

Radiation Sensitive Composition For Forming A Colored Layer, Color Filter and Color Liquid Crystal Display Device

5 Technical Field

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

Technical Background

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

In recent years, in the technical field of color  
30 filters, the mainstream is to decrease the exposure dose and decrease a tact time. When the exposure dose is decreased, however, conventional colored radiation sensitive compositions would result in a decrease in a film remaining ratio after development, the occurrence

of defects or undercuts in a pattern or the separation of a pattern from a substrate. It has been therefore difficult to obtain pixels and a black matrix having an excellent pattern form while decreasing the tact time.

5 Regarding the pixels and black matrix, further, a colored layer is required to be excellent in solvent resistance and adhesion to a substrate even when the exposure dose is decreased. However, conventional colored radiation sensitive compositions have not  
10 necessarily been satisfactory in these points.

#### Disclosure of the Invention

It is an object of the this invention to provide a novel radiation sensitive composition for forming  
15 colored layer that is highly sensitive and excellent in a pattern form and a film remaining ratio with a low dose of exposure and that gives pixels and a black matrix excellent in solvent resistance to various solvents and adhesion to a substrate.

20 It is another object of this invention to provide a color filter having a colored layer formed of the above radiation sensitive composition and a liquid crystal display device having the filter.

Other objects and advantages of this invention  
25 will be apparent from the following description.

According to this invention, the above objects and advantages of this invention are achieved by a radiation sensitive composition for forming a colored layer comprising (A) a colorant, (B) an alkali-soluble  
30 resin, (C) a polyfunctional monomer and (D) a photopolymerization initiator, said (B) alkali-soluble resin being formed of a copolymer formed from (b1) at least one member selected from the group consisting of an unsaturated carboxylic acid, an unsaturated

carboxylic anhydride and an unsaturated phenol compound,  
(b2) an N-substituted maleimide, (b3) an unsaturated  
compound having a tetrahydrofuran structure and (b4) an  
unsaturated compound different from said (b1), (b2) and  
5 (b3).

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

According to this invention, secondly, the above  
objects and advantages of this invention are achieved by  
10 a color filter having a colored layer formed of the  
above radiation sensitive composition for forming a  
colored layer.

According to this invention, thirdly, the above  
objects and advantages of this invention are achieved by  
15 a color liquid crystal display device having said color  
filter.

This invention will be explained in detail  
hereinafter.

## 20 Best Mode for Embodiments of the Invention

Radiation sensitive composition for forming a colored  
layer

### -(A) Colorant-

The colorant in this invention is not specially  
25 limited with regard to a color tone and is determined as  
required depending upon use of a color filter to be  
obtained. It may be any one of a pigment, a dye and a  
natural dyestuff.

Since a color filter is required to have high-  
30 resolution color development and heat resistance, a  
colorant having high color development and having high  
heat resistance, in particularly a colorant having high  
resistance against thermal decomposition, is preferred  
as a colorant in this invention. Preferably, an organic

pigment or inorganic pigment is used, and particularly preferably an organic pigment or carbon black is used.

Examples of the above organic pigment include compounds classified as pigments in Color Index (C.I.:  
 5 issued by The Society of Dyers and Colourists Corp.), specifically, compounds that are assigned as 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.  
 10 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  
 15 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.  
 20 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.  
 25 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.  
 30 Pigment Yellow 154, C.I. Pigment Yellow 155, C.I. Pigment Yellow 156, C.I. Pigment Yellow 166, C.I. Pigment Yellow 168, C.I. Pigment Yellow 175, C.I. Pigment Yellow 180, C.I. Pigment Yellow 185;

C.I. Pigment Orange 1, C.I. Pigment Orange 5,

C.I. Pigment Orange 13, C.I. Pigment Orange 14, C.I.  
 Pigment Orange 16, C.I. Pigment Orange 17, C.I. Pigment  
 Orange 24, C.I. Pigment Orange 34, C.I. Pigment Orange  
 36, C.I. Pigment Orange 38, C.I. Pigment Orange 40, C.I.  
 5 Pigment Orange 43, C.I. Pigment Orange 46, C.I. Pigment  
 Orange 49, C.I. Pigment Orange 51, C.I. Pigment Orange  
 61, C.I. Pigment Orange 63, C.I. Pigment Orange 64, C.I.  
 Pigment Orange 71, C.I. Pigment Orange 73;  
 C.I. Pigment Violet 1, C.I. Pigment Violet 19,  
 10 C.I. Pigment Violet 23, C.I. Pigment Violet 29, C.I.  
 Pigment Violet 32, C.I. Pigment Violet 36, C.I. Pigment  
 Violet 38;  
 C.I. Pigment Red 1, C.I. Pigment Red 2, C.I.  
 Pigment Red 3, C.I. Pigment Red 4, C.I. Pigment Red 5,  
 15 C.I. Pigment Red 6, C.I. Pigment Red 7, C.I. Pigment Red  
 8, C.I. Pigment Red 9, C.I. Pigment Red 10, C.I. Pigment  
 Red 11, C.I. Pigment Red 12, C.I. Pigment Red 14, C.I.  
 Pigment Red 15, C.I. Pigment Red 16, C.I. Pigment Red 17,  
 C.I. Pigment Red 18, C.I. Pigment Red 19, C.I. Pigment  
 20 Red 21, C.I. Pigment Red 22, C.I. Pigment Red 23, C.I.  
 Pigment Red 30, C.I. Pigment Red 31, C.I. Pigment Red 32,  
 C.I. Pigment Red 37, C.I. Pigment Red 38, C.I. Pigment  
 Red 40, C.I. Pigment Red 41, C.I. Pigment Red 42, C.I.  
 Pigment Red 48:1, C.I. Pigment Red 48:2, C.I. Pigment  
 25 Red 48:3, C.I. Pigment Red 48:4, C.I. Pigment Red 49:1,  
 C.I. Pigment Red 49:2, C.I. Pigment Red 50:1, C.I.  
 Pigment Red 52:1, C.I. Pigment Red 53:1, C.I. Pigment  
 Red 57, C.I. Pigment Red 57:1, C.I. Pigment Red 57:2,  
 C.I. Pigment Red 58:2, C.I. Pigment Red 58:4, C.I.  
 30 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.

5 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

10 177, 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.

15 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

20 264, 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, C.I. Pigment Blue 60,

C.I. Pigment Green 7, C.I. Pigment Green 36;

25 C.I. Pigment Brown 23, C.I. Pigment Brown 25; C.I. Pigment Black 1, C.I. Pigment Black 7.

These organic pigments can be used after purified by a sulfuric acid recrystallization method, a solvent washing method or a combination of these methods.

30 Further, examples of the inorganic pigment include titanium oxide, barium sulfate, calcium carbonate, zinc oxide, lead sulfate, chrome yellow, zinc chromate, colcothar (red iron oxide (III)), cadmium red, ultramarine blue, Prussian blue, chromium oxide green,

cobalt green, amber, titanium black, synthetic iron black, carbon black and the like.

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

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

In this invention, further, the colorant may be used together with a dispersing agent.

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

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

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

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

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

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

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

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

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

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

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

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

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

-(B) Alkali-soluble resin-

The alkali-soluble resin in this invention is formed of a copolymer (to be referred to as "copolymer

(BI)" hereinafter) formed from (b1) at least one member selected from the group consisting of an unsaturated carboxylic acid, an unsaturated carboxylic anhydride and an unsaturated phenol compound (these compounds will be collectively referred to as "unsaturated compound (b1)" hereinafter), (b2) an N-substituted maleimide, (b3) an unsaturated compound having a tetrahydrofuran structure (to be referred to as "unsaturated compound (b3)" hereinafter) and (b4) an unsaturated compound different from said (b1), (b2) and (b3) (to be referred to as "unsaturated compound (b4)" hereinafter). The copolymer (BI) is a component that acts as a binder on the (A) colorant and that has solubility in an alkali developing solution for use in the developing step in the formation of a colored layer.

Of the above unsaturated compound (b1), examples of the above unsaturated carboxylic acid and unsaturated carboxylic anhydrides include;

unsaturated monocarboxylic acids such as (meth)acrylic acid, crotonic acid,  $\alpha$ -chloroacrylic acid, cinnamic acid, etc.;

unsaturated dicarboxylic acids or anhydrides thereof such as maleic acid, maleic anhydride, fumaric acid, itaconic acid, itaconic anhydride, citraconic acid, citraconic anhydride, mesaconic acid, etc.;

trivalent or higher unsaturated polyvalent carboxylic acids or anhydrides thereof;

mono[(meth)acryloyloxyalkyl]esters of divalent or higher polyvalent carboxylic acids such as mono[2-(meth)acryloyloxyethyl]succinate, mono[2-(meth)acryloyloxyethyl]phthalate, etc.; and

mono(meth)acrylates of polymer having a carboxy group and a hydroxyl group on each of the two terminal ends such as  $\omega$ -carboxypolycaprolactone

mono(meth)acrylate, etc.

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

Further, examples of the above unsaturated  
10 phenol compound include

unsaturated phenols such as o-vinylphenol, m-vinylphenol, p-vinylphenol, 2-methyl-4-vinylphenol, 3-methyl-4-vinylphenol, o-isopropenylphenol, m-isopropenylphenol, p-isopropenylphenol, etc.; and  
15 unsaturated naphthols such as 2-vinyl-1-naphthol, 3-vinyl-1-naphthol, 1-vinyl-2-naphthol, 3-vinyl-2-naphthol, 2-isopropenyl-1-naphthol, 3-isopropenyl-1-naphthol, etc.

As an unsaturated compound (b1) in this  
20 invention, (meth)acrylic acid, p-vinylphenol, etc., are preferred and (meth)acrylic acid is particularly preferred.

Further, examples of the N-substituted maleimide include N-methylmaleimide, N-ethylmaleimide, N-n-propylmaleimide, N-i-propylmaleimide, N-n-butylmaleimide,  
25 N-t-butylmaleimide, N-n-hexylmaleimide, N-cyclopentylmaleimide, N-cyclohexylmaleimide, N-phenylmaleimide and N-1-naphthylmaleimide.

As an N-substituted maleimide in this invention,  
30 N-cyclohexylmaleimide, N-phenylmaleimide, etc., are preferred, and N-phenylmaleimide is particularly preferred.

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

Further, examples of the unsaturated compound (b3) include;

tetrahydrofuran esters of (meth)acrylic acids such as tetrahydrofuran-2-yl (meth)acrylate,

5 tetrahydrofuran-3-yl (meth)acrylate, etc.;

tetrahydrofurfuryl group-containing esters of (meth)acrylates such as tetrahydrofurfuryl

(meth)acrylate, tetrahydrofurfuryl (meth)acrylate, 2-

(tetrahydrofurfuryloxy)ethyl (meth)acrylate, 2-(3-

10 tetrahydrofurfuryloxy)ethyl (meth)acrylate, etc.;

acryloyl-group-containing tetrahydrofuran esters of dicarboxylic acids such as [2-

(meth)acryloyloxyethyl] (tetrahydrofuran-2-yl)phthalate,

[2-(meth)acryloyloxyethyl] (tetrahydrofuran-3-

15 yl)phthalate, [2-

(meth)acryloyloxyethyl] (tetrahydrofuran-2-yl)succinate,

[2-(meth)acryloyloxyethyl] (tetrahydrofuran-3-

yl)succinate, etc.;

(meth)acryloyl-group-containing

20 tetrahydrofurfuryl esters of dicarboxylic acids such as

[2-(meth)acryloyloxyethyl] (tetrahydrofurfuryl)phthalate,

[2-(meth)acryloyloxyethyl] (tetrahydrofurfuryl)succinate,

etc.;

tetrahydrofuran esters of 2-

25 (meth)acryloyloxypropionates such as tetrahydrofuran-2-

yl 2-(meth)acryloyloxypropionate, tetrahydrofuran-3-yl

2-(meth)acryloyloxypropionate, etc.;

tetrahydrofurfuryl-group-containing esters of 2-

(meth)acryloyloxypropionates such as tetrahydrofurfuryl

30 2-(meth)acryloyloxypropionate, 3-tetrahydrofurfuryl 2-

(meth)acryloyloxypropionate, 2-

(tetrahydrofurfuryloxy)ethyl 2-

(meth)acryloyloxypropionate, 2-(3-

tetrahydrofurfuryloxy)ethyl 2-

(meth)acryloyloxypropionate, etc.;

vinylbenzene derivatives such as  
(tetrahydrofuran-2-yl)oxy-p-vinylbenzene,  
tetrahydrofurfuryloxy-p-vinylbenzene, 2-

5 (tetrahydrofurfuryloxy)ethoxy-p-vinylbenzene, etc.; and  
vinyl ethers such as (tetrahydrofuran-2-yl)vinyl  
ether, (tetrahydrofurfuryl)vinyl ether, [2-  
(tetrahydrofurfuryloxy)ethyl]vinyl ether, etc.

As an unsaturated compound (b3) in this  
10 invention, tetrahydrofurfuryl (meth)acrylate, [2-  
(meth)acryloyloxyethyl](tetrahydrofurfuryl) succinate,  
etc., are preferred.

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

15 Examples of the unsaturated compound (b4)  
include;

aromatic vinyl compounds such as styrene,  $\alpha$ -  
methylstyrene, o-vinyltoluene, m-vinyltoluene, p-  
vinyltoluene, p-chlorostyrene, o-methoxystyrene, m-  
20 methoxystyrene, p-methoxystyrene, o-vinylbenzyl methyl  
ether, m-vinylbenzyl methyl ether, p-vinylbenzyl methyl  
ether, o-vinylbenzyl glycidyl ether, m-vinylbenzyl  
glycidyl ether, p-vinylbenzyl glycidyl ether, etc.;

indenes such as indene, 1-methylindene, etc.;

25 unsaturated carboxylic esters such as methyl  
(meth)acrylate, ethyl (meth)acrylate, n-propyl  
(meth)acrylate, i-propyl (meth)acrylate, n-butyl  
(meth)acrylate, i-butyl (meth)acrylate, sec-butyl  
(meth)acrylate, t-butyl (meth)acrylate, 2-ethylhexyl  
30 (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, 5 methoxypropylene glycol (meth)acrylate, methoxydipropylene glycol (meth)acrylate, isobornyl (meth)acrylate, dicyclopentadiethyl (meth)acrylate, 2-hydroxy-3-phenoxypropyl (meth)acrylate, glycerol mono(meth)acrylate, etc.;
- 10           unsaturated carboxylic acid amino alkyl esters such as 2-aminoethyl (meth)acrylate, 2-dimethylaminoethyl (meth)acrylate, 2-aminopropyl (meth)acrylate, 2-dimethylaminopropyl (meth)acrylate, 3-aminopropyl (meth)acrylate, 3-dimethylaminopropyl 15 (meth)acrylate, etc.;
- unsaturated carboxylic acid glycidyl esters such as glycidyl (meth)acrylate, etc.;
- vinyl cyanide compounds such as (meth)acrylonitrile,  $\alpha$ -chloroacrylonitrile, vinylidene 20 cyanide, etc.;
- unsaturated amides such as (meth)acrylamide,  $\alpha$ -chloroacrylamide, N-2-hydroxyethyl (meth)acrylamide, etc.;
- carboxylic acid vinyl esters such as vinyl 25 acetate, vinyl propionate, vinyl butylate, vinyl benzoate, etc.;
- unsaturated ethers such as vinyl methyl ether, vinyl ethyl ether, allyl glycidyl ether, etc.;
- aliphatic conjugated dienes such as 1,3- 30 butadiene, isoprene, chloroprene, etc.; and
- macromonomers having mono(meth)acryloyl groups on molecular chain ends of polymers such as polystyrene, polymethyl (meth)acrylate, poly-n-butyl (meth)acrylate, polysiloxane, etc.

The above unsaturated compounds (b4) may be used singly or in combination of two or more.

In this invention, the copolymer (BI) is preferably a copolymer (to be referred to as "copolymer (BII)" hereinafter) obtained from (meth)acrylic acid or  
 5 (BII)" hereinafter) obtained from (meth)acrylic acid or a combination of it with at least one other unsaturated compound (b1), at least one N-substituted maleimide (b2) selected from the group consisting of N-cyclohexylmaleimide and N-phenylmaleimide, at least one  
 10 unsaturated compound (b3) selected from the group consisting of tetrahydrofurfuryl (meth)acrylate and [2-(meth)acryloyloxyethyl](tetrahydrofurfuryl)succinate, and at least one unsaturated compound (b4) selected from the group consisting of styrene, methyl (meth)acrylate,  
 15 n-butyl (meth)acrylate, 2-ethylhexyl (meth)acrylate, 2-hydroxyethyl (meth)acrylate, allyl (meth)acrylate, benzyl (meth)acrylate, glycerol mono(meth)acrylate, a polystyrene macromonomer and polymethyl methacrylate macromonomer.

20 Specific examples of the copolymer (BII) include  
     a (meth)acrylic acid/N-phenylmaleimide/tetrahydrofurfuryl (meth)acrylate/styrene copolymer,  
     a (meth)acrylic acid/N-phenylmaleimide/tetrahydrofurfuryl (meth)acrylate/methyl (meth)acrylate  
 25 copolymer,  
     a (meth)acrylic acid/N-phenylmaleimide/tetrahydrofurfuryl (meth)acrylate/benzyl (meth)acrylate copolymer,  
     a (meth)acrylic acid/N-phenylmaleimide/tetrahydrofurfuryl (meth)acrylate/2-hydroxyethyl  
 30 (meth)acrylate copolymer,  
     a (meth)acrylic acid/N-phenylmaleimide/tetrahydrofurfuryl (meth)acrylate/styrene/n-butyl (meth)acrylate copolymer,

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

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

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

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

- cyclohexylmaleimide/tetrahydrofurfuryl  
(meth)acrylate/styrene/n-butyl (meth)acrylate/allyl  
(meth)acrylate copolymer,  
a (meth)acrylic acid/mono[2-
- 5 (meth)acryloyloxyethyl]succinate/N-cyclohexylmaleimide/tetrahydrofurfuryl  
(meth)acrylate/styrene/n-butyl (meth)acrylate/benzyl  
(meth)acrylate copolymer,  
a (meth)acrylic acid/mono[2-
- 10 (meth)acryloyloxyethyl]succinate/N-phenylmaleimide/tetrahydrofurfuryl  
(meth)acrylate/styrene/n-butyl (meth)acrylate/allyl  
(meth)acrylate copolymer,  
a (meth)acrylic acid/mono[2-
- 15 (meth)acryloyloxyethyl]succinate/N-phenylmaleimide/tetrahydrofurfuryl  
(meth)acrylate/styrene/n-butyl (meth)acrylate/benzyl  
(meth)acrylate copolymer,  
a (meth)acrylic acid/mono[2-
- 20 (meth)acryloyloxyethyl]succinate/N-phenylmaleimide/tetrahydrofurfuryl (meth)acrylate/n-butyl (meth)acrylate/benzyl (meth)acrylate/glycerol  
mono(meth)acrylate copolymer,  
a (meth)acrylic acid/ $\omega$ -carboxypolycaprolactone
- 25 mono(meth)acrylate/N-cyclohexylmaleimide/tetrahydrofurfuryl  
(meth)acrylate/styrene/benzyl (meth)acrylate/glycerol  
mono(meth)acrylate copolymer,  
a (meth)acrylic acid/ $\omega$ -carboxypolycaprolactone
- 30 mono(meth)acrylate/N-phenylmaleimide/tetrahydrofurfuryl  
(meth)acrylate/styrene/benzyl (meth)acrylate/glycerol  
mono(meth)acrylate copolymer,  
a (meth)acrylic acid/ $\omega$ -carboxypolycaprolactone  
mono(meth)acrylate/N-phenylmaleimide/tetrahydrofurfuryl

(meth)acrylate/styrene/n-butyl (meth)acrylate/benzyl  
(meth)acrylate/glycerol mono(meth)acrylate copolymer,  
and

copolymers formed by replacing  
5 tetrahydrofurfuryl (meth)acrylate in each of these  
copolymers with [2-  
(meth)acryloyloxyethyl] (tetrahydrofurfuryl)succinate.

Of the above copolymers (BII), a (meth)acrylic  
acid/N-phenylmaleimide/tetrahydrofurfuryl  
10 (meth)acrylate/styrene/n-butyl (meth)acrylate copolymer,  
a (meth)acrylic acid/N-  
phenylmaleimide/tetrahydrofurfuryl  
(meth)acrylate/styrene/n-butyl (meth)acrylate/2-  
hydroxyethyl (meth)acrylate copolymer, (meth)acrylic  
15 acid/N-phenylmaleimide/[2-  
(meth)acryloyloxyethyl]tetrahydrofurfuryl  
succinate/styrene/n-butyl (meth)acrylate copolymer,  
(meth)acrylic acid/N-phenylmaleimide/[2-  
(meth)acryloyloxyethyl]tetrahydrofurfuryl  
20 succinate/styrene/n-butyl (meth)acrylate/2-hydroxyethyl  
(meth)acrylate copolymer, etc., are preferred.

In the copolymer (BI), the copolymerization  
amount ratio of the unsaturated compound (b1) is  
preferably 1 to 40 % by weight, particularly preferably  
25 5 to 30 % by weight, the copolymerization amount ratio  
of the N-substituted maleimide (b2) is preferably 1 to  
50 % by weight, particularly preferably 5 to 40 % by  
weight, the copolymerization amount ratio of the  
unsaturated compound (b3) is preferably 1 to 70 % by  
30 weight, particularly preferably 10 to 40 % by weight,  
and the copolymerization amount ratio of the unsaturated  
compound (b4) is preferably 1 to 80 % by weight,  
particularly preferably 5 to 60 % by weight.

In this invention, the copolymerization amount

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

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

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

As a preferred "other" alkali-soluble resin, more specifically, there is a copolymer formed from (i) at least one unsaturated carboxylic acid containing (meth)acrylic acid as an essential component and (ii) at least one member selected from the group consisting of N-cyclohexylmaleimide, N-phenylmaleimide, styrene, methyl (meth)acrylate, n-butyl (meth)acrylate, 2-ethylhexyl (meth)acrylate, 2-hydroxyethyl (meth)acrylate, allyl (meth)acrylate, benzyl (meth)acrylate, glycerol mono(meth)acrylate, a polystyrene macromonomer and a polymethyl methacrylate macromonomer.

In this invention, the copolymer (BI) and the "other" alkali-soluble resin respectively have a weight

average molecular weight (to be referred to as "Mw" hereinafter), as a polystyrene, of 2,000 to 300,000, more preferably 3,000 to 100,000 when measured by gel permeation chromatography (GPC, elution solvent:

5 tetrahydrofuran).

Further, the copolymer (BI) and the "other" alkali-soluble resin respectively have a number average molecular weight (to be referred to as "Mn" hereinafter), as a polystyrene, of 3,000 to 60,000, more preferably  
10 5,000 to 25,000, when measured by gel permeation chromatography (GPC, elution solvent: tetrahydrofuran).

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

The ratio of Mw and Mn (Mw/Mn) of each of the copolymer (BI) and the "other" alkali-soluble resin is  
25 preferably from 1 to 5, more preferably from 1 to 4.

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

30 In this invention, the total amount of the alkali-soluble resins per 100 parts by weight of the (A) colorant is preferably 10 to 1,000 parts by weight, more preferably 20 to 500 parts by weight. When the total amount of the alkali-soluble resins is less than 10

parts by weight, for example, alkali developability may be decreased and a ground soiling or a remaining film may occur on a non-exposed portion of a substrate or on a masking layer. When it exceeds 1,000 parts by weight,  
 5 the concentration of the colorant is relatively decreased, and it may be hence difficult to attain the color density intended as a thin film.

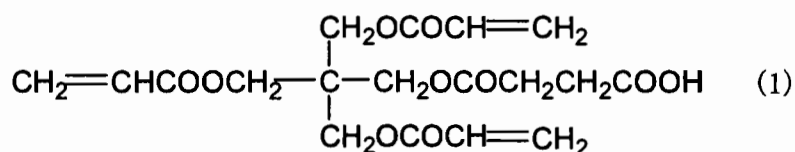
Further, the amount of the copolymer (BI) in the alkali-soluble resin is preferably 10 to 100 % by weight,  
 10 particularly preferably 20 to 100 % by weight. When the amount of the copolymer (BI) is less than 10 % by weight, the intended effect of this invention may be impaired.

-(C) Polyfunctional monomer-

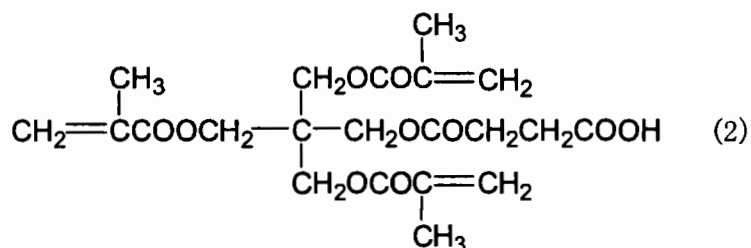
The polyfunctional monomer in this invention  
 15 refers to a monomer having two or more polymerizable unsaturated bonds.

Examples of the polyfunctional monomer include;  
 di(meth)acrylates of alkylene glycols such as ethylene glycol, propylene glycol, etc.;  
 20 di(meth)acrylates of polyalkylene glycols such as polyethylene glycol, polypropylene glycol, etc.;  
 poly(meth)acrylates of trihydric or higher polyhydric alcohols such as glycerin, trimethylol propane, pentaerythritol, dipentaerythritol, etc., and  
 25 dicarboxylic-acid-modified products of these;  
 oligo(meth)acrylates of a polyester, an epoxy resin, a urethane resin, an alkyd resin, a silicone resin, a spiran resin, etc.;  
 di(meth)acrylates of both-ends-hydroxylated  
 30 polymers such as both-ends-hydroxypoly-1,3-butadiene, both-ends-hydroxypolyisoprene, both-ends-hydroxypolycaprolactone, etc.; and  
 tris[2-(meth)acryloyloxyethyl]phosphate.  
 Of these polyfunctional monomers,

poly(meth)acrylates of trihydric or higher polyhydric alcohols or dicarboxylic-acid-modified products of these are preferred, and, specifically, preferred are trimethylolpropane triacrylate, trimethylolpropane trimethacrylate, pentaerythritol triacrylate, pentaerythritol trimethacrylate, pentaerythritol tetraacrylate, pentaerythritol tetramethacrylate, dipentaerythritol pentaacrylate, dipentaerythritol pentamethacrylate, dipentaerythritol hexaacrylate, dipentaerythritol hexamethacrylate, a compound of the following formula (1),



a compound of the following formula (2),



and the like. Above all, trimethylolpropane triacrylate, pentaerythritol triacrylate and dipentaerythritol hexaacrylate are particularly preferred in that a colored layer has high intensity and excellent surface smoothness and that the occurrence of a ground soiling, a remaining film, etc., on a non-exposed portion of a substrate and on a masking layer is suppressed.

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

The amount of the polyfunctional monomer in this invention per 100 parts by weight of the (B) alkali-soluble resin is preferably 5 to 500 parts by weight, more preferably 20 to 300 parts by weight. When the

amount of the polyfunctional monomer is less than 5 parts by weight, the intensity and surface smoothness of a colored layer are liable to decrease. When it exceeds 500 parts by weight, the alkali developability is liable to decrease or a ground soiling, a remaining film, etc., are liable to occur on a non-exposed portion of a substrate or on a masking layer.

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

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

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

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

The total amount of the polyfunctional monomer and the monofunctional monomer in this invention per 100 parts by weight of the (B) alkali-soluble resin is preferably 5 to 500 parts by weight, more preferably 20 to 300 parts by weight. When the above total amount is less than 5 parts by weight, the intensity and surface smoothness of a colored layer are liable to decrease.

When it exceeds 500 parts by weight, for example, alkali developability is liable to decrease or a ground soiling, a remaining film, etc., are liable to occur on a non-exposed portion of a substrate and on a masking layer.

5    -(D) Photopolymerization initiator-

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

          Examples of the above photopolymerization initiator include an acetophenone compound, a  
15   biimidazole compound, a triazine compound, a benzoin compound, a benzophenone compound, an  $\alpha$ -diketone compound, a polynuclear quinone compound, a xanthone compound, a diazo compound, an O-acyloxime compound, an onium salt compound and an imidosulphonate compound.

20           These compounds are components that generate an active radical or an active acid or generate both an active radical and an active acid by exposure.

          In this invention, the above photopolymerization initiators may be used singly or in combination of two  
25   or more. The photo polymerization initiator in this invention is preferably at least one member selected from the group consisting of an acetophenone compound, a biimidazole compound, a triazine compound and an O-acyloxime compound.

30           In this invention, the amount of the photopolymerization initiator per 100 parts by weight of the (C) polyfunctional monomer or a total of it and the monofunctional monomer is preferably 0.01 to 120 parts by weight, more preferably 1 to 100 parts by weight.

When the amount of the photopolymerization initiator is less than 0.01 part by weight, curing by exposure is insufficient and it may be difficult to obtain a color filter having a colored layer pattern arranged in a predetermined array. When it exceeds 120 parts by weight, a formed color layer is liable to come off a substrate during development.

Of the photopolymerization initiators preferred in this invention, the acetophenone compound specifically includes, for example, 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.

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

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

When an acetophenone compound is used as a photopolymerization initiator in this invention, the amount thereof per 100 parts by weight of the (C) polyfunctional monomer or a total of it and the monofunctional monomer is preferably 0.01 to 80 parts by weight, more preferably 1 to 60 parts by weight, still more preferably 1 to 30 parts by weight. When the amount of the acetophenone compound is less than 0.01 part by weight, curing by exposure is insufficient, and it may be difficult to obtain a color filter having a colored layer pattern arranged in a predetermined array. When it exceeds 80 parts by weight, a formed colored layer is liable to come off a substrate during the development.

Further, specific examples of the above biimidazole compound include 2,2'-bis(2-chlorophenyl)-4,4',5,5'-tetrakis(4-ethoxycarbonylphenyl)-1,2'-biimidazole, 2,2'-bis(2-bromophenyl)-4,4',5,5'-tetrakis(4-ethoxycarbonylphenyl)-1,2'-biimidazole, 2,2'-bis(2-chlorophenyl)-4,4',5,5'-tetraphenyl-1,2'-biimidazole, 2,2'-bis(2,4-dichlorophenyl)-4,4',5,5'-tetraphenyl-1,2'-biimidazole, 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.

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

These biimidazole compounds have excellent solubility in a solvent and do not generate foreign matters such as an undissolved matter, a precipitate, etc., and they have high sensitivity and cause a curing reaction to fully proceed under exposure at a low energy level. Further, they do not cause a curing reaction in a non-exposed portion. In a coating film after exposure, therefore, a cured portion insoluble in a developing solution and an uncured portion having high solubility in the developing solution are distinctly divided, whereby there can be formed a high-definition color filter in which a colored layer pattern free of an undercut is arranged according to a predetermined array.

The above biimidazole compounds may be used

singly or in combination of two or more.

When the biimidazole compound is used as a photopolymerization initiator in this invention, the amount thereof based on the (C) polyfunctional monomer or a total of it and the monofunctional monomer is preferably 0.01 to 40 parts by weight, more preferably 1 to 30 parts by weight, still more preferably 1 to 20 parts by weight. When the amount of the biimidazole compound is less than 0.01 part by weight, curing by exposure is insufficient and it may be difficult to obtain a color filter having a colored layer pattern arranged in a predetermined array. When it exceeds 40 parts by weight, a formed colored layer is liable to come off a substrate, or the colored layer surface is liable to be roughened, during development.

In this invention, when the biimidazole compound is used as a photopolymerization initiator, it is preferred to use the following hydrogen donor since sensitivity can be further improved.

The hydrogen donor as used herein means a compound that can provide hydrogen atoms to radicals which are generated from the biimidazole compound under exposure.

The hydrogen donor in this invention is preferably a mercaptan compound or an amine compound that will be defined below.

The above mercaptan compound refers to a compound containing a benzene ring or a heterocyclic ring as a base ring and having at least one, preferably 1 to 3, more preferably 1 to 2 mercapto groups bonded directly to the mother nucleus (to be referred to "mercaptan-based hydrogen donor" hereinafter).

The above amine compound refers to a compound containing a benzene ring or a heterocyclic ring as a

base ring and having at least one, preferably 1 to 3, more preferably 1 to 2 amino groups bonded directly to the base ring (to be referred to as "amine-based hydrogen donor" hereinafter).

5           These hydrogen donors may have mercapto group(s) and amino group(s) at the same time.

          The hydrogen donor will be more specifically explained below.

          The mercaptan-based hydrogen donor may have one  
10 or more benzene rings or heterocyclic rings and may have both a benzene ring and a heterocyclic ring. When it has two or more rings of these, these rings may form a fused ring.

          Further, when the mercaptan-based hydrogen donor  
15 has two or more mercapto groups and so long as it has at least one free mercapto group remains, the remaining one or more mercapto groups may be substituted with alkyl group(s), aralkyl group(s) or aryl group(s). Further, so long as at least one free mercapto group remains, it may  
20 have a structural unit in which two sulfur atoms are bonded to each other through a divalent organic group such as an alkylene group or the like or a structural unit in which two sulfur atoms are bonded to each other in the form of a disulfide.

25           In the mercaptan-based hydrogen donor, further, a site other than the mercapto group(s) may be substituted with a carboxyl group, an alkoxycarbonyl group, a substituted alkoxycarbonyl group, a phenoxycarbonyl group, a substituted phenoxycarbonyl  
30 group, a nitro group or the like.

          Specific examples of the above mercaptan-based hydrogen donor include 2-mercaptobenzothiazole, 2-mercaptobenzoxazole, 2-mercaptobenzoimidazole, 2,5-dimercapto-1,3,4-thiadiazole and 2-mercapto-2,5-

dimethylaminopyridine.

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

Further, the amine-based hydrogen donor may have one or more benzene rings or heterocyclic rings and may have both a benzene ring and a heterocyclic ring. When it has two or more rings of these, these rings may form  
10 a fused ring.

In the amine-based hydrogen donor, further, one or more amino groups may be substituted with an alkyl group or a substituted alkyl group, and a site other than the amino group may be substituted with a carboxyl  
15 group, an alkoxy carbonyl group, a substituted alkoxy carbonyl group, a phenoxy carbonyl group, a substituted phenoxy carbonyl group or a nitrile group.

Specific examples of the above amine-based hydrogen donor include 4,4'-  
20 bis(dimethylamino)benzophenone, 4,4'-bis(diethylamino)benzophenone, 4-diethylaminoacetophenone, 4-dimethylaminopropiophenone, ethyl-4-dimethylaminobenzoate, 4-dimethylaminobenzoate and 4-dimethylaminobenzonitrile.

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

The amine-based hydrogen donor also has activity  
30 as a sensitizer for radical-generating agents other than the biimidazole compound.

In this invention, the hydrogen donors may be used singly or in combination of two or more. it is preferred to use at least one mercaptan-based hydrogen

donor and at least one amine-based hydrogen donor in combination, since it is ensured that a formed colored layer does not easily come off a substrate during development and since a high colored layer intensity and high sensitivity are attained.

Specific examples of combination of the mercaptan-based hydrogen donor with the amine-based hydrogen donor include 2-mercaptobenzothiazole/4,4'-bis(dimethylamino)benzophenone, 2-mercaptobenzothiazole/4,4'-bis(diethylamino)benzophenone, 2-mercaptobenzoxazole/4,4'-bis(dimethylamino)benzophenone, 2-mercaptobenzoxazole/4,4'-bis(diethylamino)benzophenone, and the like. Further, combinations of 2-mercaptobenzothiazole/4,4'-bis(diethylamino)benzophenone and 2-mercaptobenzoxazole/4,4'-bis(diethylamino)benzophenone are preferred, and a combination of 2-mercaptobenzothiazole/4,4'-bis(diethylamino)benzophenone is particularly preferred.

In the combination of the mercaptan-based hydrogen donor with the amine-based hydrogen donor, the mercaptan-based hydrogen donor:amine-based hydrogen donor weight ratio is preferably 1:1 to 1:4, more preferably 1:1 to 1:3.

When the hydrogen donor is used in combination with the biimidazole compound in this invention, the amount of the hydrogen donor per 100 parts by weight of the (C) polyfunctional monomer or a total of it and the monofunctional monomer 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. When the amount of the hydrogen donor is less than 0.01 part by weight, the effect on improvement of sensitivity is liable to decrease. When it exceeds 40 parts by weight,

a formed colored layer is liable to come off a substrate during development.

Further, specific examples of the above triazine compound include triazine compounds having a halomethyl group such as 2,4,6-tris(trichloromethyl)-s-triazine, 2-methyl-4,6-bis(trichloromethyl)-s-triazine, 2-[2-(5-methylfuran-2-yl)ethenyl]-4,6-bis(trichloromethyl)-s-triazine, 2-[2-(furan-2-yl)ethenyl]-4,6-bis(trichloromethyl)-s-triazine, 2-[2-(4-dithylamino-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.

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

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

When the triazine compound is used as a photopolymerization initiator in this invention, the amount of the triazine compound per 100 parts by weight of the (C) polyfunctional monomer or a total of it and the monofunctional monomer 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. When the amount of the triazine compound is less than 0.01 parts by weight, curing by exposure is insufficient and it may be difficult to obtain a color filter having a colored layer pattern arranged in a predetermined array. When it exceeds 40 parts by weight, a formed colored layer is liable to come off a substrate during development.

Further, specific examples of the above O-acyloxime compound include 1-[4-(phenylthio)phenyl]-heptane-1,2-dione 2-(O-benzoyloxime), 1-[4-(phenylthio)phenyl]-octane-1,2-dione 2-(O-benzoyloxime),  
5 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), 1-[9-ethyl-6-(3-methylbenzoyl)-9H-carbazol-3-yl]-ethanone 1-(O-acetyloxime) and 1-[9-ethyl-6-benzoyl-9H-carbazol-3-yl]-  
10 ethanone 1-(O-acetyloxime).

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

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

When the O-acyloxime compound is used as a photopolymerization initiator in this invention, the amount of the O-acyloxime compound per 100 parts by weight of the (C) polyfunctional monomer or a total of  
20 it and the monofunctional monomer 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. When the amount of the O-acyloxime compound is less than  
25 0.01 part by weight, curing by exposure is insufficient, and it may be difficult to obtain a colored filter having a colored layer pattern arranged in a predetermined array. When it exceeds 40 parts by weight, a formed colored layer is liable to come off a substrate  
30 during development.

Further, examples of the above onium salt compound include diaryliodonium salt, triarylsulfonium salt, a diarylphosphonium salt and the like.

Specific examples of the above diaryliodonium

salt include diphenyliodonium tetrafluoroborate, diphenyliodonium hexafluorophosphonate, diphenyliodonium hexafluoroarsenate, diphenyliodonium trifluoromethanesulfonate, diphenyliodonium

5 trifluoroacetate, diphenyliodonium-p-toluenesulfonate, 4-methoxyphenylphenyliodonium tetrafluoroborate, 4-methoxyphenylphenyliodonium hexafluorophosphonate, 4-methoxyphenylphenyliodonium hexafluoroarsenate, 4-methoxyphenylphenyliodonium trifluoromethanesulfonate,

10 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 trifluoromethanesulfonate, bis(4-

15 tert-butylphenyl)iodonium trifluoroacetate and bis(4-tert-butylphenyl)iodonium-p-toluene sulfonate.

Specific examples of the above triarylsulfonium salt include triphenylsulfonium tetrafluoroborate, triphenylsulfonium hexafluorophosphonate,

20 triphenylsulfonium hexafluoroarsenate, triphenylsulfonium trifluoromethanesulfonate, triphenylsulfonium trifluoroacetate, triphenylsulfonium-p-toluenesulfonate, 4-methoxyphenyldiphenylsulfonium tetrafluoroborate, 4-

25 methoxyphenyldiphenylsulfonium hexafluorophosphonate, 4-methoxyphenyldiphenylsulfonium hexafluoroarsenate, 4-methoxyphenyldiphenylsulfonium trifluoromethanesulfonate, 4-methoxyphenyldiphenylsulfonium trifluoroacetate, 4-methoxyphenyldiphenylsulfonium-p-toluenesulfonate, 4-

30 phenylthiophenyldiphenyl tetrafluoroborate, 4-phenylthiophenyldiphenyl hexafluorophosphonate, 4-phenylthiophenyldiphenyl hexafluoroarsenate, 4-phenylthiophenyldiphenyl trifluoromethanesulfonate, 4-phenylthiophenyldiphenyl trifluoroacetate and 4-

phenylthiophenyldiphenyl-p-toluenesulfonate.

Specific examples of the above diarylphosphonium salt include (1-6- $\eta$ -cumene)( $\eta$ -cyclopentadienyl)iron hexafluorophosphonate, and the like.

5           Of these onium salt compounds, diphenyliodonium hexafluorophosphonate, triphenylsulfonium trifluoromethanesulfonate, etc., are particularly preferred.

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

          When the onium salt compound is used as a photopolymerization initiator in this invention, the amount of the onium salt compound per 100 parts by weight of the (C) polyfunctional monomer or a total of  
15 it and the monofunctional monomer 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. When the amount of the onium salt compound is less than 0.01 part by weight, curing by exposure is insufficient,  
20 and it may be difficult to obtain a colored filter having a colored layer pattern arranged in a predetermined array. When it exceeds 40 parts by weight, a formed colored layer is liable to come off a substrate during development.

25 -Additives-

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

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

          The above organic acid and organic amino compound are components that improve the solubility of

the radiation-sensitive composition in an alkali developing solution and that acts to more suppress an undissolved matter that remains after development.

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

Examples of the above aliphatic carboxylic acid include;

10 monocarboxylic acids such as formic acid, acetic acid, propionic acid, butyric acid, valeric acid, pivalic acid, caproic acid, diethylacetic acid, enanthic acid, caprylic acid, etc.;

dicarboxylic acids such as oxalic acid, malonic  
15 acid, succinic acid, glutaric acid, adipic acid, pimelic acid, suberic acid, azelaic acid, sebacic acid, brassylic acid, methylmalonic acid, ethylmalonic acid, dimethylmalonic acid, methylsuccinic acid, tetramethylsuccinic acid, cyclohexanedicarboxylic acid,  
20 itaconic acid, citraconic acid, maleic acid, fumaric acid, mesaconic acid, etc.; and

tricarboxylic acids such as tricarballylic acid, aconitic acid, camphoronic acid, etc.;

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

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

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

aromatic dicarboxylic acids such as phthalic

acid, isophthalic acid, terephthalic acid, etc.;

trivalent or higher aromatic polycarboxylic acids such as trimellitic acid, trimesic acid, mellophanic acid, pyromellitic acid, etc.;

5           phenylacetic acid, hydroatropic acid, hydrocinnamic acid, mandelic acid, phenylsuccinic acid, atropic acid, cinnamic acid, cinnamylidene acid, coumaric acid, umbellic acid and the like.

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

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

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

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

Examples of the above aliphatic amine include; mono(cyclo)alkylamines such as n-propylamine, i-propylamine, n-butylamine, i-butylamine, sec-butylamine, t-butylamine, n-pentylamine, n-hexylamine, n-heptylamine,

n-octylamine, n-nonylamine, n-decylamine, n-undecylamine, n-dodecylamine, cyclohexylamine, 2-methylcyclohexylamine, 3-methylcyclohexylamine, 4-methylcyclohexylamine, 2-ethylcyclohexylamine, 3-ethylcyclohexylamine, 4-ethylcyclohexylamine, etc.;

di(cyclo)alkylamines such as methylethylamine, diethylamine, methyl n-propylamine, ethyl n-propylamine, di-n-propylamine, di-i-propylamine, di-n-butylamine, di-i-butylamine, di-sec-butylamine, di-t-butylamine, di-n-pentylamine, di-n-hexylamine, methylcyclohexylamine, ethylcyclohexylamine, dicyclohexylamine, etc.;

tri(cyclo)alkylamines such as dimethylethylamine, methyldiethylamine, triethylamine, dimethyl-n-propylamine, diethyl-n-propylamine, methyl di-n-propylamine, ethyl di-n-propylamine, tri-n-propylamine, tri-i-propylamine, tri-n-butylamine, tri-i-butylamine, tri-sec-butylamine, tri-t-butylamine, tri-n-pentylamine, tri-n-hexylamine, dimethylcyclohexylamine, diethylcyclohexylamine, methyldicyclohexylamine, ethyldicyclohexylamine, tricyclohexylamine, etc.;

mono(cyclo)alkanolamines such as 2-aminoethanol, 3-amino-1-propanol, 1-amino-2-propanol, 4-amino-1-butanol, 5-amino-1-pentanol, 6-amino-1-hexanol, 4-amino-1-cyclohexanol, etc.;

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

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

amino(cyclo)alkanediols such as 3-amino-1,2-propanediol, 2-amino-1,3-propanediol, 4-amino-1,2-

butanediol, 4-amino-1,3-butanediol, 4-amino-1,2-cyclohexanediol, 4-amino-1,3-cyclohexanediol, 3-dimethylamino-1,2-propanediol, 3-diethylamino-1,2-propanediol, 2-dimethylamino-1,3-propanediol, 2-diethylamino-1,3-propandiol, etc.;

amino-group-containing cycloalkanemethanols such as 1-aminocyclopentanemethanol, 4-aminocyclopentanemethanol, 1-aminocyclohexanemethanol, 4-aminocyclohexanemethanol, 4-dimethylaminocyclopentanemethanol, 4-diethylaminocyclopentanemethanol, 4-dimethylaminocyclohexanemethanol, 4-diethylaminocyclohexanemethanol, etc.; and

aminocarboxylic acids such as  $\beta$ -alanine, 2-aminobutyric acid, 3-aminobutyric acid, 4-aminobutyric acid, 2-aminoisobutyric acid, 3-aminoisobutyric acid, 2-aminovaleric acid, 5-aminovaleric acid, 6-aminocaproic acid, 1-aminocyclopropanecarboxylic acid, 1-aminocyclohexanecarboxylic acid, 4-aminocyclohexanecarboxylic acid, etc.

Further, examples of the above phenyl-group-containing amine include compounds in which an amino group is bonded directly to a phenyl group and compounds in which an amino group is bonded to a phenyl group through a carbon chain.

Examples of the phenyl-group-containing amine include;

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

aminobenzyl alcohols such as 2-aminobenzyl

alcohol, 3-aminobenzyl alcohol, 4-aminobenzyl alcohol, 4-dimethylaminobenzyl alcohol, 4-diethylaminobenzyl alcohol, etc.; and

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

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

The above curing agent is a component that reacts with a carboxyl group and/or tetrahydrofuran ring of the (B) alkali-soluble resin to cure the (B) alkali-soluble resin.

Examples of the above curing agent include an epoxy compound and an oxetane compound.

The above epoxy compound is preferably selected from polyfunctional epoxy compounds, and specific examples thereof include aromatic epoxy resins such as a bisphenol A epoxy resin, a hydrogenised bisphenol A epoxy resin, a bisphenol F epoxy resin, a hydrogenised bisphenol F epoxy resin, a novolak type epoxy resin, etc.; other epoxy resins such as an aliphatic epoxy resin, a heterocyclic epoxy resin, a glycidyl ester resin, a glycidyl amine resin, an epoxidized oil, etc.; brominated derivatives of these epoxy resins, an

epoxidized product of a (co)polymer of butadiene, an epoxidized product of a (co)polymer of isoprene, a (co)polymer of an unsaturated compound containing a glycidyl group, triglycidyl isocyanurate, and the like.

5           The above epoxy compound is also preferably selected from epoxy-group-containing unsaturated compounds, and specific examples thereof include glycidyl (meth)acrylate, 3,4-epoxybutyl (meth)acrylate, 6,7-epoxyheptyl (meth)acrylate, o-vinylbenzyl glycidyl  
10 ether, m-vinylbenzyl glycidyl ether and p-vinylbenzyl glycidyl ether.

          Further, the above oxetane compound is preferably selected from polyfunctional oxetane compounds, and specific examples thereof include low-  
15 molecular-weight compounds such as bisoxetanyl carbonate, bisoxetanyl adipate, bisoxetanyl terephthalate, bisoxetanyl p-xylylenedicarboxylate, bisoxetanyl 1,4-cyclohexanedicarboxylate, etc., and high polymer compounds such as an oxetane etherified product of a  
20 phenol novolak resin, a (co)polymer of an oxetane-group-containing unsaturated compound, etc.

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

          The amount of the curing agent based on a solid  
25 content of the radiation-sensitive composition is preferably 30 % by weight or less, more preferably 20 % by weight or less. When the amount of the curing agent exceeds 30 % by weight, the storage stability of the radiation sensitive composition obtained is liable to  
30 decrease.

          The above curing aid is a component that promotes a curing reaction based on the above curing agent by performing the ring-opening of the epoxy group and/or oxetane ring of the above curing agents.

Examples of the above curing aid include a polyvalent carboxylic acid, a polyvalent carboxylic anhydride, an amino compound and a thermal acid generating agent.

5           Specific examples of the above polyvalent carboxylic acid include those that are similar to the above organic acids and that have two or more carboxyl groups, and specific examples of the above amino compound include the above organic amino compounds.

10           Further, specific examples of the above polyvalent carboxylic anhydride include aromatic polyvalent carboxylic anhydrides such as phthalic anhydride, pyromellitic anhydride, trimellitic anhydride, 3,3',4,4'-benzophenonetetracarboxylic dianhydride, etc.;  
15 aliphatic polyvalent carboxylic anhydrides such as itaconic anhydride, succinic anhydride, citraconic anhydride, dodecenylsuccinic anhydride, tricarballylic anhydride, maleic anhydride, 1,2,3,4-butonetetracarboxylic dianhydride, etc.; alicyclic  
20 polyvalent carboxylic anhydrides such as hexahydrophthalic anhydride, 3,4-dimethyltetrahydrophthalic anhydride, 1,2,4-cyclopentanetricarboxylic anhydride, 1,2,4-cyclohexanetricarboxylic anhydride,  
25 cyclopentanetetracarboxylic dianhydride, 1,2,4,5-cyclohexanetetracarboxylic dianhydride, HIMIC anhydride, etc.; ester-group-containing carboxylic anhydrides such as ethylene glycol bistrimellitate anhydride, glycerin tristrimellitate anhydride, etc., and others epoxy resin  
30 curing agents that are commercially available under the trade names of ADEKA HARDENER EH-700 (supplied by ADEKA CORPORATION), RIKACID HH (New Japan Chemical Co., Ltd.), MH-700 (New Japan Chemical Co., Ltd.), and the like.

Further, examples of the above thermal acid

generating agent include sulfonium salt (excluding the triarylsulfonium salt described with regard to the above (D) photopolymerization initiator), benzothiazonium salt, ammonium salt and phosphonium salt.

5                Specific examples of the above sulfonium salt include;

                 alkylsulfonium salts such as 4-acetophenyldimethylsulfonium hexafluoroantimonate, 4-acetoxyphenyldimethylsulfonium hexafluoroarsenate,  
 10        dimethyl-4-(benzyloxycarbonyloxy)phenylsulfonium hexafluoroantimonate, dimethyl-4-(benzoyloxy)phenylsulfonium hexafluoroantimonate, dimethyl-4-(benzoyloxy)phenylsulfonium hexafluoroarsenate, dimethyl-3-chloro-4-  
 15        acetoxyphenylsulfonium hexafluoroantimonate, etc.;  
                  benzylsulfonium salts such as benzyl-4-hydroxyphenylmethylylsulfonium hexafluoroantimonate, benzyl-4-hydroxyphenylmethylylsulfonium hexafluorophosphate, 4-  
 20        acetoxyphenylbenzylmethylylsulfonium hexafluoroantimonate, benzyl-4-methoxyphenylmethylylsulfonium hexafluoroantimonate, benzyl-2-methyl-4-hydroxyphenylmethylylsulfonium hexafluoroantimonate, benzyl-3-chloro-4-hydroxyphenylmethylylsulfonium  
 25        hexafluoroarsenate, 4-methoxybenzyl-4-hydroxyphenylmethylylsulfonium hexafluorophosphate, etc.;  
                  dibenzylsulfonium salts such as dibenzyl-4-hydroxyphenylsulfonium hexafluoroantimonate, dibenzyl-4-hydroxyphenylsulfonium hexafluorophosphate, 4-  
 30        acetoxyphenyldibenzylsulfonium hexafluoroantimonate, dibenzyl-4-methoxyphenylsulfonium hexafluoroantimonate, dibenzyl-3-chloro-4-hydroxyphenylsulfonium hexafluoroarsenate, dibenzyl-3-methyl-4-hydroxy-5-tert-butylphenylsulfonium hexafluoroantimonate, benzyl-4-

methoxybenzyl-4-hydroxyphenylsulfonium  
hexafluorophosphate, etc.; and

substituted benzylsulfonium salts such as p-  
chlorobenzyl-4-hydroxyphenylmethylsulfonium  
5 hexafluoroantimonate, p-nitrobenzyl-4-  
hydroxyphenylmethylsulfonium hexafluoroantimonate, p-  
chlorobenzyl-4-hydroxyphenylmethylsulfonium  
hexafluorophosphate, p-nitrobenzyl-3-methyl-4-  
hydroxyphenylmethylsulfonium hexafluoroantimonate, 3,5-  
10 dichlorobenzyl-4-hydroxyphenylmethylsulfonium  
hexafluoroantimonate, o-chlorobenzyl-3-chloro-4-  
hydroxyphenylmethylsulfonium hexafluoroantimonate, etc.

Further, specific examples of the above  
benzothiazonium salt include benzylbenzothiazonium salts  
15 such as 3-benzylbenzothiazonium hexafluoroantimonate, 3-  
benzylbenzothiazonium hexafluorophosphate, 3-  
benzylbenzothiazonium tetrafluoroborate, 3-(p-  
methoxybenzyl)benzothiazonium hexafluoroantimonate, 3-  
benzyl-2-methylthiobenzothiazonium hexafluoroantimonate,  
20 3-benzyl-5-chlorobenzothiazonium hexafluoroantimonate,  
etc.

Of these thermal acid generating agents, 4-  
acetoxyphenyldimethylsulfonium hexafluoroarsenate,  
benzyl-4-hydroxyphenylmethylsulfonium  
25 hexafluoroantimonate, 4-  
acetoxyphenylbenzylmethylsulfonium hexafluoroantimonate,  
dibenzyl-4-hydroxyphenylsulfonium hexafluoroantimonate,  
4-acetoxyphenylbenzylsulfonium hexafluoroantimonate, 3-  
benzylbenzothiazonium hexafluoroantimonate, etc., are  
30 preferred.

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

The amount of the curing aid based on the entire  
solid content of the radiation sensitive composition is

preferably 15 % by weight or less, more preferably 10 % by weight or less. When the amount of the curing aid exceeds 15 % by weight, the storage stability of the radiation sensitive composition obtained is liable to decrease or a formed colored layer is liable to come off a substrate during development.

Examples of additives other than the above-described ones include;

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

fillers such as glass, alumina, etc.;

polymer compounds such as polyvinyl alcohol, polyethylene glycol monoalkyl ether, poly(fluoroalkyl acrylate), etc.;

surfactants such as nonionic, cationic and anionic surfactants, etc.;

adhesion promoters such as vinyltrimethoxysilane, vinyltriethoxysilane, vinyltris(2-methoxyethoxy)silane, N-(2-aminoethyl)-3-aminopropylmethyldimethoxysilane, N-(2-aminoethyl)-3-aminopropyltrimethoxysilane, 3-aminopropyltriethoxysilane, 3-glycidoxypropyltrimethoxysilane, 3-glycidoxypropylmethyldimethoxysilane, 2-(3,4-epoxycyclohexyl)ethyltrimethoxysilane, 3-chloropropylmethyldimethoxysilane, 3-chloropropyltrimethoxysilane, 3-methacryloyloxypropyltrimethoxysilane, 3-mercaptopropyltrimethoxysilane, etc.;

antioxidants such as 2,2'-thiobis(4-methyl-6-t-butylphenol), 2,6-di-t-butylphenol, etc.;

ultraviolet absorbents such as 2-(3-t-butyl-5-methyl-2-hydroxyphenyl)-5-chlorobenzotriazole, alkoxybenzophenone, etc.; and

aggregation inhibitors such as sodium polyacrylate,

thermal radical generating agents such as 1,1'-azobis(cyclohexane-1-carbonitrile), 2-phenylazo-4-methoxy-2,4-dimethylvaleronitrile, etc.

#### Solvent

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

The above solvent can be selected from solvents before use as required so long as they disperse or dissolve the (A) to (D) components and the additive components for constituting the radiation sensitive composition, do not react with these components and exhibits proper volatility.

Examples of the above 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 monoethyl ether, diethylene glycol mono-n-propyl ether, diethylene glycol mono-n-butyl ether, triethylene glycol monomethyl ether, triethylene glycol monoethyl ether, propylene glycol monomethyl ether, propylene glycol monoethyl ether, propylene glycol mono-n-propyl ether, propylene glycol mono-n-butyl ether, dipropylene glycol monomethyl ether, dipropylene glycol monoethyl ether, dipropylene glycol mono-n-propyl ether, dipropylene glycol mono-n-butyl ether, tripropylene glycol monomethyl ether,

tripropylene glycol monoethyl ether, etc.;

(poly)alkylene glycol monoalkyl ether acetates  
such as ethylene glycol monomethyl ether acetate,  
ethylene glycol monoethyl ether acetate, diethylene  
5 glycol monomethyl ether acetate, diethylene glycol  
monoethyl ether acetate, propylene glycol monomethyl  
ether acetate, propylene glycol monoethyl ether acetate,  
etc.;

other ethers such as diethylene glycol dimethyl  
10 ether, diethylene glycol methyl ethyl ether, diethylene  
glycol diethyl ether, tetrahydrofuran, etc.;

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

alkyl lactates such as methyl lactate, ethyl  
15 lactate, etc.;

other esters such as ethyl 2-hydroxy-2-  
methylpropionate, methyl 3-methoxypropionate, ethyl 3-  
methoxypropionate, methyl 3-ethoxypropionate, ethyl 3-  
ethoxypropionate, ethyl ethoxyacetate, ethyl  
20 hydroxyacetate, methyl 2-hydroxy-3-methylbutanoate, 3-  
methyl-3-methoxybutyl acetate, 3-methyl-3-methoxybutyl  
propionate, ethyl acetate, n-propyl acetate, i-propyl  
acetate, n-butyl acetate, i-butyl acetate, n-amyl  
formate, i-amyl acetate, n-butyl propionate, ethyl  
25 butyrate, n-propyl butyrate, i-propyl butyrate, n-butyl  
butyrate, methyl pyruvate, ethyl pyruvate, n-propyl  
pyruvate, methyl acetoacetate, ethyl acetoacetate, ethyl  
2-oxobutanoate, etc.;

aromatic hydrocarbons such as toluene, xylene,  
30 etc.;

amides or lactams such as N,N-dimethylformamide,  
N,N-dimethylacetamide, N-methylpyrrolidone, etc.

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

preferred are propylene glycol monomethyl ether,  
ethylene glycol monomethyl ether acetate, propylene  
glycol monomethyl ether acetate, propylene glycol  
monoethyl ether acetate, diethylene glycol dimethyl  
5 ether, diethylene glycol methyl ethyl ether,  
cyclohexanone, 2-heptanone, 3-heptanone, ethyl lactate,  
ethyl 3-methoxypropionate, methyl 3-ethoxypropionate,  
ethyl 3-ethoxypropionate, 3-methyl-3-methoxybutyl  
propionate, n-butyl acetate, i-butyl acetate, n-amyl  
10 formate, i-amyl acetate, n-butyl propionate, ethyl  
butyrate, i-propyl butyrate, n-butyl butyrate, ethyl  
pyruvate, etc.

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

15 In combination with the above solvent, there may  
be used high-boiling-point solvents such as benzyl ethyl  
ether, di-n-hexyl ether, acetonyl acetone, isophorone,  
caproic acid, caprylic acid, 1-octanol, 1-nonanol,  
benzyl alcohol, benzyl acetate, ethyl benzoate, diethyl  
20 oxalate, diethyl maleate,  $\gamma$ -butyrolactone, ethylene  
carbonate, propylene carbonate, ethylene glycol  
monophenyl ether, etc.

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

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

#### Color filter

The color filter of this invention has a colored

layer formed from the radiation sensitive composition for forming a colored layer of this invention.

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

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

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

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

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

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

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

For applying a liquid composition of the radiation sensitive composition to a substrate, there may be employed a pray method, a roll coating method, a spin coating method, a slit die method, a bar coating method, an ink jet method, or the like as required, while a spin coating method and a slit die method are preferred.

The thickness of the coating film, as a thickness of a dry coating film, is preferably 0.1 to 10  $\mu\text{m}$ , more preferably 0.2 to 8.0  $\mu\text{m}$ , particularly preferably 0.2 to 6.0  $\mu\text{m}$ .

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

The exposure dose of the radiation is preferably 10 to 10,000  $\text{J}/\text{m}^2$ .

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

diazabicyclo[4.3.0]-5-nonene and the like.

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

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

The color filter of this invention, obtained in the above manner, is remarkably useful for a transmission type or reflection type color liquid crystal display device, a color image-sensing device, a color sensor and the like.

#### Color liquid crystal display device

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

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

The radiation sensitive composition for forming a colored layer of this invention contains the above (A) to (D) components as essential components, and, specially, the following compositions (a) to (d) are particularly preferred.

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

(b) A radiation sensitive composition for forming a colored layer of the above (a), in which the (C) polyfunctional monomer is at least one member selected from the group consisting of trimethylolpropane triacrylate, pentaerythritol triacrylate and dipentaerythritol hexaacrylate.

(c) A radiation sensitive composition for forming a colored layer of the above (a) or (b), in which the photopolymerization initiator is at least one member selected from the group consisting of an acetophenone compound, a biimidazole compound, a triazine compound and an O-acyloxime compound.

(d) A radiation sensitive composition for forming a colored layer of the above (a), (b) or (c), in which the (A) colorant is an organic pigment or carbon black.

Further, a preferred color filter of this invention

(e) has pixels and/or a black matrix formed from the above radiation sensitive composition for forming a colored layer (a), (b), (c) or (d).

Further, a preferred color liquid crystal display device of this invention

(f) has the above color filter (e), and a more preferred color liquid crystal display device of this invention

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

As described above, the radiation sensitive composition for forming a colored layer of this invention has high sensitivity and is excellent in a

pattern form and a film remaining ratio even under a low exposure dose, and it can form pixels and a black matrix which are excellent in solvent resistance against various solvents and adhesion to a substrate.

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

#### Examples

          This invention will be more specifically explained with reference to Examples hereinafter, while  
15 this invention shall not be limited to these Examples.

#### Synthesis of alkali-soluble resin

##### Synthesis Example 1

          A flask having a cooling tube and a stirrer was  
20 charged with 3 parts by weight of 2,2'-azobisisobutyronitrile and 200 parts by weight of propylene glycol monomethyl ether acetate and then charged with 15 parts by weight of methacrylic acid, 15 parts by weight of N-phenylmaleimide, 30 parts by weight  
25 of tetrahydrofurfuryl methacrylate, 10 parts by weight of styrene, 30 parts by weight of n-butyl methacrylate and 3 parts by weight of  $\alpha$ -methylstyrene dimer as a molecular weight adjusting agent, followed by substituted with nitrogen. Then, stirring was moderately  
30 started, the temperature of a reaction mixture was increased to 80°C and this temperature was maintained for 5 hours to carry out polymerization, whereby a solution of a copolymer (BI) was obtained. This copolymer (BI) will be referred to as "alkali-soluble resin (B-1)".

## Synthesis Example 2

A flask having a cooling tube and a stirrer was charged with 3 parts by weight of 2,2'-azobisisobutyronitrile and 200 parts by weight of propylene glycol monomethyl ether acetate and then charged with 15 parts by weight of methacrylic acid, 15 parts by weight of N-phenylmaleimide, 30 parts by weight of (2-methacryloyloxyethyl)(tetrahydrofurfuryl)succinate, 10 parts by weight of styrene, 30 parts by weight of n-butyl methacrylate and 3 parts by weight of  $\alpha$ -methylstyrene dimer as a molecular weight adjusting agent, followed by substituted with nitrogen. Then, stirring was moderately started, the temperature of a reaction mixture was increased to 80°C and this temperature was maintained for 5 hours to carry out polymerization, whereby a solution of a copolymer (BI) was obtained. This copolymer (BI) will be referred to as "alkali-soluble resin (B-2)".

20

## Comparative Synthesis Example 1

A flask having a cooling tube and a stirrer was charged with 3 parts by weight of 2,2'-azobisisobutyronitrile and 200 parts by weight of propylene glycol monomethyl ether acetate and charged with 15 parts by weight of methacrylic acid, 45 parts by weight of benzyl methacrylate, 10 parts by weight of styrene, 30 parts by weight of n-butyl methacrylate and 3 parts by weight of  $\alpha$ -methylstyrene dimer as a molecular weight adjusting agent, followed by substituted with nitrogen. Then, stirring was moderately started, the temperature of a reaction mixture was increased to 80°C and this temperature was maintained for 5 hours to carry out polymerization, whereby a solution

30

of a copolymer was obtained. This copolymer will be referred to as "alkali-soluble resin (B-3)".

#### Preparation of pigment dispersion

##### 5 Preparation Example 1

20 Parts by weight of a mixture of C.I. Pigment Red 254/C.I. Pigment Red 177 = 80/20 (weight ratio) as (A) colorant, 5 parts by weight (as a solid content) of BYK-2001 as a dispersing agent and 75 parts by weight of  
10 propylene glycol monomethyl ether acetate as a solvent were treated with a bead mill to prepare a pigment dispersion (R1).

##### Preparation Example 2

15 A pigment dispersion (R2) was prepared in the same manner as in Preparation Example 1 except that BYK-2001 was replaced with 5 parts by weight (as a solid content) of Solsperse 24000 as a dispersing agent.

##### 20 Preparation Example 3

20 Parts by weight of a mixture of C.I. Pigment Green 36/C.I. Pigment Yellow 150 = 50/50 (weight ratio) as (A) colorant, 5 parts by weight (as a solid content) of BYK-2001 as a dispersing agent and 75 parts by weight  
25 of propylene glycol monomethyl ether acetate as a solvent were treated with a bead mill to prepare a pigment dispersion (G1).

##### Preparation Example 4

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

## Preparation Example 5

20 Parts by weight of a mixture of C.I. Pigment Blue 15:6/C.I. Pigment Violet 23 = 90/10 (weight ratio) as (A) colorant, 5 parts by weight (as a solid content) of BYK-2001 as a dispersing agent and 75 parts by weight of propylene glycol monomethyl ether acetate as a solvent were treated with a bead mill to prepare a pigment dispersion (B1).

## 10 Preparation Example 6

A pigment dispersion (B2) was prepared in the same manner as in Preparation Example 5 except that BYK-2001 was replaced with 5 parts by weight (as a solid content) of Solsperse 24000 as a dispersing agent.

15

## Example 1

100 Parts by weight of the pigment dispersion (R1), 15 parts by weight (as a solid content) of the alkali-soluble resin (B-1), 20 parts by weight of dipentaerythritol hexaacrylate as a (C) polyfunctional monomer, 5 parts by weight of 2-methyl-1[4-(methylthio)phenyl]-2-morpholinopropan-1-one as a (D) photopolymerization initiator and propylene glycol monomethyl ether acetate as a solvent were mixed to prepare a liquid composition (R1-1) having a solid concentration of 25 % by weight.

25 With regard to the liquid composition (R1-1), a pattern was formed, and evaluation was made, according to the following procedures. Table 1 shows the evaluation results.

30

## Formation of pattern

The liquid composition (R1-1) was applied onto the surface of each of six glass substrates with a spin

coater and then an applied liquid composition was pre-baked at 90°C for 4 minutes to form a 1.3  $\mu\text{m}$  thick coating film on each substrate. Then, the six substrates were cooled to room temperature and the coating film on each substrate was exposed to a high-pressure mercury lamp at an exposure dose of 300  $\text{J}/\text{m}^2$ , 400  $\text{J}/\text{m}^2$ , 500  $\text{J}/\text{m}^2$ , 750  $\text{J}/\text{m}^2$ , 1,000  $\text{J}/\text{m}^2$  or 2,000  $\text{J}/\text{m}^2$  through a photomask. A 0.04 % by weight potassium hydroxide aqueous solution at 23°C was ejected on the coating films on the substrates at a development pressure (nozzle diameter 1 mm) of 1  $\text{kgf}/\text{cm}^2$  to carry out shower development, and then the coating films were post-baked at 220°C for 30 minutes to form 200 x 200  $\mu\text{m}$  dot patterns.

#### 15 Evaluation of sensitivity

The dot pattern on each substrate was observed through a scanning electron microscope. When an excellent pattern was formed and when a film remaining ratio calculated as a film thickness ratio of film thicknesses before and after the development (film thickness after development x 100/film thickness before development) was 90 % or more, such a case was evaluated as ○, when an excellent pattern was formed but when the film remaining ratio was less than 90 % or when it was observed that the pattern was partly missing, such a case was evaluated as △, and when no pattern was formed, such a case was evaluated as ×.

#### Evaluation of solvent resistance

30 The substrates were immersed in N-methylpyrrolidone at 25°C for 30 minutes, and the dot pattern on each substrate before and after immersion was observed through a scanning electron microscope. When a pattern had no change and when the film thickness ratio

of film thicknesses before and after the immersion (film thickness after immersion  $\times 100$ /film thickness before immersion) was 95 % or more, such a case was evaluated as ○, when the film thickness ratio was less than 95 % or when it was observed that the pattern was partly missing, such a case was evaluated as △, and when the entire pattern was peeled from the substrates after the immersion, such a case was evaluated as ×. When no dot pattern could not be formed due to the shortage of sensitivity, no evaluation was made (such a case is shown as "-" in Table 1).

#### Evaluation of adhesion

The liquid composition (R1-1) was applied onto the surface of a glass substrate with a spin coater, an applied composition was pre-baked at 90°C for 4 minutes to form a 1.3  $\mu\text{m}$  coating film. Then, the substrate was cooled to room temperature and the coating film was exposed to a high-pressure mercury lamp at an exposure dose of 2,000 J/m<sup>2</sup>. A 0.04 % by weight potassium hydroxide aqueous solution at 23°C was ejected on the coating film at a development pressure (nozzle diameter 1 mm) of 1 kgf/cm<sup>2</sup> to carry out shower development, and then the coating film was post-baked at 220°C for 30 minutes. Then, the coating film was cross-cut in the form of 100 squares according to JIS K5400 standard and evaluated for adhesion. A case where no square piece was peeled off was evaluated as ○, a case where 1 to 10 square pieces were peeled off was evaluated as △ and a case where more than 10 square pieces were peeled off was evaluated as ×.

#### Example 2

A liquid composition (R1-2) was prepared in the

same manner as in Example 1 except that the (D) photopolymerization initiator was replaced with 5 parts by weight of 1-[9-ethyl-6-(2-methylbenzoyl)-9H-carbazol-3-yl]-ethanone-1-(O-acetyloxime).

5           Then, evaluations were carried out in the same manner as in Example 1 except that the liquid composition (R1-1) was replaced with the liquid composition (R1-2). Table 1 shows the evaluation results.

#### 10   Example 3

100 Parts by weight of the pigment dispersion (R1), 12 parts by weight (as a solid content) of the alkali-soluble resin (B-1), 20 parts by weight of dipentaerythritol hexaacrylate as a (C) polyfunctional  
15   monomer, 5 parts by weight of 2-methyl-1-[4-(methylthio)phenyl]-2-morpholinopropan-1-one as a (D) photopolymerization initiator, 3 parts by weight of a bisphenol A novolak type epoxy resin (trade name 157S65, supplied by Japan Epoxy Resins Co., Ltd.) as a curing  
20   agent and propylene glycol monomethyl ether acetate as a solvent were mixed to prepare a liquid composition (R1-3) having a solid concentration of 25 % by weight.

Then, evaluations were carried out in the same manner as in Example 1 except that the liquid  
25   composition (R1-1) was replaced with the liquid composition (R1-3). Table 1 shows the evaluation results.

#### Example 4

100 Parts by weight of the pigment dispersion  
30   (R1), 15 parts by weight (as a solid content) of the alkali-soluble resin (B-1), 20 parts by weight of dipentaerythritol hexaacrylate as a (C) polyfunctional monomer, 5 parts by weight of 2-methyl-1-[4-(methylthio)phenyl]-2-morpholinopropan-1-one as a (D)

photopolymerization initiator, 1 part by weight of trimellitic anhydride as a curing agent and propylene glycol monomethyl ether acetate as a solvent were mixed to prepare a liquid composition (R1-4) having a solid  
5 concentration of 25 % by weight.

Then, evaluations were carried out in the same manner as in Example 1 except that the liquid composition (R1-1) was replaced with the liquid composition (R1-4). Table 1 shows the evaluation results.  
10

#### Example 5

A liquid composition (R1-5) was prepared in the same manner as in Example 1 except that the alkali-soluble resin (B-1) was replaced with 15 parts by weight  
15 (as a solid content) of the alkali-soluble resin (B-2).

Then, evaluations were carried out in the same manner as in Example 1 except that the liquid composition (R1-1) was replaced with the liquid composition (R1-5). Table 1 shows the evaluation results.  
20

#### Example 6

A liquid composition (R2-1) was prepared in the same manner as in Example 1 except that the pigment dispersion (R1) was replaced with 100 parts by weight of  
25 the pigment dispersion (R2).

Then, evaluations were carried out in the same manner as in Example 1 except that the liquid composition (R1-1) was replaced with the liquid composition (R2-1). Table 1 shows the evaluation results.  
30

#### Example 7

A liquid composition (R2-2) was prepared in the same manner as in Example 1 except that the pigment dispersion (R1) was replaced with 100 parts by weight of

the pigment dispersion (R2) and that the alkali-soluble resin (B-1) was replaced with 15 parts by weight (as a solid content) of the alkali-soluble resin (B-2).

Then, evaluations were carried out in the same manner as in Example 1 except that the liquid composition (R1-1) was replaced with the liquid composition (R2-2). Table 1 shows the evaluation results.

#### Example 8

10        100 Parts by weight of the pigment dispersion (G1),  
20 parts by weight (as a solid content) of the alkali-soluble resin (B-1), 10 parts by weight of dipentaerythritol hexaacrylate as a (C) polyfunctional monomer, 10 parts by weight of 2-benzyl-2-dimethylamino-  
15 1-(4-morpholinophenyl)-butan-1-one as a (D) photopolymerization initiator and propylene glycol monomethyl ether acetate as a solvent were mixed to prepare a liquid composition (G1-1) having a solid concentration of 25 % by weight.

20        Then, evaluations were carried out in the same manner as in Example 1 except that the liquid composition (R1-1) was replaced with the liquid composition (G1-1). Table 1 shows the evaluation results.

#### 25 Example 9

A liquid composition (G2-1) was prepared in the same manner as in Example 8 except that the pigment dispersion (G1) was replaced with 100 parts by weight of the pigment dispersion (G2).

30        Then, evaluations were carried out in the same manner as in Example 1 except that the liquid composition (R1-1) was replaced with the liquid composition (G2-1). Table 1 shows the evaluation results.

## Example 10

A liquid composition (G1-2) was prepared in the same manner as in Example 8 except that the alkali-soluble resin (B-1) was replaced with 20 parts by weight (as a solid content) of the alkali-soluble resin (B-2).

Then, evaluations were carried out in the same manner as in Example 1 except that the liquid composition (R1-1) was replaced with the liquid composition (G1-2). Table 1 shows the evaluation results.

## Example 11

A liquid composition (G2-2) was prepared in the same manner as in Example 8 except that the pigment dispersion (G1) was replaced with 100 parts by weight of the pigment dispersion (G2) and that the alkali-soluble resin (B-1) was replaced with 20 parts by weight (as a solid content) of the alkali-soluble resin (B-2).

Then, evaluations were carried out in the same manner as in Example 1 except that the liquid composition (R1-1) was replaced with the liquid composition (G2-2). Table 1 shows the evaluation results.

## Example 12

100 Parts by weight of the pigment dispersion (B1), 15 parts by weight (as a solid content) of the alkali-soluble resin (B-1), 15 parts by weight of dipentaerythritol hexaacrylate as a (C) polyfunctional monomer, 4 parts by weight of 2-methyl-1-[4-(methylthio)phenyl]-2-morpholinopropan-1-one and 1 part by weight of 2,4-diethylthioxanthone both as a (D) photopolymerization initiator and propylene glycol monomethyl ether acetate as a solvent were mixed to prepare a liquid composition (B1-1) having a solid concentration of 25 % by weight.

Then, evaluations were carried out in the same manner as in Example 1 except that the liquid composition (R1-1) was replaced with the liquid composition (B1-1). Table 1 shows the evaluation results.

5

#### Example 13

A liquid composition (B2-1) was prepared in the same manner as in Example 12 except that the pigment dispersion (B1) was replaced with 100 parts by weight of the pigment dispersion (B2).

Then, evaluations were carried out in the same manner as in Example 1 except that the liquid composition (R1-1) was replaced with the liquid composition (B2-1). Table 1 shows the evaluation results.

15

#### Example 14

A liquid composition (B1-2) was prepared in the same manner as in Example 12 except that the alkali-soluble resin (B-1) was replaced with 15 parts by weight (as a solid content) of the alkali-soluble resin (B-2).

Then, evaluations were carried out in the same manner as in Example 1 except that the liquid composition (R1-1) was replaced with the liquid composition (B1-2). Table 1 shows the evaluation results.

25

#### Example 15

A liquid composition (B2-2) was prepared in the same manner as in Example 12 except that the pigment dispersion (B1) was replaced with 100 parts by weight of the pigment dispersion (B2) and that the alkali-soluble resin (B-1) was replaced with 15 parts by weight (as a solid content) of the alkali-soluble resin (B-2).

Then, evaluations were carried out in the same manner as in Example 1 except that the liquid

composition (R1-1) was replaced with the liquid composition (B2-2). Table 1 shows the evaluation results.

#### Comparative Example 1

5           A liquid composition (R1-6) was prepared in the same manner as in Example 1 except that the alkali-soluble resin (B-1) was replaced with 15 parts by weight (as a solid content) of the alkali-soluble resin (B-3).

10           Then, evaluations were carried out in the same manner as in Example 1 except that the liquid composition (R1-1) was replaced with the liquid composition (R1-6). Table 2 shows the evaluation results.

#### Comparative Example 2

15           A liquid composition (R1-7) was prepared in the same manner as in Example 2 except that the alkali-soluble resin (B-1) was replaced with 15 parts by weight (as a solid content) of the alkali-soluble resin (B-3).

20           Then, evaluations were carried out in the same manner as in Example 1 except that the liquid composition (R1-1) was replaced with the liquid composition (R1-7). Table 2 shows the evaluation results.

#### Comparative Example 3

25           A liquid composition (R1-8) was prepared in the same manner as in Example 3 except that the alkali-soluble resin (B-1) was replaced with 12 parts by weight (as a solid content) of the alkali-soluble resin (B-3).

30           Then, evaluations were carried out in the same manner as in Example 1 except that the liquid composition (R1-1) was replaced with the liquid composition (R1-8). Table 2 shows the evaluation results.

#### Comparative Example 4

A liquid composition (R1-9) was prepared in the same manner as in Example 4 except that the alkali-soluble resin (B-1) was replaced with 15 parts by weight (as a solid content) of the alkali-soluble resin (B-3).

5           Then, evaluations were carried out in the same manner as in Example 1 except that the liquid composition (R1-1) was replaced with the liquid composition (R1-9). Table 2 shows the evaluation results.

10   Comparative Example 5

A liquid composition (R2-3) was prepared in the same manner as in Example 6 except that the alkali-soluble resin (B-1) was replaced with 15 parts by weight (as a solid content) of the alkali-soluble resin (B-3).

15           Then, evaluations were carried out in the same manner as in Example 1 except that the liquid composition (R1-1) was replaced with the liquid composition (R2-3). Table 2 shows the evaluation results.

20   Comparative Example 6

A liquid composition (G1-3) was prepared in the same manner as in Example 8 except that the alkali-soluble resin (B-1) was replaced with 20 parts by weight (as a solid content) of the alkali-soluble resin (B-3).

25           Then, evaluations were carried out in the same manner as in Example 1 except that the liquid composition (R1-1) was replaced with the liquid composition (G1-3). Table 2 shows the evaluation results.

30   Comparative Example 7

A liquid composition (G2-3) was prepared in the same manner as in Example 9 except that the alkali-soluble resin (B-1) was replaced with 20 parts by weight (as a solid content) of the alkali-soluble resin (B-3).

Then, evaluations were carried out in the same manner as in Example 1 except that the liquid composition (R1-1) was replaced with the liquid composition (G2-3). Table 2 shows the evaluation results.

5

#### Comparative Example 8

A liquid composition (B1-3) was prepared in the same manner as in Example 12 except that the alkali-soluble resin (B-1) was replaced with 15 parts by weight (as a solid content) of the alkali-soluble resin (B-3).

10

Then, evaluations were carried out in the same manner as in Example 1 except that the liquid composition (R1-1) was replaced with the liquid composition (B1-3). Table 2 shows the evaluation results.

15

#### Comparative Example 9

A liquid composition (B2-3) was prepared in the same manner as in Example 13 except that the alkali-soluble resin (B-1) was replaced with 15 parts by weight (as a solid content) of the alkali-soluble resin (B-3).

20

Then, evaluations were carried out in the same manner as in Example 1 except that the liquid composition (R1-1) was replaced with the liquid composition (B2-3). Table 2 shows the evaluation results.

Table 1

|       | Liquid composition | Sensitivity                      |     |     |     |      |      | Solvent resistance               |     |     |     |      |      | Adhesion |
|-------|--------------------|----------------------------------|-----|-----|-----|------|------|----------------------------------|-----|-----|-----|------|------|----------|
|       |                    | Exposure dose(J/m <sup>2</sup> ) |     |     |     |      |      | Exposure dose(J/m <sup>2</sup> ) |     |     |     |      |      |          |
|       |                    | 300                              | 400 | 500 | 750 | 1000 | 2000 | 300                              | 400 | 500 | 750 | 1000 | 2000 |          |
| Ex.1  | R1-1               | ○                                | ○   | ○   | ○   | ○    | ○    | △                                | △   | ○   | ○   | ○    | ○    | ○        |
| Ex.2  | R1-2               | ○                                | ○   | ○   | ○   | ○    | ○    | ○                                | ○   | ○   | ○   | ○    | ○    | ○        |
| Ex.3  | R1-3               | △                                | ○   | ○   | ○   | ○    | ○    | -                                | ○   | ○   | ○   | ○    | ○    | ○        |
| Ex.4  | R1-4               | ×                                | ○   | ○   | ○   | ○    | ○    | -                                | ○   | ○   | ○   | ○    | ○    | ○        |
| Ex.5  | R1-5               | ○                                | ○   | ○   | ○   | ○    | ○    | △                                | ○   | ○   | ○   | ○    | ○    | ○        |
| Ex.6  | R2-1               | ○                                | ○   | ○   | ○   | ○    | ○    | △                                | △   | ○   | ○   | ○    | ○    | ○        |
| Ex.7  | R2-2               | ○                                | ○   | ○   | ○   | ○    | ○    | △                                | ○   | ○   | ○   | ○    | ○    | ○        |
| Ex.8  | G1-1               | ○                                | ○   | ○   | ○   | ○    | ○    | △                                | ○   | ○   | ○   | ○    | ○    | ○        |
| Ex.9  | G2-1               | ○                                | ○   | ○   | ○   | ○    | ○    | △                                | ○   | ○   | ○   | ○    | ○    | ○        |
| Ex.10 | G1-2               | ○                                | ○   | ○   | ○   | ○    | ○    | △                                | ○   | ○   | ○   | ○    | ○    | ○        |
| Ex.11 | G2-2               | ○                                | ○   | ○   | ○   | ○    | ○    | △                                | ○   | ○   | ○   | ○    | ○    | ○        |
| Ex.12 | B1-1               | ○                                | ○   | ○   | ○   | ○    | ○    | △                                | ○   | ○   | ○   | ○    | ○    | ○        |
| Ex.13 | B2-1               | ○                                | ○   | ○   | ○   | ○    | ○    | △                                | △   | ○   | ○   | ○    | ○    | ○        |
| Ex.14 | B1-2               | ○                                | ○   | ○   | ○   | ○    | ○    | △                                | ○   | ○   | ○   | ○    | ○    | ○        |
| Ex.15 | B2-2               | ○                                | ○   | ○   | ○   | ○    | ○    | △                                | ○   | ○   | ○   | ○    | ○    | ○        |

Ex.: Example

Table 2

|        | Liquid composition | Sensitivity                      |     |     |     |      |      | Solvent resistance               |     |     |     |      |      | Adhesion |
|--------|--------------------|----------------------------------|-----|-----|-----|------|------|----------------------------------|-----|-----|-----|------|------|----------|
|        |                    | Exposure dose(J/m <sup>2</sup> ) |     |     |     |      |      | Exposure dose(J/m <sup>2</sup> ) |     |     |     |      |      |          |
|        |                    | 300                              | 400 | 500 | 750 | 1000 | 2000 | 300                              | 400 | 500 | 750 | 1000 | 2000 |          |
| C.Ex.1 | R1-6               | ×                                | △   | △   | ○   | ○    | ○    | -                                | -   | -   | △   | △    | △    | △        |
| C.Ex.2 | R1-7               | ×                                | ×   | △   | ○   | ○    | ○    | -                                | -   | -   | △   | △    | ○    | △        |
| C.Ex.3 | R1-8               | ×                                | ×   | ×   | △   | ○    | ○    | -                                | -   | -   | -   | △    | △    | △        |
| C.Ex.4 | R1-9               | ×                                | ×   | ×   | △   | △    | ○    | -                                | -   | -   | -   | -    | △    | ×        |
| C.Ex.5 | R2-3               | ×                                | △   | △   | ○   | ○    | ○    | -                                | -   | -   | △   | △    | ○    | ○        |
| C.Ex.6 | G1-3               | ×                                | △   | △   | △   | ○    | ○    | -                                | -   | -   | -   | △    | △    | ○        |
| C.Ex.7 | G2-3               | ×                                | ×   | △   | △   | ○    | ○    | -                                | -   | -   | -   | △    | △    | △        |
| C.Ex.8 | B1-3               | ×                                | ×   | △   | ○   | ○    | ○    | -                                | -   | -   | △   | △    | ○    | ×        |
| C.Ex.9 | B2-3               | ×                                | △   | △   | △   | ○    | ○    | -                                | -   | -   | -   | △    | △    | ○        |

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-  
5 soluble resin, (C) a polyfunctional monomer and (D) a photopolymerization initiator, said (B) alkali-soluble resin being formed of a copolymer formed from (b1) at least one member selected from the group consisting of an unsaturated carboxylic acid, an unsaturated  
10 carboxylic anhydride and an unsaturated phenol compound, (b2) an N-substituted maleimide, (b3) an unsaturated compound having a tetrahydrofuran structure and (b4) an unsaturated compound different from said (b1), (b2) and (b3).  
15
2. A color filter having a colored layer formed of the radiation sensitive composition for forming a colored layer of claim 1.
- 20 3. A color liquid crystal display device having the color filter of claim 2.