

Radiation Sensitive Composition, Color Filter, Black
Matrix and Liquid Crystal Display Device

BACKGROUND OF THE INVENTION

5 (i) Field of the Invention

The present invention relates to a radiation sensitive composition for forming a colored layer that are used for a color liquid crystal display, image pickup tube device and the like, a color filter, a black matrix and a liquid crystal display device. More specifically, it relates to a radiation sensitive composition for formation of a colored layer that can easily produce a colored layer which is excellent in various properties including coating film physical properties and has excellent developability, a color filter having a colored layer formed from the composition, a black matrix comprising a colored layer formed from the composition, and a liquid crystal display device comprising the color filter or black matrix.

(ii) Description of the Related Art

Heretofore, when a color filter or a black matrix is formed by use of a radiation sensitive composition, the radiation sensitive composition is applied on a substrate or on a substrate on which a light shielding layer of desired pattern has been formed in advance, a solvent is removed, and the obtained coating film is exposed to light and developed to a desired pattern to obtain a colored layer that comprises pixel arrays of each color or is the black matrix. The thus formed colored layer has problems that the colored layer is liable to have residues or scums in an unexposed area on the substrate or on the light blocking layer at the time of development, that the adhesion of the colored

layer formed in an exposed area to the substrate or light blocking layer is insufficient and that the colored layer postbaked after development shows poor coating film physical properties.

5 Japanese Patent Application Laid-Open No. 110577/1995 discloses that a photopolymerizable composition containing (1) a photopolymerization initiator, (2) an addition-polymerizable monomer having an ethylenically unsaturated double bond and (3)
10 an alkali soluble resin obtained by reacting a copolymer of styrene or its nuclear-substituted derivative and maleic anhydride with an aralkyl amine compound having a primary amino group has alkali solubility and can form a color filter that is excellent
15 in developer resistance, alkali resistance, substrate adhesion and the like. However, since a radiation sensitive composition which can form a color filter of high color purity and a black matrix having a high light shielding ability has been demanded in recent years,
20 it has been becoming necessary to increase pigment concentration in the composition. As a result, problems have occurred that residues are more liable to remain at the time of development of the composition and adhesion between the substrate and the colored
25 layer is insufficient, and it has been desired that these problems be solved.

Further, in the field of color filters in recent years, it has been predominantly practiced to shorten takt time by decreasing light exposure, coupled with
30 a fact that the size of substrates used for formation of color filters has been increasing, and it has been demanded that pixels and a black matrix that are formed with low light exposure are excellent in pattern shape and adhesion to a substrate. However, with

conventionally known colored radiation sensitive compositions, it is difficult to obtain pixels and a black matrix that have a good pattern shape while shortening takt time, because chips and undercuts are
5 liable to be produced in a pattern or the pattern is liable to come off from a substrate due to insufficient adhesion to the substrate with low light exposure condition.

No radiation sensitive compositions that can form
10 a color filter of high color purity and a black matrix having a high light shielding ability without having the above problems have heretofore been known.

SUMMARY OF THE INVENTION

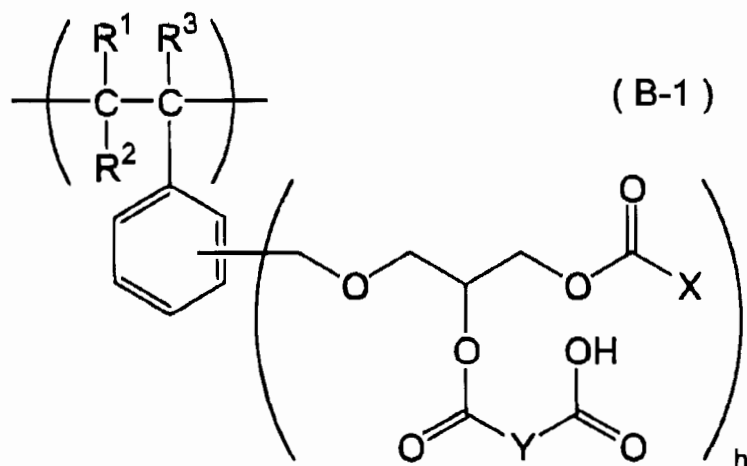
15 The present invention has been conceived in view of the above circumstance. An object of the present invention is to provide a radiation sensitive composition for formation of a colored layer that shows excellent developability, more specifically, a
20 novel radiation sensitive composition for formation of a colored layer that has neither chipping of pattern edge nor undercuts even with low light exposure, can form a fine pattern without having undissolved materials and scums at pattern edges at the time of
25 development and can form a color filter of high color purity and a black matrix having a high light shielding ability.

Another object of the present invention is to provide a color filter that has a colored layer formed
30 from the above radiation sensitive composition and a black matrix that comprises a colored layer formed from the above radiation sensitive composition and a liquid crystal display device comprising the color filter or black matrix.

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

According to the present invention, firstly, the above objects and advantages of the present invention are achieved by a radiation sensitive composition comprising:

- (A) a colorant,
 - (B) an alkali soluble resin,
 - 10 (C) a polyfunctional monomer, and
 - (D) a photopolymerization initiator,
- wherein the alkali soluble resin (B) having a structure represented by the following formula (B-1):



15 (wherein R^1 , R^2 and R^3 each independently represent a hydrogen atom or an alkyl group having 1 to 10 carbon atoms, X represents a monovalent organic group having an acryloyl group or methacryloyl group, a vinyl group or a 1-methylvinyl group, Y represents a divalent
20 organic group, and h is an integer of 1 to 5), and the composition is used for formation of a colored layer.

Secondly, the above objects and advantages of the present invention are achieved by a color filter that has a colored layer formed from the above radiation
25 sensitive composition or a black matrix that comprises a colored layer formed from the above radiation

sensitive composition. Thirdly, the above objects and advantages of the present invention are achieved by a liquid crystal display device comprising the above color filter or black matrix.

5 In the present invention, "radiation" includes visible light, ultraviolet radiation, far-ultraviolet radiation, an electron beam and an X-ray, and "colored layer" indicates a layer comprising pixel arrays constituting a color filter or a layer that is a black
10 matrix itself.

Further, "color filter" in the present invention comprises at least a substrate and pixel arrays of each color (colored layer) formed on the substrate and may also comprise a black matrix, a transparent conductive
15 film, a thin-film transistor, a protective film, a spacer and the like.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Hereinafter, the present invention will be
20 described in detail.

A radiation sensitive composition of the present invention comprises (A) a colorant, (B) an alkali soluble resin, (C) a polyfunctional monomer and (D) a photopolymerization initiator.

25 (A) Colorant

The colorant (A) contained in the radiation sensitive composition of the present invention is not particularly limited in color and is selected as appropriate according to application of a target
30 colored layer. Further, it may be an organic colorant or an inorganic colorant.

Illustrative examples of the organic colorant include organic pigments and natural pigments. Illustrative examples of the inorganic colorant

include inorganic pigments and extender pigments.

Illustrative examples of the above organic pigments include compounds classified in "Pigment" in Color Index (C. I.; published by The Society of Dyers and Colourists), specifically, those with the following Color Index (C. I.) numbers, that is, C. I. Pigment Yellow 12, C. I. Pigment Yellow 13, C. I. Pigment Yellow 14, 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 83, C. I. Pigment Yellow 93, C. I. Pigment Yellow 109, C. I. Pigment Yellow 110, C. I. Pigment Yellow 138, C. I. Pigment Yellow 139, C. I. Pigment Yellow 150, C. I. Pigment Yellow 153, C. I. Pigment Yellow 154, C. I. Pigment Yellow 166, C. I. Pigment Yellow 168 and C. I. Pigment Yellow 180; C. I. Pigment Orange 36, C. I. Pigment Orange 43, and C. I. Pigment Orange 51; C. I. Pigment Red 9, C. I. Pigment Red 97, C. I. Pigment Red 122, C. I. Pigment Red 123, C. I. Pigment Red 149, C. I. Pigment Red 176, C. I. Pigment Red 177, C. I. Pigment Red 180, C. I. Pigment Red 215, C. I. Pigment Red 242, and C. I. Pigment Red 254; C. I. Pigment Violet 19, C. I. Pigment Violet 23, and C. I. Pigment Violet 29; C. I. Pigment Blue 15, C. I. Pigment Blue 15:3, C. I. Pigment Blue 15:6; C. I. Pigment Green 7, C. I. Pigment Green 36, and C. I. Pigment Green 58; C. I. Pigment Brown 23, and C. I. Pigment Brown 25; and C. I. Pigment Black 1, and C. I. Pigment Black 7.

Illustrative examples of the above inorganic pigments include lead sulfate, yellow lead, zinc yellow, rouge (red iron oxide (III)), cadmium red, ultramarine

blue, iron blue, chromic oxide green, cobalt green, amber, titanium black, synthetic iron black, and carbon black. Illustrative examples of the above extender pigments include titanium oxide, barium sulfate, zinc
5 oxide, and calcium carbonate.

Illustrative examples of the above carbon black include furnace black, thermal black, and acetylene black. Specific examples of the furnace black include SAF, SAF-HS, ISAF, ISAF-LS, ISAF-HS, HAF, HAF-LS,
10 HAF-HS, MAF, FEF, FEF-HS, SRF, SRF-LM, SRF-LS, GPF, ECF, N-339 and N-351. Specific examples of the thermal black include FT and MT.

Illustrative examples of their commercial products include DIABLACK A (product of Mitsubishi
15 Chemical Corporation) and SEAST 9 (product of Tokai Carbon Co., Ltd.) as SAF;
DIABLACK SA (product of Mitsubishi Chemical Corporation) and SEAST 9H (product of Tokai Carbon Co., Ltd.) as SAF-HS;
20 DIABLACK I (product of Mitsubishi Chemical Corporation) and SEAST 6 (product of Tokai Carbon Co., Ltd.) as ISAF;
DIABLACK LI (product of Mitsubishi Chemical Corporation) and SEAST 600 (product of Tokai Carbon Co.,
25 Ltd.) as ISAF-LS;
DIABLACK N234 (product of Mitsubishi Chemical Corporation) and SEAST 7HM (product of Tokai Carbon Co., Ltd.) as ISAF-HS;
DIABLACK H (product of Mitsubishi Chemical
30 Corporation) and SEAST 3 (product of Tokai Carbon Co., Ltd.) as HAF;
DIABLACK LH (product of Mitsubishi Chemical Corporation) and SEAST 300 (product of Tokai Carbon Co., Ltd.) as HAF-LS;

DIABLACK SH (product of Mitsubishi Chemical Corporation) and SEAST KH (product of Tokai Carbon Co., Ltd.) as HAF-HS;

DIABLACK N550M (product of Mitsubishi Chemical Corporation) and SEAST 116 (product of Tokai Carbon Co., Ltd.) as MAF;

DIABLACK E (product of Mitsubishi Chemical Corporation) and SEAST SO, SEAST F and SEAST FM (products of Tokai Carbon Co., Ltd.) as FEF;

DIABLACK N760M (product of Mitsubishi Chemical Corporation) and HTC#SL (product of Nippon Steel Chemical Co., Ltd.) as SRF-LM; and

DIABLACK G (product of Mitsubishi Chemical Corporation) and SEAST V (product of Tokai Carbon Co., Ltd.) as GPF.

These colorants may be used with the surfaces of the particles modified with a polymer as desired. Methods for coating the surface of carbon black with a polymer are disclosed in Japanese Patent

Application Laid-Open Nos. 71733/1997, 95625/1997 and 124969/1997, for example.

The above colorants can be used alone or in admixture of two or more.

When the radiation sensitive composition of the present invention is used for formation of a color filter, the colorant (A) is preferably a colorant having high color developability and high heat resistance, particularly preferably a colorant having high thermal decomposition resistance, and to be more specific, an organic colorant is preferred, and an organic pigment is particularly preferably used, because the color filter is required to show high-definition color development and heat resistance.

Meanwhile, when the radiation sensitive composition of the present invention is used for formation of a black matrix, an organic pigment or carbon black is preferably used as the colorant (A),
5 because the black matrix is required to have a high light shielding ability.

The colorant in the present invention can be used in combination with a dispersant or dispersion aid as desired.

10 As the above dispersant, various surfactants such as cationic, anionic, nonionic and amphoteric surfactants or appropriate dispersants such as a polymer dispersant can be used, for example. Of these, the polymer dispersant is preferred. Specific
15 examples thereof include an acrylic copolymer, modified acrylic copolymer, polyurethane, polyester, alkylammonium salt or phosphate of copolymer, and cationic comb-like graft polymer. The cationic comb-like graft polymer is a polymer having a structure
20 in which two or more molecules of branch polymer are grafted to one molecule of trunk polymer having a plurality of basic groups (cationic functional groups). An example of such a polymer is a polymer comprising polyethyleneimine as the trunk polymer portion and a
25 ring-opened polymer of ϵ -caprolactone as the branch polymer portion. Of these dispersants, the modified acrylic copolymer, polyurethane and cationic comb-like graft polymer are preferred.

Such dispersants are commercially available.
30 Illustrative examples of commercial products of the modified acrylic copolymer include Disperbyk-2000 and Disperbyk-2001 (products of BYK Japan KK). Illustrative examples of commercial products of the polyurethane include Disperbyk-161, Disperbyk-162,

Disperbyk-165, Disperbyk-167, Disperbyk-170 and Disperbyk-182 (products of BYK Japan KK).

Illustrative examples of commercial products of the cationic comb-like graft polymer include Solsperser 24000 (product of Lubrizol Japan Ltd.).

These dispersants can be used alone or in admixture of two or more.

The dispersant is used in an amount of preferably not larger than 50 parts by weight, more preferably not larger than 30 parts by weight, based on 100 parts by weight of the colorant (A).

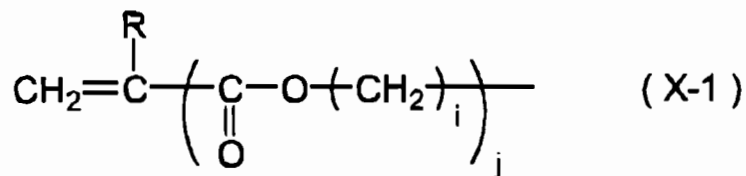
Illustrative examples of the above dispersion aid include blue pigment derivatives and yellow pigment derivatives. Specific examples thereof include copper phthalocyanine derivatives.

(B) Alkali Soluble Resin

The alkali soluble resin (B) contained in the radiation sensitive composition of the present invention has a structure represented by the above formula (B-1).

In the above formula (B-1), R^1 and R^2 are preferably a hydrogen atom. R^3 is preferably a hydrogen atom or a methyl group, more preferably a hydrogen atom. Preferably, h is 1.

X in the above formula (B-1) is preferably a monovalent group represented by the following formula (X-1):

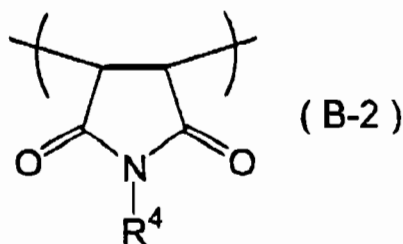


(wherein R represents a hydrogen atom or a methyl group, i is an integer of 2 to 5, and j is an integer of 0 to 10). In the above formula (X-1), i is preferably 2 or

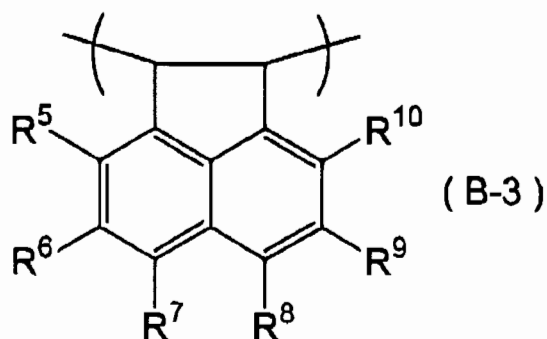
5, and j is preferably an integer of 0 to 4.

Y in the above formula (X-1) is preferably a methylene group, an alkylene or alkenylene group having 2 to 6 carbon atoms (these alkylene group and
 5 alkenylene group may be interrupted in the middle by an oxygen atom), a cyclohexanediyl group, a cyclohexenediyl group or an arylene group having 6 to 12 carbon atoms (this arylene group may have a carboxyl group or an acid anhydride group), more preferably a
 10 methylene group, an ethylene group, a 1,3-propylene group, a 1,2-ethenylene group, a 1,2-propenylene group, a 1,3-propenylene group, a 2,3-propenylene group, a cyclohexane-1,2-diyl group, a 4-cyclohexene-1,2-diyl group, a 1,2-phenylene group, a biphenyl-2-2'-diyl
 15 group or a divalent group represented by a formula $-\text{CH}_2-\text{O}-\text{CH}_2-$.

The alkali soluble resin (B) contained in the radiation sensitive composition of the present invention preferably has at least one structure
 20 selected from the group consisting of, in addition to the structure represented by the above formula (B-1), a structure represented by the following formula (B-2):



(wherein R^4 represents an aryl group having 6 to 10
 25 carbon atoms or an alicyclic group having 3 to 10 carbon atoms), and
 a structure represented by the following formula (B-3):



(wherein R^5 to R^{10} each independently represent a hydrogen atom, a halogen atom, a hydroxyl group, a hydroxymethyl group or a carboxyl group).

5 Illustrative examples of the aryl group having 6 to 10 carbon atoms as R^4 in the above formula (B-2) include a phenyl group, o-hydroxyphenyl group, m-hydroxyphenyl group, p-hydroxyphenyl group, o-toluyyl group, m-toluyyl group, p-toluyyl group, 10 o-methoxyphenyl group, m-methoxyphenyl group, p-methoxyphenyl group, and naphthyl group. Illustrative examples of the alicyclic group having 3 to 10 carbon atoms as R^4 in the above formula (B-2) include a cyclohexyl group. As R^4 in the above formula 15 (B-2), a phenyl group is preferred.

Illustrative examples of the halogen atom as R^5 to R^{10} in the above formula (B-3) include a chlorine atom, bromine atom and iodine atom. The chlorine atom is preferred.

20 In the above formula (B-3), it is preferred that all of R^5 to R^{10} be a hydrogen atom or that R^7 be a chlorine atom, hydroxyl group or hydroxymethyl group and all of R^5 , R^6 and R^8 to R^{10} be a hydrogen atom, and it is more preferred that all of R^5 to R^{10} be a hydrogen atom or 25 that R^7 be a hydroxyl group and all of R^5 , R^6 and R^8 to R^{10} be a hydrogen atom.

In the alkali soluble resin (B) contained in the radiation sensitive composition of the present

invention, the structure represented by the above formula (B-1) is preferably 5 to 80 wt%, more preferably 10 to 60 wt%, based on the total amount of the alkali soluble resin (B). With the content of the structure represented by the formula (B-1) in the alkali soluble resin (B) within the above range, the developability of the radiation sensitive composition containing the alkali soluble resin (B) is improved and inhibition of production of residues at the time of development becomes more effective advantageously.

The alkali soluble resin (B) contained in the radiation sensitive composition of the present invention has the structure represented by the above formula (B-2) in an amount of preferably not larger than 50 wt%, more preferably 5 to 45 wt%, based on the total amount of the alkali soluble resin (B). Further, the alkali soluble resin (B) has the structure represented by the above formula (B-3) in an amount of preferably not larger than 60 wt%, more preferably 5 to 40 wt%, based on the total amount of the alkali soluble resin (B). Further, the alkali soluble resin (B) may have both the structure represented by the above formula (B-2) and the structure represented by the above formula (B-3), and in this case, the total of the contents of these structures is preferably not larger than 80 wt%, more preferably 10 to 70 wt%, based on the total amount of the alkali soluble resin (B). In this case, the individual contents of the structure represented by the above formula (B-2) and the structure represented by the above formula (B-3) are preferably within the above ranges, respectively.

With the contents of the structure represented by the above formula (B-2) and the structure represented by the above formula (B-3) in the alkali

soluble resin (B) within the above ranges, an advantage is obtained that adhesion of the colored layer to be formed to the substrate is further improved advantageously.

5 The alkali soluble resin (B) contained in the radiation sensitive composition of the present invention has a weight average molecular weight M_w in terms of polystyrene measured by gel permeation chromatography (GPC) of preferably 2,000 to 100,000,
10 more preferably 3,000 to 50,000. With the weight average molecular weight of the alkali soluble resin (B) within this range, an advantage is obtained that the solubility of the alkali soluble resin in a solvent or a developer is further improved. The alkali soluble
15 resin (B) has a ratio M_w/M_n of the weight average molecular weight M_w to number average molecular weight M_n in terms of polystyrene measured by GPC of preferably 1.0 to 4.0, more preferably 1.0 to 3.0. With the M_w/M_n of the alkali soluble resin (B) within the above range,
20 an advantage is obtained that the resolution of the radiation sensitive composition to be obtained and adhesion of the colored layer to be formed to the substrate are further improved.

 The alkali soluble resin (B) can be produced by,
25 for example, adding a compound (hereinafter referred to as "unsaturated monocarboxylic acid (a1)") represented by the following formula (a1):

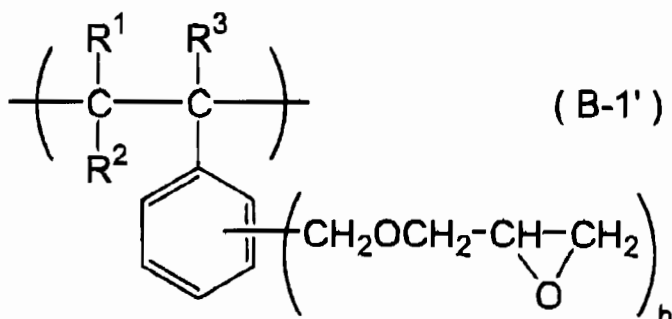


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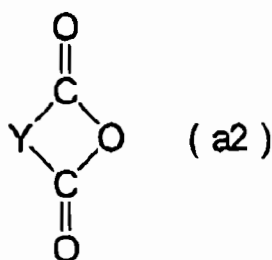
(wherein X is the same as defined in the above formula (B-1))

to a resin (hereinafter referred to as "styrene epoxy resin") having a structure represented by the following

formula (B-1') :



5 (wherein R^1 , R^2 , R^3 and h are the same as defined in the above formula (B-1)), preferably to a resin having the group consisting of the structure represented by the above formula (B-1'), and at least one structure selected from the structure
10 represented by the above formula (B-2) and the structure represented by the above formula (B-3), and then adding a compound (hereinafter referred to as "polybasic acid anhydride (a2)") represented by the following formula (a2):

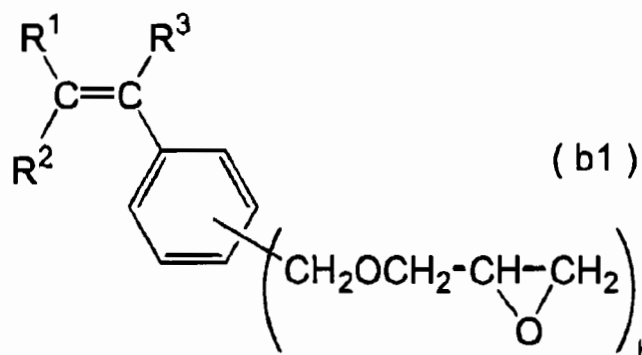


(wherein Y is the same as defined in the above formula (B-1))

20 to the reaction product of the unsaturated monocarboxylic acid(a1) and the styrene epoxy resin(B-1').

The styrene epoxy resin as described above is preferably a polymer of a compound (hereinafter referred to as "compound (b1)") represented by the

following formula (b1) :



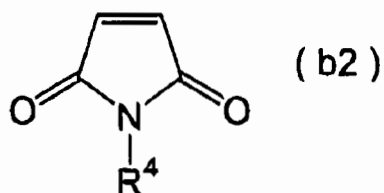
(wherein R^1 , R^2 , R^3 and h are the same as defined in
5 the above formula (B-1))

or a copolymer of the compound (b1) with other radical polymerizable compound.

Specific examples of the compound (b1) include o-vinylbenzyl glycidyl ether, m-vinylbenzyl glycidyl ether, p-vinylbenzyl glycidyl ether, α -methyl-o-vinylbenzyl glycidyl ether, α -methyl-m-vinylbenzyl glycidyl ether, α -methyl-p-vinylbenzyl glycidyl ether, 2,3-diglycidyloxymethyl styrene, 2,4-diglycidyloxymethyl styrene, 2,5-diglycidyloxymethyl styrene, 2,6-diglycidyloxymethyl styrene, 2,3,4-triglycidyloxymethyl styrene, 2,3,5-triglycidyloxymethyl styrene, 2,3,6-triglycidyloxymethyl styrene, 3,4,5-triglycidyloxymethyl styrene, and 2,4,6-triglycidyloxymethyl styrene. Of these, o-vinylbenzyl glycidyl ether, m-vinylbenzyl glycidyl ether, p-vinylbenzyl glycidyl ether are preferred. These compounds may be used in combination of two or more.

Illustrative examples of the above other radical polymerizable compound include a compound

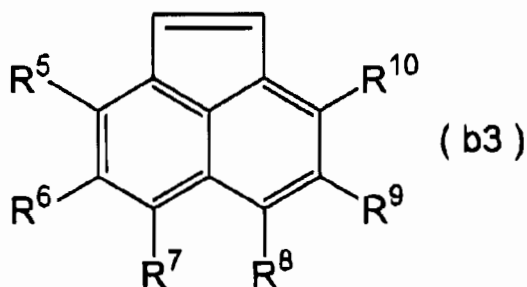
(hereinafter referred to as "compound (b2)")
represented by the following formula (b2):



5

(wherein R^4 is the same as defined in the above formula
(B-2)),

a compound (hereinafter referred to as "compound (b3)")
represented by the following formula (b3):



10

(wherein R^5 to R^{10} are the same as defined in the above
formula (B-3)),

and a radical polymerizable compound (hereinafter
15 referred to as "compound (b4)") other than the
compounds (b1), (b2) and (b3).

The above compound (b2) introduces the structure
represented by the above formula (B-2) into the alkali
soluble resin (B). Specific examples of the compound
20 (b2) include N-phenyl maleimide, N-o-hydroxyphenyl
maleimide, N-m-hydroxyphenyl maleimide,
N-p-hydroxyphenyl maleimide, N-o-methylphenyl
maleimide, N-m-methylphenyl maleimide,
N-p-methylphenyl maleimide, N-o-methoxyphenyl
25 maleimide, N-m-methoxyphenyl maleimide,
N-p-methoxyphenyl maleimide, and N-cyclohexyl

maleimide. Of these, N-phenyl maleimide is preferred.

The above compound (b3) introduces the structure represented by the above formula (B-3) into the alkali soluble resin (B). Specific examples of the compound
 5 (b3) include acenaphthylene, 5-chloroacenaphthylene, 5-hydroxymethyl acenaphthylene, and 5-hydroxyacenaphthylene. Of these, acenaphthylene and 5-hydroxyacenaphthylene are preferred.

Illustrative examples of the above compound (b4)
 10 include aromatic vinyl compounds such as styrene, α -methylstyrene, o-vinyl toluene, m-vinyl toluene, p-vinyl toluene, p-chlorostyrene, o-methoxystyrene, m-methoxystyrene, p-methoxystyrene, indene, and p-vinylbenzylmethyl ether;
 15 unsaturated carboxylic esters such as methyl acrylate, methyl methacrylate, ethyl acrylate, ethyl methacrylate, n-propyl acrylate, n-propyl methacrylate, i-propyl acrylate, i-propyl methacrylate, n-butyl acrylate, n-butyl methacrylate,
 20 i-butyl acrylate, i-butyl methacrylate, sec-butyl acrylate, sec-butyl methacrylate, t-butyl acrylate, t-butyl methacrylate, 2-hydroxyethyl acrylate, 2-hydroxyethyl methacrylate, 2-hydroxypropyl acrylate, 2-hydroxypropyl methacrylate,
 25 3-hydroxypropyl acrylate, 3-hydroxypropyl methacrylate, 2-hydroxybutyl acrylate, 2-hydroxybutyl methacrylate, 3-hydroxybutyl acrylate, 3-hydroxybutyl methacrylate, 4-hydroxybutyl acrylate, 4-hydroxybutyl methacrylate, allyl acrylate, allyl
 30 methacrylate, benzyl acrylate, benzyl methacrylate, phenyl acrylate, phenyl methacrylate, methoxy triethylene glycol acrylate, methoxy triethylene glycol methacrylate, and glycerin monomethacrylate; unsaturated carboxylic aminoalkyl esters such as

2-aminoethyl acrylate, 2-aminoethyl methacrylate, 2-aminopropyl acrylate, 2-aminopropyl methacrylate, 3-aminopropyl acrylate, and 3-aminopropyl methacrylate;

5 carboxylic vinyl esters such as vinyl acetate, vinyl propionate, vinyl butyrate, and vinyl benzoate; unsaturated ethers such as vinyl methyl ether, vinyl ethyl ether, allyl glycidyl ether, and methallyl glycidyl ether;

10 vinyl cyanide compounds such as acrylonitrile, methacrylonitrile, α -chloroacrylonitrile, and vinylidene cyanide;

unsaturated amides such as acrylamide, methacrylamide, α -chloroacrylamide, N-hydroxyethyl acrylamide, and

15 N-hydroxyethyl methacrylamide;

aliphatic conjugated dienes such as 1,3-butadiene, isoprene, and chloroprene; and

macromonomers having a monoacryloyl group or monomethacryloyl group at the terminals of a polymer

20 molecular chain such as polystyrene, polymethyl acrylate, polymethyl methacrylate, poly-n-butyl acrylate, poly-n-butyl methacrylate, and polysiloxane.

These compounds (b4) can be used alone or in
25 admixture of two or more.

When the styrene epoxy resin is a copolymer of the compound (b1) and other radical polymerizable compound, the proportions of the compound (b1) and other radical polymerizable compound to be

30 copolymerized can be set as appropriate according to desired proportions of the structure represented by the above formula (B-1), the structure represented by the above formula (B-2) and the structure represented by the above formula (B-3) in the alkali soluble resin (B),

in view of ease of synthesis of the alkali soluble resin (B).

For example, the proportion of the compound (b1) to be copolymerized is preferably 5 to 80 wt%, more preferably 10 to 80 wt%. When the proportion of the compound (b1) to be copolymerized is higher than 80 wt%, gelation is liable to occur in an addition reaction to be described later of the unsaturated monocarboxylic acid (a1) and it may be difficult to produce the alkali soluble resin (B) in some cases. Meanwhile, when the proportion of the compound (b1) to be copolymerized is lower than 5 wt%, the alkali solubility of the resin resulting from an addition reaction of the styrene epoxy resin, unsaturated monocarboxylic acid (a1) and polybasic acid anhydride (a2) is unsatisfactory, so that when the radiation sensitive composition containing the resin is used for formation of the colored layer, residues or scums may be produced in an unexposed area on the substrate or on the light shielding layer.

The proportion of the compound (b2) to be copolymerized is preferably not higher than 50 wt%, more preferably 5 to 45 wt%. The proportion of the compound (b3) to be copolymerized is preferably not higher than 60 wt%, more preferably 5 to 40 wt%. The compounds (b2) and (b3) may be used together in copolymerization, and in that case, they are copolymerized in an amount of preferably not larger than 80 wt%, more preferably 5 to 70 wt%, as the total amount of the compounds (b2) and (b3). The amounts of the compounds (b2) and (b3) when they are used in combination are preferably within the above respective ranges.

The styrene epoxy resin is particularly

preferably a copolymer of:

- (1) the compound (b1),
 - (2) at least one of the compounds (b2) and (b3), and
 - (3) the compound (b4). In this case, the amount of the
- 5 compound (b1) in the copolymer is preferably 10 to 60 wt%, the amount of at least one of the compounds (b2) and (b3) (or the total amount of the compounds (b2) and (b3) when they are used in combination) in the copolymer is preferably 5 to 60 wt%, and the amount of the compound
- 10 (b4) in the copolymer is preferably not higher than 50 wt%.

The weight average molecular weight M_w and ratio M_w/M_n of the weight average molecular weight to number average molecular weight of the styrene epoxy resin can

15 be set as appropriate according to desired M_w and M_w/M_n of the alkali soluble resin (B).

The above styrene epoxy resin can be produced by polymerizing the above compound or a mixture of the above compounds in an appropriate solvent in the

20 presence of an appropriate radical polymerization initiator. As solvents that can be used in production of the styrene epoxy resin, the same solvents as those to be described later as solvents used in the radiation sensitive composition of the present invention can be

25 used, for example. Illustrative examples of the radical polymerization initiator include

2,2'-azobisisobutyronitrile,

2,2'-azobis(2,4-dimethylvaleronitrile), and

2,2'-azobis(4-methoxy-2,4-dimethylvaleronitrile).

30 The above unsaturated carboxylic acid (a1) can be selected as appropriate according to a desired type of X in the above formula (B-1). Preferred examples of the unsaturated carboxylic acid (a1) include acrylic acid, methacrylic acid, ω -carboxy-polycaprolactone

monoacrylate, ω -carboxy-polycaprolactone monomethacrylate, 2-acryloyloxyethyl succinic acid, and 2-methacryloyloxyethyl succinic acid. In the above ω -carboxy-polycaprolactone monoacrylate and
 5 ω -carboxy-polycaprolactone monomethacrylate, the number of recurring units of polycaprolactone is preferably 1 to 10, more preferably 2 to 4. Of the above unsaturated carboxylic acids (a1), acrylic acid and methacrylic acid are particularly preferred because
 10 they are highly reactive. These can be used alone or in admixture of two or more.

The addition reaction of the unsaturated monocarboxylic acid (a1) to the above styrene epoxy resin can be carried out in accordance with a known
 15 method. For example, the addition reaction can be preferably carried out in the presence of a solvent and an esterification catalyst at a temperature of 50 to 150°C for 6 to 24 hours. Illustrative examples of solvents that can be used as the solvent include
 20 propylene glycol monomethyl ether acetate, ethylene glycol monomethyl ether acetate, propylene glycol monomethyl ether acetate, propylene glycol monoethyl ether acetate, diethylene glycol dimethyl ether, diethylene glycol methyl ethyl ether, cyclohexanone,
 25 2-heptanone, 3-heptanone, ethyl 2-hydroxypropionate, ethyl 3-methoxypropionate, methyl 3-ethoxypropionate, ethyl 3-ethoxypropionate, 3-methyl-3-methoxybutyl propionate, n-butyl acetate, i-butyl acetate, n-pentyl formate, i-pentyl acetate, n-butyl
 30 propionate, ethyl butyrate, i-propyl butyrate, n-butyl butyrate, and ethyl pyruvate.

As the esterification catalyst, tertiary amines such as triethylamine, trimethylamine, benzylmethylaniline and benzyldiethylamine; and

quaternary ammonium salts such as tetramethylammonium chloride, tetraethylammonium chloride, benzyltriethylammonium chloride, dodecyltrimethylammonium chloride, and

5 tetrabutylammonium bromide can be used, for example. As required, a polymerization inhibitor such as p-methoxyphenol or methyl hydroquinone may be used. The esterification catalyst is used in an amount of preferably not larger than 0.5 equivalents, more

10 preferably 0.01 to 0.1 equivalents, based on epoxy groups contained in the styrene epoxy resin. The polymerization inhibitor is used in an amount of preferably not larger than 5,000 ppm, more preferably 500 to 3,000 ppm, based on the total amount of the

15 reaction solution.

The unsaturated monocarboxylic acid (a1) is used in an amount of preferably 0.7 to 1.3 equivalents, more preferably 0.9 to 1.2 equivalents, per equivalent of epoxy groups in the styrene epoxy resin.

20 The above polybasic acid anhydride (a2) can be selected as appropriate according to a desired type of Y in the above formula (B-1). Preferred examples of the polybasic acid anhydride (a2) include malonic anhydride, maleic anhydride, citraconic anhydride,

25 succinic anhydride, glutaric anhydride, glutaconic anhydride, itaconic anhydride, diglycolic anhydride, phthalic anhydride, cyclohexanone-1,2-dicarboxylic anhydride, 4-cyclohexene-1,2-dicarboxylic anhydride, and diphenic anhydride. Of these, succinic anhydride,

30 glutaric anhydride, phthalic anhydride and 4-cyclohexene-1,2-dicarboxylic anhydride are particularly preferred because they are highly reactive.

The addition reaction of the polybasic acid

anhydride (a2) to the styrene epoxy resin can be carried out under the same conditions as those for the above addition reaction of the unsaturated monocarboxylic acid (a1) to the styrene epoxy resin. It is also possible that subsequent to the addition reaction of the unsaturated monocarboxylic acid (a1) to the styrene epoxy resin, the polybasic acid anhydride (a2) is added into the reaction mixture and the addition reaction is continued.

10 The polybasic acid anhydride (a2) is used in an amount of preferably 0.2 to 1.0 equivalents, more preferably 0.4 to 0.9 equivalents, per equivalent of epoxy groups in the styrene epoxy resin.

15 The radiation sensitive composition of the present invention contains the above alkali soluble resin (B) in an amount of preferably 10 to 200 parts by weight, more preferably 20 to 150 parts by weight, based on 100 parts by weight of the colorant (A). When this value is smaller than 10 parts by weight, the hardness of the colored layer to be formed may be insufficient due to insufficient sensitivity, while when it is larger than 200 parts by weight, the color purity of the color filter to be obtained or the light shielding ability of the black matrix to be obtained may be insufficient.

25 (C) Polyfunctional Monomers

 Illustrative examples of the polyfunctional monomer (C) in the radiation sensitive composition of the present invention include diacrylates or dimethacrylates of alkylene glycols such as ethylene glycol and propylene glycol; diacrylates or dimethacrylates of polyalkylene glycols such as polyethylene glycol and polypropylene glycol;

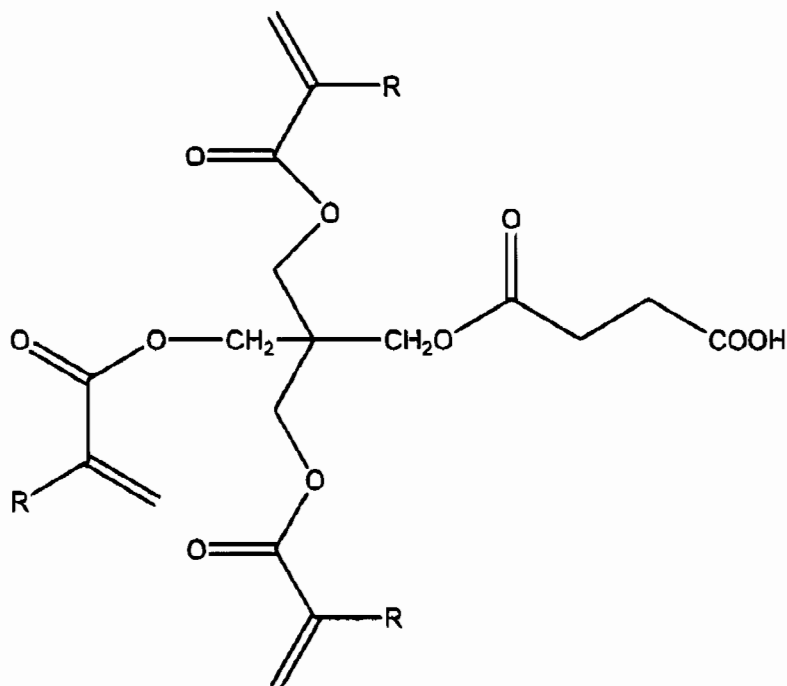
polyacrylates or polymethacrylates of polyhydric alcohols having three or more functional groups such as glycerin, trimethylolpropane, pentaerythritol and dipentaerythritol;

- 5 polyacrylates or polymethacrylates of dicarboxylic-acid-modified polyhydric alcohols having three or more functional groups; oligoacrylates or oligomethacrylates of polyester, epoxy resin, urethane resin, alkyd resin, silicone
10 resin, spirane resin and the like; diacrylates or dimethacrylates of both-terminal-hydroxylated polymers such as both-terminal-hydroxylated polybutadiene, both-terminal-hydroxylated polyisoprene and
15 both-terminal-hydroxylated polycaprolactone; and trisacryloyloxyethyl phosphate, and trimethacryloyloxyethyl phosphate.

Of the above, the "polyacrylates or polymethacrylates of dicarboxylic-acid-modified
20 polyhydric alcohols having three or more functional groups" indicates polyacrylates or polymethacrylates of monoester compounds resulting from adding one dicarboxylic acid to polyhydric alcohols having three or more functional groups.

25 Of these polyfunctional monomers, the polyacrylates or polymethacrylates of polyhydric alcohols having three or more functional groups and the polyacrylates or polymethacrylates of dicarboxylic-acid-modified polyhydric alcohols
30 having three or more functional groups are preferred. Specific examples thereof include trimethylolpropane triacrylate, trimethylolpropane trimethacrylate, pentaerythritol triacrylate, pentaerythritol trimethacrylate, succinic-acid-modified

pentaerythritol triacrylate, succinic-acid-modified
 pentaerythritol trimethacrylate, pentaerythritol
 tetraacrylate, pentaerythritol tetramethacrylate,
 dipentaerythritol hexaacrylate, and
 5 dipentaerythritol hexamethacrylate. Of the above,
 the succinic-acid-modified pentaerythritol
 triacrylate and the succinic-acid-modified
 pentaerythritol trimethacrylate are compounds
 represented by the following formula:



10

(wherein R represents a hydrogen atom or a methyl group).

Of these polyfunctional monomers, trimethylolpropane
 triacrylate, pentaerythritol triacrylate and
 15 dipentaerythritol hexaacrylate are preferred, because
 a colored layer having high strength and excellent
 surface smoothness is obtained and scums and film
 residues are hardly produced in areas other than areas
 where a pattern of the colored layer is formed.

20 The above polyfunctional monomers can be used
 alone or in admixture of two or more.

The amount of the polyfunctional monomer (C) used

in the radiation sensitive composition of the present invention is preferably 5 to 500 parts by weight, more preferably 20 to 300 parts by weight, based on 100 parts by weight of the alkali soluble resin (B). When the amount of the polyfunctional monomer (C) is smaller than 5 parts by weight, the strength and surface smoothness of the colored layer may be insufficient, while when the amount is larger than 500 parts by weight, developability with respect to an alkali developer may be insufficient or scums and film residues may be liable to be produced in areas other than areas where a pattern of the colored layer is formed.

In the radiation sensitive composition of the present invention, the above polyfunctional monomers may be partially substituted with monofunctional monomers.

Specific examples of such monofunctional monomers include ω -carboxy-polycaprolactone monoacrylate, ω -carboxy-polycaprolactone monomethacrylate, methoxy triethylene glycol acrylate, methoxy triethylene glycol methacrylate, methoxy dipropylene glycol acrylate, methoxy dipropylene glycol methacrylate, 2-hydroxy-3-phenoxypropyl acrylate, 2-hydroxy-3-phenoxypropyl methacrylate, 2-acryloyloxyethyl monosuccinate, and 2-methacryloyloxyethyl monosuccinate. Illustrative examples of commercial products thereof include M-5300 (product of TOAGOSEI CO., LTD.).

These monofunctional monomers can be used alone or in admixture of two or more.

The above monofunctional monomer is used in an amount of preferably not larger than 90 wt%, more preferably not larger than 50 wt%, based on the total of the polyfunctional monomer and the monofunctional

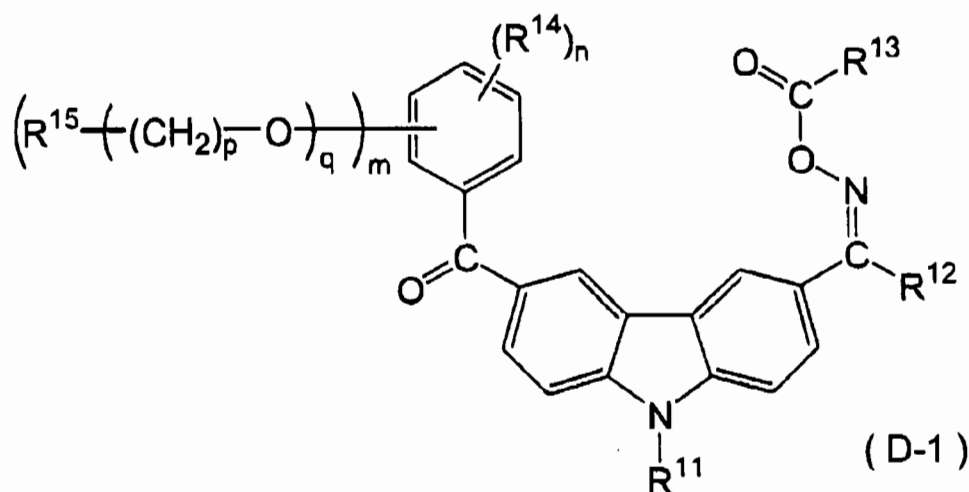
monomer.

(D) Photopolymerization Initiator

The photopolymerization initiator contained in the radiation sensitive composition of the present invention is a component that produces radicals which can initiate polymerization of the above polyfunctional monomer (C) and monofunctional monomers used in some cases by exposure to radiation such as visible light, ultraviolet radiation, far-ultraviolet radiation, an electron beam or an X-ray. As the photopolymerization initiator, an oxime compound, biimidazole compound, benzoin compound, acetophenone compound, benzophenone compound, α -diketone compound, polynuclear quinone compound, xanthone compound, phosphine compound, triazine compound, diazo compound, onium salt, imidosulfonate compound or the like can be suitably used.

Illustrative examples of the above oxime compound include a carbazole compound and other oxime compounds.

An example of the carbazole compound is a compound represented by the following formula (D-1):



(wherein R^{11} represents an alkyl group having 1 to 20 carbon atoms, a cycloalkyl group having 3 to 8 carbon atoms or a phenyl group,

R^{12} and R^{13} each independently represent a hydrogen atom,
 an alkyl group having 1 to 20 carbon atoms, a
 cycloalkyl group having 3 to 8 carbon atoms, a phenyl
 group which may be substituted or a monovalent
 5 alicyclic group having 7 to 20 carbon atoms (excluding
 the above cycloalkyl group),
 R^{14} represents an alkyl group having 1 to 12 carbon atoms,
 a cycloalkyl group having 3 to 8 carbon atoms, an
 alkoxyl group having 1 to 12 carbon atoms or a
 10 cycloalkyloxy group having 3 to 8 carbon atoms, and when
 a plurality of R^{14} s exist, they may be the same or
 different from each other,
 R^{15} represents a monovalent oxygen-containing
 heterocyclic group having 4 to 20 carbon atoms, a
 15 monovalent nitrogen-containing heterocyclic group
 having 4 to 20 carbon atoms or a monovalent
 sulfur-containing heterocyclic group having 4 to 20
 carbon atoms, and when a plurality of R^{15} s exist, they
 may be the same or different from each other,
 20 p is an integer of 0 to 6, q is 0 or 1, n is an integer
 of 0 to 5, m is an integer of 0 to 5, provided that $(n$
 $+ m) \leq 5$).

Illustrative examples of the alkyl group having
 1 to 20 carbon atoms as R^{11} in the formula (D-1) include
 25 methyl, ethyl, n-propyl, i-propyl, n-butyl, sec-butyl,
 t-butyl, n-pentyl, n-hexyl, n-heptyl, n-octyl,
 n-nonyl, n-decyl, n-undecyl and n-dodecyl groups.
 Illustrative examples of the cycloalkyl group having
 3 to 8 carbon atoms as R^{11} include cyclopentyl and
 30 cyclohexyl groups. Preferred examples of R^{11} in the
 formula (D-1) include methyl and ethyl groups.

Illustrative examples of the alkyl group having
 1 to 20 carbon atoms as R^{12} and R^{13} in the formula (D-1)
 include methyl, ethyl, n-propyl, i-propyl, n-butyl,

sec-butyl, t-butyl, n-pentyl, n-hexyl, n-heptyl, n-octyl, n-nonyl, n-decyl, n-undecyl and n-dodecyl groups. Illustrative examples of the cycloalkyl group having 3 to 8 carbon atoms as R^{12} and R^{13} include

5 cyclopentyl and cyclohexyl groups. Illustrative examples of substituents for the phenyl group as R^{12} and R^{13} include an alkyl group having 1 to 6 carbon atoms such as methyl, ethyl, n-propyl, i-propyl, n-butyl, sec-butyl, t-butyl, n-pentyl and n-hexyl groups; a

10 cycloalkyl group having 3 to 6 carbon atoms such as cyclopentyl and cyclohexyl groups; an alkoxyl group having 1 to 6 carbon atoms such as methoxyl, ethoxyl, n-propoxyl, i-propoxyl, n-butoxyl and t-butoxyl groups; a cycloalkyloxy group having 3 to 6 carbon atoms

15 such as cyclopentyloxy and cyclohexyloxy groups; a phenyl group; and a halogen atom such as fluorine and chlorine atoms. The number of substituents for the phenyl group as R^{12} and R^{13} is preferably 0 to 4, more preferably 0 or 1.

20 Further, illustrative examples of the monovalent alicyclic group having 7 to 20 carbon atoms (excluding the above cycloalkyl group) as R^{12} and R^{13} include a group having a 1-alkylcycloalkane structure, a group having a bicycloalkane structure, a group having a

25 tricycloalkane structure, a group having a spiroalkane structure, a group having a terpene structure, and a group having an adamantane structure. As R^{12} and R^{13} in the formula (D-1), a hydrogen atom, a methyl group and an ethyl group are preferred.

30 Illustrative examples of the alkyl group having 1 to 12 carbon atoms as R^{14} in the formula (D-1) include methyl, ethyl, n-propyl, i-propyl, n-butyl, sec-butyl, t-butyl, n-pentyl, n-hexyl, n-heptyl, n-octyl, n-nonyl, n-decyl, n-undecyl and n-dodecyl groups.

Illustrative examples of the cycloalkyl group having 3 to 8 carbon atoms as R^{14} include cyclopentyl and cyclohexyl groups. Illustrative examples of the alkoxyl group having 1 to 12 carbon atoms as R^{14} include
 5 methoxyl, ethoxyl, n-propoxyl, i-propoxyl, n-butoxyl, t-butoxyl, n-pentyloxy, n-hexyloxy, n-heptyloxy, n-octyloxy, n-nonyloxy, n-decyloxy, n-undecyloxy and n-dodecyloxy groups. Illustrative examples of the cycloalkyloxy group having 3 to 8 carbon atoms as R^{14}
 10 include cyclopentyloxy and cyclohexyloxy groups. As R^{14} in the formula (D-1), methyl, ethyl, n-propyl, i-propyl, n-butyl, methoxyl and ethoxyl groups are preferred.

Illustrative examples of the monovalent
 15 oxygen-containing heterocyclic group having 4 to 20 carbon atoms, monovalent nitrogen-containing heterocyclic group having 4 to 20 carbon atoms or monovalent sulfur-containing heterocyclic group having 4 to 20 carbon atoms as R^{15} in the formula (D-1)
 20 include thiolanyl, azepinyl, dihydroazepinyl, dioxolanyl, triazinyl, oxathianyl, thiazolyl, oxadiazinyl, dioxaindanyl, dithianaphthalenyl, furanyl, thiophenyl, pyrrolyl, oxazolyl, isooxazolyl, thiazolyl, isothiazolyl, pyrazolyl, furazanyl,
 25 pyranyl, pyridinyl, pyridazinyl, pyrimidyl, pyrazinyl, pyrrolinyl, morphonyl, piperazinyl, quinuclidinyl, indolyl, isoindolyl, benzofuranyl, benzothiophenyl, indolizinyl, chromenyl, quinolinyl, isoquinolinyl, purinyl, quinazolinyl, cinnolinyl, phthalazinyl,
 30 pteridinyl, carbazolyl, acridinyl, phenanthridinyl, thioxanthenyl, phenazinyl, phenothiazinyl, phenoxathiinyl, phenoxazinyl, thianthrenyl, tetrahydrofuranyl and tetrahydropyranyl groups. As R^{15} in the formula (D-1), dioxolanyl, tetrahydrofuranyl

and tetrahydropyranyl groups are preferred.

p in the formula (D-1) is preferably 0, 1 or 2, particularly preferably 1.

n in the formula (D-1) is preferably 0, 1 or 2, particularly preferably 1, and m in the formula (D-1) is preferably 0 or 1.

Of the compounds represented by the above formula (D-1), a compound in which q is 0 (hereinafter referred to as "carbazole compound (1)") and a compound in which q is 1 and m is 1 (hereinafter referred to as "carbazole compound (2)") are preferred.

Specific examples of the above carbazole compound (1) include

1-[9-ethyl-6-benzoyl-9.H.-carbazole-3-yl]-1,2
 15 -nonane-2-oxime-O-benzoate,
 1-[9-ethyl-6-benzoyl-9.H.-carbazole-3-yl]-1,2
 -nonane-2-oxime-O-acetate,
 1-[9-ethyl-6-benzoyl-9.H.-carbazole-3-yl]-1,2
 -pentane-2-oxime-O-acetate,
 20 1-[9-ethyl-6-benzoyl-9.H.-carbazole-3-yl]-octane-1-oneoxime-O-acetate,
 1-[9-ethyl-6-(2-methylbenzoyl)-9.H.-carbazole-3-yl]
 -ethane-1-oneoxime-O-benzoate,
 1-[9-ethyl-6-(2-methylbenzoyl)-9.H.-carbazole-3-yl]
 25 -ethane-1-oneoxime-O-acetate,
 1-[9-n-butyl-6-(2-ethylbenzoyl)-9.H.-carbazole-3-yl]
]-ethane-1-oneoxime-O-benzoate,
 ethanone-1-[9-ethyl-6-(2-methyl-4-tetrahydrofuran-2-ylbenzoyl)-9.H.-carbazole-3-yl]-1-(O
 30 -acetyloxime), ethanone-1-[9-ethyl-6-(2-methyl-4-tetrahydropyranylbenzoyl)-9.H.-carbazole-3-yl]-1-(O
 -acetyloxime), ethanone-1-[9-ethyl-6-(2-methyl-5-tetrahydrofuran-2-ylbenzoyl)-9.H.-carbazole-3-yl]-1-(O
 -acetyloxime), ethanone-1-[9-ethyl-6-(2-methyl-5-

tetrahydropyranylbenzoyl)-9.H.-carbazole-3-yl]-1-(O-
-acetyloxime), and

ethanone-1-[9-ethyl-6-{2-methyl-4-(2,2-
dimethyl-1,3-dioxolanyl)benzoyl}-9.H.-carbazole-3-y
5 l]-1-(O-acetyloxime).

Specific examples of the above carbazole compound
(2) include ethanone-1-[9-ethyl-6-(2-methyl-4-
tetrahydrofuranylmethoxybenzoyl)-9.H.-carbazole-3-y
l]-1-(O-acetyloxime),
10 ethanone-1-[9-ethyl-6-(2-methyl-4-
tetrahydropyranylmethoxybenzoyl)-9.H.-carbazole-3-y
l]-1-(O-acetyloxime),
ethanone-1-[9-ethyl-6-(2-methyl-5-
tetrahydrofuranylmethoxybenzoyl)-9.H.-carbazole-3-y
15 l]-1-(O-acetyloxime),
ethanone-1-[9-ethyl-6-(2-methyl-5-
tetrahydropyranylmethoxybenzoyl)-9.H.-carbazole-3-y
l]-1-(O-acetyloxime), and
ethanone-1-[9-ethyl-6-{2-methyl-4-(2,2-
20 dimethyl-1,3-dioxolanyl)methoxybenzoyl}-9.H.-carbaz
ole-3-yl]-1-(O-acetyloxime).

Of these, 1-[9-ethyl-6-(2-methylbenzoyl)-9.H.-
carbazole-3-yl]-ethane-1-oneoxime-O-acetate out of
the carbazole compounds (1) and
25 ethanone-1-[9-ethyl-6-(2-methyl
-4-tetrahydrofuranylmethoxybenzoyl)-9.H.-carbazole-
3-yl]-1-(O-acetyloxime) and
ethanone-1-[9-ethyl-6-{2-methyl-4-(2,2-
dimethyl-1,3-dioxolanyl)methoxybenzoyl}-9.H.-carbaz
30 ole-3-yl]-1-(O-acetyloxime) out of the carbazole
compounds (2) are preferred. Particularly preferred
is ethanone-1-[9-ethyl-6
-{2-methyl-4-(2,2-dimethyl-1,3-dioxolanyl)methoxybe
nzoyl}-9.H.-carbazole-3-yl]-1-(O-acetyloxime) out of

the carbazole compounds (2).

Illustrative examples of the above other oxime compounds include

- 1,2-octadione-1-[4-(phenylthio)phenyl]-2-(O
 5 -benzoyloxime),
 1,2-butanedione-1-[4-(phenylthio)phenyl]-2
 -(O-benzoyloxime),
 1,2-butanedione-1-[4-(phenylthio)phenyl]
 -2-(O-acetyloxime),
 10 1,2-octadione-1-[4-(methylthio)phenyl]
 -2-(O-benzoyloxime), and
 1,2-octadione-1-[4-(phenylthio)
 phenyl]-2-(O-(4-methylbenzoyloxime)). Of these,
 1,2-octadione-1-[4-(phenylthio)phenyl]-2-(O-benzoyl
 15 oxime) is particularly preferred.

Illustrative examples of the above biimidazole compound include

- 2,2'-bis(2-chlorophenyl)-4,4',5,5'-tetrakis(4-
 ethoxycarbonylphenyl)-1,2'-biimidazole,
 20 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'
 25 -tetraphenyl-1,2'-biimidazole, 2,2'-bis(2,4,6
 -trichlorophenyl)-4,4',5,5'-tetraphenyl-1,2'-biimid
 azole,
 2,2'-bis(2-bromophenyl)-4,4',5,5'-tetraphenyl-1,2'-
 -biimidazole, 2,2'-bis(2,4-dibromophenyl)-4,4',5,5'
 30 -tetraphenyl-1,2'-biimidazole, and
 2,2'-bis(2,4,6-tribromophenyl)-4,4',5,5'-tetrapheny
 1-1,2'-biimidazole.

When the biimidazole compound is used as the photopolymerization initiator (D) in the radiation

sensitive composition of the present invention, it is preferably used in combination with a hydrogen donor because sensitivity can be further improved. The "hydrogen donor" refers to a compound that can provide
5 hydrogen atoms to radicals produced from the biimidazole compound by exposure to light. As the hydrogen donor, a mercaptan compound, amine compound and the like are preferred.

The above mercaptan compound is a compound having
10 a benzene ring or heterocyclic ring and one or more, preferably one to three, more preferably one or two mercapto groups that are directly bonded to the ring. Specific examples of the mercaptan compound include 2-mercaptobenzothiazole, 2-mercaptobenzoxazole,
15 2-mercaptobenzoimidazole, 2,5-dimercapto-1,3,4-thiadiazole, and 2-mercapto-2,5-dimethylaminopyridine.

The above amine compound is a compound having a benzene ring or heterocyclic ring and one or more,
20 preferably one to three, more preferably one or two amino groups that are directly bonded to the ring. Specific examples of the amine compound include 4,4'-bis(dimethylamino)benzophenone, 4,4'-bis(diethylamino)benzophenone,
25 4-diethylaminoacetophenone, 4-dimethylaminopropiophenone, ethyl 4-dimethylaminobenzoate, i-amyl 4-dimethylaminobenzoate, 4-dimethylaminobenzoic acid, and 4-dimethylaminobenzonitrile.

30 When the biimidazole compound is used as the photopolymerization initiator (D) in the radiation sensitive composition of the present invention, it is preferable to use both the mercaptan compound and the amine compound as the hydrogen donors, since the

sensitivity of the radiation sensitive composition is high, a colored layer to be formed hardly comes off from a substrate during development and the strength of the colored layer is also high.

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

10 Illustrative examples of the above acetophenone compound include 2,2-dimethoxyacetophenone, 2,2-diethoxyacetophenone, 2,2-dimethoxy-2-phenylacetophenone, 2-hydroxy-2-methyl-1-phenylpropane-1-one, 1-(4-i-propylphenyl)-2-hydroxy-2-methylpropane-1-
 15 one, 2-methyl-(4-methylthiophenyl)-2-morpholino-1-propane-1-one, 4-(2-hydroxyethoxy)phenyl-(2-hydroxy-2-propyl) ketone, 2-benzyl-2-dimethylamino-1-(4-morpholinophenyl)
 20 butane-1-one, 1-hydroxycyclohexylphenyl ketone, and 2,2-dimethoxy-1,2-diphenylethane-1-one.

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

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

30 Illustrative examples of the above polynuclear quinone compound include anthraquinone, 2-ethyl anthraquinone, 2-t-butyl anthraquinone, and 1,4-naphthoquinone.

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

Illustrative examples of the above phosphine compound include bis(2,4,6-trimethylbenzoyl)phenyl phosphine oxide and 2,4,6-trimethylbenzoyldiphenyl phosphine oxide.

5 Illustrative examples of the above triazine compound include compounds having a halomethyl group such as 2,4,6-tris(trichloromethyl)-s-triazine, 2-methyl-4,6-bis(trichloromethyl)-s-triazine, 2-[2-(furan-2
10 -yl)ethenyl]-4,6-bis(trichloromethyl)-s-triazine, 2-[2-(5-methylfuran-2-yl)ethenyl]-4,6-bis(trichloromethyl)-s-triazine, 2-[2-(4-diethylamino-2-methylphenyl)ethenyl]-4,6-bis(trichloromethyl)-s-triazine,
15 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)
20 -s-triazine, and 2-(4-n-butoxyphenyl)-4,6-bis(trichloromethyl)-s-triazine.

These photopolymerization initiators can be used alone or in admixture of two or more.

In the present invention, the amount of the
25 photopolymerization initiator (D) is preferably 0.01 to 500 parts by weight, more preferably 1 to 300 parts by weight, particularly preferably 10 to 200 parts by weight, based on 100 parts by weight of the total of the polyfunctional monomer (C) and the monofunctional
30 monomers used in some cases. When the amount of the photopolymerization initiator (D) is smaller than 0.01 parts by weight, curing by exposure to light is insufficient, so that a pattern array having colored layer patterns arranged according to a given

arrangement may become difficult to obtain, while when its amount is larger than 500 parts by weight, a formed colored layer is liable to come off from a substrate during development, and scums are liable to be formed and film residues are liable to remain in an unexposed area of the substrate or on the light-shielding layer.

The photopolymerization initiator (D) contained in the radiation sensitive composition of the present invention preferably contains an oxime compound and more preferably contains the compound represented by the above formula (D-1). When the photopolymerization initiator (D) contains an oxime compound and other photopolymerization initiators, the other photopolymerization initiators used in combination with the oxime compound are preferably a biimidazole compound, acetophenone compound, triazine compound, benzoin compound, benzophenone compound, α -diketone compound, polynuclear quinone compound, xanthone compound, diazo compound, onium salt and imidosulfonate compound, and the acetophenone compound is particularly preferred.

In the present invention, the oxime compound is used in an amount of preferably at least 20 wt%, more preferably at least 50 wt%, based on the total amount of the photopolymerization initiator (D)

Other Additives

In addition to the above colorant (A), alkali soluble resin (B), polyfunctional monomer (C) and photopolymerization initiator (D), the radiation sensitive composition of the present invention can contain various other additives as required.

Illustrative examples of such other additives include a filler, surfactant, adhesion promoter, antioxidant, ultraviolet absorber, aggregation

inhibitor, and developability adjuster.

Specific examples of the above filler include glass and alumina. Specific examples of the above surfactant include a nonionic surfactant, cationic surfactant, and anionic surfactant. Specific examples of the above adhesion promoter include vinyl trimethoxysilane, vinyl triethoxysilane, vinyl tris(2-methoxyethoxy)silane, N-(2-aminoethyl)-3-aminopropylmethyl dimethoxysilane, N-(2-aminoethyl)-3-aminopropyl trimethoxysilane, 3-aminopropyl triethoxysilane, 3-glycidoxypropyl trimethoxysilane, 3-glycidoxypropylmethyl dimethoxysilane, 2-(3,4-epoxycyclohexyl)ethyl trimethoxysilane, 3-chloropropylmethyl dimethoxysilane, 3-chloropropyl trimethoxysilane, 3-methacryloxypropyl trimethoxysilane, and 3-mercaptopropyl trimethoxysilane. Specific examples of the above antioxidant include 2,2-thiobis(4-methyl-6-t-butylphenol) and 2,6-di-t-butylphenol. Specific examples of the above ultraviolet absorber include 2-(3-t-butyl-5-methyl-2-hydroxyphenyl)-5-chlorobenzotriazole and alkoxybenzophenone. Specific examples of the above aggregation inhibitor include sodium polyacrylate.

The above developability adjuster can be added to further improve the solubility of coating film formed from the radiation sensitive composition of the present invention in an alkaline developer and further inhibit undissolved materials from remaining after development. An example of the developability adjuster is an organic acid. As such an organic acid, an aliphatic carboxylic acid or

benzene-ring-containing carboxylic acid having a molecular weight of not higher than 1,000 is preferred.

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

Illustrative examples of the above benzene-ring-containing carboxylic acid include an
20 aromatic carboxylic acid whose carboxyl group is directly bonded to a phenyl group and a carboxylic acid whose carboxyl group is bonded to a phenyl group via a carbon chain. Specific examples thereof include aromatic monocarboxylic acids such as benzoic acid,
25 toluic acid, cuminic acid, hemellitic acid and mesitylenic acid; aromatic dicarboxylic acids such as phthalic acid, isophthalic acid and terephthalic acid; aromatic polycarboxylic acids having three or more functional groups such as trimellitic acid, trimesic
30 acid, mellophanic acid and pyromellitic acid; and phenylacetic acid, hydratropic acid, hydrocinnamic acid, mandelic acid, phenylsuccinic acid, atropic acid, cinnamic acid, cinnamylidenic acid, coumaric acid and umbellic acid.

Of these organic acids, aliphatic dicarboxylic acids and aromatic dicarboxylic acids such as malonic acid, adipic acid, itaconic acid, citraconic acid, fumaric acid, mesaconic acid and phthalic acid are preferred from the viewpoints of alkali solubility, solubility in solvents to be described later and prevention of scums and film residues in an area other than a portion where the colored layer is formed.

The above organic acids can be used alone or in admixture of two or more.

In the present invention, the developability adjuster is used in an amount of preferably not larger than 10 wt%, more preferably 0.001 to 10 wt%, much more preferably 0.01 to 1 wt%, based on the whole radiation sensitive composition. When the amount of the developability adjuster is larger than 10 wt%, adhesion of the formed colored layer to the substrate may be insufficient in some cases.

Solvents

The radiation sensitive composition of the present invention comprises the above colorant (A), alkali soluble resin (B), polyfunctional monomer (C) and photopolymerization initiator (D) as essential components and comprises the above other additives as required. However, the radiation sensitive composition is preferably prepared as a liquid composition having the components other than the colorant (A) dissolved in a proper solvent and having the colorant (A) dispersed uniformly.

As the above solvent, any solvent can be selected and used as appropriate as long as it disperses or dissolves the colorant (A), alkali soluble resin (B), polyfunctional monomer (C) and photopolymerization initiator (D) and the other additives, does not react

with these components and has moderate volatility.

Illustrative examples of such a solvent include (poly)alkylene glycol monoalkyl ethers such as ethylene glycol monomethyl ether, ethylene glycol monoethyl 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, dipropylene glycol monomethyl ether, dipropylene glycol monoethyl ether, dipropylene glycol mono-n-propyl ether, dipropylene glycol mono-n-butyl ether, tripropylene glycol monomethyl ether and tripropylene glycol monoethyl ether; (poly)alkylene glycol monoalkyl ether acetates such as ethylene glycol monomethyl ether acetate, ethylene glycol monoethyl ether acetate, propylene glycol monomethyl ether acetate and propylene glycol monoethyl ether acetate; 3-methoxybutyl acetate; other ethers such as diethylene glycol dimethyl ether, diethylene glycol methyl ethyl ether, diethylene glycol diethyl ether and tetrahydrofuran; ketones such as methyl ethyl ketone, cyclohexanone, 2-heptanone and 3-heptanone; alkyl lactates such as methyl 2-hydroxypropionate and ethyl 2-hydroxypropionate; other esters such as methyl 2-hydroxy-2-methyl propionate, ethyl 2-hydroxy-2-methyl propionate, methyl 3-methoxypropionate, ethyl 3-methoxypropionate, methyl 3-ethoxypropionate, ethyl 3-ethoxypropionate, ethyl ethoxyacetate, ethyl hydroxyacetate, methyl 2-hydroxy-3-methyl butyrate, 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 acetate, i-amyl acetate, n-butyl propionate, ethyl butyrate, n-propyl butyrate, i-propyl butyrate, n-butyl butyrate, methyl pyruvate, ethyl pyruvate, n-propyl pyruvate, methyl
 5 acetoacetate, ethyl acetoacetate and ethyl 2-oxobutyrate; aromatic hydrocarbons such as toluene and xylene; and carboxylic amides such as N-methylpyrrolidone, N,N-dimethyl formamide and N,N-dimethyl acetamide.

10 These solvents can be used alone or in admixture of two or more.

Further, together with these solvents, a high-boiling-point solvent such as benzyl ethyl ether, dihexyl ether, acetonylacetone, isophorone, caproic
 15 acid, caprylic acid, 1-octanol, 1-nonanol, benzyl alcohol, benzyl acetate, ethyl benzoate, diethyl oxalate, diethyl maleate, γ -butyrolactone, ethylene carbonate, propylene carbonate or ethylene glycol monophenyl ether acetate can be used.

20 These high-boiling-point solvents can be used alone or in admixture of two or more.

Of the above solvents, ethylene glycol monomethyl ether acetate, propylene glycol monomethyl ether acetate, propylene glycol monoethyl ether acetate,
 25 3-methoxybutyl acetate, diethylene glycol dimethyl ether, cyclohexanone, 2-heptanone, 3-heptanone, ethyl 2-hydroxypropionate, 3-methyl-3-methoxybutyl propionate, ethyl 3-methoxypropionate, methyl 3-ethoxypropionate, ethyl 3-ethoxypropionate,
 30 n-butyl acetate, i-butyl acetate, n-amyl acetate, i-amyl acetate, n-butyl propionate, ethyl butyrate, i-propyl butyrate, n-butyl butyrate, ethyl pyruvate and the like are preferred from the viewpoints of solubility, pigment dispersibility, coatability and

the like. As the high-boiling-point solvents, γ -butyrolactone and the like are preferred.

The amount of the solvent used in the radiation sensitive composition of the present invention is preferably 100 to 10,000 parts by weight, more preferably 500 to 5,000 parts by weight, as the total amount of the solvent and the high-boiling-point solvent, based on 100 parts by weight of the alkali soluble resin (B). When the high-boiling-point solvent is used together with the solvent in the radiation sensitive composition of the present invention, it is used in an amount of not larger than 20 wt%, more preferably not larger than 10 wt%, based on the total amount of the solvents.

15 Method for Forming Colored Layer

Next, a method for forming a colored layer by use of the radiation sensitive composition of the present invention will be described. First, a case where the colored layer is a layer comprising pixel arrays constituting a color filter will be described, followed by description of a case where the colored layer is a black matrix.

[Method for Forming Colored Layer Comprising Pixel Arrays]

25 First, a light shielding layer (black matrix) is formed to partition areas where pixels are formed on the surface of a substrate. On this substrate, a liquid radiation sensitive composition having, for example, a red pigment dispersed therein is applied, and the substrate is heat-treated (prebaked) to evaporate and remove a solvent, thereby forming a coating film. Then, after an area of this coating film is irradiated with radiation, the coating film is developed with an alkali developer to dissolve and

remove an unexposed area of the coating film and then heat-treated (postbaked) to form a pixel array having red pixels arranged in a predetermined pattern.

Then, liquid radiation sensitive compositions having a green pigment and a blue pigment dispersed therein, respectively, are applied, prebaked, exposed to radiation and developed in the same manner as described above to form a green pixel array and a blue pixel array on the same substrate in turn. Thereby, a color filter having the red, green and blue pixel arrays (colored layer) arranged on the substrate can be obtained. However, in the present invention, the order of formation of the pixel arrays of the above three colors is not particularly limited.

Illustrative examples of the substrate used in forming the colored layer include glass, silicon, polycarbonate, polyester, aromatic polyamide, polyamideimide, and polyimide. These substrates may be subjected to an appropriate pretreatment such as a chemical treatment using a silane coupling agent or the like, plasma treatment, ion plating, sputtering, a gas phase reaction method or vacuum deposition as desired.

A method for applying the radiation sensitive composition on the substrate is not particularly limited. Illustrative examples of the method include methods using a slit nozzle (hereinafter referred to as "slit nozzle coating methods") such as slit-and-spin coating and slit die coating.

Coating conditions in the slit nozzle coating method differ between the slit-and-spin coating and slit die coating and vary depending on the size of the substrate to be coated or the like. For example, when a glass substrate (1,100 mm x 1,250 mm) of the fifth generation is coated by the slit die coating, the amount

of the radiation sensitive composition discharged from the slit nozzle is, for example, 500 to 2,000 $\mu\text{l}/\text{sec}$, preferably 800 to 1,500 $\mu\text{l}/\text{sec}$, and coating speed is preferably 500 to 1,500 mm/sec, more preferably 700 to 1,200 mm/sec.

The solid concentration (proportion of the total weight of the components other than the solvent in the composition in the total weight of the composition) of the radiation sensitive composition used in the slit nozzle coating method is preferably 10 to 20 wt%, more preferably 13 to 18 wt%.

When the slit nozzle coating method is employed, prebaking is preferably "vacuum baking" which is carried out under reduced pressure. As for conditions for this vacuum baking, the degree of vacuum is preferably 10 to 150 Pa, more preferably about 25 to 75 Pa, the temperature is preferably 60 to 120°C, more preferably about 70 to 110°C, and the baking time is preferably 1 to 5 minutes, more preferably about 2 to 4 minutes.

The thickness of the coating film to be formed is, for example, 0.1 to 10 μm , preferably 0.2 to 8.0 μm , particularly preferably 0.2 to 6.0 μm as a thickness after the solvent is removed.

Then, at least a portion of the formed coating film is exposed to light. This can be carried out by irradiating radiation via a photomask having an appropriate pattern, for example.

As the radiation used for irradiation, visible light, ultraviolet radiation, far-ultraviolet radiation, an electron beam, an X-ray or the like can be used, for example. Of these, radiation having a wavelength of 190 to 450 nm is preferred.

The exposure of the radiation is about 10 to 10,000

J/m², for example.

Then, the coating film is developed with a developer to dissolve and remove an unexposed area of the coating film.

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

To the above alkali developer, a water-soluble organic solvent such as methanol or ethanol, a surfactant or the like can be added in an appropriate
15 amount. The developed coating film is preferably washed with water.

As a development method, shower development, spray development, dip development, puddle development or the like can be employed, for example.

20 The development is preferably carried out at room temperature for about 5 to 300 seconds.

Then, the developed coating film is postbaked, whereby the colored layer can be formed on the substrate.

25 The postbaking is preferably carried out at 180 to 230°C for about 20 to 40 minutes.

By repeating the above steps with colored-layer-forming compositions having red, green and blue pigments dispersed therein, respectively, in
30 given order, a color filter having a red pixel array, a green pixel array and a blue pixel array (colored layer) formed on the same substrate can be obtained.
[Method for Forming Colored Layer as Black Matrix]

In the above "Method for Forming Colored Layer

Comprising Pixel Arrays", by carrying out the above steps sequentially by using a radiation sensitive composition having a black pigment or a mixture of red, yellow and blue pigments dispersed therein, a substrate
5 having a black matrix pattern arranged in a predetermined arrangement can be obtained.

The thus formed color filter having the colored layer or the black matrix comprising the colored layer is very useful for a color liquid crystal display, a
10 color image pickup tube device, a color sensor and the like, for example.

Liquid Crystal Display Device

The liquid crystal display device of the present invention comprises a color filter that has a colored
15 layer formed from the radiation sensitive composition of the present invention or a black matrix that comprises a colored layer formed from the radiation sensitive composition of the present invention.

The liquid crystal display device of the present invention can have any appropriate structure. For
20 example, it may have a structure in which a color filter is formed on a substrate different from a substrate for driving on which a thin-film transistor (TFT) is placed and the substrate for driving and the substrate having
25 the color filter face each other with a liquid crystal layer situated therebetween or a structure in which a substrate having a color filter formed on the surface of a substrate for driving on which a thin-film transistor (TFT) is placed and a substrate having
30 electrodes made of ITO (indium oxide doped with tin) formed thereon face each other with a liquid crystal layer situated therebetween. The latter structure has advantages that an aperture ratio can be significantly improved and that a bright, high-definition color

liquid crystal display device is obtained.

Other specific embodiments of the above liquid crystal display device should be self-evident to one skilled in the art.

- 5 The liquid crystal display device of the present invention is excellent in color purity.

Examples

Hereinafter, the present invention will be
10 further described with reference to examples. However, the present invention shall not be limited to the following examples.

In the following examples, a weight average molecular weight (Mw) in terms of polystyrene was
15 measured by gel permeation chromatography (GPC) using a monodisperse polystyrene as a standard, using a GPC column (comprising two G2000HXLs, one G3000HXL and one G4000HXL connected in series) of Tosoh Corporation and tetrahydrofuran as an elution solvent, at a flow rate
20 of 1.0 ml/min and a column temperature of 40°C.

<Synthesis Examples of Styrene Epoxy Resins>

Synthesis Example 1

In a flask equipped with a condenser and an agitator, 40.0 g of p-vinylbenzyl glycidyl ether, 27.0
25 g of N-phenyl maleimide, 17.0 g of styrene and 16.0 g of benzyl methacrylate were dissolved in 300 g of propylene glycol monomethyl ether acetate. Then, 4.0 g of 2,2'-azobisisobutyronitrile and 6.0 g of α -methylstyrene dimmer were added to the mixture which
30 was then purged with nitrogen for 15 minutes.

Thereafter, the reactor was heated to 80°C under agitation and the mixture was allowed to react for 5 hours to obtain a solution containing 25 wt% of styrene epoxy resin [A-1]. The weight average molecular

weight (Mw) in terms of polystyrene of this styrene epoxy resin [A-1] was 6,000.

Synthesis Examples 2 to 8

Solutions containing 25 wt% of styrene epoxy
5 resins [A-2] to [A-8] were obtained in the same manner
as in the above Synthesis Example 1 except that the
types and amounts of the monomers and the amounts of
2,2'-azobisisobutyronitrile and α -methylstyrene
dimmer were changed as shown in Table 1. The amounts
10 of components in Table 1 are expressed in weight (g).

The weight average molecular weights (Mw) in
terms of polystyrene of the styrene epoxy resins
obtained in these Synthesis Examples are shown in Table
1.

Table 1

	S.Ex.1	S.Ex.2	S.Ex.3	S.Ex.4	S.Ex.5	S.Ex.6	S.Ex.7	S.Ex.8
Names of Resins	A-1	A-2	A-3	A-4	A-5	A-6	A-7	A-8
p-vinylbenzyl glycidyl ether	40.0	4.0	50.0	44.0	40.0	44.0	40.0	34.0
N-phenyl maleimide	27.0	38.0	27.0	40.0	27.0	40.0	-	43.0
acenaphthylene	-	-	-	-	-	16.0	40.0	-
styrene	17.0	28.0	17.0	-	17.0	-	-	7.0
benzyl methacrylate	16.0	30.0	6.0	16.0	6.0	-	20.0	16.0
2-hydroxyethyl methacrylate	-	-	-	-	10.0	-	-	-
2,2'-azobisisobutyronitrile	4.0	3.0	3.0	4.0	5.0	4.0	4.0	8.0
α -methylstyrene dimer	6.0	5.0	4.0	6.0	6.0	4.0	6.0	8.0
Weight Average Molecular Weight (Mw)	6,000	12,000	15,000	6,000	5,000	8,000	6,000	5,500

S.Ex.: Synthesis Example

<Synthesis of Alkali Soluble Resin Represented by the
Formula (1)>

Synthesis Example 9

200 g of the solution containing the styrene epoxy
5 resin [A-1] which was obtained in the above Synthesis
Example 1, 10.0 g of methacrylic acid as an unsaturated
monocarboxylic acid, 0.2 g of p-methoxyphenol, 0.2 g of
tetrabutylammonium bromide and 300 g of propylene glycol
monomethyl ether acetate were charged into a flask and
10 allowed to react at a temperature of 120°C for 9 hours.
Thereby, 1 equivalent of acrylic acid was reacted per
equivalent of epoxy groups of the styrene epoxy resin.
Further, 16.0 g of 4-cyclohexene-1,2-dicarboxylic
anhydride as a polybasic acid anhydride was added, and the
15 mixture was allowed to react at 80°C for 6 hours. This
reaction mixture was rinsed with water twice and
vacuum-concentrated with the solution temperature kept at
80°C. As a result, a solution containing 20 wt% of alkali
soluble resin [B-1] was obtained. The weight average
20 molecular weight (Mw) in terms of polystyrene of the alkali
soluble resin [B-1] was 7,800.

Synthesis Examples 10 to 18

Solutions containing 20 wt% of alkali soluble resins
[B-2] to [B-10] were obtained in the same manner as in the
25 above Synthesis Example 9 except that the type of the styrene
epoxy resin solution, the type and amount of the unsaturated
monocarboxylic acid and the type and amount of the polybasic
acid anhydride were changed as shown in Table 2.

The weight average molecular weights (Mw) in terms
30 of polystyrene of the alkali soluble resins obtained in
these Synthesis Examples are shown in Table 2.

Table 2

	S.Ex. 9	S.Ex. 10	S.Ex. 11	S.Ex. 12	S.Ex. 13	S.Ex. 14	S.Ex. 15	S.Ex. 16	S.Ex. 17	S.Ex. 18
Names of Alkali Soluble Resins	B-1	B-2	B-3	B-4	B-5	B-6	B-7	B-8	B-9	B-10
Types of Styrene Epoxy Resins	A-1	A-1	A-2	A-3	A-1	A-4	A-5	A-6	A-7	A-8
methacrylic acid (g)	10.0	-	1.0	12.5	10.0	11.0	10.0	11.0	-	8.5
acrylic acid (g)	-	8.4	-	-	-	-	-	-	8.4	-
4-cyclohexene-1,2-dicarboxylic anhydride (g)	16.0	4.8	1.3	20.0	-	-	16.0	12.8	-	-
succinic anhydride (g)	-	-	-	-	-	11.6	-	-	-	6.9
glutaric anhydride (g)	-	-	-	-	9.6	-	-	-	12.0	-
p-methylphenol (g)	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
Tetrabutyl ammonium bromide (g)	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
Weight Average Molecular Weight (Mw)	7,800	7,100	14,000	17,000	7,700	8,000	7,000	10,000	8,000	7,200

S.Ex.: Synthesis Example

<Comparative Synthesis Example of Alkali Soluble Resin>

Comparative Synthesis Example 1

In a flask equipped with a condenser and an agitator, 30.0 g of styrene, 45.0 g of benzyl methacrylate and 15.0 g of methacrylic acid were dissolved in 200 g of propylene glycol monomethyl ether acetate. Then, 4.0 g of 2,2'-azobisisobutyronitrile and 6.0 g of α -methylstyrene dimmer were added to the mixture which was then purged with nitrogen for 15 minutes. Thereafter, the reactor was heated to 80°C under agitation and the mixture was allowed to react for 5 hours to obtain a solution containing 33 wt% of alkali soluble resin [R-1]. The weight average molecular weight (Mw) in terms of polystyrene of this alkali soluble resin [R-1] was 6,000.

Comparative Synthesis Example 2

In a flask equipped with a condenser and an agitator, 30.0 g of N-phenyl maleimide, 20.0 g of styrene, 35.0 g of benzyl methacrylate and 15.0 g of methacrylic acid were dissolved in 200 g of propylene glycol monomethyl ether acetate. Then, 3.0 g of 2,2'-azobisisobutyronitrile and 5.0 g of α -methylstyrene dimmer were added to the mixture which was then purged with nitrogen for 15 minutes. Thereafter, the reactor was heated to 80°C under agitation and the mixture was allowed to react for 5 hours to obtain a solution containing 33 wt% of alkali soluble resin [R-2]. The weight average molecular weight (Mw) in terms of polystyrene of this alkali soluble resin [R-2] was 12,000.

<Preparation and Evaluation of Radiation sensitive Composition>

Example 1

15 parts by weight of mixture comprising 80 wt% of C. I. Pigment Red 254 and 20 wt% of C. I. Pigment Red 177 as the colorant (A), 4 parts by weight, in terms of solid content (weight other than a solvent), of Disperbyk-2000 (trade name,

(trade name, product of BYK-Chemie GmbH) as a dispersant and 81 parts by weight of propylene glycol monomethyl ether acetate as a dispersion medium for pigments were processed by a bead mill to prepare a pigment dispersion.

5 Then, 100 parts by weight of the pigment dispersion prepared above, 65 parts by weight of the solution containing the alkali soluble resin [B-1] (resin concentration: 20 wt%) as the alkali soluble resin (B), 13 parts by weight of dipentaerythritol hexaacrylate as the polyfunctional
10 monomer (C), 4.3 parts by weight of 2-methyl-(4-methylthiophenyl)-2-morpholino-1-propane-1-one as the photopolymerization initiator (D) and 63 parts by weight of ethyl 3-ethoxypropionate as a solvent were mixed together to
15 prepare a colored-layer-forming composition.

The obtained colored-layer-forming composition was evaluated in accordance with the following procedure. The evaluation results are shown in Table 3.

Evaluation of Radiation sensitive Composition

20 The obtained colored-layer-forming composition was coated, by use of a spin coater, on a soda glass substrate on which an SiO₂ film for preventing elution of sodium ions had been formed, and the substrate was prebaked on a hot plate of 90°C for 2 minutes to form a coating film having a thickness
25 of 1.7 μm.

After this substrate having the coating film was cooled to room temperature, the coating film was exposed, via a photomask having slits of different widths ranging from 5 to 50 μm, to ultraviolet radiation including wavelengths of
30 365 nm, 405 nm and 436 nm by use of a high-pressure mercury lamp at a light exposure of 1,000 J/m².

Then, the substrate with the exposed coating film was shower-developed by use of a 0.04 wt% potassium hydroxide aqueous solution of 23°C for 1 minute, rinsed with ultrapure

water, and then air-dried. Further, the substrate was postbaked in a clean oven of 220°C for 30 minutes to obtain a pixel array having red stripe-shaped pixel patterns arranged on the substrate.

5 The surface of the substrate on which the pixel array was formed was observed by an optical microscope, and whether the edges of the pixel patterns were chipped and whether the residues of pigments remained in areas other than the pixel patterns on the substrate were evaluated on the following
10 three-grade scale.

[Chipping of Pixel Patterns]

○: No chips are observed in a pixel pattern having a width of 30 μm .

△: Some chips are observed in a pixel pattern having a width
15 of 30 μm .

X: Many chips are observed in a pixel pattern having a width of 30 μm .

[Residues of Pigments in Areas other than Pixel Patterns]

○: No residues are observed.

20 △: Some residues are observed.

X: Many residues are observed.

Further, the minimum width of a pixel pattern that did not come off at all and was completely intact was evaluated as the width of the smallest formable pattern (μm).

25 The results are shown in Table 3.

Example 2 and Comparative Example 1

Pigment dispersions were prepared in the same manner as in Example 1 except that the types of the colorant (A), dispersant and dispersion medium for pigments were changed
30 as shown in Table 3.

Colored-layer-forming compositions were prepared and evaluated in the same manner as in Example 1 except that the pigment dispersions prepared above were used and the types and amounts of the alkali soluble resin (B),

photopolymerization initiator (D) and solvent and the amount of dipentaerythritol hexaacrylate as the polyfunctional monomer were changed as shown in Table 3. The results are shown in Table 3.

Table 3

Pigment Dispersion	Ex. 1		Ex. 2		C.Ex. 1	
	Type of Colorant (A)	Red Pigment	Green Pigment	Red Pigment	Red Pigment	Red Pigment
	Type of Dispersant	BYK-2000	BYK-2001	BYK-2000	BYK-2000	BYK-2000
	Type of Dispersion Medium for Pigments	PGMEA	3MBA	PGMEA	PGMEA	PGMEA
Radiation sensitive Composition	Alkali Soluble Resin (B)	Type	B-1	B-4	B-1	R-1
		Amount	65	70	40	40
	Polyfunctional Monomer (C)	Amount	13	14	13	13
	Photopolymerization Initiator (D)	Type	Initiator A	Initiator B	Initiator A	Initiator A
	Solvent	Amount	4.3	2.0	4.3	4.3
		Type	3EPE	3EPE	3MBA	3MBA
		Amount	63	59	88	88
Evaluation Results	Presence or Absence of Residues		○	○	○	X
	Presence or Absence of Chips in Edges		△	○	○	X
	Formable Pattern Size (μm)		18	6	45	45

Ex.: Example, C.Ex.: Comparative Example

The abbreviations for the components in Table 3 indicate the following.

(A) Colorant:

Red Pigment: Mixture of 80 wt% of C. I. Pigment Red 254 and
5 20 wt% of C. I. Pigment Red 177

Green Pigment: Mixture of 60 wt% of C. I. Pigment Green 36
and 40 wt% of C. I. Pigment Yellow 150

Dispersant:

BYK-2000: Disperbyk-2000 (trade name, product of BYK-Chemie
10 GmbH)

BYK-2001: Disperbyk-2001 (trade name, product of BYK-Chemie
GmbH)

Dispersion Medium for Pigments:

PGMEA: propylene glycol monomethyl ether acetate

15 3MBA: 3-methoxybutylacetate

(D) Photopolymerization Initiator:

Initiator A:

2-methyl-(4-methylthiophenyl)-2-morpholino-11-
propane-1-one

20 Initiator B:

ethanone-1-[9-ethyl-6-[2-methyl-4-(2,2-dimethyl
-1,3-dioxolanyl)methoxybenzoyl]-9.H.-carbazole-3-yl]-1-
(O-acetyloxime)

Solvent:

25 3EPE: ethyl 3-ethoxypropionate

3MBA: 3-methoxybutylacetate

The amounts of the components in Table 3 are expressed
in parts by weight.

The dispersants in preparation of the pigment
30 dispersions are added as solutions, and the amounts of the
dispersants in Table 3 are expressed in terms of solid content
(weight other than a solvent).

The alkali soluble resins (B) are added as the solutions
containing the alkali soluble resins that were prepared in

the above Synthesis Examples, and the amounts of the alkali soluble resins in Table 3 are amounts as the solutions.

Example 3

20 parts by weight of carbon black as the colorant (A),
5 4 parts by weight of Disperbyk-167 (trade name, product of BYK-Chemie GmbH) as a dispersant and 76 parts by weight of 3-methoxybutylacetate as a dispersion medium for pigments were processed by a bead mill to prepare a black pigment dispersion.

10 Then, 100 parts by weight of the pigment dispersion prepared above, 52.5 parts by weight of the above-prepared solution containing the alkali soluble resin [B-2] (resin concentration: 20 wt%) as the alkali soluble resin (B), 5.6 parts by weight of pentaerythritol tetraacrylate and 2.4
15 parts by weight of dipentaerythritol hexaacrylate as the polyfunctional monomer (C), 3.7 parts by weight of ethanone-1-[9-ethyl-6-[2-methyl-4-(2,2-dimethyl-1,3-dioxolanyl)methoxybenzoyl]-9.H.-carbazole-3-yl]-1-(O-acetyloxime) as the photopolymerization initiator (D) and
20 76 parts by weight of propylene glycol monomethyl ether acetate as a solvent were mixed together to prepare a colored-layer-forming composition.

The obtained colored-layer-forming composition was evaluated in accordance with the procedure of Example 1
25 except that the thickness of the formed coating film was 1.0 μm . The evaluation results are shown in Table 4.

Examples 4 to 10 and Comparative Example 2

In Examples 4 to 6, 8 to 10 and Comparative Example 2, pigment dispersions were prepared in the same manner as
30 in Example 1. In Example 7, a pigment dispersion was prepared in the same manner as in Example 3 except that propylene glycol monomethyl ether acetate was used as a dispersion medium for pigments.

Colored-layer-forming compositions were prepared and

evaluated in the same manner as in Example 3 except that the pigment dispersions prepared above were used, that the types and amounts of the alkali soluble resin (B) and solvent were changed as shown in Table 4 and that polyfunctional monomers and photopolymerization initiators shown in Table 4 were used in amounts shown in Table 4 as the polyfunctional monomer (C) and the photopolymerization initiator (D). The results are shown in Table 4.

Table 4

			Ex. 3	Ex. 4	Ex. 5	Ex. 6	Ex. 7	Ex. 8	Ex. 9	Ex. 10	C.Ex. 2
Radiation sensitive Composition	Alkali	Type	B-2	B-5	B-6	B-7	B-8	B-9	B-3	B-10	R-2
	Soluble Resin (B)	Amount	52.5	52.5	46.5	52.5	52.5	52.5	52.5	61.7	32.0
	Polyfunctional Monomer (C)										
	Amount of dipentaerythritol hexaacrylate		2.4	2.4	9.3	2.4	-	2.4	2.4	6.2	2.4
	Amount of pentaerythritol tetraacrylate		5.6	5.6	-	5.6	8.0	5.6	5.6	-	5.6
	Photopolymerization Initiator (D)										
	Amount of Initiator A		-	-	-	1.0	-	-	-	-	-
	Amount of Initiator B		3.7	3.7	3.7	2.7	3.7	3.7	3.7	3.7	3.7
	Solvent	Type	3MBA	3MBA	3MBA	3EPE	3MBA	3MBA	3MBA	3MBA	3EPE
	Amount		76	76	81	76	76	76	76	68.6	97
Evaluation Results	Presence or Absence of Residues		○	○	○	○	○	○	○	○	Δ
	Presence or Absence of Chips in Edges		○	○	○	○	○	○	Δ	○	X
	Formable Pattern Size (μm)		6	7	5	5	5	5	20	5	50

Ex.: Example, C.Ex.: Comparative Example

The abbreviations for the photopolymerization initiators (D) and solvents in Table 4 indicate the same as those in Table 3 indicate.

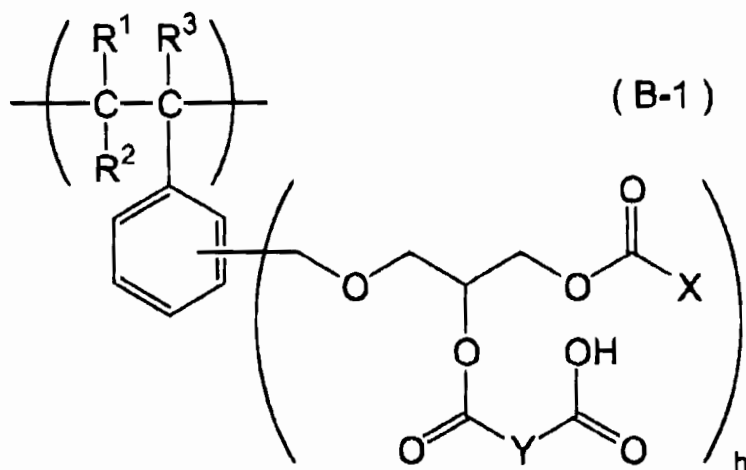
Further, the amounts of the components in Table 4 are
5 expressed in parts by weight.

The alkali soluble resins (B) are added as the solutions containing the alkali soluble resins that were prepared in the above Synthesis Examples, and the amounts of the alkali soluble resins in Table 4 are amounts as the
10 solutions.

As described above, the radiation sensitive composition of the present invention can form a fine pattern without having chipping of pattern edge and undercuts even with low light exposure and can be suitably used for
15 formation of a colored layer that comprises pixels constituting a color filter or a colored layer that is a black matrix because no undissolved materials remain and no scums are formed at pattern edges at the time of development.

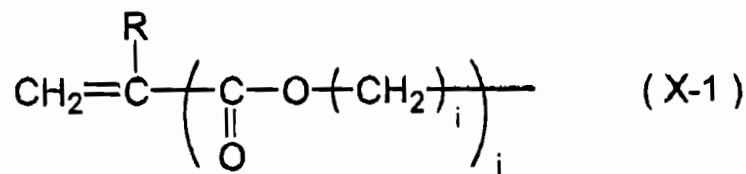
WHAT IS CLAIMED IS:

1. A radiation sensitive composition comprising:
- (A) a colorant,
 - 5 (B) an alkali soluble resin,
 - (C) a polyfunctional monomer, and
 - (D) a photopolymerization initiator,
- wherein the alkali soluble resin (B) having a structure represented by the following formula (B-1):



- 10 (wherein R^1 , R^2 and R^3 each independently represent a hydrogen atom or an alkyl group having 1 to 10 carbon atoms, X represents a monovalent organic group having an acryloyl group or methacryloyl group, a vinyl group or a 1-methylvinyl group, Y represents a divalent organic group, and h is an integer of 1 to 5), and the composition is used for formation of a colored layer.

2. The radiation sensitive composition of claim 1, wherein X in the formula (B-1) represents a monovalent group represented by the following formula (X-1):

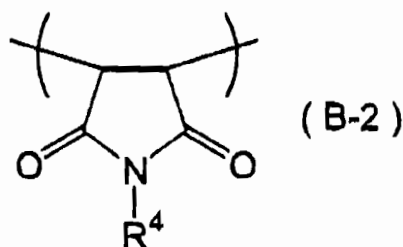


(wherein R represents a hydrogen atom or a methyl group, i

is an integer of 2 to 5, and j is an integer of 0 to 10),
and

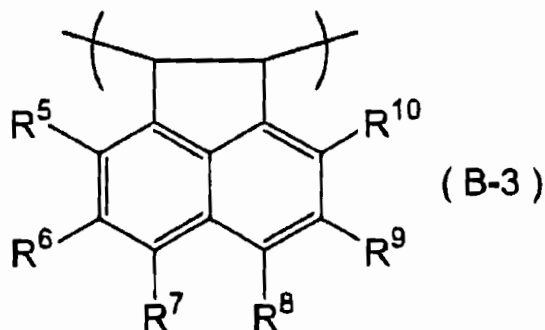
The radiation sensitive composition of claim 1,
wherein Y is a methylene group, an alkylene or alkenylene
5 group having 2 to 6 carbon atoms (these alkylene group and
alkenylene group may be interrupted in the middle by an oxygen
atom), a cyclohexanediyl group, a cyclohexenediyl group or
an arylene group having 6 to 12 carbon atoms (this arylene
group may have a carboxyl group or an acid anhydride group).

10 3. The radiation sensitive composition of claim 1 or
2, wherein the alkali soluble resin (B) has at least one
structure selected from the group consisting of, in addition
to the structure represented by the formula (B-1), a
structure represented by the following formula (B-2):



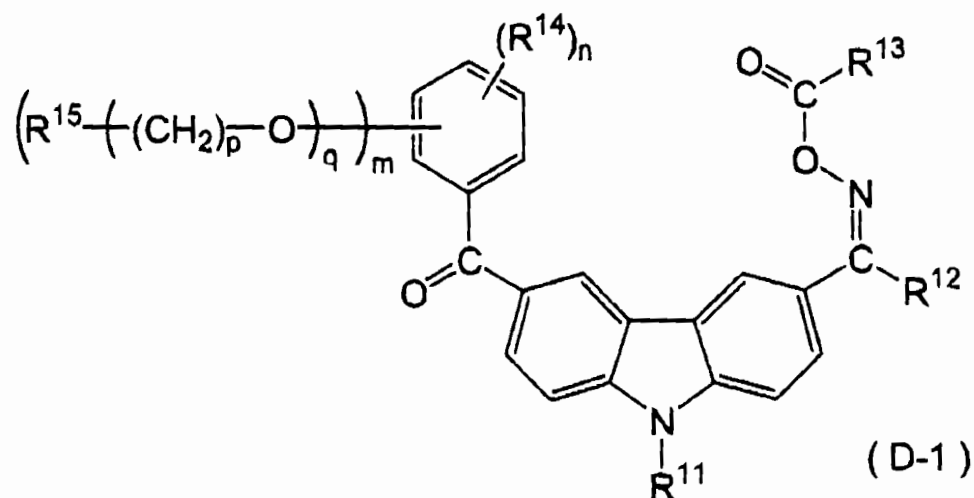
15 (wherein R^4 represents an aryl group having 6 to 10 carbon
atoms or an alicyclic group having 3 to 10 carbon atoms),
and

a structure represented by the following formula (B-3):



20 (wherein R^5 to R^{10} each independently represent a hydrogen
atom, a halogen atom, a hydroxyl group, a hydroxymethyl group
or a carboxyl group).

4. The radiation sensitive composition of claim 1 or 2, wherein the photopolymerization initiator (D) comprises a compound represented by the following formula (D-1):



- 5 (wherein R¹¹ represents an alkyl group having 1 to 20 carbon atoms, a cycloalkyl group having 3 to 8 carbon atoms or a phenyl group,
 R¹² and R¹³ each independently represent a hydrogen atom, an
 alkyl group having 1 to 20 carbon atoms, a cycloalkyl group
 10 having 3 to 8 carbon atoms, a phenyl group which may be
 substituted or a monovalent alicyclic group having 7 to 20
 carbon atoms (excluding the cycloalkyl group),
 R¹⁴ represents an alkyl group having 1 to 12 carbon atoms,
 a cycloalkyl group having 3 to 8 carbon atoms, an alkoxy
 15 group having 1 to 12 carbon atoms or a cycloalkyloxy group
 having 3 to 8 carbon atoms, and when a plurality of R¹⁴s exist,
 they may be the same or different from each other,
 R¹⁵ represents a monovalent oxygen-containing heterocyclic
 group having 4 to 20 carbon atoms, a monovalent
 20 nitrogen-containing heterocyclic group having 4 to 20 carbon
 atoms or a monovalent sulfur-containing heterocyclic group
 having 4 to 20 carbon atoms, and when a plurality of R¹⁵s exist,
 they may be the same or different from each other,
 p is an integer of 0 to 6, q is 0 or 1, n is an integer of
 25 0 to 5, m is an integer of 0 to 5, provided that (n + m) ≤

5).

5. A color filter that has a colored layer formed from the radiation sensitive composition of claim 1 or 2.

5

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

7. A black matrix that comprises a colored layer
10 formed from the radiation sensitive composition of claim 1 or 2.

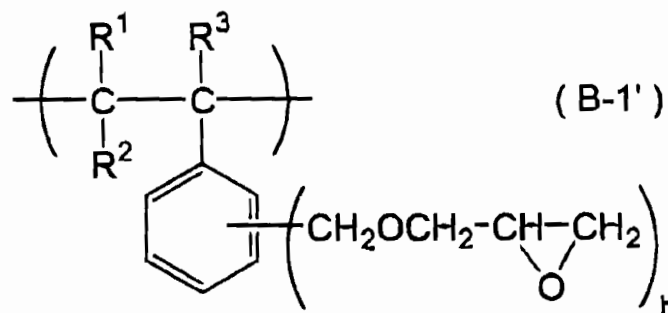
8. A liquid crystal display device comprising the black matrix of claim 7.

15

9. A method for producing an alkali soluble resin having a structure represented by the formula (B-1), comprising adding a compound represented by the following formula (a1):

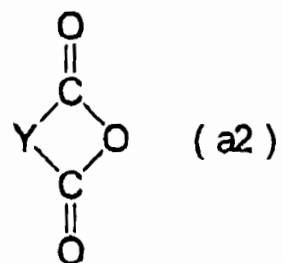
20 **X-COOH (a1)**

(wherein X is the same as defined in the formula (B-1)) to a polymer having a structure represented by the following formula (B-1'):



25 (wherein R^1 , R^2 , R^3 and h are the same as defined in the formula (B-1)), and

then adding a compound represented by the following formula (a2):



(wherein Y is the same as defined in the formula (B-1))
to the polymer.