b3) an oxetane unsaturated compound essentially composed of 3-[(meth)acryloyloxymethyl]oxetane and optionally (b4) at least one other unsaturated compound selected from the group consisting of styrene, N-cyclohexylmaleimide, 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 (BII-2) comprising as essential components (b1) an acid unsaturated compound essentially composed of (meth)acrylic acid, (b2) an alicyclic unsaturated compound essentially composed of cyclohexyl (meth)acrylate and (b3)

an oxetane unsaturated compound essentially composed of 3-[(meth)acryloyloxymethyl]-3-ethyloxetane and optionally (b4) at least one other unsaturated compound selected from the group consisting of styrene, N-cyclohexylmaleimide, 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 (BII-3) comprising as essential components (b1)

10 an acid unsaturated compound essentially composed of (meth)acrylic acid, (b2) an alicyclic unsaturated compound essentially composed of cyclohexyl (meth)acrylate and (b3) an oxetane unsaturated compound essentially 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-cyclohexylmaleimide, N-phenylmaleimide, methyl (meth)acrylate, 2-hydroxyethyl (meth)acrylate, allyl (meth)acrylate, benzyl (meth)acrylate, glycerol

20 mono(meth)acrylate, polystyrene macromonomer and polymethyl methacrylate macromonomer; a copolymer (BII-4) comprising as essential components (b1) an acid unsaturated compound essentially composed of (meth)acrylic acid, (b2) an alicyclic unsaturated compound essentially composed of

25 cyclohexyl (meth)acrylate and (b3) an oxetane unsaturated compound essentially composed of 3-[(meth)acryloyloxymethyl]-2-phenyloxetane and optionally (b4) at least one other unsaturated compound selected from the group consisting of styrene,

30 N-cyclohexylmaleimide, 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 (BII-5)

comprising as essential components (b1) an acid unsaturated compound essentially composed of (meth)acrylic acid, (b2) an alicyclic unsaturated compound essentially composed of cyclohexyl (meth)acrylate and (b3) an oxetane unsaturated compound essentially composed of

5 2-[(meth)acryloyloxymethyl]oxetane and optionally (b4) at least one other unsaturated compound selected from the group consisting of styrene, N-cyclohexylmaleimide, N-phenylmaleimide, methyl (meth)acrylate, 2-hydroxyethyl

10 (meth)acrylate, allyl (meth)acrylate, benzyl (meth)acrylate, glycerol mono(meth)acrylate, polystyrene macromonomer and polymethyl methacrylate macromonomer; a copolymer (BII-6) comprising as essential components (b1) an acid unsaturated compound essentially composed of

15 (meth)acrylic acid, (b2) an alicyclic unsaturated compound essentially composed of cyclohexyl (meth)acrylate and (b3) an oxetane unsaturated compound essentially composed of 2-[(meth)acryloyloxymethyl]-4-trifluoromethyloxetane and optionally (b4) at least one other unsaturated compound

20 selected from the group consisting of styrene, N-cyclohexylmaleimide, 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 (BII-7) comprising as essential components (b1) an acid unsaturated compound essentially composed of (meth)acrylic acid, (b2) an alicyclic unsaturated compound essentially composed of isobornyl (meth)acrylate and (b3) an oxetane unsaturated

30 compound essentially composed of 3-[(meth)acryloyloxymethyl]oxetane and optionally (b4) at least one other unsaturated compound selected from the group consisting of styrene, N-cyclohexylmaleimide, 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 (BII-8) comprising as essential components (b1) an acid unsaturated compound essentially composed of (meth)acrylic acid, (b2) an alicyclic unsaturated compound essentially composed of isobornyl (meth)acrylate and (b3) an oxetane unsaturated compound essentially composed of 3-[(meth)acryloyloxymethyl]-3-ethyloxetane and optionally (b4) at least one other unsaturated compound selected from the group consisting of styrene, N-cyclohexylmaleimide, 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 (BII-9) comprising as essential components (b1) an acid unsaturated compound essentially composed of (meth)acrylic acid, (b2) an alicyclic unsaturated compound essentially composed of isobornyl (meth)acrylate and (b3) an oxetane unsaturated compound essentially composed of 3-[(meth)acryloyloxymethyl]-2-trifluoromethyloxetane and optionally (b4) at least one other unsaturated compound selected from the group consisting of styrene, N-cyclohexylmaleimide, 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 (BII-10) comprising as essential components (b1) an acid unsaturated compound essentially composed of (meth)acrylic acid, (b2) an alicyclic unsaturated compound essentially composed of isobornyl (meth)acrylate and (b3) an oxetane unsaturated compound essentially composed of 3-[(meth)acryloyloxymethyl]-2-phenyloxetane and

optionally (b4) at least one other unsaturated compound selected from the group consisting of styrene, N-cyclohexylmaleimide, 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 (BII-11) comprising as essential components (b1) an acid unsaturated compound essentially composed of (meth)acrylic acid, (b2) an alicyclic unsaturated compound essentially composed of isobornyl (meth)acrylate and (b3) an oxetane unsaturated compound essentially composed of 2-[(meth)acryloyloxymethyl]oxetane and optionally (b4) at least one other unsaturated compound selected from the group consisting of styrene, N-cyclohexylmaleimide, 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 (BII-12) comprising as essential components (b1) an acid unsaturated compound essentially composed of (meth)acrylic acid, (b2) an alicyclic unsaturated compound essentially composed of isobornyl (meth)acrylate and (b3) an oxetane unsaturated compound essentially composed of 2-[(meth)acryloyloxymethyl]-4-trifluoromethyloxetane and optionally (b4) at least one other unsaturated compound selected from the group consisting of styrene, N-cyclohexylmaleimide, 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 (BII-13) comprising as essential components (b1) an acid unsaturated compound essentially composed of (meth)acrylic acid, (b2)

an alicyclic unsaturated compound essentially composed of tricyclo[5.2.1.0^{2,6}]decan-8-yl (meth)acrylate and (b3) an oxetane unsaturated compound essentially composed of 3-[(meth)acryloyloxymethyl]oxetane and optionally (b4) at least one other unsaturated compound selected from the group consisting of styrene, N-cyclohexylmaleimide, 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 (BII-14) comprising as essential components (b1) an acid unsaturated compound essentially composed of (meth)acrylic acid, (b2) an alicyclic unsaturated compound essentially composed of tricyclo[5.2.1.0^{2,6}]decan-8-yl (meth)acrylate and (b3) an oxetane unsaturated compound essentially composed of 3-[(meth)acryloyloxymethyl]-3-ethyloxetane and optionally (b4) at least one other unsaturated compound selected from the group consisting of styrene, N-cyclohexylmaleimide, 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 (BII-15) comprising as essential components (b1) an acid unsaturated compound essentially composed of (meth)acrylic acid, (b2) an alicyclic unsaturated compound essentially composed of tricyclo[5.2.1.0^{2,6}]decan-8-yl (meth)acrylate and (b3) an oxetane unsaturated compound essentially composed of 3-[(meth)acryloyloxymethyl]-2-trifluoromethyloxetane and optionally (b4) at least one other unsaturated compound selected from the group consisting of styrene, N-cyclohexylmaleimide, 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 (BII-16) comprising as essential components (b1) an acid unsaturated compound essentially composed of (meth)acrylic acid, (b2) an alicyclic unsaturated compound essentially composed of tricyclo[5.2.1.0^{2.6}]decan-8-yl (meth)acrylate and (b3) an oxetane unsaturated compound essentially composed of 3-[(meth)acryloyloxymethyl]-2-phenyloxetane and optionally (b4) at least one other unsaturated compound selected from the group consisting of styrene, N-cyclohexylmaleimide, 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 (BII-17) comprising as essential components (b1) an acid unsaturated compound essentially composed of (meth)acrylic acid, (b2) an alicyclic unsaturated compound essentially composed of tricyclo[5.2.1.0^{2.6}]decan-8-yl (meth)acrylate and (b3) an oxetane unsaturated compound essentially composed of 2-[(meth)acryloyloxymethyl]oxetane and optionally (b4) at least one other unsaturated compound selected from the group consisting of styrene, N-cyclohexylmaleimide, 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 (BII-18) comprising as essential components (b1) an acid unsaturated compound essentially composed of (meth)acrylic acid, (b2) an alicyclic unsaturated compound essentially composed of tricyclo[5.2.1.0^{2.6}]decan-8-yl (meth)acrylate and (b3) an oxetane unsaturated compound essentially composed of

2-[(meth)acryloyloxymethyl]-4-trifluoromethyloxetane and optionally (b4) at least one other unsaturated compound selected from the group consisting of styrene, N-cyclohexylmaleimide, N-phenylmaleimide, methyl
5 (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 (BII), the copolymer (BII-1),
10 the copolymer (BII-2), the copolymer (BII-7), the copolymer (BII-8), the copolymer (BII-13) and the copolymer (BII-14) are preferred.

In the copolymer (BI), the copolymerization amount of the acid unsaturated compound is preferably 1 to 40 wt%,
15 particularly preferably 5 to 30 wt% based on the copolymer, the copolymerization amount of the alicyclic unsaturated compound is preferably 1 to 50 wt%, particularly preferably 1 to 30 wt% based on the copolymer, the copolymerization amount of the oxetane unsaturated compound is preferably 1
20 to 60 wt%, particularly preferably 10 to 45 wt% based on the copolymer, and the copolymerization amount of the other unsaturated compound is preferably 0 to 50 wt%, more preferably 1 to 50 wt%, particularly preferably 5 to 40 wt% based on the copolymer.

25 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 stability of the alkali-soluble resin itself and the storage
30 stabilities of the pigment dispersion and the liquid composition and has high sensitivity, solvent resistance and adhesion to the substrate even when the content of the pigment is high can be obtained.

In the present invention, other alkali-soluble resin

may be used in combination with the copolymer (BI).

The above other alkali-soluble resin is not particularly limited as far as it serves as a binder for the colorant (A) and has solubility in an alkali developer which is used in a development step for forming a colored layer. For example, it is preferably an alkali-soluble resin having a carboxyl group. An example of the other alkali-soluble resin is a copolymer of at least one of the unsaturated carboxylic acids enumerated for the copolymer (BI) and at least one selected from the group consisting of alicyclic unsaturated compounds and other unsaturated compounds enumerated for the copolymer (BI).

A preferred example of the other alkali-soluble resin is a copolymer of (i) at least one carboxyl group-containing unsaturated compound essentially composed of (meth)acrylic acid and (ii) at least one 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.

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 copolymer (BI) and the other alkali-soluble resin in the present invention are each preferably 2,000 to 300,000, more preferably 3,000 to 100,000.

The number average molecular weights in terms of polystyrene (to be referred to as "Mn" hereinafter) measured by gel permeation chromatography (GPC, eluting solvent: tetrahydrofuran) of the copolymer (BI) and the other alkali-soluble resin in the present invention are each preferably 1,000 to 60,000, more preferably 2,000 to 25,000.

In the present invention, by using the above copolymer (BI) having specific Mw and Mn or a combination of the copolymer (BI) and the above other alkali-soluble resin having specific Mw and Mn, a radiation sensitive composition having excellent developability is obtained. It is thereby 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.

10 The Mw/Mn ratios of the copolymer (BI) and the other alkali-soluble resin are each preferably 1 to 5, more preferably 1 to 4.

In the present invention, the copolymers (BI) may be used alone or in combination of two or more. The other alkali-soluble resins may also be used alone or in combination of two or more.

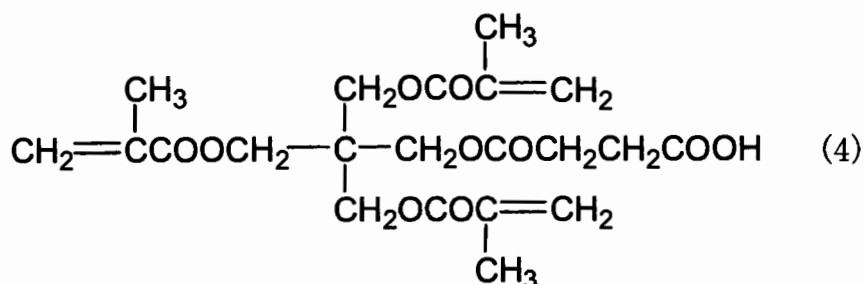
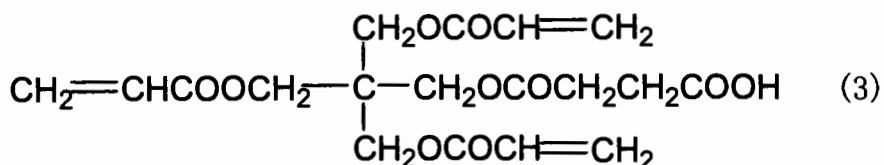
The total amount of the alkali-soluble resins in the present invention is preferably 10 to 1,000 parts by weight, more preferably 20 to 500 parts by weight based on 100 parts by weight of the colorant (A). When the total amount of the alkali-soluble resins is smaller than 10 parts by weight, alkali developability may lower, or a stain or the film residue may be produced on the substrate or light screening layer of an unexposed portion. 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 amount of the copolymer (BI) in the alkali-soluble resin is preferably 10 to 100 wt%, more preferably 20 to 100 wt%. When the amount of the copolymer (BI) is smaller than 10 wt%, the intended effect of the present invention may be impaired.

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

Examples of the polyfunctional monomer include
5 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
10 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
15 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 tris[2-(meth)acryloyloxyethyl]phosphate.

20 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,
25 pentaerythritol triacrylate, pentaerythritol trimethacrylate, pentaerythritol tetraacrylate, pentaerythritol tetramethacrylate, dipentaerythritol pentaacrylate, dipentaerythritol pentamethacrylate, dipentaerythritol hexaacrylate, dipentaerythritol
30 hexamethacrylate and compounds represented by the following formulas (3) and (4).



Out of these, trimethylolpropane triacrylate,
 5 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
 10 portion.

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

The amount of the polyfunctional monomer in the present
 invention is preferably 5 to 500 parts by weight, more
 15 preferably 20 to 300 parts by weight based on 100 parts by
 weight of the alkali-soluble resin (B). When the amount of
 the polyfunctional monomer is smaller than 5 parts by weight,
 the strength and surface smoothness of the colored layer may
 deteriorate and when the amount is larger than 500 parts by
 20 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
 25 having one polymerizable unsaturated bond.

Examples of the above monofunctional monomer include

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

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%
10 or less based on the polyfunctional monomer or 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.

15 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 (B). When the total amount is smaller
20 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
25 portion.

- (D) photopolymerization initiator -

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

The photopolymerization initiator is, for example, an acetophenone-based compound, biimidazole-based compound, triazine-based compound, benzoin-based compound, benzophenone-based compound, α -diketone-based compound, 5 polynuclear quinine-based compound, xanthone-based compound, diazo-based compound, O-acyloxime-based compound, onium salt-based compound or imidosulfonato-based compound. These compounds form an active radical, an active acid or both of them upon exposure.

10 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-based compound, biimidazole-based compound, triazine-based compound and 15 O-acyloxime-based compound is preferably used as the photopolymerization initiator in the present invention.

The amount of the photopolymerization initiator in the present invention is preferably 0.01 to 120 parts by weight, more preferably 1 to 100 parts by weight based on 100 parts 20 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 25 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-based compound out of the preferred photopolymerization initiators in the present 30 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-
5 one
2-benzyl-2-dimethylamino-1-(4-morpholinophenyl)butan-1-
one and 1,2-octanedione are preferred.

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

10 When the acetophenone-based compound is used as the
photopolymerization initiator in the present invention, the
amount of the acetophenone-based 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
15 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-based compound is smaller
than 0.01 part by weight, it may be difficult to obtain a
color filter having a predetermined colored layer pattern
20 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-based compound
include 2,2'-bis(2-chlorophenyl)-4,4',5,5'-tetrakis(4-
25 ethoxycarbonylphenyl)-1,2'-biimidazole,
2,2'-bis(2-bromophenyl)-4,4',5,5'-tetrakis(4-
ethoxycarbonylphenyl)-1,2'-biimidazole,
2,2'-bis(2-chlorophenyl)-4,4',5,5'-tetraphenyl-1,2'-
biimidazole,
30 2,2'-bis(2,4-dichlorophenyl)-4,4',5,5'-tetraphenyl-1,2'-
biimidazole,
2,2'-bis(2,4,6-trichlorophenyl)-4,4',5,5'-tetraphenyl-1,
2'-biimidazole,
2,2'-bis(2-bromophenyl)-4,4',5,5'-tetraphenyl-1,2'-

biimidazole,

2,2'-bis(2,4-dibromophenyl)-4,4',5,5'-tetraphenyl-1,2'-
biimidazole and

2,2'-bis(2,4,6-tribromophenyl)-4,4',5,5'-tetraphenyl-
1,2'-biimidazole.

Out of these biimidazole-based compounds,

2,2'-bis(2-chlorophenyl)-4,4',5,5'-tetraphenyl-1,2'-
biimidazole,

2,2'-bis(2,4-dichlorophenyl)-4,4',5,5'-tetraphenyl-1,2'-
biimidazole and

2,2'-bis(2,4,6-trichlorophenyl)-4,4',5,5'-tetraphenyl-1,
2'-biimidazole are preferred, and

2,2'-bis(2,4-dichlorophenyl)-4,4',5,5'-tetraphenyl-1,2'-
biimidazole is particularly preferred.

These biimidazole-based compounds have excellent
solubility in a solvent, do not form foreign matter such as
an undissolved product and a precipitate, have high
sensitivity, 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.

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

When the biimidazole-based compound is used as the
photopolymerization initiator in the present invention, the
amount of the biimidazole-based 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
of the polyfunctional monomer and the monofunctional monomer.

When the amount of the biimidazole-based 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
5 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.

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

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

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

The above mercaptan-based 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
20 mercapto groups directly bonded to the mother nucleus (to be referred to as "mercaptan-based hydrogen donor" hereinafter).

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

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

A detailed description is subsequently given of these hydrogen donors.

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

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

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

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

The amine-based 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.

At least one amino group of the amine-based hydrogen donor may be substituted by an alkyl group or substituted alkyl group. The amine-based hydrogen donor may be substituted by a carboxyl group, alkoxycarbonyl group, substituted alkoxycarbonyl group, phenoxycarbonyl group, substituted phenoxycarbonyl group or nitrile group at a

position other than the amino group(s).

Examples of the above amine-based hydrogen donor include 4,4'-bis(dimethylamino)benzophenone, 4,4'-bis(diethylamino)benzophenone, 5 4-diethylaminoacetophenone, 4-dimethylaminopropiophenone, ethyl-4-dimethylaminobenzoate, 4-dimethylaminobenzoic acid and 4-dimethylaminobenzonitrile.

Out of these amine-based hydrogen donors, 4,4'-bis(dimethylamino)benzophenone and 10 4,4'-bis(diethylamino)benzophenone are preferred, and 4,4'-bis(diethylamino)benzophenone is particularly preferred.

The amine-based hydrogen donor serves as a sensitizer even when a photopolymerization initiator other than a 15 biimidazole-based 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-based hydrogen donor and at least one amine-based hydrogen donor is preferably 20 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-based hydrogen donor and the amine-based hydrogen 25 donor include a combination of 2-mercaptobenzothiazole/ 4,4'-bis(dimethylamino)benzophenone, combination of 2-mercaptobenzothiazole/ 4,4'-bis(diethylamino)benzophenone, combination of 2-mercaptobenzoxazole/ 30 4,4'-bis(dimethylamino)benzophenone, and combination of 2-mercaptobenzoxazole/4,4'-bis(diethylamino)benzophenone. Out of these combinations, a combination of 2-mercaptobenzothiazole/ 4,4'-bis(diethylamino)benzophenone and a combination of

2-mercaptobenzoxazole/4,4'-bis(diethylamino)benzophenone
are more preferred, and a combination of
2-mercaptobenzothiazole/
4,4'-bis(diethylamino)benzophenone is particularly
5 preferred.

The weight ratio of the mercaptan-based hydrogen donor
to the amine-based hydrogen donor in the combination of the
mercaptan-based hydrogen donor and the amine-based hydrogen
donor is preferably 1:1 to 1:4, more preferably 1:1 to 1:3.
10 When the hydrogen donor is used in conjunction with
the biimidazole-based 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
15 parts by weight 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
20 colored layer may fall off from the substrate during
development.

Examples of the above triazine-based compound include
triazine-based compounds having a halomethyl group such as
2,4,6-tris(trichloromethyl)-s-triazine,
25 2-methyl-4,6-bis(trichloromethyl)-s-triazine,
2-[2-(5-methylfuran-2-yl)ethenyl]-4,6-bis
(trichloromethyl)-s-triazine,
2-[2-(furan-2-yl)ethenyl]-4,6-bis(trichloromethyl)-s-
triazine,
30 2-[2-(4-diethylamino-2-methylphenyl)ethenyl]-4,6-
bis(trichloromethyl)-s-triazine,
2-[2-(3,4-dimethoxyphenyl)ethenyl]-4,6-bis
(trichloromethyl)-s-triazine,
2-(4-methoxyphenyl)-4,6-bis(trichloromethyl)-s-triazine,

2-(4-ethoxystyryl)-4,6-bis(trichloromethyl)-s-triazine
and 2-(4-n-butoxyphenyl)-4,6-bis(trichloromethyl)-s-
triazine.

Out of these triazine-based compounds,
5 2-[2-(3,4-dimethoxyphenyl)ethenyl]-4,6-bis
(trichloromethyl)-s-triazine is particularly preferred.

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

When the triazine-based compound is used as the
10 photopolymerization initiator in the present invention, the
amount of the triazine-based 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
15 parts by weight of the polyfunctional monomer (C) or the total
of the polyfunctional monomer and the monofunctional monomer.
When the amount of the triazine-based 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
20 larger 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),
25 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]-
ethanone 1-(O-acetyloxime),
30 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).

Out of these O-acyloxime-based 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.

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

 When the O-acyloxime-based compound is used as the
photopolymerization initiator in the present invention, the
amount of the O-acyloxime-based compound is preferably 0.01
10 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
of the polyfunctional monomer and the monofunctional monomer.
When the amount of the O-acyloxime-based compound is smaller
15 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 40 parts by weight, the formed colored layer may
fall off from the substrate during development.

20 The above onium salt-based 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
25 hexafluorophosphate, diphenyliodonium
hexafluoroarsenate, diphenyliodonium trifluoromethane
sulfonate, diphenyliodonium trifluoroacetate,
diphenyliodonium-p-toluene sulfonate,
4-methoxyphenylphenyliodonium tetrafluoroborate,
30 4-methoxyphenylphenyliodonium hexafluorophosphate,
4-methoxyphenylphenyliodonium hexafluoroarsenate,
4-methoxyphenylphenyliodonium trifluoromethane sulfonate,
4-methoxyphenylphenyliodonium trifluoroacetate,
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
 5 trifluoroacetate and
 bis(4-tert-butylphenyl)iodonium-p-toluene sulfonate.

Examples of the above triaryl sulfonium salt include
 triphenylsulfonium tetrafluoroborate, triphenylsulfonium
 hexafluorophosphonate, triphenylsulfonium
 10 hexafluoroarsenate, triphenylsulfonium trifluoromethane
 sulfonate, triphenylsulfonium trifluoroacetate,
 triphenylsulfonium-p-toluene sulfonate,
 4-methoxyphenyldiphenylsulfonium tetrafluoroborate,
 4-methoxyphenyldiphenylsulfonium hexafluorophosphonate,
 15 4-methoxyphenyldiphenylsulfonium hexafluoroarsenate,
 4-methoxyphenyldiphenylsulfonium trifluoromethane
 sulfonate, 4-methoxyphenyldiphenylsulfonium
 trifluoroacetate,
 4-methoxyphenyldiphenylsulfonium-p-toluene sulfonate,
 20 4-phenylthiophenyldiphenylsulfonium tetrafluoroborate,
 4-phenylthiophenyldiphenylsulfonium hexafluorophosphonate,
 4-phenylthiophenyldiphenylsulfonium hexafluoroarsenate,
 4-phenylthiophenyldiphenylsulfonium trifluoromethane
 sulfonate, 4-phenylthiophenyldiphenylsulfonium
 25 trifluoroacetate and
 4-phenylthiophenyldiphenylsulfonium-p-toluene sulfonate.

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

30 Out of these onium salt-based compounds,
 diphenyliodonium hexafluorophosphonate and
 triphenylsulfonium trifluoromethane sulfonate are
 particularly preferred. The above onium salt-based
 compounds may be used alone or in combination of two or more.

When the onium salt-based compound is used as the photopolymerization initiator in the present invention, the amount of the onium salt-based 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 of the polyfunctional monomer and the monofunctional monomer. When the amount of the onium salt-based 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 40 parts by weight, the formed colored layer may fall off from the substrate during development.

15 - 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 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 having at least one carboxyl group in the molecule.

30 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 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,

5 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, 10 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 15 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 20 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.

25 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 30 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 whole
 5 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
 10 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,
 15 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
 20 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, di-n-hexylamine, methylcyclohexylamine, ethylcyclohexylamine and
 25 dicyclohexylamine; tri(cyclo)alkylamines such as dimethyl·ethylamine, methyl·diethylamine, triethylamine, dimethyl·n-propylamine, diethyl·n-propylamine, methyl·di-n-propylamine, ethyl·di-n-propylamine, tri-n-propylamine, tri-i-propylamine, tri-n-butylamine,
 30 tri-i-butylamine, tri-sec-butylamine, tri-t-butylamine, tri-n-pentylamine, tri-n-hexylamine, 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 and 4-amino-1-cyclohexanol; di(cyclo)alkanolamines such as diethanolamine, di-n-propanolamine, di-i-propanolamine, 5 di-n-butanolamine, di-i-butanolamine, di-n-pentanolamine, di-n-hexanolamine and di(4-cyclohexanol)amine; tri(cyclo)alkanolamines such as triethanolamine, tri-n-propanolamine, tri-i-propanolamine, tri-n-butanolamine, tri-i-butanolamine, 10 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, 4-amino-1,2-butanediol, 4-amino-1,3-butanediol, 4-amino-1,2-cyclohexanediol, 4-amino-1,3-cyclohexanediol, 15 3-dimethylamino-1,2-propanediol, 3-diethylamino-1,2-propanediol, 2-dimethylamino-1,3-propanediol and 2-diethylamino-1,3-propanediol; amino group-containing cycloalkane methanols such as 1-aminocyclopentane methanol, 20 4-aminocyclopentane methanol, 1-aminocyclohexane methanol, 4-aminocyclohexane methanol, 4-dimethylaminocyclopentane methanol, 4-diethylaminocyclopentane methanol, 4-dimethylaminocyclohexane methanol and 4-diethylaminocyclohexane methanol; and aminocarboxylic 25 acids such as β -alanine, 2-aminobutyric acid, 3-aminobutyric acid, 4-aminobutyric acid, 2-aminoisobutyric acid, 3-aminoisobutyric acid, 2-aminovaleric acid, 5-aminovaleric acid, 6-aminocaproic acid, 1-aminocyclopropanecarboxylic acid, 30 1-aminocyclohexanecarboxylic acid and 4-aminocyclohexanecarboxylic acid.

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 aromatic amines such as aniline, 2-methylaniline, 3-methylaniline, 4-methylaniline, 4-ethylaniline, 5 4-n-propylaniline, 4-i-propylaniline, 4-n-butyylaniline, 4-t-butylianiline, 1-naphthylamine, 2-naphthylamine, N,N-dimethylaniline, N,N-diethylaniline and 4-methyl-N,N-dimethylaniline; aminobenzyl alcohols such as 2-aminobenzyl alcohol, 3-aminobenzyl alcohol, 10 4-aminobenzyl alcohol, 4-dimethylaminobenzyl alcohol and 4-diethylaminobenzyl alcohol; and aminophenols such as 2-aminophenol, 3-aminophenol, 4-aminophenol, 4-dimethylaminophenol and 4-diethylaminophenol.

Out of these organic amino compounds, 15 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, 2-amino-1,3-propanediol and 4-amino-1,2-butanediol are particularly preferred as the aliphatic amine from the 20 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 25 as the phenyl group-containing amine.

The above curing agent is a component which reacts with a carboxyl group and/or an oxetane ring contained in the alkali-soluble resin (B) to cure the alkali-soluble resin.

The curing agent is, for example, an epoxy compound 30 or an oxetane compound.

The above epoxy compound is preferably a polyfunctional epoxy compound as exemplified by aromatic epoxy resins such as bisphenol A epoxy resin, hydrogenated bisphenol A epoxy resin, bisphenol F epoxy resin,

hydrogenated bisphenol F epoxy resin and novolak epoxy resin; alicyclic epoxy resins, heterocyclic epoxy resins and other epoxy resins such as glycidyl ester-based resins, glycidyl amine-based resins, epoxylated oil; and brominated
5 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.

An epoxy group-containing unsaturated compound is also
10 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.

15 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-xylylene dicarboxylate and bisoxetanyl
20 1,4-cyclohexanedicarboxylate, and high molecular weight compounds such as an oxetane etherified product of phenol novolak resin and (co)polymer of an unsaturated compound having an oxetane ring structure (excluding the copolymer (BI)). The copolymer (BI) has an oxetane ring structure and
25 falls below the category of an oxetane compound as a curing agent.

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
30 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 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.

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

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

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

15 Example 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
20 anhydride, succinic anhydride, citraconic anhydride, dodecenylsuccinic anhydride, tricarballic anhydride, maleic anhydride and 1,2,3,4-butanetetracarboxylic dianhydride; alicyclic polycarboxylic anhydrides such as hexahydrophthalic anhydride,
25 3,4-dimethyltetrahydrophthalic anhydride, 1,2,4-cyclopentanetricarboxylic anhydride, 1,2,4-cyclohexanetricarboxylic anhydride, cyclopentanetetracarboxylic dianhydride and 1,2,4,5-cyclohexanetetracarboxylic dianhydride; ester
30 group-containing 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., Ltd.) and MH-700 (of Shin Nippon Rika Co., Ltd.).

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

The above sulfonium salts include alkylsulfonium salts such as 4-acetophenyldimethylsulfonium hexafluoroantimonate, 4-acetoxyphenyldimethylsulfonium hexafluoroarsenate,
 15 dimethyl-4-(benzyloxycarbonyloxy)phenylsulfonium hexafluoroantimonate, dimethyl-4-(benzoyloxy)phenylsulfonium hexafluoroantimonate, dimethyl-4-(benzoyloxy)phenylsulfonium hexafluoroarsenate,
 20 and dimethyl-3-chloro-4-acetoxyphenylsulfonium hexafluoroantimonate; benzylsulfonium salts such as benzyl-4-hydroxyphenylmethylsulfonium hexafluoroantimonate, benzyl-4-hydroxyphenylmethylsulfonium hexafluorophosphate,
 25 4-acetoxyphenylbenzylmethylsulfonium hexafluoroantimonate, benzyl-4-methoxyphenylmethylsulfonium hexafluoroantimonate, benzyl-2-methyl-4-hydroxyphenylmethylsulfonium hexafluoroantimonate,
 30 benzyl-3-chloro-4-hydroxyphenylmethylsulfonium hexafluoroarsenate and 4-methoxybenzyl-4-hydroxyphenylmethylsulfonium hexafluorophosphate; dibenzylsulfonium salts such as dibenzyl-4-hydroxyphenylsulfonium hexafluoroantimonate,

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

- The above benzothiazonium salts include
 benzylbenzothiazonium salts such as
 3-benzylbenzothiazonium hexafluoroantimonate,
 25 3-benzylbenzothiazonium hexafluorophosphate,
 3-benzylbenzothiazonium tetrafluoroborate,
 3-(p-methoxybenzyl)benzothiazonium hexafluoroantimonate,
 3-benzyl-2-methylthiobenzothiazonium hexafluoroantimonate
 and 3-benzyl-5-chlorobenzothiazonium
 30 hexafluoroantimonate.

The above sulfonate compounds include benzoin tosylate,
 α -methylolbenzoin tosylate, α -methylolbenzoin
 n-octanesulfonate,
 pyrogalloltris(trifluoromethanesulfonate),

pyrogalloltris(nonafluoro-n-butanesulfonate),
 pyrogalloltris(methanesulfonate) and
 nitrobenzyl-9,10-diethoxyanthracene-2-sulfonate.

The above sulfonimide compounds include

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

The above diazomethane compounds include

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

Out of these thermal acid generators,

- 4-acetoxyphenyldimethylsulfonium hexafluoroarsenate,
 benzyl-4-hydroxyphenylmethylsulfonium
 hexafluoroantimonate,
- 20 4-acetoxyphenylbenzylmethylsulfonium hexafluoroantimonate,
 dibenzyl-4-hydrophenylsulfonium hexafluoroantimonate,
 4-acetoxyphenylbenzylsulfonium hexafluoroantimonate,
 3-benzylbenzothiazonium hexafluoroantimonate and
 N-(trifluoromethanesulfonyloxy)bicyclo[2.2.1]hept-5-ene-
- 25 2,3-dicarboxyimide are particularly preferred.

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

Solvent

The radiation sensitive composition for forming a
 30 colored layer of the present invention comprises the above components (A) to (D) as 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 composition, does not react with these components and has suitable volatility.

- 5 Examples of the solvent include (poly)alkylene glycol monoalkyl ethers such as ethylene glycol monomethyl ether, ethylene glycol monoethyl ether, ethylene glycol mono-n-propyl ether, ethylene glycol mono-n-butyl ether, diethylene glycol monomethyl ether, diethylene glycol
- 10 monoethyl ether, diethylene glycol mono-n-propyl ether, diethylene glycol mono-n-butyl ether, triethylene glycol monomethyl ether, triethylene glycol monoethyl ether, propylene glycol monomethyl ether, propylene glycol monoethyl ether, propylene glycol mono-n-propyl ether,
- 15 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
- 20 monoalkyl ether acetates such as ethylene glycol monomethyl ether acetate, ethylene glycol monoethyl ether acetate, diethylene glycol monomethyl ether acetate, diethylene glycol monoethyl ether acetate, propylene glycol monomethyl ether acetate and propylene glycol monoethyl ether acetate;
- 25 other ethers such as diethylene glycol dimethyl ether, diethylene glycol methyl ethyl ether, diethylene glycol diethyl ether and tetrahydrofuran; ketones such as methyl ethyl ketone, cyclohexanone, 2-heptanone and 3-heptanone; alkyl lactates such as methyl lactate and ethyl lactate;
- 30 other esters such as ethyl 2-hydroxy-2-methylpropionate, methyl 3-methoxypropionate, ethyl 3-methoxypropionate, methyl 3-ethoxypropionate, ethyl 3-ethoxypropionate, ethyl ethoxyacetate, ethyl hydroxyacetate, methyl 2-hydroxy-3-methylbutanoate,

3-methyl-3-methoxybutylacetate,
3-methyl-3-methoxybutylpropionate, ethyl acetate, n-propyl
acetate, i-propyl acetate, n-butyl acetate, i-butyl acetate,
n-amyl formate, i-amyl acetate, n-butyl propionate, ethyl
5 butyrate, n-propyl butyrate, i-propyl butyrate, n-butyl
butyrate, methyl pyruvate, ethyl pyruvate, n-propyl pyruvate,
methyl acetoacetate, ethyl acetoacetate and ethyl
2-oxobutanoate; aromatic hydrocarbons such as toluene and
xylene; and amides and lactams such as N,N-dimethylformamide,
10 N,N-dimethylacetamide and N-methylpyrrolidone.

Out of these solvents, propylene glycol monomethyl
ether, ethylene glycol monomethyl ether acetate, propylene
glycol monomethyl ether acetate, propylene glycol monoethyl
ether acetate, diethylene glycol dimethyl ether, diethylene
15 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
20 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
25 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,
30 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 is preferably 5 to 50 wt%, particularly preferably 10 to 40 wt% from the viewpoints of the coatability and stability of the obtained radiation sensitive composition.

Color filter

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

15 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.

20 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 red pixel array having a predetermined pixel pattern.

25 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 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 black pigment dispersed therein.

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

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

To apply the liquid radiation sensitive composition to the substrate, a suitable coating technique such as spray coating, roll coating, rotational coating (spin coating), slit die coating, bar coating or ink jet coating may be
15 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 .

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

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

The above alkali developer is preferably an aqueous solution of sodium carbonate, sodium hydroxide, potassium hydroxide, tetramethylammonium hydroxide, choline,
30 1,8-diazabicyclo-[5.4.0]-7-undecene or 1,5-diazabicyclo-[4.3.0]-5-nonene.

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

preferably rinsed with water after alkali development.

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

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

Color Liquid crystal display device

The color liquid crystal display device of the present
invention comprises the color filter of the present
15 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
20 for forming a colored layer 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 for forming a
colored layer of the present invention comprises the above
25 components (A) to (D) as essential components. Particularly
preferred examples of the composition are given below.

- (1) a radiation sensitive composition for forming a
colored layer, wherein the alkali-soluble resin (B)
comprises the copolymer (BII)
- 30 (2) the radiation sensitive composition (1) for forming
a colored layer, wherein the copolymer (II) is at least
one selected from the group consisting of copolymers
(BII-1) to (BII-18)
- (3) the radiation sensitive composition (1) or (2) for

forming a colored layer, wherein the polyfunctional monomer (C) is at least one selected from the group consisting of trimethylolpropane triacrylate, pentaerthritol triacrylate and dipentaerythritol hexaacrylate

(4) the radiation sensitive composition (1), (2) or (3) for forming a colored layer, wherein the photopolymerization initiator (D) is at least one selected from the group consisting of an acetophenone-based compound, biimidazole-based compound and triazine-based compound

(5) the radiation sensitive composition (1), (2), (3) or (4) for forming a colored layer, wherein the colorant (A) is an organic pigment or carbon black

The preferred color filter (6) of the present invention has pixels and/or a black matrix formed from the radiation sensitive composition (1), (2), (3), (4) or (5) for forming a colored layer.

The preferred color liquid crystal display device (7) of the present invention comprises the above color filter (6), and the more preferred color liquid crystal display device (8) of the present invention comprises the above color filter (6) on a thin film transistor substrate array.

As described above, the radiation sensitive composition for forming a colored layer of the present invention is excellent in the storage stability of an alkali-soluble resin itself, the storage stability of a pigment dispersion and the storage stability of a liquid composition even when the content of a pigment is high, is free from a reduction in film retention, a missing part of a pattern edge and an undercut even when the amount of exposure is small, and provides a pixel pattern and a black matrix pattern having excellent solvent resistance and adhesion to a substrate.

Therefore, the radiation sensitive composition for forming a colored layer of the 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.

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.

Synthesis of alkali-soluble resin

Synthesis Example 1

3 parts by weight of 2,2'-azobisisobutyronitrile and 200 parts by weight of propylene glycol monomethyl ether acetate were fed to a flask equipped with a cooling tube and a stirrer, 15 parts by weight of methacrylic acid, 60 parts by weight of benzyl methacrylate, 15 parts by weight of 3-(methacryloyloxymethyl)-3-ethyloxetane, 10 parts by weight of tricyclo[5.2.1.0^{2,6}]decan-8-yl methacrylate and 3 parts by weight 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 solution of a copolymer (BII). This copolymer (BII) was designated as an alkali-soluble resin (B-1).

Synthesis Example 2

3 parts by weight of 2,2'-azobisisobutyronitrile and 200 parts by weight of propylene glycol monomethyl ether acetate were fed to a flask equipped with a cooling tube and a stirrer, 15 parts by weight of methacrylic acid, 20 parts by weight of benzyl methacrylate, 30 parts by weight of

3-(methacryloyloxymethyl)-3-ethyloxetane, 10 parts by weight of styrene, 25 parts by weight of tricyclo[5.2.1.0^{2.6}]decan-8-yl methacrylate and 3 parts by weight 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 solution of a copolymer (BII). This copolymer (BII) was designated as an alkali-soluble resin (B-2).

Synthesis Example 3

3 parts by weight of 2,2'-azobisisobutyronitrile and 200 parts by weight of propylene glycol monomethyl ether acetate were fed to a flask equipped with a cooling tube and a stirrer, 15 parts by weight of methacrylic acid, 20 parts by weight of N-phenylmaleimide, 30 parts by weight of 3-(methacryloyloxymethyl)-3-ethyloxetane, 10 parts by weight of styrene, 25 parts by weight of tricyclo[5.2.1.0^{2.6}]decan-8-yl methacrylate and 3 parts by weight 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 solution of a copolymer (BII). This copolymer (BII) was designated as an alkali-soluble resin (B-3).

30

Synthesis Example 4

3 parts by weight of 2,2'-azobisisobutyronitrile and 200 parts by weight of propylene glycol monomethyl ether acetate were fed to a flask equipped with a cooling tube and

a stirrer, 15 parts by weight of methacrylic acid, 20 parts by weight of N-phenylmaleimide, 30 parts by weight of 3-(methacryloyloxymethyl)oxetane, 10 parts by weight of styrene, 25 parts by weight of tricyclo[5.2.1.0^{2,6}]decan-8-yl methacrylate and 3 parts by weight 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 solution of a copolymer (BII). This copolymer (BII) was designated as an alkali-soluble resin (B-4).

Comparative Synthesis Example 1

3 parts by weight of 2,2'-azobisisobutyronitrile and 200 parts by weight of propylene glycol monomethyl ether acetate were fed to a flask equipped with a cooling tube and a stirrer, 15 parts by weight of methacrylic acid, 70 parts by weight of benzyl methacrylate, 15 parts by weight of 3-(methacryloyloxymethyl)-3-ethyloxetane and 3 parts by weight 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 solution of an alkali-soluble resin. This alkali-soluble resin was designated as an alkali-soluble resin (B-5).

Comparative Synthesis Example 2

3 parts by weight of 2,2'-azobisisobutyronitrile and 200 parts by weight of propylene glycol monomethyl ether acetate were fed to a flask equipped with a cooling tube and a stirrer, 15 parts by weight of methacrylic acid, 25 parts

by weight of benzyl methacrylate, 30 parts by weight of 3-(methacryloyloxymethyl)-3-ethyloxetane, 10 parts by weight of styrene, 20 parts by weight of N-phenylmaleimide and 3 parts by weight 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 solution of an alkali-soluble resin. This alkali-soluble resin was designated as an alkali-soluble resin (B-6).

Comparative Synthesis Example 3

3 parts by weight of 2,2'-azobisisobutyronitrile and 200 parts by weight of propylene glycol monomethyl ether acetate were fed to a flask equipped with a cooling tube and a stirrer, 15 parts by weight of methacrylic acid, 70 parts by weight of benzyl methacrylate, 15 parts by weight of 3-(methacryloyloxymethyl)oxetane and 3 parts by weight 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 solution of an alkali-soluble resin. This alkali-soluble resin was designated as an alkali-soluble resin (B-7).

Evaluation of storage stability of alkali-soluble resin

When each of the solutions of the alkali-soluble resins obtained in the above Synthesis Examples and Comparative Synthesis Examples was put into a glass bottle and kept in an thermo-hydrostat at 40°C for 3 weeks, the viscosity of the solution was measured before and after storage by using

the ELD viscometer (25°C) of Tokyo Keiki Co., Ltd. to calculate the change rate of viscosity (viscosity after storage x 100/viscosity before storage) for evaluation. The evaluation results are shown in Table 1.

5

Table 1

	Alkali-soluble resin	Storage stability (change rate of viscosity, %)
10	B-1	102
	B-2	100
	B-3	100
	B-4	101
	B-5	169
15	B-6	175
	B-7	239

Preparation of pigment dispersion

Preparation Example 1

20 20 parts by weight of a mixture of C.I. Pigment Red 254/C.I. Pigment Red 177 in a weight ratio of 80/20 as the colorant (A), 5 parts by weight (solid content) of BYK-2001 as a dispersant and 75 parts by weight of propylene glycol monomethyl ether acetate as a solvent were mixed together
25 by a bead mill to prepare a pigment dispersion (R1).

Preparation Example 2

A pigment dispersion (R2) was prepared in the same manner as in Preparation Example 1 except that 5 parts by weight (solid content) of Solsperser 24000 was used as a
30 dispersant in place of BYK-2001.

Preparation Example 3

20 parts by weight of a mixture of C.I. Pigment Green 36/C.I. Pigment Yellow 150 in a weight ratio of 50/50 as the colorant (A), 5 parts by weight (solid content) of BYK-2001

as a dispersant and 75 parts by weight of propylene glycol monomethyl ether acetate as a solvent were mixed together by a bead mill to prepare a pigment dispersion (G1).

Preparation Example 4

- 5 A pigment dispersion (G2) was prepared in the same manner as in Preparation Example 3 except that 5 parts by weight (solid content) of Solsperse 24000 was used as a dispersant in place of BYK-2001.

Preparation Example 5

- 10 20 parts by weight of a mixture of C.I. Pigment Blue 15:6/C.I. Pigment Violet 23 in a weight ratio of 90/10 as the colorant (A), 5 parts by weight (solid content) of BYK-2001 as a dispersant and 75 parts by weight of propylene glycol monomethyl ether acetate as a solvent were mixed
15 together by a bead mill to prepare a pigment dispersion (B1).
Preparation Example 6

- A pigment dispersion (B2) was prepared in the same manner as in Preparation Example 5 except that 5 parts by weight (solid content) of Solsperse 24000 was used as a
20 dispersant in place of BYK-2001.

Example 1

- 100 parts by weight of the pigment dispersion (R1) as the colorant (A), 15 parts by weight (solid content) of the
25 alkali-soluble resin (B-1) as the alkali-soluble resin (B), 15 parts by weight of dipentaerythritol hexaacrylate as the polyfunctional monomer (C), 5 parts by weight of 2-methyl-1-[4-(methylthio)phenyl]-2-morpholinopropan-1-one as the photopolymerization initiator (D) and propylene
30 glycol monomethyl ether acetate as a solvent in an amount that the solid content became 25 wt% were mixed together to prepare a liquid composition (R1-1).

 A pattern was formed from the liquid composition (R1-1) as follows to make evaluations. The evaluation results are

shown in Table 8.

Pattern formation

The liquid composition (R1-1) 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, 6 of the substrates were cooled to room temperature and the coating films on the substrates were exposed to 300 J/m², 400 J/m², 500 J/m², 750 J/m², 1,000 J/m² and 2,000 J/m² of radiation through a photomask with a high-pressure mercury lamp, respectively. 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.

Evaluation of sensitivity

The dot patterns formed on the substrates with the above amounts of exposure were observed through a scanning electron microscope to be evaluated. ○ means that the pattern is well formed and the film retention (film thickness after development x 100/film thickness before development) calculated as a film thickness ratio before and after development is 90 % or more, △ means that the patterns are well formed but the film retention calculated as a film thickness ratio before and after development is less than 90 % or a missing part of the pattern is seen, and × means that the pattern is not formed.

Evaluation of solvent resistance

After six substrates exposed with the above amounts of exposure were immersed in N-methylpyrrolidone at 25°C for 30 minutes, the dot patterns before and after immersion were

observed through a scanning electron microscope to be evaluated. ○ means that the pattern remains unchanged 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 a missing part of the pattern is seen, and × means that all the pattern peels off from the substrate after immersion. When the substrate could not be formed well due to insufficient sensitivity, the evaluation was not made ("-" in Tables 8 to 11).

Evaluation of adhesion

The liquid composition (R1-1) 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 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 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. Thereafter, the coating film was cross cut into 100 squares in accordance with JIS K5400 to evaluate its adhesion. ○ means that no squares 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 (R1-1) 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) .

Examples 2 to 40 and Comparative Examples 1 to 30

5 Liquid compositions were prepared and evaluated in the same manner as in Example 1 except that the types and amounts of the components of the liquid composition were changed as shown in Tables 2 to 7 (parts are based on weight). The evaluation results are shown in Tables 8 to 11.

10 In Tables 2 to 7, the polyfunctional monomer, photopolymerization initiators, additives and solvents are given below.

Polyfunctional monomer

C-1: dipentaerythritol hexaacrylate

Photopolymerization initiators

15 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)

20 D-3: 2,4-diethylthioxanthone

Additives

E-1: bisphenol A novolack type epoxy resin (trade name: 157S65, manufactured by Japan Epoxy Resin Co., Ltd.)

E-2: trimellitic anhydride

25 E-3:

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

Table 2

	Pigment dispersion (part)	Alkali-soluble resin (part)	Polyfunctional monomer (part)	Photopolymerization initiator (part)	Additive (part)
Ex. 1	R1 (100)	B-1 (15)	C-1 (15)	D-1 (5)	-
Ex. 2	R1 (100)	B-1 (15)	C-1 (15)	D-2 (5)	-
Ex. 3	R1 (100)	B-1 (15)	C-1 (15)	D-1 (5)	E-1 (3)
Ex. 4	R1 (100)	B-1 (15)	C-1 (15)	D-1 (5)	E-2 (1)
Ex. 5	R1 (100)	B-1 (15)	C-1 (15)	D-1 (5)	E-3 (2)
Ex. 6	R1 (100)	B-2 (15)	C-1 (15)	D-1 (5)	-
Ex. 7	R1 (100)	B-2 (15)	C-1 (15)	D-2 (5)	-
Ex. 8	R1 (100)	B-2 (15)	C-1 (15)	D-1 (5)	E-1 (3)
Ex. 9	R1 (100)	B-2 (15)	C-1 (15)	D-1 (5)	E-2 (1)
Ex. 10	R1 (100)	B-2 (15)	C-1 (15)	D-1 (5)	E-3 (2)
Ex. 11	R1 (100)	B-3 (15)	C-1 (15)	D-1 (5)	-
Ex. 12	R1 (100)	B-3 (15)	C-1 (15)	D-2 (5)	-
Ex. 13	R1 (100)	B-3 (15)	C-1 (15)	D-1 (5)	E-1 (3)
Ex. 14	R1 (100)	B-3 (15)	C-1 (15)	D-1 (5)	E-2 (1)
Ex. 15	R1 (100)	B-3 (15)	C-1 (15)	D-1 (5)	E-3 (2)
Ex. 16	R1 (100)	B-4 (15)	C-1 (15)	D-1 (5)	-
Ex. 17	R1 (100)	B-4 (15)	C-1 (15)	D-2 (5)	-
Ex. 18	R1 (100)	B-4 (15)	C-1 (15)	D-1 (5)	E-1 (3)
Ex. 19	R1 (100)	B-4 (15)	C-1 (15)	D-1 (5)	E-2 (1)

Ex.: Example

Table 2 (continued)

	Pigment dispersion (part)	Alkali-soluble resin (part)	Polyfunctional monomer (part)	Photopolymerization initiator (part)	Additive (part)
Ex. 20	R1 (100)	B-4 (15)	C-1 (15)	D-1 (5)	E-3 (2)
Ex. 21	R2 (100)	B-1 (15)	C-1 (15)	D-1 (5)	-
Ex. 22	R2 (100)	B-2 (15)	C-1 (15)	D-1 (5)	-
Ex. 23	R2 (100)	B-3 (15)	C-1 (15)	D-1 (5)	-
Ex. 24	R2 (100)	B-4 (15)	C-1 (15)	D-1 (5)	-

Ex.: Example

Table 3

	Pigment dispersion (part)	Alkali-soluble resin (part)	Polyfunctional monomer (part)	Photopolymerization initiator (part)	Additive (part)
Ex. 25	G1 (100)	B-1 (10)	C-1 (10)	D-1 (5)	-
Ex. 26	G1 (100)	B-2 (10)	C-1 (10)	D-1 (5)	-
Ex. 27	G1 (100)	B-3 (10)	C-1 (10)	D-1 (5)	-
Ex. 28	G1 (100)	B-4 (10)	C-1 (10)	D-1 (5)	-
Ex. 29	G2 (100)	B-1 (10)	C-1 (10)	D-1 (5)	-
Ex. 30	G2 (100)	B-2 (10)	C-1 (10)	D-1 (5)	-
Ex. 31	G2 (100)	B-3 (10)	C-1 (10)	D-1 (5)	-
Ex. 32	G2 (100)	B-4 (10)	C-1 (10)	D-1 (5)	-

Ex.: Example

Table 4

	Pigment dispersion (part)	Alkali-soluble resin (part)	Polyfunctional monomer (part)	Photopolymerization initiator (part)	Additive (part)
Ex. 33	B1 (100)	B-1 (20)	C-1 (10)	D-1 (4) D-3 (1)	-
Ex. 34	B1 (100)	B-2 (20)	C-1 (10)	D-1 (4) D-3 (1)	-
Ex. 35	B1 (100)	B-3 (20)	C-1 (10)	D-1 (4) D-3 (1)	-
Ex. 36	B1 (100)	B-4 (20)	C-1 (10)	D-1 (4) D-3 (1)	-
Ex. 37	B2 (100)	B-1 (20)	C-1 (10)	D-1 (4) D-3 (1)	-
Ex. 38	B2 (100)	B-2 (20)	C-1 (10)	D-1 (4) D-3 (1)	-
Ex. 39	B2 (100)	B-3 (20)	C-1 (10)	D-1 (4) D-3 (1)	-
Ex. 40	B2 (100)	B-4 (20)	C-1 (10)	D-1 (4) D-3 (1)	-

Ex.: Example

Table 5

	Pigment dispersion (part)	Alkali-soluble resin (part)	Polyfunctional monomer (part)	Photopolymerization initiator (part)	Additive (part)
C.Ex. 1	R1 (100)	B-5 (15)	C-1 (15)	D-1 (5)	-
C.Ex. 2	R1 (100)	B-5 (15)	C-1 (15)	D-2 (5)	-
C.Ex. 3	R1 (100)	B-5 (15)	C-1 (15)	D-1 (5)	E-1 (3)
C.Ex. 4	R1 (100)	B-5 (15)	C-1 (15)	D-1 (5)	E-2 (1)
C.Ex. 5	R1 (100)	B-5 (15)	C-1 (15)	D-1 (5)	E-3 (2)
C.Ex. 6	R1 (100)	B-6 (15)	C-1 (15)	D-1 (5)	-
C.Ex. 7	R1 (100)	B-6 (15)	C-1 (15)	D-2 (5)	-
C.Ex. 8	R1 (100)	B-6 (15)	C-1 (15)	D-1 (5)	E-1 (3)
C.Ex. 9	R1 (100)	B-6 (15)	C-1 (15)	D-1 (5)	E-2 (1)
C.Ex. 10	R1 (100)	B-6 (15)	C-1 (15)	D-1 (5)	E-3 (2)
C.Ex. 11	R1 (100)	B-7 (15)	C-1 (15)	D-1 (5)	-
C.Ex. 12	R1 (100)	B-7 (15)	C-1 (15)	D-2 (5)	-
C.Ex. 13	R1 (100)	B-7 (15)	C-1 (15)	D-1 (5)	E-1 (3)
C.Ex. 14	R1 (100)	B-7 (15)	C-1 (15)	D-1 (5)	E-2 (1)
C.Ex. 15	R1 (100)	B-7 (15)	C-1 (15)	D-1 (5)	E-3 (2)
C.Ex. 16	R2 (100)	B-5 (15)	C-1 (15)	D-1 (5)	-
C.Ex. 17	R2 (100)	B-6 (15)	C-1 (15)	D-1 (5)	-
C.Ex. 18	R2 (100)	B-7 (15)	C-1 (15)	D-1 (5)	-

C.Ex.: Comparative Example

Table 6

	Pigment dispersion (part)	Alkali-soluble resin (part)	Polyfunctional monomer (part)	Photopolymerization initiator (part)	Additive (part)
C.Ex. 19	G1 (100)	B-5 (10)	C-1 (10)	D-1 (5)	-
C.Ex. 20	G1 (100)	B-6 (10)	C-1 (10)	D-1 (5)	-
C.Ex. 21	G1 (100)	B-7 (10)	C-1 (10)	D-1 (5)	-
C.Ex. 22	G2 (100)	B-5 (10)	C-1 (10)	D-1 (5)	-
C.Ex. 23	G2 (100)	B-6 (10)	C-1 (10)	D-1 (5)	-
C.Ex. 24	G2 (100)	B-7 (10)	C-1 (10)	D-1 (5)	-

C.Ex.:Comparative Example

Table 7

	Pigment dispersion (part)	Alkali-soluble resin (part)	Polyfunctional monomer (part)	Photopolymerization initiator (part)	Additive (part)
C.Ex.25	B1 (100)	B-5 (20)	C-1 (10)	D-1 (4) D-3 (1)	-
C.Ex.26	B1 (100)	B-6 (20)	C-1 (10)	D-1 (4) D-3 (1)	-
C.Ex.27	B1 (100)	B-7 (20)	C-1 (10)	D-1 (4) D-3 (1)	-
C.Ex.28	B2 (100)	B-5 (20)	C-1 (10)	D-1 (4) D-3 (1)	-
C.Ex.29	B2 (100)	B-6 (20)	C-1 (10)	D-1 (4) D-3 (1)	-
C.Ex.30	B2 (100)	B-7 (20)	C-1 (10)	D-1 (4) D-3 (1)	-

C.Ex.:Comparative Example

Table 8

	Sensitivity							Solvent resistance							Adhesion	Storage stability of liquid composition
	Amount of exposure(J/m ²)							Amount of exposure(J/m ²)								
	300	400	500	750	1000	2000		300	400	500	750	1000	2000			
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.: Example

Table 8 (continued)

	Sensitivity						Solvent resistance						Adhesion	Storage stability of liquid composition
	Amount of exposure(J/m ²)						Amount of exposure(J/m ²)							
	300	400	500	750	1000	2000	300	400	500	750	1000	2000		
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.23	○	○	○	○	○	○	○	○	○	○	○	○	○	100
Ex.24	○	○	○	○	○	○	○	○	○	○	○	○	○	100

Ex.:Example

Table 9

	Sensitivity				Solvent resistance								Adhesion	Storage stability of liquid composition
	Amount of exposure (J/m ²)						Amount of exposure (J/m ²)							
	300	400	500	750	1000	2000	300	400	500	750	1000	2000		
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.: Example

Table 10

	Sensitivity		Solvent resistance										Adhesion	Storage stability of liquid composition
			Amount of exposure (J/m²)											
	300	400	500	750	1000	2000	300	400	500	750	1000	2000		
C.Ex.1	X	○	○	○	○	○	-	-	○	○	○	○	○	123
C.Ex.2	X	○	○	○	○	○	-	-	△	○	○	○	○	132
C.Ex.3	X	X	X	○	○	○	-	-	-	○	○	○	X	145
C.Ex.4	X	X	X	○	○	○	-	-	-	△	○	○	X	179
C.Ex.5	X	X	X	X	○	○	-	-	-	△	○	○	X	200
C.Ex.6	X	○	○	○	○	○	-	-	○	○	○	○	○	135
C.Ex.7	X	○	○	○	○	○	-	-	○	○	○	○	○	156
C.Ex.8	X	X	○	○	○	○	-	-	○	○	○	○	X	204
C.Ex.9	X	X	○	○	○	○	-	-	○	○	○	○	△	305
C.Ex.10	X	X	X	○	○	○	-	-	-	△	△	○	X	315
C.Ex.11	X	○	○	○	○	○	-	-	○	○	○	○	○	176
C.Ex.12	X	○	○	○	○	○	-	-	○	○	○	○	○	156
C.Ex.13	X	X	X	○	○	○	-	-	-	○	○	○	X	405
C.Ex.14	X	X	X	○	○	○	-	-	-	△	△	○	X	478
C.Ex.15	X	X	X	X	○	○	-	-	-	△	△	○	X	520
C.Ex.16	X	○	○	○	○	○	-	-	○	○	○	○	○	119
C.Ex.17	X	○	○	○	○	○	-	-	△	○	○	○	○	156
C.Ex.18	X	○	○	○	○	○	-	-	○	○	○	○	△	198

C.Ex.: Comparative Example

Table 11

	Sensitivity						Solvent resistance						Adhesion	Storage stability of liquid composition
	Amount of exposure(J/m ²)						Amount of exposure(J/m ²)							
	300	400	500	750	1000	2000	300	400	500	750	1000	2000		
C.Ex.19	×	○	○	○	○	○	-	-	○	○	○	○	○	178
C.Ex.20	×	○	○	○	○	○	-	-	○	○	○	○	○	165
C.Ex.21	×	○	○	○	○	○	-	-	-	○	○	○	×	201
C.Ex.22	×	○	○	○	○	○	-	-	△	○	○	○	×	204
C.Ex.23	×	○	○	○	○	○	-	-	○	○	○	○	○	178
C.Ex.24	×	○	○	○	○	○	-	-	-	○	○	○	△	145
C.Ex.25	×	○	○	○	○	○	-	-	○	○	○	○	△	135
C.Ex.26	×	○	○	○	○	○	-	-	○	○	○	○	○	176
C.Ex.27	×	○	○	○	○	○	-	-	△	○	○	○	○	204
C.Ex.28	×	○	○	○	○	○	-	-	-	○	○	○	△	203
C.Ex.29	×	○	○	○	○	○	-	-	○	○	○	○	△	207
C.Ex.30	×	○	○	○	○	○	-	-	○	○	○	○	○	334

C.Ex.:Comparative Example

What is claimed is:

1. A radiation sensitive composition for forming a colored layer, comprising (A) a colorant, (B) an alkali-soluble resin, (C) a polyfunctional monomer and (D) a photopolymerization
5 initiator, wherein

the alkali-soluble resin (B) is a copolymer comprising (b1) at least one selected from the group consisting of an unsaturated carboxylic acid, an unsaturated carboxylic anhydride and an unsaturated phenolic compound, (b2) an
10 unsaturated compound having an alicyclic carbon ring structure and (b3) an unsaturated compound having an oxetane ring structure.

2. A color filter having a colored layer formed from the
15 radiation sensitive composition for forming a colored layer of claim 1.

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