

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

Field of the Invention

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

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Description of the Prior Art

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

 In the technical field of color filters, the tact time is now generally shortened by reducing the amount of exposure, and the formation of a finer pattern is strongly desired, reflecting the higher definition of liquid crystal display
30 devices. However, it is difficult to obtain a satisfactory pixel pattern and black matrix pattern from the colored radiation sensitive composition of the prior art when the tact time is shortened because a missing part of the pattern edge or an undercut is apt to be produced during development.

Also, it cannot be said that the radiation sensitive composition of the prior art is satisfactory in terms of the formation of an extremely fine pattern.

5 Summary of the Invention

It is an object of the present invention to provide a radiation sensitive composition for forming a colored layer which exhibits excellent developability, more specifically a novel radiation sensitive composition for forming a colored
10 layer which an undissolved product does not remain or scum is not produced on the pattern edge at the time of development, provides pixels and a black matrix without a missing part of the pattern edge or an undercut even when the amount of exposure is small and enables the formation of a fine pattern.

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

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

20 According to the present invention, firstly, the above objects and advantages of the present invention are attained by a radiation sensitive composition which comprises (A) a colorant, (B) an alkali-soluble resin, (C) a polyfunctional monomer and (D) a photoradical generator, wherein

25 the alkali-soluble resin (B) comprises a polyester having an alicyclic hydrocarbon skeleton in the main chain and a polymerizable unsaturated bond in the side chain and the radiation sensitive composition is used to form a colored layer.

30 The term "colored layer" as used herein means a layer composed of pixels and/or a black matrix for use in a color filter.

According to the present invention, secondly, the above objects and advantages of the present invention are

attained by a color filter having a colored layer made of the above radiation sensitive composition.

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

The present invention will be described in detail hereinunder.

10 Detailed Description of the Preferred Embodiments
Radiation sensitive composition

- component (A) -

The colorant as the component (A) is not limited to a particular color and is suitably selected according to the
15 application purpose of the obtained color filter. It may be a pigment, dye or natural coloring matter.

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

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

30 C.I. Pigment Yellow 1, C.I. Pigment Yellow 3, C.I. Pigment Yellow 12, C.I. Pigment Yellow 13, C.I. Pigment Yellow 14, C.I. Pigment Yellow 15, C.I. Pigment Yellow 16, C.I. Pigment Yellow 17, C.I. Pigment Yellow 20, C.I. Pigment Yellow 24, C.I. Pigment Yellow 31, C.I. Pigment Yellow 55, C.I. Pigment

Yellow 60, C.I. Pigment Yellow 61, C.I. Pigment Yellow 65,
 C.I. Pigment Yellow 71, C.I. Pigment Yellow 73, C.I. Pigment
 Yellow 74, C.I. Pigment Yellow 81, C.I. Pigment Yellow 83,
 C.I. Pigment Yellow 93, C.I. Pigment Yellow 95, C.I. Pigment
 5 Yellow 97, C.I. Pigment Yellow 98, C.I. Pigment Yellow 100,
 C.I. Pigment Yellow 101, C.I. Pigment Yellow 104, C.I.
 Pigment Yellow 106, C.I. Pigment Yellow 108, C.I. Pigment
 Yellow 109, C.I. Pigment Yellow 110, C.I. Pigment Yellow 113,
 C.I. Pigment Yellow 114, C.I. Pigment Yellow 116, C.I.
 10 Pigment Yellow 117, C.I. Pigment Yellow 119, C.I. Pigment
 Yellow 120, C.I. Pigment Yellow 126, C.I. Pigment Yellow 127,
 C.I. Pigment Yellow 128, C.I. Pigment Yellow 129, C.I.
 Pigment Yellow 138, C.I. Pigment Yellow 139, C.I. Pigment
 Yellow 150, C.I. Pigment Yellow 151, C.I. Pigment Yellow 152,
 15 C.I. Pigment Yellow 153, C.I. Pigment Yellow 154, C.I.
 Pigment Yellow 155, C.I. Pigment Yellow 156, C.I. Pigment
 Yellow 166, C.I. Pigment Yellow 168, C.I. Pigment Yellow 175,
 C.I. Pigment Yellow 180 and C.I. Pigment Yellow 185;
 C.I. Pigment Orange 1, C.I. Pigment Orange 5, C.I. Pigment
 20 Orange 13, C.I. Pigment Orange 14, C.I. Pigment Orange 16,
 C.I. Pigment Orange 17, C.I. Pigment Orange 24, C.I. Pigment
 Orange 34, C.I. Pigment Orange 36, C.I. Pigment Orange 38,
 C.I. Pigment Orange 40, C.I. Pigment Orange 43, C.I. Pigment
 Orange 46, C.I. Pigment Orange 49, C.I. Pigment Orange 51,
 25 C.I. Pigment Orange 61, C.I. Pigment Orange 63, C.I. Pigment
 Orange 64, C.I. Pigment Orange 71 and C.I. Pigment Orange
 73;
 C.I. Pigment Violet 1, C.I. Pigment Violet 19, C.I. Pigment
 Violet 23, C.I. Pigment Violet 29, C.I. Pigment Violet 32,
 30 C.I. Pigment Violet 36 and C.I. Pigment Violet 38;
 C.I. Pigment Red 1, C.I. Pigment Red 2, C.I. Pigment Red 3,
 C.I. Pigment Red 4, C.I. Pigment Red 5, C.I. Pigment Red 6,
 C.I. Pigment Red 7, C.I. Pigment Red 8, C.I. Pigment Red 9,
 C.I. Pigment Red 10, C.I. Pigment Red 11, C.I. Pigment Red

12, C.I. Pigment Red 14, C.I. Pigment Red 15, C.I. Pigment Red 16, C.I. Pigment Red 17, C.I. Pigment Red 18, C.I. Pigment Red 19, C.I. Pigment Red 21, C.I. Pigment Red 22, C.I. Pigment Red 23, C.I. Pigment Red 30, C.I. Pigment Red 31, C.I. Pigment Red 32, C.I. Pigment Red 37, C.I. Pigment Red 38, C.I. Pigment Red 40, C.I. Pigment Red 41, C.I. Pigment Red 42, C.I. Pigment Red 48:1, C.I. Pigment Red 48:2, C.I. Pigment Red 48:3, C.I. Pigment Red 48:4, C.I. Pigment Red 49:1, C.I. Pigment Red 49:2, C.I. Pigment Red 50:1, C.I. Pigment Red 52:1, C.I. Pigment Red 53:1, C.I. Pigment Red 57, C.I. Pigment Red 57:1, C.I. Pigment Red 57:2, C.I. Pigment Red 58:2, C.I. Pigment Red 58:4, C.I. Pigment Red 60:1, C.I. Pigment Red 63:1, C.I. Pigment Red 63:2, C.I. Pigment Red 64:1, C.I. Pigment Red 81:1, C.I. Pigment Red 83, C.I. Pigment Red 88, C.I. Pigment Red 90:1, C.I. Pigment Red 97, C.I. Pigment Red 101, C.I. Pigment Red 102, C.I. Pigment Red 104, C.I. Pigment Red 105, C.I. Pigment Red 106, C.I. Pigment Red 108, C.I. Pigment Red 112, C.I. Pigment Red 113, C.I. Pigment Red 114, C.I. Pigment Red 122, C.I. Pigment Red 123, C.I. Pigment Red 144, C.I. Pigment Red 146, C.I. Pigment Red 149, C.I. Pigment Red 150, C.I. Pigment Red 151, C.I. Pigment Red 166, C.I. Pigment Red 168, C.I. Pigment Red 170, C.I. Pigment Red 171, C.I. Pigment Red 172, C.I. Pigment Red 174, C.I. Pigment Red 175, C.I. Pigment Red 176, C.I. Pigment Red 177, C.I. Pigment Red 178, C.I. Pigment Red 179, C.I. Pigment Red 180, C.I. Pigment Red 185, C.I. Pigment Red 187, C.I. Pigment Red 188, C.I. Pigment Red 190, C.I. Pigment Red 193, C.I. Pigment Red 194, C.I. Pigment Red 202, C.I. Pigment Red 206, C.I. Pigment Red 207, C.I. Pigment Red 208, C.I. Pigment Red 209, C.I. Pigment Red 215, C.I. Pigment Red 216, C.I. Pigment Red 220, C.I. Pigment Red 224, C.I. Pigment Red 226, C.I. Pigment Red 242, C.I. Pigment Red 243, C.I. Pigment Red 245, C.I. Pigment Red 254, C.I. Pigment Red 255, C.I. Pigment Red 264 and C.I. Pigment Red 265;

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

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

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

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

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

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

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

Examples of the above surfactant include polyoxyethylene alkyl ethers such as polyoxyethylene lauryl ether, polyoxyethylene stearyl ether and polyoxyethylene

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

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

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

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

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

impaired.

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

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

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

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

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

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

- component (B) -

30 The component (B) in the present invention is an alkali-soluble resin (to be referred to as "(B) alkali-soluble resin" hereinafter) which contains a polyester having an alicyclic hydrocarbon skeleton in the main chain and a polymerizable unsaturated bond in the side chain

(to be referred to as "side chain unsaturated alicyclic polyester" hereinafter), serves as a binder for the colorant (A) and has solubility in an alkali developer used in a developing step for the manufacture of a color filter.

5 Examples of the alicyclic hydrocarbon skeleton in the side chain unsaturated alicyclic polyester include skeletons derived from a hydrocarbon having a 4- to 8-membered carbon ring such as cyclopentane, methylcyclopentane, ethylcyclopentane, n-propylcyclopentane,
 10 i-propylcyclopentane, 1-methyl-3-i-propylcyclopentane, cyclopentene, cyclohexane, methylcyclohexane, ethylcyclohexane, n-propylcyclohexane, i-propylcyclohexane, 1-methyl-3-i-propylcyclohexane, 1-methyl-4-i-propylcyclohexane, cyclohexene, cycloheptane,
 15 methylcycloheptane, ethylcycloheptane, n-propylcycloheptane, i-propylcycloheptane, 1-methyl-3-i-propylcycloheptane, 1-methyl-4-i-propylcycloheptane, cycloheptene, cyclooctane and cyclooctene.

20 Out of these alicyclic hydrocarbon skeletons, skeletons having a cyclohexane ring are preferred, and skeletons derived from 1-methyl-3-i-propylcyclohexane and 1-methyl-4-i-propylcyclohexane are particularly preferred.

25 In the side chain unsaturated alicyclic polyester, the alicyclic hydrocarbon skeleton can form a main chain ester structure for interconnecting the structural units of the polyester directly or through a divalent bond group.

30 Examples of the above divalent bond group include methylene group and linear or branched alkylene groups having 1 to 6 main chain carbon atoms such as methylene group, ethylene group, propylene group, trimethylene group and tetrabutylene group; cycloalkylene groups having a 4- to 8-membered carbon ring such as cyclobutylene group, cyclopentylene group and cyclohexylene group; groups having

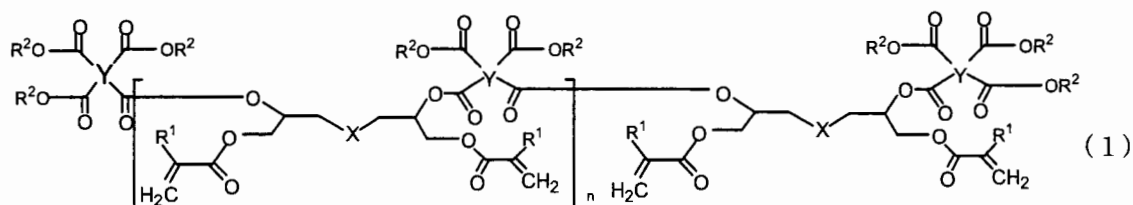
a divalent hydrocarbon chain with 1 to 6 main chain carbon atoms such as methylene group, ethylene group or propylene group bonded to a cycloalkylene group having a 4- to 8-membered carbon ring, such as cyclopentylene methylene group, cyclopentylene ethylene group, cyclopentylene propylene group, cyclohexylene methylene group, cyclohexylene ethylene group and cyclohexylene propylene group; arylene groups having 6 to 10 carbon atoms such as 1,3-phenylene group, 1,4-phenylene group and 1,4-naphthylene group; groups having a divalent hydrocarbon chain with 1 to 6 main chain carbon atoms such as methylene group, ethylene group or propylene group bonded to the above arylene group having 6 to 10 carbon atoms; aryleneoxy groups having 6 to 10 carbon atoms such as m-phenyleneoxy group (-m-C₆H₄-O-) or p-phenyleneoxy group (-p-C₆H₄-O-); and groups having a divalent hydrocarbon chain with 1 to 6 main chain carbon atoms such as methylene group, ethylene group or propylene group bonded to an oxy group in the above aryleneoxy group.

Out of these divalent bond groups, aryleneoxy groups having 6 to 10 carbon atoms are preferred, and a p-phenyleneoxy group is particularly preferred.

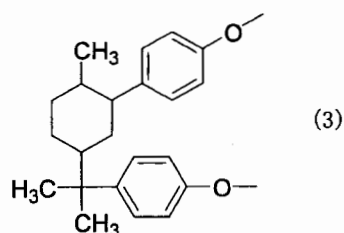
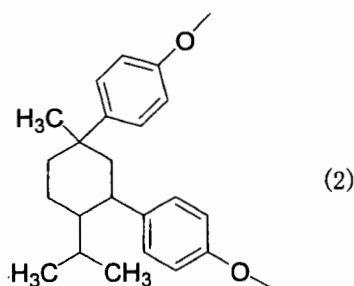
The polymerizable unsaturated bond in the side chain of the side chain unsaturated alicyclic polyester is not particularly limited as long as it can be copolymerized with the polyfunctional monomer (C) and an optional monofunctional monomer which will be described hereinafter when the radiation sensitive composition for forming a colored layer is to be obtained. However, it is preferably an unsaturated bond derived from a polymerizable unsaturated carboxylic acid such as (meth)acrylic acid, crotonic acid, maleic acid, fumaric acid or itaconic acid, particularly preferably an unsaturated bond derived from (meth)acrylic acid from the viewpoint of the ease of synthesizing the side

chain unsaturated alicyclic polyester.

The side chain unsaturated alicyclic polyester in the present invention is particularly preferably a polyester represented by the following formula (1) (to be referred to as "polyester (1)" hereinafter).



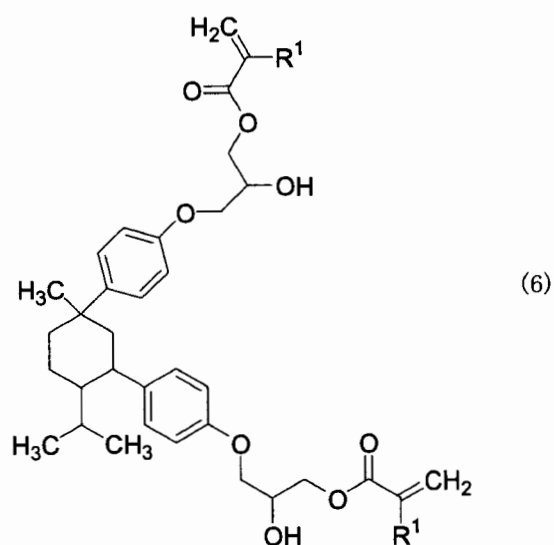
[In the formula (1), X's are each independently a divalent group represented by the following formula (2) or (3), Y's are each independently the residue obtained by excluding four carboxyl groups from an organic tetracarboxylic acid, R¹'s are each independently a hydrogen atom or methyl group, R²'s are each independently a hydrogen atom or the residue of a carboxyl group capping agent, and n is an integer of 1 to 40.]



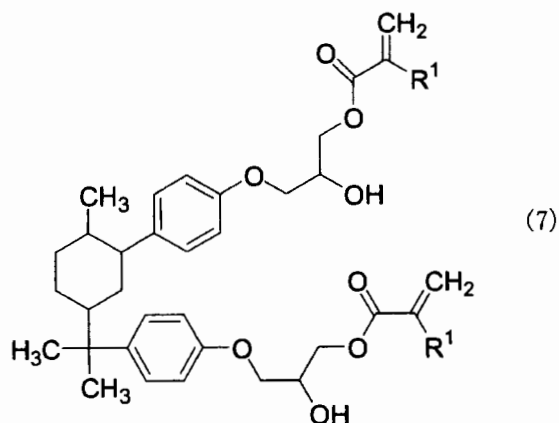
The side chain unsaturated alicyclic polyester can be manufactured by synthesizing a diol compound having an alicyclic hydrocarbon skeleton in the main chain and a

polymerizable unsaturated bond in the side chain and carrying out an esterification reaction between the diol compound and an acid anhydride having 2 or more carboxyl groups, preferably 2 to 4 carboxyl groups, particularly preferably a tetracarboxylic anhydride.

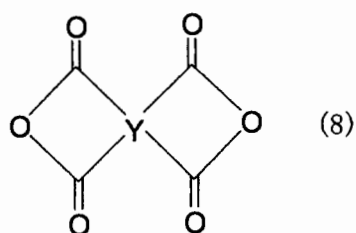
The polyester (1) can be manufactured from an esterification reaction between a di(meth)acryloyl group-containing diol compound represented by the following formula (6) or (7) and a tetracarboxylic dianhydride (to be referred to as "tetracarboxylic dianhydride (8)" represented by the following formula (8)).



[In the formula (6), R^1 is as defined in the formula (1).]



[In the formula (7), R^1 is as defined in the formula (1).]

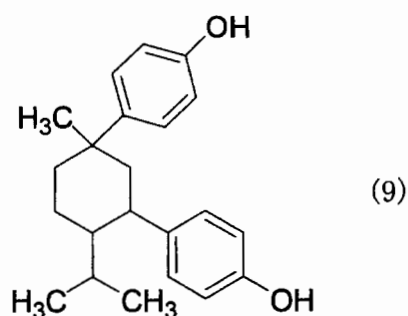


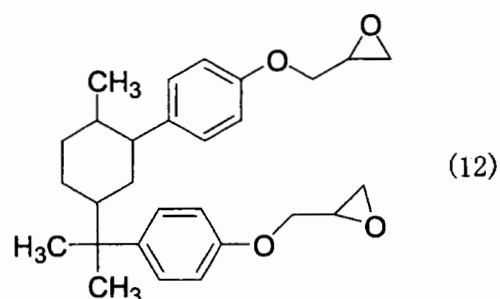
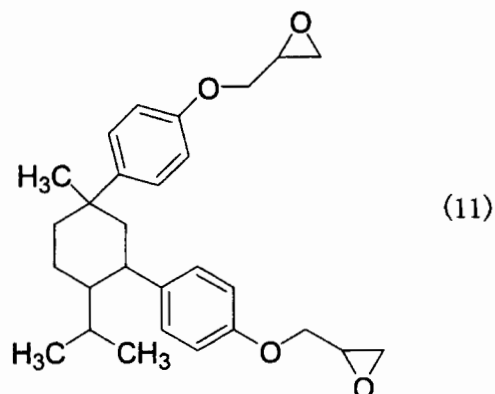
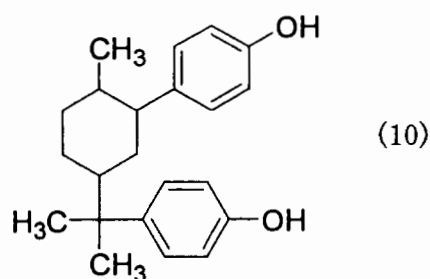
[In the formula (8), Y is as defined in the above formula (1).]

The process of manufacturing the side chain
 5 unsaturated alicyclic polyester will be described
 hereinunder mainly in the case of the polyester (1).

The di(meth)acryloyl group-containing diol compound
 can be manufactured by diglycidyl etherifying a diphenol
 represented by the following formula (9) (to be referred to
 10 as "diphenol (9)" hereinafter) and/or a diphenol represented
 by the following formula (10) (to be referred to as "diphenol
 (10)" hereinafter) to synthesize a diglycidyl etherified
 product represented by the following formula (11) or (12)
 and addition reacting acrylic acid and/or methacrylic acid
 15 with an epoxy group at both terminals of the diglycidyl
 etherified product.

Preferably, the di(meth)acryloyl group-containing
 diol compound obtained as described above has an acid value
 of less than 10 mgKOH/g and an epoxy equivalent of 10,000
 20 to 20,000.





5 To synthesize the di(meth)acryloyl group-containing diol compound, the diphenol (9) and the diphenol (10) are desirably used in combination in a weight ratio of preferably 80 to 60:20 to 40 though diphenols may be used alone or in combination of two or more.

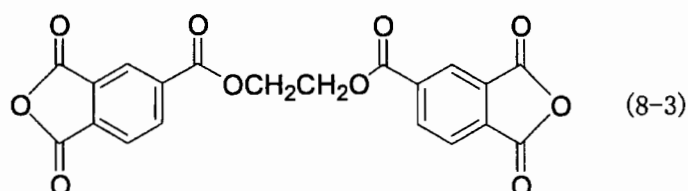
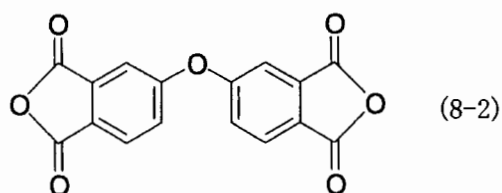
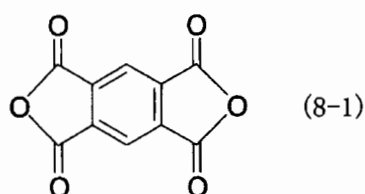
10 The diglycidyl etherification reaction between the diphenols for the synthesis of the di(meth)acryloyl group-containing diol compound may be carried out in accordance with the general method of synthesizing an epoxy resin. For example, the di(meth)acryloyl group-containing

15 diol compound can be synthesized by reacting the diphenols with epichlorohydrin in the presence of a basic catalyst.

The diglycidyl etherified product obtained as

described above preferably has an epoxy equivalent of 260 to 300.

The tetracarboxylic dianhydride (8) is not particularly limited but preferably a compound represented by the following formula (8-1), a compound represented by the following formula (8-2) or a compound represented by the following formula (8-3).



The method of carrying out an esterification reaction between the di(meth)acryloyl group-containing diol compound and the tetracarboxylic dianhydride (8) for the manufacture of the polyester (1) is not particularly limited. For example, the polyester (1) can be manufactured by dissolving the di(meth)acryloyl group-containing diol compound in an organic solvent under heating, adding the tetracarboxylic dianhydride (8) to the resulting solution and reacting them with each other under agitation.

In the polyester (1) obtained by the above esterification reaction, R^2 's in the formula (1) are all hydrogen atoms and the residue of the tetracarboxylic dianhydride (8) has two or three carboxyl groups, whereby

the polyester (1) exhibits excellent solubility in an alkali aqueous solution.

In the present invention, at least some of free carboxyl groups in the polyester (1) obtained by the esterification reaction can be capped with a carboxyl group capping agent before use. By changing the ratio of the capped carboxyl groups, the acid value of the polyester (1) is adjusted to control alkali solubility.

The above carboxyl group capping agent is not particularly limited and a known capping agent such as a glycidyl ether or carbodiimide may be used. For example, phenyl glycidyl ether, 4-n-butylphenyl glycidyl ether and resorcin glycidyl ether are preferred.

In the present invention, the acid value of the polyester (1) is preferably 20 to 80 mgKOH/g, more preferably 30 to 70 mgKOH/g. Depending on the type of the tetracarboxylic dianhydride (8), it is desired that preferably 50 mol% or more, more preferably 70 mol% or more of the total of all R²'s in the polyester (1) should consist of a hydrogen atom to ensure high alkali developability.

The epoxy equivalent of the polyester (1) after capping with the carboxyl group capping agent is preferably 60,000 or more.

Since the polyester (1) has a plurality of acryloyl groups or methacryloyl groups having polymerizability, it is cured by exposure to become hardly dissolved in an alkali aqueous solution. Meanwhile, since it is soluble in an alkali aqueous solution when it is not cured, it is partially exposed as a resist film to leave a cured portion, and an uncured portion exhibits alkali developability that it can be dissolved in an alkali aqueous solution and removed. The polyester (1) has high adhesion to various substrates, small cure shrinkage and excellent heat resistance with a high glass transition point (T_g) and can form a resist film having

high hardness. Further, as the alicyclic hydrocarbon skeleton contained in the molecular main chain forms a relatively soft structure, the polyester (1) has high flexibility.

5 In the present invention, the weight average molecular weight in terms of polystyrene (to be referred to as "Mw" hereinafter) measured by gel permeation chromatography (GPC) (eluting solvent: tetrahydrofuran) of the side chain unsaturated alicyclic polyester is preferably 3,000 to
10 100,000, more preferably 5,000 to 25,000. When Mw falls below the above range, flexibility or adhesion may lower and when Mw exceeds the above range, photocurability or alkali solubility in an uncured state may lower. Mw can be adjusted by changing the amounts of the organic solvent and the
15 reaction raw materials in the above esterification reaction in the case of the polyester (1).

 The number average molecular weight in terms of polystyrene (to be referred to as "Mn" hereinafter) measured by gel permeation chromatography (GPC) (eluting solvent:
20 tetrahydrofuran) of the side chain unsaturated alicyclic polyester is preferably 1,000 to 60,000, more preferably 2,000 to 25,000.

 The side chain unsaturated alicyclic polyester preferably has an acid value of 60 to 70 mgKOH/g in order
25 to ensure high alkali solubility in an uncured state.

 In the present invention, side chain unsaturated alicyclic polyesters may be used alone or in combination of two or more.

 In the present invention, another alkali-soluble resin
30 may be used in conjunction with the side chain unsaturated alicyclic polyester as an alkali-soluble resin.

 The another alkali-soluble resin is, for example, a copolymer of a polymerizable unsaturated monomer having an acid functional group such as carboxyl group, phenolic

hydroxyl group or sulfonic acid group and another copolymerizable unsaturated monomer different from the above monomer (to be referred to as "copolymerizable unsaturated monomer" hereinafter).

- 5 Examples of the polymerizable unsaturated monomer having a carboxyl group (to be referred to as "carboxyl group-containing unsaturated monomer" hereinafter) include unsaturated monocarboxylic acids such as (meth)acrylic acid, crotonic acid, α -chloroacrylic acid and cinnamic acid;
- 10 unsaturated dicarboxylic acids and anhydrides thereof such as maleic acid, maleic anhydride, fumaric acid, itaconic acid, itaconic anhydride, citraconic acid, citraconic anhydride and mesaconic acid; unsaturated polycarboxylic acids having three or more carboxyl groups and anhydrides thereof;
- 15 mono[(meth)acryloyloxyalkyl]esters of a polycarboxylic acid having two or more carboxyl groups such as mono[2-(meth)acryloyloxyethyl]succinate and mono[2-(meth)acryloyloxyethyl]phthalate; and
- 20 mono(meth)acrylates of a polymer having a carboxyl group and a hydroxyl group at both terminals such as ω -carboxypolycaprolactone mono(meth)acrylate.

The above carboxyl group-containing unsaturated monomers may be used alone or in combination of two or more.

- Examples of the above polymerizable unsaturated
- 25 monomer having a phenolic hydroxyl group include o-hydroxystyrene, m-hydroxystyrene, p-hydroxystyrene, o-hydroxy- α -methylstyrene, m-hydroxy- α -methylstyrene, p-hydroxy- α -methylstyrene, N-o-hydroxyphenylmaleimide, N-m-hydroxyphenylmaleimide and
- 30 N-p-hydroxyphenylmaleimide.

These polymerizable unsaturated monomers having a phenolic hydroxyl group may be used alone or in combination of two or more.

Examples of the polymerizable unsaturated monomer

having a sulfonic acid group include isoprenesulfonic acid and p-styrenesulfonic acid.

These polymerizable unsaturated monomer having a sulfonic acid group may be used alone or in combination of
 5 two or more.

Examples of the copolymerizable unsaturated monomer include macromonomers having a mono(meth)acryloyl group at a terminal of a polymer molecular chain (to be simply referred to as "macromonomers" hereinafter) such as polystyrene,
 10 polymethyl (meth)acrylate, poly-n-butyl (meth)acrylate and polysiloxane; N-arylmaleimides such as N-phenylmaleimide, N-o-hydroxyphenylmaleimide, N-m-hydroxyphenylmaleimide, N-p-hydroxyphenylmaleimide, N-o-methylphenylmaleimide, N-m-methylphenylmaleimide, N-p-methylphenylmaleimide,
 15 N-o-methoxyphenylmaleimide, N-m-methoxyphenylmaleimide and N-p-methoxyphenylmaleimide and N-substituted maleimides such as N-cyclohexylmaleimide; aromatic vinyl compounds such as styrene, α -methylstyrene, o-vinyltoluene, m-vinyltoluene, p-vinyltoluene, p-chlorostyrene,
 20 o-methoxystyrene, m-methoxystyrene, p-methoxystyrene, o-vinylbenzylmethyl ether, m-vinylbenzylmethyl ether, p-vinylbenzylmethyl ether, o-vinylbenzylglycidyl ether, m-vinylbenzylglycidyl ether and p-vinylbenzylglycidyl ether; indenenes such as indene and 1-methylindene;
 25 unsaturated carboxylates such as methyl (meth)acrylate, ethyl (meth)acrylate, n-propyl (meth)acrylate, i-propyl (meth)acrylate, n-butyl (meth)acrylate, i-butyl (meth)acrylate, sec-butyl (meth)acrylate, t-butyl (meth)acrylate, 2-hydroxyethyl (meth)acrylate,
 30 2-hydroxypropyl (meth)acrylate, 3-hydroxypropyl (meth)acrylate, 2-hydroxybutyl (meth)acrylate, 3-hydroxybutyl (meth)acrylate, 4-hydroxybutyl (meth)acrylate, allyl (meth)acrylate, benzyl (meth)acrylate, cyclohexyl (meth)acrylate, phenyl

(meth)acrylate, 2-methoxyethyl (meth)acrylate, 2-phenoxyethyl (meth)acrylate, methoxydiethylene glycol (meth)acrylate, methoxytriethylene glycol (meth)acrylate, methoxypropylene glycol (meth)acrylate, methoxydipropylene glycol (meth)acrylate, isobornyl (meth)acrylate, dicyclopentadienyl (meth)acrylate, 2-hydroxy-3-phenoxypropyl (meth)acrylate and glycerol mono(meth)acrylate; unsaturated aminoalkyl carboxylates such as 2-aminoethyl (meth)acrylate, 2-dimethylaminoethyl (meth)acrylate, 2-aminopropyl (meth)acrylate, 2-dimethylaminopropyl (meth)acrylate, 3-aminopropyl (meth)acrylate and 3-dimethylaminopropyl (meth)acrylate; unsaturated glycidyl carboxylates such as glycidyl (meth)acrylate; vinyl carboxylates such as vinyl acetate, vinyl propionate, vinyl butyrate and vinyl benzoate; unsaturated ethers such as vinyl methyl ether, vinyl ethyl ether and allyl glycidyl ether; vinyl cyanide compounds such as (meth)acrylonitrile, α -chloroacrylonitrile and vinylidene cyanide; unsaturated amides such as (meth)acrylamide, α -chloroacrylamide and N-2-hydroxyethyl (meth)acrylamide; and aliphatic conjugated dienes such as 1,3-butadiene, isoprene and chloroprene.

In the present invention, the above another alkali-soluble resin is preferably a copolymer (to be simply referred to as "carboxyl group-containing copolymer" hereinafter) of a carboxyl group-containing unsaturated monomer and a copolymerizable unsaturated monomer, more preferably a copolymer of a monomer mixture of (a) a carboxyl group-containing unsaturated monomer containing (meth)acrylic acid and (b) at least one selected from the group consisting of polystyrene macromonomer, polymethyl (meth)acrylate macromonomer, N-phenylmaleimide, N-cyclohexylmaleimide, 2-hydroxyethyl (meth)acrylate, benzyl (meth)acrylate and glycerol (meth)acrylate and

optionally (c) at least one selected from the group consisting of styrene, α -methylstyrene, methyl (meth)acrylate, allyl (meth)acrylate and phenyl (meth)acrylate.

5 Mw of the another alkali-soluble resin is preferably 2,000 to 300,000, more preferably 3,000 to 100,000. Mn is preferably 1,000 to 60,000, more preferably 2,000 to 25,000.

In the present invention, the above alkali-soluble resins may be used alone or in combination of two or more.

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

The amount of the side chain unsaturated alicyclic polyester in the alkali-soluble resin is preferably 10 to 100 wt%, more preferably 20 to 100 wt%. When the amount of
25 the side chain unsaturated alicyclic polyester is smaller than 10 wt%, the intended effect of the present invention may be impaired.

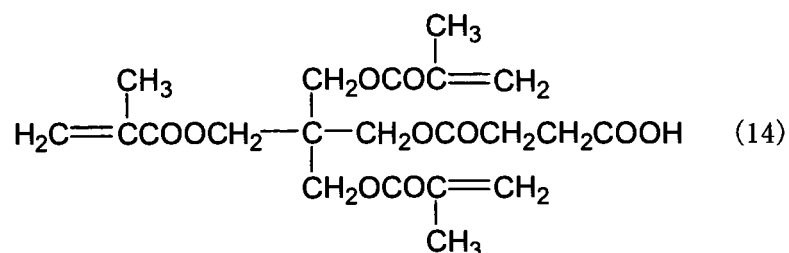
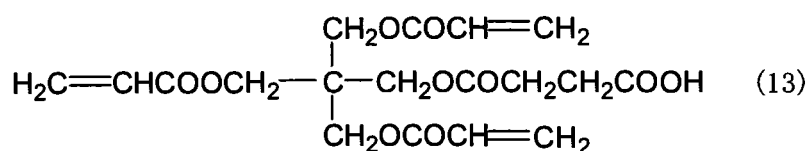
- component (C) -

30 The component (C) in the present invention is a polyfunctional monomer having two or more polymerizable unsaturated bonds in the molecule.

Examples of the polyfunctional monomer include di(meth)acrylates of an alkylene glycol such as ethylene

glycol and propylene glycol; di(meth)acrylates of a polyalkylene glycol such as polyethylene glycol and polypropylene glycol; poly(meth)acrylates of a polyhydric alcohol having 3 or more hydroxyl groups and dicarboxylic acid modified products thereof such as glycerin, trimethylolpropane, pentaerythritol and dipentaerythritol; oligo(meth)acrylates such as polyester, epoxy resin, urethane resin, alkyd resin, silicone resin and spiran resin; di(meth)acrylates of a polymer having a hydroxyl group at both terminals such as poly-1,3-butadiene having a hydroxyl group at both terminals, polyisoprene having a hydroxyl group at both terminals and polycaprolactone having a hydroxyl group at both terminals; and tris[2-(meth)acryloyloxyethyl]phosphate.

Out of these polyfunctional monomers, poly(meth)acrylates of a polyhydric alcohol having 3 or more hydroxyl groups and dicarboxylic acid modified products thereof are preferred, as exemplified by trimethylolpropane triacrylate, trimethylolpropane trimethacrylate, pentaerythritol triacrylate, pentaerythritol trimethacrylate, pentaerythritol tetraacrylate, pentaerythritol tetramethacrylate, dipentaerythritol pentaacrylate, dipentaerythritol pentamethacrylate, dipentaerythritol hexaacrylate, dipentaerythritol hexamethacrylate and compounds represented by the following formulas (13) and (14).



Out of these, trimethylolpropane triacrylate,
pentaerythritol triacrylate and dipentaerythritol

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

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

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

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

25 Examples of the above monofunctional monomer include
the above compounds enumerated for the carboxyl

group-containing unsaturated monomer and the copolymerizable unsaturated monomer in the above another alkali-soluble resin, N-(meth)acryloylmorpholine, N-vinylpyrrolidone, N-vinyl-ε-caprolactam and commercially available M-5600 (trade name of Toagosei Chemical Industry Co., Ltd.).

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

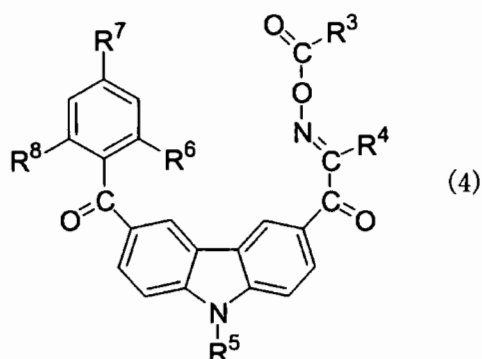
The amount of the monofunctional monomer is preferably 90 wt% or less, more preferably 50 wt% or less based on the total of the polyfunctional monomer and the monofunctional monomer. When the amount of the monofunctional monomer is larger than 90 wt%, the strength and surface smoothness of the obtained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

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

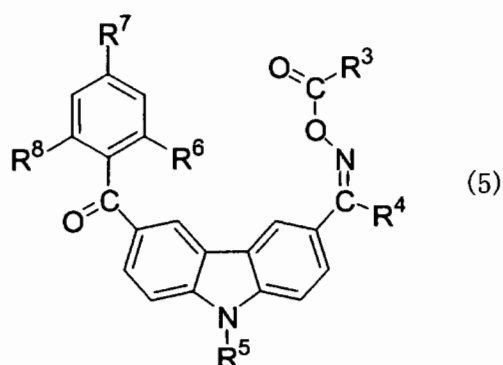
- (D) photoradical generator -

The photoradical generator (D) in the present invention forms a radical capable of initiating the polymerization of the above polyfunctional monomer (C) and the optionally used monofunctional monomer upon exposure to radiation such as visible radiation, ultraviolet radiation, far ultraviolet radiation, charged particle radiation or X-radiation.

The photoradical generator in the present invention is preferably a compound represented by the following formula (4) or (5) (to be referred to as "carbazole-based compound (D1)" hereinafter).



5



(5)

[In the formulas (4) and (5), R³'s are each independently a linear, branched or cyclic alkyl group having 1 to 12 carbon atoms or phenyl group, R⁴'s are each independently a hydrogen atom, linear, branched or cyclic alkyl group having 1 to 12 carbon atoms or phenyl group, R⁵'s are each independently a hydrogen atom or linear, branched or cyclic alkyl group having 1 to 12 carbon atoms, and R⁶'s, R⁷'s and R⁸'s are each independently a hydrogen atom or linear, branched or cyclic alkyl group having 1 to 6 carbon atoms, with the proviso that the alkyl group represented by R³, R⁴, R⁵, R⁶, R⁷ and R⁸ may be substituted by a substituent selected from the group consisting of a linear, branched or cyclic alkoxy group having 1 to 6 carbon atoms, phenyl group and halogen atom, and the phenyl group represented by R³ and R⁴ may be substituted by a substituent selected from the group

consisting of a linear, branched or cyclic alkyl group having 1 to 6 carbon atoms, linear, branched or cyclic alkoxy group having 1 to 6 carbon atoms, phenyl group and halogen atom.]

Examples of the linear, branched or cyclic alkyl group having 1 to 12 carbon atoms represented by R^3 , R^4 and R^5 in the formulas (4) and (5) include methyl group, ethyl group, n-propyl group, i-propyl group, n-butyl group, i-butyl group, sec-butyl group, t-butyl group, n-pentyl group, n-hexyl group, n-heptyl group, n-octyl group, n-nonyl group, n-decyl group, n-undecyl group, n-dodecyl group, cyclopentyl group and cyclohexyl group.

Examples of the linear, branched or cyclic alkyl group having 1 to 6 carbon atoms represented by R^6 , R^7 and R^8 include methyl group, ethyl group, n-propyl group, i-propyl group, n-butyl group, i-butyl group, sec-butyl group, t-butyl group, n-pentyl group, n-hexyl group, cyclopentyl group and cyclohexyl group.

Examples of the linear, branched or cyclic alkoxy group having 1 to 6 carbon atoms out of the substituents for the alkyl group represented by R^3 , R^4 , R^5 , R^6 , R^7 and R^8 and the substituents for the phenyl group represented by R^3 and R^4 include methoxy group, ethoxy group, n-propoxy group, i-propoxy group, n-butoxy group and t-butoxy group.

Examples of the halogen atom include fluorine atom and chlorine atom.

Examples of the linear, branched or cyclic alkyl group having 1 to 6 carbon atoms out of the substituents for the phenyl group represented by R^3 and R^4 include methyl group, ethyl group, n-propyl group, i-propyl group, n-butyl group and t-butyl group. One or more of these substituents of the same kind or different kinds may be existent in the alkyl group and the phenyl group.

In the formulas (4) and (5), R^3 is preferably a methyl group, ethyl group, n-propyl group, i-propyl group, n-butyl

group or phenyl group, R⁴ is preferably a hydrogen atom, methyl group, ethyl group, n-propyl group, i-propyl group, n-butyl group, n-pentyl group, n-hexyl group, n-heptyl group or n-octyl group, R⁵ is preferably a hydrogen atom, methyl
 5 group, ethyl group, n-propyl group, i-propyl group or n-butyl group, and R⁶, R⁷ and R⁸ are each preferably a hydrogen atom, methyl group, ethyl group, n-propyl group, i-propyl group or n-butyl group.

Preferred examples of the carbazole-based compound
 10 (D1) in the present invention include

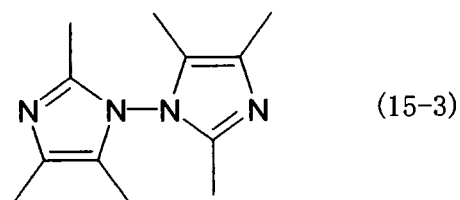
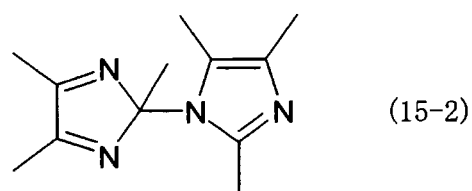
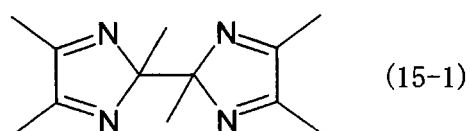
1-[9-ethyl-6-benzoyl-9.H.-carbazol-3-yl]-nonane-1,2-
 nonane-2-oxime-O-benzoate,
 1-[9-ethyl-6-benzoyl-9.H.-carbazol-3-yl]-nonane-1,2-
 nonane-2-oxime-O-acetate,
 15 1-[9-ethyl-6-benzoyl-9.H.-carbazol-3-yl]-pentane-1,2-
 pentane-2-oxime-O-acetate,
 1-[9-ethyl-6-benzoyl-9.H.-carbazol-3-yl]-octan-1-
 oneoxime-O-acetate,
 1-[9-ethyl-6-(2-methylbenzoyl)-9.H.-carbazol-3-yl]-
 20 ethan-1-oneoxime-O-benzoate,
 1-[9-ethyl-6-(2-methylbenzoyl)-9.H.-carbazol-3-yl]-
 ethan-1-oneoxime-O-acetate,
 1-[9-ethyl-6-(1,3,5-trimethylbenzoyl)-9.H.-carbazol-3-
 yl]-ethan-1-oneoxime-O-benzoate and
 25 1-[9-n-butyl-6-(2-ethylbenzoyl)-9.H.-carbazol-3-yl]-
 ethan-1-oneoxime-O-benzoate.

Out of these carbazole-based compounds (D1),
 1-[9-ethyl-6-(2-methylbenzoyl)-9.H.-carbazol-3-yl]-
 ethan-1-oneoxime-O-acetate is particularly preferred.

30 In the present invention, the carbazole-based
 compounds (D1) may be used alone or in combination of two
 or more.

In the present invention, a photoradical generator
 other than the carbazole-based compound (D1) (to be referred

to as "another photoradical generator" hereinafter) may be used. The another photoradical generator is, for example, a biimidazole-based compound, benzoin-based compound, acetophenone-based compound, benzophenone-based compound,
 5 α -diketone-based compound, polynuclear quinone-based compound, xanthone-based compound, phosphine-based compound or triazine-based compound having at least one main skeleton represented by the following formula (15-1), (15-2) or (15-3).



10

Examples of the above biimidazole-based compound include 2,2'-bis(2-chlorophenyl)-4,4',5,5'-tetrakis(4-ethoxycarbonylphenyl)-1,2'-biimidazole,
 15 2,2'-bis(2-bromophenyl)-4,4',5,5'-tetrakis(4-ethoxycarbonylphenyl)-1,2'-biimidazole,
 2,2'-bis(2-chlorophenyl)-4,4',5,5'-tetraphenyl-1,2'-biimidazole,
 2,2'-bis(2,4-dichlorophenyl)-4,4',5,5'-tetraphenyl-1,2'-
 20 biimidazole,
 2,2'-bis(2,4,6-trichlorophenyl)-4,4',5,5'-tetraphenyl-1,2'-biimidazole,
 2,2'-bis(2-bromophenyl)-4,4',5,5'-tetraphenyl-1,2'-

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

Out of these biimidazole-based compounds,
2,2'-bis(2-chlorophenyl)-4,4',5,5'-tetraphenyl-1,2'-
biimidazole,
2,2'-bis(2,4-dichlorophenyl)-4,4',5,5'-tetraphenyl-
10 1,2'-biimidazole and
2,2'-bis(2,4,6-trichlorophenyl)-4,4',5,5'-tetraphenyl-
1,2'-biimidazole are preferred, and
2,2'-bis(2-chlorophenyl)-4,4',5,5'-tetraphenyl-1,2'-
biimidazole is particularly preferred.

15

- hydrogen donor -

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

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

The hydrogen donor is preferably a mercaptan-based
25 compound defined hereinbelow or an amine-based compound
defined hereinbelow.

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

The above amine-based compound is a compound having
a benzene ring or a hetero ring as a mother nucleus and 1

or more, preferably 1 to 3, more preferably 1 or 2 amino groups directly bonded to the mother nucleus (to be referred to as "amine-based hydrogen donor" hereinafter).

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

A detailed description is subsequently given of the hydrogen donor.

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

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

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

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

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

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

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

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

Out of these amine-based hydrogen donors, 4,4'-bis(dimethylamino)benzophenone and 4,4'-bis(diethylamino)benzophenone are preferred, and 4,4'-bis(diethylamino)benzophenone is particularly preferred. 4,4'-bis(dimethylamino)benzophenone and 4,4'-bis(diethylamino)benzophenone can be used alone as a photoradical generator even when the biimidazole-based compound is not existent.

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

Preferred examples of the combination of the mercaptan-based hydrogen donor and the amine-based hydrogen

donor include a combination of 2-mercaptobenzothiazole and 4,4'-bis(dimethylamino)benzophenone, combination of 2-mercaptobenzothiazole and 4,4'-bis(diethylamino)benzophenone, combination of 2-mercaptobenzoxazole and 4,4'-bis(dimethylamino)benzophenone, and combination of 2-mercaptobenzoxazole and 4,4'-bis(diethylamino)benzophenone. A combination of 2-mercaptobenzothiazole and 4,4'-bis(diethylamino)benzophenone and a combination of 2-mercaptobenzoxazole and 4,4'-bis(diethylamino)benzophenone are more preferred, and a combination of 2-mercaptobenzothiazole and 4,4'-bis(diethylamino)benzophenone is particularly preferred.

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

Examples of the above benzoin-based compound as the photoradical generator include benzoin, benzoin methyl ether, benzoin ethyl ether, benzoin isopropyl ether, benzoin isobutyl ether and methyl 2-benzoylbenzoate.

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

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

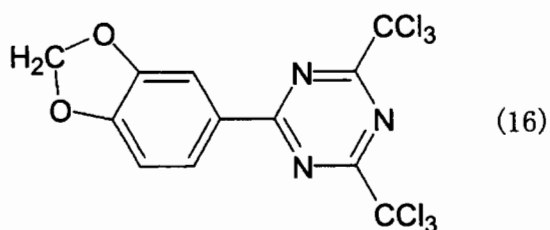
5 Examples of the above α -diketone-based compound include diacetyl, dibenzoyl and methyl benzoyl formate.

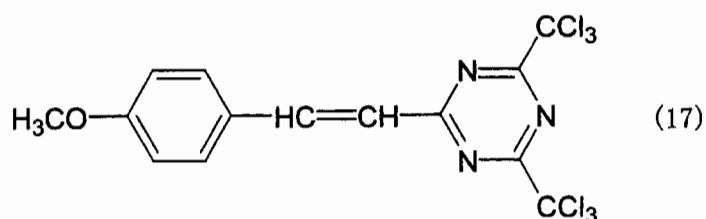
Examples of the above polynuclear quinone-based compound include anthraquinone, 2-ethylantraquinone, 2-t-butylantraquinone and 1,4-naphthoquinone.

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

Examples of the above phosphine-based compound include bis(2,4,6-trimethylbenzoyl)phenylphosphine oxide and 2,4,6-trimethylbenzoyldiphenylphosphine oxide.

15 Examples of the above triazine-based 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-yl)ethenyl]-4,6-bis(trichloromethyl)-s-triazine, 2-[2-(5-methylfuran-2-yl)ethenyl]-4,6-
20 bis(trichloromethyl)-s-triazine, 2-[2-(4-diethylamino-2-methylphenyl)ethenyl]-4,6-bis(trichloromethyl)-s-triazine, 2-[2-(3,4-dimethoxyphenyl)ethenyl]-4,6-bis(trichloromethyl)-s-triazine,
25 2-(4-methoxyphenyl)-4,6-bis(trichloromethyl)-s-triazine, 2-(4-ethoxystyryl)-4,6-bis(trichloromethyl)-s-triazine, 2-(4-n-butoxyphenyl)-4,6-bis(trichloromethyl)-s-triazine, and compounds represented by the following formulas (16) and (17).





In the present invention, the photoradical generators may be used alone or in combination of two or more.

5 In the present invention, the above photoradical generator may be used in conjunction with at least one of a sensitizer, a curing accelerator and a polymer photocrosslinking/sensitizing agent as required.

The amount of the photoradical generator in the present
 10 invention is preferably 0.01 to 200 parts by weight, more preferably 1 to 120 parts by weight, particularly preferably 1 to 100 parts by weight based on 100 parts by weight of the polyfunctional monomer (C) or the total of the polyfunctional monomer and the monofunctional monomer. When the amount of
 15 the photoradical generator is smaller than 0.01 part by weight, it may be difficult to obtain a pattern array having a predetermined pixel pattern or black matrix pattern due to incomplete curing by exposure. When the amount is larger than 200 parts by weight, the formed colored layer may fall
 20 off from the substrate during development and a stain or the film residue may be produced on the substrate or light screening layer of an unexposed portion.

When the carbazole-based compound (D1) and another photoradical generator are used in combination as the
 25 photoradical generator in the present invention, the amount of the another photoradical generator is preferably 50 wt% or less, more preferably 30 wt% or less based on the total of the carbazole-based compound (D1) and the another photoradical generator.

- additives -

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

5 The above additives include an organic acid or an organic amino compound (excluding the above hydrogen donor) which serves to further improve the solubility in an alkali developer of the radiation sensitive composition and further suppress the production of the residual undissolved product
10 after development.

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

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

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

Examples of the phenyl group-containing carboxylic acid include aromatic monocarboxylic acids such as benzoic acid, toluic acid, cuminic acid, hemellitic acid and

mesitylenic acid; aromatic dicarboxylic acids such as phthalic acid, isophthalic acid and terephthalic acid; aromatic polycarboxylic acids having 3 or more carboxyl groups such as trimellitic acid, trimesic acid, mellophanic acid and pyromellitic acid; and phenylacetic acid, hydroatropic acid, hydrocinnamic acid, mandelic acid, phenylsuccinic acid, atropic acid, cinnamic acid, cinnamylidenic acid, coumaric acid and umbellic acid.

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

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

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

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

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

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

2-dimethylamino-1,3-propanediol and
 2-diethylamino-1,3-propanediol; amino group-containing
 cycloalkane methanols such as 1-aminocyclopentane methanol,
 4-aminocyclopentane methanol, 1-aminocyclohexane methanol,
 5 4-aminocyclohexane methanol, 4-dimethylaminocyclopentane
 methanol, 4-diethylaminocyclopentane methanol,
 4-dimethylaminocyclohexane methanol and
 4-diethylaminocyclohexane methanol; and aminocarboxylic
 acids such as β -alanine, 2-aminobutyric acid, 3-aminobutyric
 10 acid, 4-aminobutyric acid, 2-aminoisobutyric acid,
 3-aminoisobutyric acid, 2-aminovaleric acid,
 5-aminovaleric acid, 6-aminocaproic acid,
 1-aminocyclopropanecarboxylic acid,
 1-aminocyclohexanecarboxylic acid and
 15 4-aminocyclohexanecarboxylic acid.

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

20 Examples of the phenyl group-containing amine include
 aromatic amines such as aniline, 2-methylaniline,
 3-methylaniline, 4-methylaniline, 4-ethylaniline,
 4-n-propylaniline, 4-i-propylaniline, 4-n-butyylaniline,
 4-t-butyylaniline, 1-naphthylamine, 2-naphthylamine,
 25 N,N-dimethylaniline, N,N-diethylaniline and
 4-methyl-N,N-dimethylaniline; aminobenzyl alcohols such as
 2-aminobenzyl alcohol, 3-aminobenzyl alcohol,
 4-aminobenzyl alcohol, 4-dimethylaminobenzyl alcohol and
 4-diethylaminobenzyl alcohol; and aminophenols such as
 30 2-aminophenol, 3-aminophenol, 4-aminophenol,
 4-dimethylaminophenol and 4-diethylaminophenol.

Out of these organic amino compounds,
 mono(cyclo)alkanolamines and amino(cyclo)alkanediols are
 preferred, and 2-aminoethanol, 3-amino-1-propanol,

5-amino-1-pentanol, 3-amino-1,2-propanediol, 2-amino-1,3-propanediol and 4-amino-1,2-butanediol are particularly preferred as the aliphatic amine from the viewpoints of solubility in a solvent which will be described hereinafter and the prevention of a stain or the film residue on the substrate or light screening layer of an unexposed portion. Aminophenols are preferred, and 2-aminophenol, 3-aminophenol and 4-aminophenol are particularly preferred as the phenyl group-containing amine.

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

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

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

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

10 Solvent

The radiation sensitive composition for forming a colored layer of the present invention comprises the above components (A) to (D) as essential ingredients and optionally the above additives and is generally mixed with a solvent to be prepared as a liquid composition.

A suitable solvent may be selected and used as far as it disperses or dissolves the components (A) to (D) and additives constituting the radiation sensitive composition, does not react with these components and has suitable volatility.

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

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

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

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

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

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

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

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

Color filter

The color filter of the present invention comprises a colored layer made of the radiation sensitive composition for forming a colored layer of the present invention.

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

A light screening layer is optionally formed on the surface of a substrate to define a portion for forming pixels thereon, and a liquid radiation sensitive composition

comprising, for example, a red pigment dispersed therein is applied to the substrate and prebaked to vaporize the solvent so as to form a coating film. This coating film is then exposed to radiation through a photomask, developed with an alkali developer to dissolve and remove an unexposed portion of the coating film and post-baked to form a pixel array having a predetermined red pixel pattern.

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

The black matrix can be formed likewise by using a radiation sensitive composition for forming a colored layer comprising a black pigment dispersed therein.

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

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

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

The thickness of the coating film after drying is preferably 0.1 to 10 μm , more preferably 0.2 to 8.0 μm , particularly preferably 0.2 to 6.0 μm .

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

The dose of the radiation is preferably 10 to 10,000 J/m².

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

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

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

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

Color liquid crystal display device

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

As an example of the color liquid crystal display device of the present invention, a color liquid crystal display device having excellent characteristic properties can be manufactured by using the radiation sensitive composition

for forming a colored layer of the present invention to form pixels and/or a black matrix on a thin film transistor substrate array as described above.

The radiation sensitive composition for forming a colored layer of the present invention comprises the above components (A) to (D) as essential ingredients.

Particularly preferred examples (i) to (iv) of the composition are given below.

(i) a radiation sensitive composition for forming a colored layer comprising a polyester (1) obtained from an esterification reaction between a di(meth)acryloyl group-containing diol compound and a tetracarboxylic dianhydride (8) and having an Mw of 3,000 to 100,000 as the alkali-soluble resin (B)

(ii) the radiation sensitive composition for forming a colored layer (i) comprising at least one selected from the group consisting of trimethylolpropane triacrylate, pentaerythritol triacrylate and dipentaerythritol hexaacrylate as the polyfunctional monomer (C)

(iii) the radiation sensitive composition for forming a colored layer (i) or (ii) comprising 1-[9-ethyl-6-(2-methylbenzoyl)-9H.-carbazol-3-yl]-ethan-1-oneoxime-O-acetate as the carbazole-based compound (D1) which is the photoradical generator (D)

(iv) the radiation sensitive composition for forming a colored layer (i), (ii) or (iii) comprising an organic pigment and/or carbon black as the colorant (A)

The preferred color filter (v) of the present invention has pixels and/or a black matrix made of the radiation sensitive composition for forming a colored layer (i), (ii), (iii) or (iv).

The preferred color liquid crystal display device (vi) of the present invention comprises the above color filter (v), and the more preferred liquid crystal display device

(vii) of the present invention comprises the above color filter (v) on a thin film transistor substrate array.

As described above, even when the radiation sensitive composition for forming a colored layer of the present invention comprises a pigment in a high concentration, an excellent pixel pattern and black matrix pattern without a missing part of the pattern edge or an undercut can be formed with a small amount of exposure without leaving an undissolved product on the substrate or light screening layer of an unexposed portion during development and producing scum at the edges of the pixel pattern and the black matrix pattern.

Further, the pixels and black matrix made of the radiation sensitive composition for forming a colored layer of the present invention have high surface smoothness and excellent adhesion to the substrate.

Therefore, the radiation sensitive composition for forming a colored layer of the present invention can be extremely advantageously used in the manufacture of various types of color filters including a color filter for color liquid crystal display devices in the field of the electronic industry.

Examples

The following examples are provided for the purpose of further illustrating the present invention but are in no way to be taken as limiting. "Parts" as used herein means parts by weight.

<manufacture of alkali-soluble resin>

Synthesis Example 1 (synthesis of diglycidyl etherified product of diphenol)

1,070 g of a mixture of diphenol (9) and diphenol (10) in a weight ratio of 70:30 (trade name:YP-90 manufactured by Yasuhara Chemical Co., Ltd.), 1,520 g of epichlorohidrin and 1,700 g of dimethyl sulfoxide were charged into a flask

equipped with a cooling tube and a stirrer and heated at 50°C under agitation to be dissolved, and 290 g of caustic soda was added to carry out a reaction at 65 to 90°C for 10 hours. The proceeding and end of the reaction were confirmed by measuring the epoxy equivalent. After the epoxy equivalent reached a target value, the solvent was distilled off under reduced pressure at 90 to 100°C. Thereafter, the reaction product was dissolved in toluene at 50 to 70°C again, distilled water was added to rinse the reaction product with water, standing separation was carried out, and then the solvent was removed from the organic layer under reduced pressure to obtain 1,260 g of the reaction product. The obtained reaction product had an epoxy equivalent of 260.

When the ^1H -NMR spectrum (solvent: CDCl_3 , based on tetramethylsilane, the same shall apply hereinafter) of the reaction product was measured, a peak was observed at chemical shifts δ (ppm) of 6.8 to 7.3 (derived from a benzene ring bonded to a cyclohexane skeleton; 8H), 3.3 and 3.9 to 4.2 (derived from an epoxy group; 6H) and 0.7 to 0.9 (derived from two methyl groups in an i-propyl group bonded to a cyclohexyl skeleton).

When the infrared absorption spectrum (IR) was measured, an absorption was observed at $1,241\text{ cm}^{-1}$ (derived from an aromatic ether structure and an epoxy group), and $1,036\text{ cm}^{-1}$ and 828 cm^{-1} (derived from an aromatic ether structure).

It was confirmed from the above results that this reaction product was a mixture of a diglycidyl etherified product represented by the above formula (11) and a diglycidyl etherified product represented by the above formula (12).

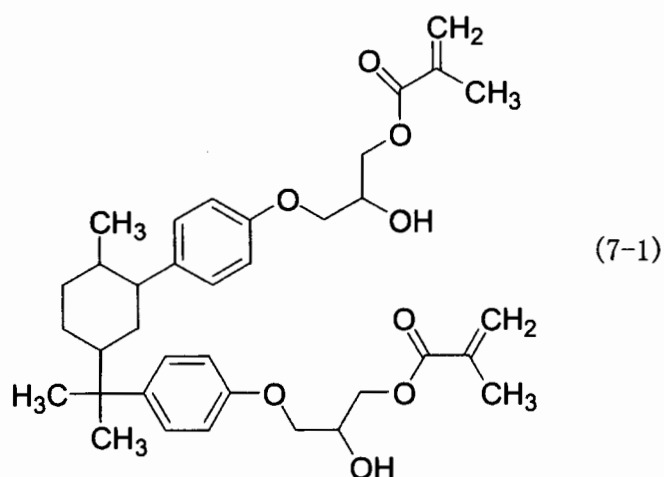
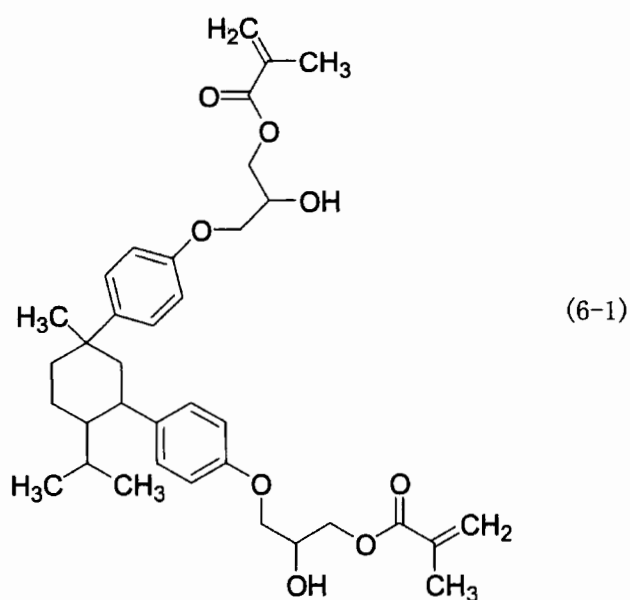
Synthesis Example 2 (synthesis of dimethacryloyl group-containing diol compound)

1,000 g of the mixture of diglycidyl etherified products obtained in Synthesis Example 1, 350 g of methacrylic acid and 1.0 g of hydroquinone monomethyl ether were charged into a flask equipped with a cooling tube and a stirrer and heated at 60°C under agitation to be dissolved, and 8 g of tetraethylammonium bromide was added to carry out a reaction at 70 to 90°C under agitation until the acid value and the epoxy equivalent of the reaction product became 8 mgKOH/g and 17,000, respectively. After 15 hours, the end of the reaction was confirmed with the acid value and the epoxy equivalent and then, 1,300 g of the reaction product was obtained by cooling to room temperature. The obtained reaction product had an acid value of 8 mgKOH/g, a hydroxyl value of 165 mgKOH/g and an epoxy equivalent of 17,000.

When the ^1H -NMR spectrum of this reaction product was measured, a peak was observed at chemical shifts δ (ppm) of 5.6 and 6.1 (derived from the double bond of methacrylic acid; 4H), and 3.9 to 4.4 (the peaks of the mixture of diglycidyl etherified products at 3.3 and 3.9 to 4.2 were shifted by the ring opening of an epoxy group; 10H).

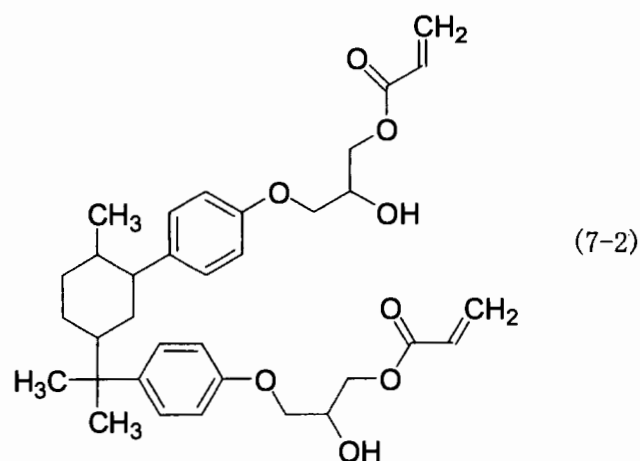
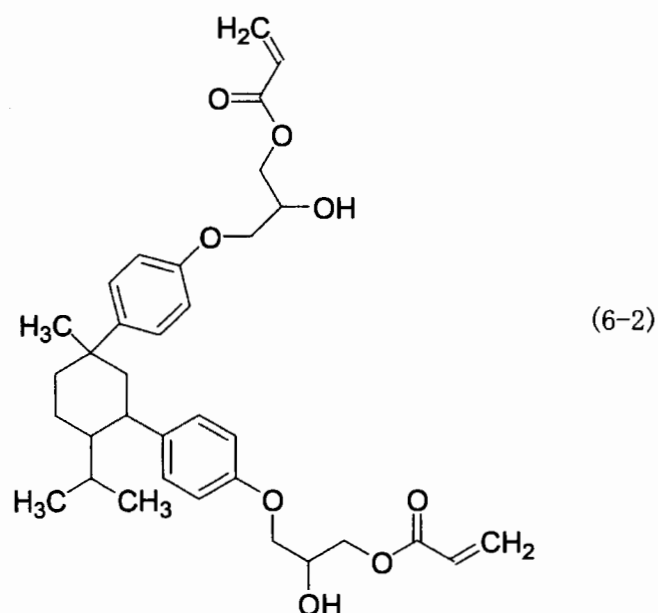
When the infrared absorption spectrum (IR) was measured, an absorption was observed at $1,720\text{ cm}^{-1}$ (derived from an aliphatic ester structure).

It was confirmed from the above results that this reaction product was a mixture of a dimethacryloyl group-containing diol compound represented by the following formula (6-1) and a dimethacryloyl group-containing diol compound represented by the following formula (7-1).



Synthesis Example 3 (synthesis of diacryloyl
5 group-containing diol compound)

1,200 g of a mixture of a diacryloyl group-containing
diol compound represented by the following formula (6-2) and
a diacryloyl group-containing diol compound represented by
the following formula (7-2) was obtained in the same manner
10 as in Synthesis Example 2 except that 293 g of acrylic acid
was used in place of methacrylic acid. The obtained mixture
had an acid value of 6 mgKOH/g, a hydroxyl value of 171 mgKOH/g
and an epoxy equivalent of 16,500.



5 Synthesis Example 4 (manufacture of polyester (1))

670 g of the mixture of dimethacryloyl group-containing diol compounds obtained in Synthesis Example 2 and 1,300 g of methyl isobutyl ketone were charged into a flask equipped with a cooling tube and a stirrer and heated at 60°C under agitation to be dissolved, and 220 g of pyromellitic anhydride represented by the above formula (8-1) (manufactured by Daicel Chemical Industries, Ltd.) was added to carry out a reaction at 80°C under agitation until the average acid value of the obtained reaction product

15 became 67.9 mgkOH/g and the variation width of the acid value

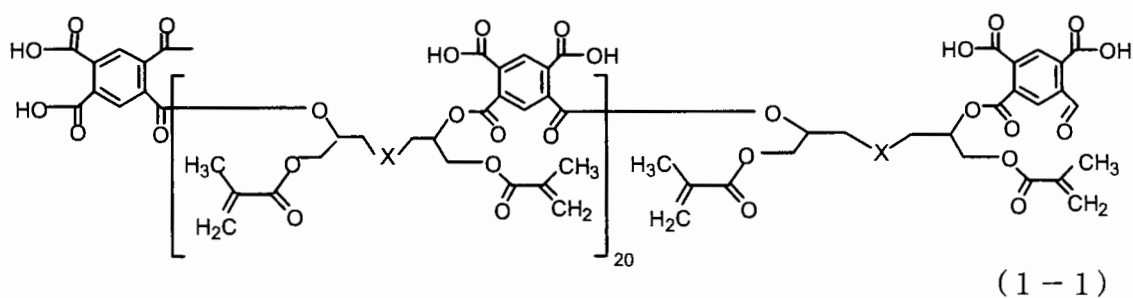
became 2 mgKOH/g or less. After the end of the reaction, distilled water was added to the reaction solution to rinse it, standing separation was carried out, and the solvent was distilled off from the organic layer under reduced pressure at 50 to 70°C to obtain 860 g of a resin. The obtained resin

When the $^1\text{H-NMR}$ spectrum of this resin was measured, a peak was observed at chemical shifts δ (ppm) of 6.9 to 7.6 (derived from a benzene ring bonded to a cyclohexane skeleton and the benzene ring of pyromellitic acid), 5.8 and 6.2 (derived from the double bond of methacrylic acid), 1.1 to 2.2 (derived from a cyclohexane skeleton) and 0.7 to 0.9 (derived from two methyl groups in a 2,2-propylene group bonded to a cyclohexane skeleton:6H).

When the infrared absorption spectrum (IR) was measured, an absorption was observed at $1,735\text{ cm}^{-1}$ (derived from an aliphatic ester structure), and $1,735\text{ cm}^{-1}$, $1,241\text{ cm}^{-1}$ and $1,102\text{ cm}^{-1}$ (derived from an aromatic ester structure).

It was confirmed from the above results that this resin was a polyester (1) represented by the following formula (1-1).

This polyester (1) was designated as alkali-soluble resin (B-1).

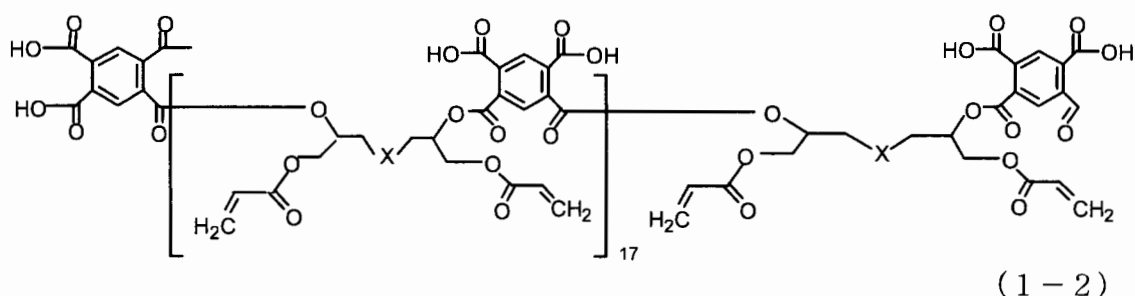


[In the formula (1-1), X is as defined in the above formula (1).]

Synthesis Example 5 (manufacture of polyester (1))

840 g of a polyester (1) represented by the following formula (1-2) was obtained in the same manner as in Synthesis Example 4 except that 660 g of the mixture of diacryloyl group-containing diol compounds obtained in Synthesis Example 3 was used in place of the mixture of dimethacryloyl group-containing diol compounds obtained in Synthesis Example 2. The obtained polyester (1) had an Mw of 15,000 and an acid value of 60.9 mgKOH/g.

This polyester (1) was designated as alkali-soluble resin (B-2).



[In the formula (1-2), X is as defined in the above formula (1).]

Synthesis Example 6 (manufacture of carboxyl group capped polyester (1))

275 g of the polyester (1) obtained in Synthesis Example 4 and 275 g of propylene glycol monomethyl acetate were charged into a flask equipped with a cooling tube and a stirrer and heated at 60°C under agitation to be dissolved, and 1.5 g of tetraethylammonium bromide and 30 g of phenyl glycidyl ether (Epiol P of NOF Corporation) as a carboxyl group capping agent were added to carry out a reaction at 80 to 90°C under agitation until the variation width of the acid value became 2 mgKOH/g or less. After the end of the reaction, the reaction product was cooled to room temperature to obtain

300 g of a resin. The obtained resin had an Mw of 21,000 and an acid value of 52.1 mgKOH/g.

When the ^1H -NMR spectrum of this resin was measured, a peak was observed at a chemical shift δ (ppm) of 6.9 to 7.6 (derived from a benzene ring in a phenyl glycidyl ether group) in addition to the peak of the polyester (1) obtained in Synthesis Example 4.

When the infrared absorption spectrum (IR) was measured, an absorption was observed at $1,047\text{ cm}^{-1}$ (derived from an aromatic ether structure). This absorption was stronger than that of the polyester (1) obtained in Synthesis Example 4 due to the capping of the carboxyl group.

It was confirmed from the above results that this resin was a polyester (1) having a structure that 78 % of hydrogen atoms in the carboxyl group in the above formula (1-1) was substituted by the capping agent residue $(-\text{CH}_2\text{CH}(\text{OH})\text{CH}_2\text{OC}_6\text{H}_5)$.

This polyester (1) was designated as alkali-soluble resin (B-3).

20

Synthesis Example 7 (manufacture of carboxyl group capped polyester (1))

340 g of a resin was obtained in the same manner as in Synthesis Example 6 except that 300 g of the polyester (1) obtained in Synthesis Example 5 was used in the place of polyester (1) obtained in Synthesis Example 4. The obtained resin had an Mw of 25,000 and an acid value of 50.0 mgKOH/g,

This polyester (1) was designated as alkali-soluble resin (B-4).

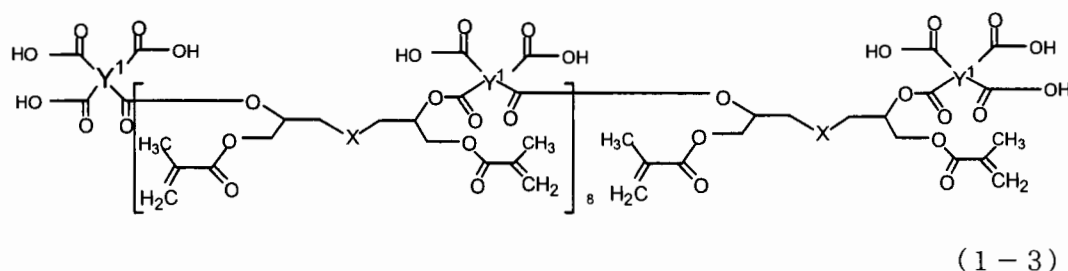
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Synthesis Example 8 (manufacture of polyester (1))

670 g of the mixture of dimethacryloyl group-containing diol compounds obtained in Synthesis

Example 2 and 1,470 g of methyl isobutyl ketone were charged into a flask equipped with a cooling tube and a stirrer and heated at 60°C under agitation to be dissolved, and 313 g of diphenyl ether tetracarboxylic dianhydride (manufactured by Manac Co., Ltd.) represented by the above formula (8-2) was added to carry out a reaction at 80°C under agitation until the acid value became 53.3 mgKOH/g or less. After the end of the reaction, distilled water was added to the reaction solution to rinse it with water, standing separation was carried out, and the solvent was distilled off from the organic layer under reduced pressure at 50 to 70°C to obtain 800 g of a resin. This resin had an Mw of 18,000 and an acid value of 61.2 mgKOH/g.

This polyester (1) was designated as alkali-soluble resin (B-5).



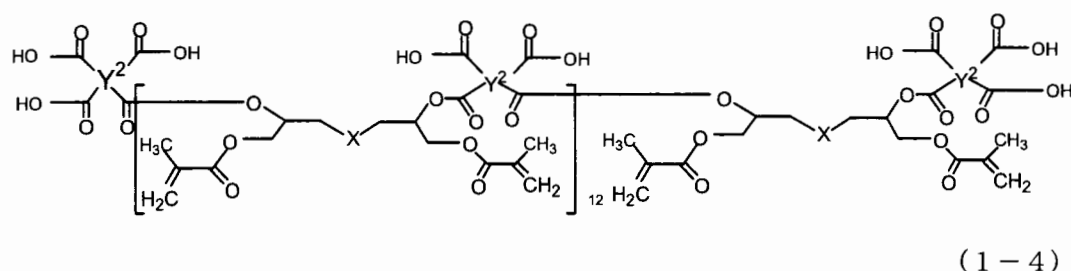
[In the formula (1-3), X is as defined in the above formula (1), and Y¹ is the residue obtained by removing 4 carboxyl groups from diphenyl ether tetracarboxylic acid.]

Synthesis Example 9 (manufacture of polyester (1))

670 g of the mixture of dimethacryloyl group-containing diol compounds obtained in Synthesis Example 2 and 1,660 g of methyl isobutyl ketone were charged into a flask equipped with a cooling tube and a stirrer and heated at 60°C under agitation to be dissolved, and 434 g of ethylene glycol bis(trimellitate)dianhydride represented by the above formula (8-3) (manufactured by Shin

Nippon Rika Co., Ltd.) was added to carry out a reaction at 80°C under agitation until the acid value became 46.2 mgKOH/g. After the end of the reaction, distilled water was added to the reaction solution to rinse it with water, standing separation was carried out, and the solvent was distilled off from the organic layer under reduced pressure at 50 to 70°C to obtain 900 g of a resin. The obtained resin had an Mw of 13,000 and was a polyester (1) represented by the following formula (1-4).

This polyester (1) was designated as alkali-soluble resin (B-6).



[In the formula (1-4), X is as defined in the above formula (1), and Y² is the residue obtained by removing 4 carboxyl groups from ethylene glycol bis(trimellitate).]

Synthesis Example 10 (manufacture of comparative alkali-soluble resin)

4 parts of 2,2'-azobis(2,4-dimethylvaleronitrile) and 200 parts of propylene glycol monomethyl ether acetate were charged into a flask equipped with a cooling tube and a stirrer, 12 parts of methacrylic acid, 18 parts of styrene, 24 parts of benzyl methacrylate, 30 parts of N-phenylmaleimide, 16 parts of 2-hydroxyethyl methacrylate and 6.5 parts of α-methylstyrene dimer as a chain transfer agent were charged into the flask, the inside of the flask was substituted by nitrogen, the mixture was stirred gently, and the obtained reaction solution was heated at 80°C to carry out

polymerization by maintaining that temperature for 3 hours. After the end of the polymerization, the reaction solution was heated at 100°C, 0.5 part of 2,2'-azobis(2,4-dimethylvaleronitrile) was added, and
5 polymerization was further carried out for another 1 hour to obtain a solution of an alkali-soluble resin (solid content of 33.2 wt%).

The obtained alkali-soluble resin had an Mw of 8,500 and an Mn of 4,500.

10 This alkali-soluble resin was designated as alkali-soluble resin (B-7).

Synthesis Example 11 (manufacture of comparative alkali-soluble resin)

15 2 parts of 2,2'-azobis(2,4-dimethylvaleronitrile) and 200 parts of propylene glycol monomethyl ether acetate were charged into a flask equipped with a cooling tube and a stirrer, 10 parts of methacrylic acid, 15 parts of styrene, 30 parts of benzyl methacrylate, 25 parts of N-phenylmaleimide, 20
20 parts of ω -carboxypolycaprolactone mono(meth)acrylate and 2 parts of α -methylstyrene dimer as a chain transfer agent were charged into the flask, the inside of the flask was substituted by nitrogen, the mixture was stirred gently, and the obtained reaction solution was heated at 80°C to carry
25 out polymerization by maintaining that temperature for 3 hours. After the end of the polymerization, the reaction solution was heated at 100°C, 0.5 part of 2,2'-azobis(2,4-dimethylvaleronitrile) was added, and polymerization was further carried out for another 1 hour
30 to obtain a solution of an alkali-soluble resin (solid content of 33.1 wt%).

The obtained alkali-soluble resin had an Mw of 20,000 and an Mn of 9,000.

This alkali-soluble resin was designated as

alkali-soluble resin (B-8).

Synthesis Example 12 (manufacture of comparative alkali-soluble resin)

5 4 parts of 2,2'-azobis(2,4-dimethylvaleronitrile) and
200 parts of propylene glycol monomethyl ether acetate were
charged into a flask equipped with a cooling tube and a stirrer,
10 parts of methacrylic acid, 15 parts of styrene, 40 parts
of benzyl methacrylate, 25 parts of N-phenylmaleimide, 10
10 parts of 2-hydroxyethyl methacrylate and 6.5 parts of
 α -methylstyrene dimer as a chain transfer agent were charged
into the flask, the inside of the flask was substituted by
nitrogen, the mixture was stirred gently, and the obtained
reaction solution was heated at 80°C to carry out
15 polymerization by maintaining that temperature for 3 hours.
After the end of the polymerization, the reaction solution
was heated at 100°C, 0.5 part of
2,2'-azobis(2,4-dimethylvaleronitrile) was added, and
polymerization was further carried out for another 1 hour
20 to obtain a solution of an alkali-soluble resin (solid
content of 33.3 wt%).

The obtained alkali-soluble resin had an Mw of 7,800
and an Mn of 4,500.

This alkali-soluble resin was designated as
25 alkali-soluble resin (B-9).

Example 1

<preparation of liquid composition>

8 parts of a mixture of C.I. Pigment Red 254 and C.I.
30 Pigment Red 177 in a weight ratio of 80:20 as the colorant
(A), 4 parts (solid content) of EFKA-46 as a dispersant and
75 parts of propylene glycol monomethyl ether acetate as a
solvent were mixed together by a bead mill to prepare a pigment
dispersion.

87 parts of the obtained pigment dispersion, 8 parts of the alkali-soluble resin (B-1) as the alkali-soluble resin, 2 parts of dipentaerythritol hexaacrylate and 4 parts of pentaerythritol tetraacrylate as the polyfunctional
5 monomers (C), 3 parts of 1-[9-ethyl-6-(2-methylbenzoyl)-9.H.-carbazol-3-yl]-ethan-1-oneoxime-O-acetate (trade name: CGI-242 of Chiba Specialty Chemicals Holding Inc., the same shall apply hereinafter) as the photoradical generator (D), and 70 parts
10 of methoxybutyl acetate and 96 parts of ethyl-3-ethoxypropionate as solvents were mixed together to prepare a liquid composition (R1).
<formation of colored layer>

The liquid composition (R1) was applied to the surface
15 of a soda lime glass substrate having a silicon dioxide (SiO_2) film for preventing the elution of sodium ions on the surface with a spin coater and prebaked on a hot plate at 90°C for 2 minutes to form a $1.2\text{ }\mu\text{m}$ -thick coating film.

Thereafter, the substrate was cooled to room
20 temperature, and the coating film was exposed to ultraviolet radiation having wavelengths of 365 nm, 405 nm and 436 nm through a photomask (slit width of $30\text{ }\mu\text{m}$) with a high-pressure mercury lamp. The amount of exposure at this point was 100 J/m^2 . The substrate was then immersed in a 0.04 wt% aqueous
25 solution of potassium hydroxide at 23°C for 45 seconds to be developed, rinsed with ultra pure water and dried with air. The coating film was then post-baked in a clean oven at 230°C for 30 minutes to form a red striped pixel pattern on the substrate.

30 <evaluation>

When the pixel array on the substrate was observed through an optical microscope, the development residue was not seen on the substrate of an unexposed portion and a missing part of the pixel pattern edge was not seen.

When the section of the pixel pattern was observed through a scanning electron microscope (SEM), no undercut was seen and a pattern having a line width of 5 μm could be formed.

5 The above results are shown in Table 1-1.

Examples 2 to 5

<preparation of liquid compositions and formation of colored layers>

10 Liquid compositions (R2) to (R5) were prepared in the same manner as in Example 1 except that the dispersant was changed as shown in Table 1-1.

Then, red striped pixel patterns were formed on the substrates in the same manner as in Example 1 except that
15 the liquid compositions (R2) to (R5) were used in place of the liquid composition (R1).

<evaluation>

When each pixel array on the substrate was observed through an optical microscope, the development residue was
20 not seen on the substrate of an unexposed portion and a missing part of each pixel pattern edge was not seen.

When the section of each pixel pattern was observed through a scanning electron microscope (SEM), no undercut was seen and patterns having line widths of 8 or 6 μm could
25 be formed.

The above results are shown in Table 1-1.

Example 6

<preparation of liquid composition and formation of colored
30 layer>

A liquid composition (R6) was prepared in the same manner as in Example 1 except that the alkali-soluble resin (B) was changed to the alkali-soluble resin (B-2).

Then, a red striped pixel pattern was formed on the

substrate in the same manner as in Example 1 except that the liquid composition (R6) was used in place of the liquid composition (R1).

<evaluation>

5 When the pixel array on the substrate was observed through an optical microscope, the development residue was not seen on the substrate of an unexposed portion and a missing part of the pixel pattern edge was not seen.

10 When the section of the pixel pattern was observed through a scanning electron microscope (SEM), no undercut was seen and a pattern having a line width of 6 μm could be formed.

The above results are shown in Table 1-1.

15 Examples 7 to 10

<preparation of liquid compositions and formation of colored layers>

20 Liquid compositions (R7) to (R10) were prepared in the same manner as in Example 6 except that the dispersant was changed as shown in Table 1-1.

 Then, red striped pixel patterns were formed on the substrates in the same manner as in Example 1 except that the liquid compositions (R7) to (R10) were used in place of the liquid composition (R1).

25 <evaluation>

 When each pixel array on the substrate was observed through an optical microscope, the development residue was not seen on the substrate of an unexposed portion and a missing part of each pixel pattern edge was not seen.

30 When the section of each pixel pattern was observed through a scanning electron microscope (SEM), no undercut was seen and patterns having line widths of 5 μm , 8 μm or 6 μm could be formed.

The above results are shown in Table 1-1.

Example 11

<preparation of liquid composition and formation of colored layer>

5 A liquid composition (R11) was prepared in the same manner as in Example 1 except that the alkali-soluble resin (B) was changed to the alkali-soluble resin (B-3).

Then, a red striped pixel pattern was formed on the substrate in the same manner as in Example 1 except that the
10 liquid composition (R11) was used in place of the liquid composition (R1).

<evaluation>

When the pixel array on the substrate was observed through an optical microscope, the development residue was
15 not seen on the substrate of an unexposed portion and a missing part of the pixel pattern edge was not seen.

When the section of the pixel pattern was observed through a scanning electron microscope (SEM), no undercut was seen and a pattern having a line width of 5 μm could be
20 formed.

The above results are shown in Table 1-2.

Examples 12 to 15

<preparation of liquid compositions and formation of colored
25 layers>

Liquid compositions (R12) to (R15) were prepared in the same manner as in Example 11 except that the dispersant was changed as shown in Table 1-2.

Then, red striped pixel patterns were formed on the
30 substrates in the same manner as in Example 1 except that the liquid compositions (R12) to (R15) were used in place of the liquid composition (R1).

<evaluation>

When each pixel array on the substrate was observed

through an optical microscope, the development residue was not seen on the substrate of an unexposed portion and a missing part of each pixel pattern edge was not seen.

When the section of each pixel pattern was observed through a scanning electron microscope (SEM), no undercut was seen and patterns having line widths of 6 μm or 8 μm could be formed.

The above results are shown in Table 1-2.

10 Example 16

<preparation of liquid composition and formation of colored layer>

A liquid composition (R16) was prepared in the same manner as in Example 1 except that the alkali-soluble resin (B) was changed to the alkali-soluble resin (B-4).

Then, a red striped pixel pattern was formed on the substrate in the same manner as in Example 1 except that the liquid composition (R16) was used in place of the liquid composition (R1).

20 <evaluation>

When the pixel array on the substrate was observed through an optical microscope, the development residue was not seen on the substrate of an unexposed portion and a missing part of the pixel pattern edge was not seen.

When the section of the pixel pattern was observed through a scanning electron microscope (SEM), no undercut was seen and a pattern having a line width of 6 μm could be formed.

The above results are shown in Table 1-2.

30

Examples 17 to 20

<preparation of liquid compositions and formation of colored layers>

Liquid compositions (R17) to (R20) were prepared in

the same manner as in Example 16 except that the dispersant was changed as shown in Table 1-2.

Then, red striped pixel patterns were formed on the substrates in the same manner as in Example 1 except that
5 the liquid compositions (R17) to (R20) were used in place of the liquid composition (R1).

<evaluation>

When each pixel array on the substrate was observed through an optical microscope, the development residue was
10 not seen on the substrate of an unexposed portion and a missing part of each pixel pattern edge was not seen.

When the section of each pixel pattern was observed through a scanning electron microscope (SEM), no undercut was seen and patterns having line widths of 5 μm , 8 μm or
15 6 μm could be formed.

The above results are shown in Table 1-2.

Example 21

<preparation of liquid composition and formation of colored
20 layer>

A liquid composition (R21) was prepared in the same manner as in Example 1 except that the alkali-soluble resin (B) was changed to the alkali-soluble resin (B-5).

Then, a red striped pixel pattern was formed on the substrate in the same manner as in Example 1 except that the
25 liquid composition (R21) was used in place of the liquid composition (R1).

<evaluation>

When the pixel array on the substrate was observed
30 through an optical microscope, the development residue was not seen on the substrate of an unexposed portion and a missing part of the pixel pattern edge was not seen.

When the section of the pixel pattern was observed through a scanning electron microscope (SEM), no undercut

was seen and a pattern having a line width of 8 μm could be formed.

The above results are shown in Table 1-3.

5 Examples 22 to 25

<preparation of liquid composition and formation of colored layer>

Liquid compositions (R22) to (R25) were prepared in the same manner as in Example 21 except that the dispersant
10 was changed as shown in Table 1-3.

Then, red striped pixel patterns were formed on the substrates in the same manner as in Example 1 except that the liquid compositions (R22) to (R25) were used in place of the liquid composition (R1).

15 <evaluation>

When each pixel array on the substrate was observed through an optical microscope, the development residue was not seen on the substrate of an unexposed portion and a missing part of each pixel pattern edge was not seen.

20 When the section of each pixel pattern was observed through a scanning electron microscope (SEM), no undercut was seen and patterns having line widths of 5 μm , 8 μm or 6 μm could be formed.

The above results are shown in Table 1-3.

25

Example 26

<preparation of liquid composition and formation of colored layer>

A liquid composition (R26) was prepared in the same
30 manner as in Example 1 except that the alkali-soluble resin (B) was changed to the alkali-soluble resin (B-6).

Then, a red striped pixel pattern was formed on the substrate in the same manner as in Example 1 except that the liquid composition (R26) was used in place of the liquid

composition (R1).

<evaluation>

When the pixel array on the substrate was observed through an optical microscope, the development residue was not seen on the substrate of an unexposed portion and a missing part of the pixel pattern edge was not seen.

When the section of the pixel pattern was observed through a scanning electron microscope (SEM), no undercut was seen and a pattern having a line width of 6 μm could be formed.

The above results are shown in Table 1-3.

Examples 27 to 30

<preparation of liquid compositions and formation of colored layers>

Liquid compositions (R27) to (R30) were prepared in the same manner as in Example 26 except that the dispersant was changed as shown in Table 1-3.

Then, red striped pixel patterns were formed on the substrates in the same manner as in Example 1 except that the liquid compositions (R27) to (R30) were used in place of the liquid composition (R1).

<evaluation>

When each pixel array on the substrate was observed through an optical microscope, the development residue was not seen on the substrate of an unexposed portion and a missing part of each pixel pattern edge was not seen.

When the section of each pixel pattern was observed through a scanning electron microscope (SEM), no undercut was seen and patterns having line widths of 5 μm , 8 μm or 6 μm could be formed.

The above results are shown in Table 1-3.

Example 31

<preparation of liquid composition >

11 parts of a mixture of C.I. Pigment Green 36 and C.I. Pigment Yellow 150 in a weight ratio of 60:40 as the colorant (A), 4 parts (solid content) of EFKA-46 as a dispersant and
5 75 parts of propylene glycol monomethyl ether acetate as a solvent were mixed together by a bead mill to prepare a pigment dispersion.

90 parts of the obtained pigment dispersion, 8 parts of the alkali-soluble resin (B-1) as the alkali-soluble resin
10 (B), 2 parts of dipentaerythritol hexaacrylate and 4 parts of pentaerythritol tetraacrylate as the polyfunctional monomers (C), 3 parts of
1-[9-ethyl-6-(2-methylbenzoyl)-9H-carbazol-3-yl]-ethan-
-1-oneoxime-O-acetate as the photoradical generator (D), and
15 70 parts of methoxybutyl acetate and 96 parts of ethyl-3-ethoxypropionate as solvents were mixed together to prepare a liquid composition (G1).

<formation of colored layer>

A green striped pixel pattern was formed on a substrate
20 in the same manner as in Example 1 except that the liquid composition (G1) was used in place of the liquid composition (R1).

<evaluation>

When the pixel array on the substrate was observed
25 through an optical microscope, the development residue was not seen on the substrate of an unexposed portion and a missing part of the pixel pattern edge was not seen.

When the section of the pixel pattern was observed through a scanning electron microscope (SEM), no undercut
30 was seen and a pattern having a line width of 6 μm could be formed.

The above results are shown in Table 2-1.

<preparation of liquid compositions and formation of colored layers>

Liquid compositions (G2) to (G5) were prepared in the same manner as in Example 31 except that the dispersant was
5 changed as shown in Table 2-1.

Then, green striped pixel patterns were formed on the substrates in the same manner as in Example 1 except that the liquid compositions (G2) to (G5) were used in place of the liquid composition (R1).

10 <evaluation>

When each pixel array on the substrate was observed through an optical microscope, the development residue was not seen on the substrate of an unexposed portion and a missing part of each pixel pattern edge was not seen.

15 When the section of each pixel pattern was observed through a scanning electron microscope (SEM), no undercut was seen and patterns having line widths of 8 μm or 6 μm could be formed.

The above results are shown in Table 2-1.

20

Example 36

<preparation of liquid composition and formation of colored layer>

A liquid composition (G6) was prepared in the same
25 manner as in Example 31 except that the alkali-soluble resin (B) was changed to the alkali-soluble resin (B-2).

Then, a green striped pixel pattern was formed on the substrate in the same manner as in Example 1 except that the liquid composition (G6) was used in place of the liquid
30 composition (R1).

<evaluation>

When the pixel array on the substrate was observed through an optical microscope, the development residue was not seen on the substrate of an unexposed portion and a missing

part of the pixel pattern edge was not seen.

When the section of the pixel pattern was observed through a scanning electron microscope (SEM), no undercut was seen and a pattern having a line width of 5 μm could be
5 formed.

The above results are shown in Table 2-1.

Examples 37 to 40

<preparation of liquid compositions and formation of colored
10 layers>

Liquid compositions (G7) to (G10) were prepared in the same manner as in Example 36 except that the dispersant was changed as shown in Table 2-1.

Then, green striped pixel patterns were formed on the
15 substrates in the same manner as in Example 1 except that the liquid compositions (G7) to (G10) were used in place of the liquid composition (R1).

<evaluation>

When each pixel array on the substrate was observed
20 through an optical microscope, the development residue was not seen on the substrate of an unexposed portion and a missing part of each pixel pattern edge was not seen.

When the section of each pixel pattern was observed through a scanning electron microscope (SEM), no undercut
25 was seen and patterns having line widths of 6 μm , 8 μm or 5 μm could be formed.

The above results are shown in Table 2-1.

Example 41

<preparation of liquid composition and formation of colored
30 layer>

A liquid composition (G11) was prepared in the same manner as in Example 31 except that the alkali-soluble resin (B) was changed to the alkali-soluble resin (B-3).

Then, a green striped pixel pattern was formed on the substrate in the same manner as in Example 1 except that the liquid composition (G11) was used in place of the liquid composition (R1).

5 <evaluation>

When the pixel array on the substrate was observed through an optical microscope, the development residue was not seen on the substrate of an unexposed portion and a missing part of the pixel pattern edge was not seen.

10 When the section of the pixel pattern was observed through a scanning electron microscope (SEM), no undercut was seen and a pattern having a line width of 5 μm could be formed.

The above results are shown in Table 2-2.

15

Examples 42 to 45

<preparation of liquid compositions and formation of colored layers>

20 Liquid compositions (G12) to (G15) were prepared in the same manner as in Example 41 except that the dispersant was changed as shown in Table 2-2.

25 Then, green striped pixel patterns were formed on the substrates in the same manner as in Example 1 except that the liquid compositions (G12) to (G15) were used in place of the liquid composition (R1).

<evaluation>

30 When each pixel array on the substrate was observed through an optical microscope, the development residue was not seen on the substrate of an unexposed portion and a missing part of each pixel pattern edge was not seen.

When the section of each pixel pattern was observed through a scanning electron microscope (SEM), no undercut was seen and patterns having line widths of 5 μm or 6 μm could be formed.

The above results are shown in Table 2-2.

Example 46

<preparation of liquid composition and formation of colored
5 layer>

A liquid composition (G16) was prepared in the same manner as in Example 31 except that the alkali-soluble resin (B) was changed to the alkali-soluble resin (B-4).

Then, a green striped pixel pattern was formed on the
10 substrate in the same manner as in Example 1 except that the liquid composition (G16) was used in place of the liquid composition (R1).

<evaluation>

When the pixel array on the substrate was observed
15 through an optical microscope, the development residue was not seen on the substrate of an unexposed portion and a missing part of the pixel pattern edge was not seen.

When the section of the pixel pattern was observed through a scanning electron microscope (SEM), no undercut
20 was seen and a pattern having a line width of 6 μm could be formed.

The above results are shown in Table 2-2.

Examples 47 to 50

<preparation of liquid compositions and formation of colored
25 layers>

Liquid compositions (G17) to (G20) were prepared in the same manner as in Example 46 except that the dispersant was changed as shown in Table 2-2.

Then, green striped pixel patterns were formed on the
30 substrates in the same manner as in Example 1 except that the liquid compositions (G17) to (G20) were used in place of the liquid composition (R1).

<evaluation>

When each pixel array on the substrate was observed through an optical microscope, the development residue was not seen on the substrate of an unexposed portion and a missing part of each pixel pattern edge was not seen.

5 When the section of each pixel pattern was observed through a scanning electron microscope (SEM), no undercut was seen and patterns having line widths of 6 μm , 5 μm or 8 μm could be formed.

The above results are shown in Table 2-2.

10

Example 51

<preparation of liquid composition and formation of colored layer>

15 A liquid composition (G21) was prepared in the same manner as in Example 31 except that the alkali-soluble resin (B) was changed to the alkali-soluble resin (B-5).

20 Then, a green striped pixel pattern was formed on the substrate in the same manner as in Example 1 except that the liquid composition (G21) was used in place of the liquid composition (R1).

<evaluation>

25 When the pixel array on the substrate was observed through an optical microscope, the development residue was not seen on the substrate of an unexposed portion and a missing part of the pixel pattern edge was not seen.

 When the section of the pixel pattern was observed through a scanning electron microscope (SEM), no undercut was seen and a pattern having a line width of 6 μm could be formed.

30 The above results are shown in Table 2-3.

Examples 52 to 55

<preparation of liquid compositions and formation of colored layers>

Liquid compositions (G22) to (G25) were prepared in the same manner as in Example 51 except that the dispersant was changed as shown in Table 2-3.

Then, green striped pixel patterns were formed on the substrates in the same manner as in Example 1 except that the liquid compositions (G22) to (G25) were used in place of the liquid composition (R1).

<evaluation>

When each pixel array on the substrate was observed through an optical microscope, the development residue was not seen on the substrate of an unexposed portion and a missing part of each pixel pattern edge was not seen.

When the section of each pixel pattern was observed through a scanning electron microscope (SEM), no undercut was seen and patterns having line widths of 6 μm , 8 μm or 5 μm could be formed.

The above results are shown in Table 2-3.

Example 56

<preparation of liquid composition and formation of colored layer>

A liquid composition (G26) was prepared in the same manner as in Example 31 except that the alkali-soluble resin (B) was changed to the alkali-soluble resin (B-6).

Then, a green striped pixel pattern was formed on the substrate in the same manner as in Example 1 except that the liquid composition (G26) was used in place of the liquid composition (R1).

<evaluation>

When the pixel array on the substrate was observed through an optical microscope, the development residue was not seen on the substrate of an unexposed portion and a missing part of the pixel pattern edge was not seen.

When the section of the pixel pattern was observed

through a scanning electron microscope (SEM), no undercut was seen and a pattern having a line width of 5 μm could be formed.

The above results are shown in Table 2-3.

5

Examples 57 to 60

<preparation of liquid compositions and formation of colored layers>

Liquid compositions (G27) to (G30) were prepared in the same manner as in Example 56 except that the dispersant was changed as shown in Table 2-3.

Then, green striped pixel patterns were formed on the substrates in the same manner as in Example 1 except that the liquid compositions (G27) to (G30) were used in place of the liquid composition (R1).

15

<evaluation>

When each pixel array on the substrate was observed through an optical microscope, the development residue was not seen on the substrate of an unexposed portion and a missing part of each pixel pattern edge was not seen.

20

When the section of each pixel pattern was observed through a scanning electron microscope (SEM), no undercut was seen and patterns having line widths of 5 μm , 6 μm or 8 μm could be formed.

25

The above results are shown in Table 2-3.

Example 61

<preparation of liquid composition >

9 parts of a mixture of C.I. Pigment Blue 15:6 and C.I. Pigment Violet 23 in a weight ratio of 95:5 as the colorant (A), 4 parts (solid content) of EFKA-46 as a dispersant and 75 parts of propylene glycol monomethyl ether acetate as a solvent were mixed together by a bead mill to prepare a pigment dispersion.

30

88 parts of the obtained pigment dispersion, 8 parts of the alkali-soluble resin (B-1) as the alkali-soluble resin (B), 2 parts of dipentaerythritol hexaacrylate and 4 parts of pentaerythritol tetraacrylate as the polyfunctional monomers (C), 3 parts of 1-[9-ethyl-6-(2-methylbenzoyl)-9.H.-carbazol-3-yl]-ethan-1-oneoxime-O-acetate as the photoradical generator (D), and 70 parts of methoxybutyl acetate and 96 parts of ethyl-3-ethoxypropionate as solvents were mixed together to prepare a liquid composition (B1).
<formation of colored layer>

A blue striped pixel pattern was formed on a substrate in the same manner as in Example 1 except that the liquid composition (B1) was used in place of the liquid composition (R1).
<evaluation>

When the pixel array on the substrate was observed through an optical microscope, the development residue was not seen on the substrate of an unexposed portion and a missing part of the pixel pattern edge was not seen.

When the section of the pixel pattern was observed through a scanning electron microscope (SEM), no undercut was seen and a pattern having a line width of 5 μm could be formed.

The above results are shown in Table 3-1.

Examples 62 to 65

<preparation of liquid compositions and formation of colored layers>

Liquid compositions (B2) to (B5) were prepared in the same manner as in Example 61 except that the dispersant was changed as shown in Table 3-1.

Then, blue striped pixel patterns were formed on the substrates in the same manner as in Example 1 except that

the liquid compositions (B2) to (B5) were used in place of the liquid composition (R1).

<evaluation>

When each pixel array on the substrate was observed
5 through an optical microscope, the development residue was not seen on the substrate of an unexposed portion and a missing part of each pixel pattern edge was not seen.

When the section of each pixel pattern was observed through a scanning electron microscope (SEM), no undercut
10 was seen and patterns having line widths of 5 μm or 6 μm could be formed.

The above results are shown in Table 3-1.

Example 66

15 <preparation of liquid composition and formation of colored layer>

A liquid composition (B6) was prepared in the same manner as in Example 61 except that the alkali-soluble resin (B) was changed to the alkali-soluble resin (B-2).

20 Then, a blue striped pixel pattern was formed on the substrate in the same manner as in Example 1 except that the liquid composition (B6) was used in place of the liquid composition (R1).

<evaluation>

25 When the pixel array on the substrate was observed through an optical microscope, the development residue was not seen on the substrate of an unexposed portion and a missing part of the pixel pattern edge was not seen.

When the section of the pixel pattern was observed
30 through a scanning electron microscope (SEM), no undercut was seen and a pattern having a line width of 6 μm could be formed.

The above results are shown in Table 3-1.

Examples 67 to 70

<preparation of liquid compositions and formation of colored layers>

Liquid compositions (B7) to (B10) were prepared in the same manner as in Example 66 except that the dispersant was changed as shown in Table 3-1.

Then, blue striped pixel patterns were formed on the substrates in the same manner as in Example 1 except that the liquid compositions (B7) to (B10) were used in place of the liquid composition (R1).

<evaluation>

When each pixel array on the substrate was observed through an optical microscope, the development residue was not seen on the substrate of an unexposed portion and a missing part of each pixel pattern edge was not seen.

When the section of each pixel pattern was observed through a scanning electron microscope (SEM), no undercut was seen and patterns having line widths of 8 μm or 5 μm could be formed.

The above results are shown in Table 3-1.

Example 71

<preparation of liquid composition and formation of colored layer>

A liquid composition (B11) was prepared in the same manner as in Example 61 except that the alkali-soluble resin (B) was changed to the alkali-soluble resin (B-3).

Then, a blue striped pixel pattern was formed on the substrate in the same manner as in Example 1 except that the liquid composition (B11) was used in place of the liquid composition (R1).

<evaluation>

When the pixel array on the substrate was observed through an optical microscope, the development residue was

not seen on the substrate of an unexposed portion and a missing part of the pixel pattern edge was not seen.

When the section of the pixel pattern was observed through a scanning electron microscope (SEM), no undercut
5 was seen and a pattern having a line width of 6 μm could be formed.

The above results are shown in Table 3-2.

Examples 72 to 75

10 <preparation of liquid compositions and formation of colored layers>

Liquid compositions (B12) to (B15) were prepared in the same manner as in Example 71 except that the dispersant was changed as shown in Table 3-2.

15 Then, blue striped pixel patterns were formed on the substrates in the same manner as in Example 1 except that the liquid compositions (B12) to (B15) were used in place of the liquid composition (R1).
<evaluation>

20 When each pixel array on the substrate was observed through an optical microscope, the development residue was not seen on the substrate of an unexposed portion and a missing part of each pixel pattern edge was not seen.

When the section of each pixel pattern was observed
25 through a scanning electron microscope (SEM), no undercut was seen and patterns having line widths of 5 μm , 6 μm or 8 μm could be formed.

The above results are shown in Table 3-2.

30 Example 76

<preparation of liquid composition and formation of colored layer>

A liquid composition (B16) was prepared in the same manner as in Example 61 except that the alkali-soluble resin

(B) was changed to the alkali-soluble resin (B-4).

Then, a blue striped pixel pattern was formed on the substrate in the same manner as in Example 1 except that the liquid composition (B16) was used in place of the liquid composition (R1).

<evaluation>

When the pixel array on the substrate was observed through an optical microscope, the development residue was not seen on the substrate of an unexposed portion and a missing part of the pixel pattern edge was not seen.

When the section of the pixel pattern was observed through a scanning electron microscope (SEM), no undercut was seen and a pattern having a line width of 5 μm could be formed.

The above results are shown in Table 3-2.

Examples 77 to 80

<preparation of liquid compositions and formation of colored layers>

Liquid compositions (B17) to (B20) were prepared in the same manner as in Example 76 except that the dispersant was changed as shown in Table 3-2.

Then, blue striped pixel patterns were formed on the substrates in the same manner as in Example 1 except that the liquid compositions (B17) to (B20) were used in place of the liquid composition (R1).

<evaluation>

When each pixel array on the substrate was observed through an optical microscope, the development residue was not seen on the substrate of an unexposed portion and a missing part of each pixel pattern edge was not seen.

When the section of each pixel pattern was observed through a scanning electron microscope (SEM), no undercut was seen and patterns having line widths of 5 μm or 8 μm could

be formed.

The above results are shown in Table 3-2.

Example 81

5 <preparation of liquid composition and formation of colored layer>

A liquid composition (B21) was prepared in the same manner as in Example 61 except that the alkali-soluble resin (B) was changed to the alkali-soluble resin (B-5).

10 Then, a blue striped pixel pattern was formed on the substrate in the same manner as in Example 1 except that the liquid composition (B21) was used in place of the liquid composition (R1).

<evaluation>

15 When the pixel array on the substrate was observed through an optical microscope, the development residue was not seen on the substrate of an unexposed portion and a missing part of the pixel pattern edge was not seen.

20 When the section of the pixel pattern was observed through a scanning electron microscope (SEM), no undercut was seen and a pattern having a line width of 5 μm could be formed.

The above results are shown in Table 3-3.

25 Examples 82 to 85

<preparation of liquid compositions and formation of colored layers>

30 Liquid compositions (B22) to (B25) were prepared in the same manner as in Example 81 except that the dispersant was changed as shown in Table 3-3.

Then, blue striped pixel patterns were formed on the substrates in the same manner as in Example 1 except that the liquid compositions (B22) to (B25) were used in place of the liquid composition (R1).

<evaluation>

When each pixel array on the substrate was observed through an optical microscope, the development residue was not seen on the substrate of an unexposed portion and a missing
5 part of each pixel pattern edge was not seen.

When the section of each pixel pattern was observed through a scanning electron microscope (SEM), no undercut was seen and patterns having line widths of 5 μm or 8 μm could be formed.

10 The above results are shown in Table 3-3.

Example 86

<preparation of liquid composition and formation of colored layer>

15 A liquid composition (B26) was prepared in the same manner as in Example 61 except that the alkali-soluble resin (B) was changed to the alkali-soluble resin (B-6).

Then, a blue striped pixel pattern was formed on the substrate in the same manner as in Example 1 except that the
20 liquid composition (B26) was used in place of the liquid composition (R1).

<evaluation>

When the pixel array on the substrate was observed through an optical microscope, the development residue was
25 not seen on the substrate of an unexposed portion and a missing part of the pixel pattern edge was not seen.

When the section of the pixel pattern was observed through a scanning electron microscope (SEM), no undercut was seen and a pattern having a line width of 8 μm could be
30 formed.

The above results are shown in Table 3-3.

Examples 87 to 90

<preparation of liquid compositions and formation of colored

layers>

Liquid compositions (B27) to (B30) were prepared in the same manner as in Example 86 except that the dispersant was changed as shown in Table 3-3.

5 Then, blue striped pixel patterns were formed on the substrates in the same manner as in Example 1 except that the liquid compositions (B27) to (B30) were used in place of the liquid composition (R1).

<evaluation>

10 When each pixel array on the substrate was observed through an optical microscope, the development residue was not seen on the substrate of an unexposed portion and a missing part of each pixel pattern edge was not seen.

15 When the section of each pixel pattern was observed through a scanning electron microscope (SEM), no undercut was seen and patterns having line widths of 8 μm or 5 μm could be formed.

The above results are shown in Table 3-3.

20 Example 91

<preparation of liquid composition >

25 20 parts of carbon black as the colorant (A), 4 parts (solid content) of EFKA-46 as a dispersant and 75 parts of propylene glycol monomethyl ether acetate as a solvent were mixed together by a bead mill to prepare a pigment dispersion.

30 99 parts of the obtained pigment dispersion, 8 parts of the alkali-soluble resin (B-1) as the alkali-soluble resin (B), 2 parts of dipentaerythritol hexaacrylate and 4 parts of pentaerythritol tetraacrylate as the polyfunctional monomers (C), 3 parts of

1-[9-ethyl-6-(2-methylbenzoyl)-9.H.-carbazol-3-yl]-ethan-1-oneoxime-O-acetate as the photoradical generator (D), and 150 parts of propylene glycol monomethyl ether acetate as a solvent were mixed together to prepare a liquid composition

(BK1) .

<formation of colored layer>

A black striped pixel pattern was formed on a substrate in the same manner as in Example 1 except that the liquid composition (BK1) was used in place of the liquid composition (R1) .

<evaluation>

When the pixel array on the substrate was observed through an optical microscope, the development residue was not seen on the substrate of an unexposed portion and a missing part of the pixel pattern edge was not seen.

When the section of the pixel pattern was observed through a scanning electron microscope (SEM), no undercut was seen and a pattern having a line width of 8 μm could be formed.

The above results are shown in Table 4-1.

Examples 92 to 95

<preparation of liquid compositions and formation of colored layers>

Liquid compositions (BK2) to (BK5) were prepared in the same manner as in Example 91 except that the dispersant was changed as shown in Table 4-1.

Then, black striped pixel patterns were formed on the substrates in the same manner as in Example 1 except that the liquid compositions (BK2) to (BK5) were used in place of the liquid composition (R1) .

<evaluation>

When each pixel array on the substrate was observed through an optical microscope, the development residue was not seen on the substrate of an unexposed portion and a missing part of each pixel pattern edge was not seen.

When the section of each pixel pattern was observed through a scanning electron microscope (SEM), no undercut

was seen and patterns having line widths of 5 μm or 6 μm could be formed.

The above results are shown in Table 4-1.

5 Example 96

<preparation of liquid composition and formation of colored layer>

A liquid composition (BK6) was prepared in the same manner as in Example 91 except that the alkali-soluble resin
10 (B) was changed to the alkali-soluble resin (B-2).

Then, a black striped pixel pattern was formed on the substrate in the same manner as in Example 1 except that the liquid composition (BK6) was used in place of the liquid composition (R1).

15 <evaluation>

When the pixel array on the substrate was observed through an optical microscope, the development residue was not seen on the substrate of an unexposed portion and a missing part of the pixel pattern edge was not seen.

20 When the section of the pixel pattern was observed through a scanning electron microscope (SEM), no undercut was seen and a pattern having a line width of 5 μm could be formed.

The above results are shown in Table 4-1.

25

Examples 97 to 100

<preparation of liquid compositions and formation of colored layers>

Liquid compositions (BK7) to (BK10) were prepared in the same manner as in Example 96 except that the dispersant
30 was changed as shown in Table 4-1.

Then, black striped pixel patterns were formed on the substrates in the same manner as in Example 1 except that the liquid compositions (BK7) to (BK10) were used in place

of the liquid composition (R1).

<evaluation>

When each pixel array on the substrate was observed through an optical microscope, the development residue was not seen on the substrate of an unexposed portion and a missing part of each pixel pattern edge was not seen.

When the section of each pixel pattern was observed through a scanning electron microscope (SEM), no undercut was seen and patterns having line widths of 6 μm or 5 μm could be formed.

The above results are shown in Table 4-1.

Example 101

<preparation of liquid composition and formation of colored layer>

A liquid composition (BK11) was prepared in the same manner as in Example 91 except that the alkali-soluble resin (B) was changed to the alkali-soluble resin (B-3).

Then, a black striped pixel pattern was formed on the substrate in the same manner as in Example 1 except that the liquid composition (BK11) was used in place of the liquid composition (R1).

<evaluation>

When the pixel array on the substrate was observed through an optical microscope, the development residue was not seen on the substrate of an unexposed portion and a missing part of the pixel pattern edge was not seen.

When the section of the pixel pattern was observed through a scanning electron microscope (SEM), no undercut was seen and a pattern having a line width of 6 μm could be formed.

The above results are shown in Table 4-2.

Examples 102 to 105

<preparation of liquid compositions and formation of colored layers>

Liquid compositions (BK12) to (BK15) were prepared in the same manner as in Example 101 except that the dispersant
5 was changed as shown in Table 4-2.

Then, black striped pixel patterns were formed on the substrates in the same manner as in Example 1 except that the liquid compositions (BK12) to (BK15) were used in place of the liquid composition (R1).

10 <evaluation>

When each pixel array on the substrate was observed through an optical microscope, the development residue was not seen on the substrate of an unexposed portion and a missing part of each pixel pattern edge was not seen.

15 When the section of each pixel pattern was observed through a scanning electron microscope (SEM), no undercut was seen and patterns having line widths of 5 μm , 8 μm or 6 μm could be formed.

The above results are shown in Table 4-2.

20

Example 106

<preparation of liquid composition and formation of colored layer>

A liquid composition (BK16) was prepared in the same
25 manner as in Example 91 except that the alkali-soluble resin (B) was changed to the alkali-soluble resin (B-4).

Then, a black striped pixel pattern was formed on the substrate in the same manner as in Example 1 except that the liquid composition (BK16) was used in place of the liquid
30 composition (R1).

<evaluation>

When the pixel array on the substrate was observed through an optical microscope, the development residue was not seen on the substrate of an unexposed portion and a missing

part of the pixel pattern edge was not seen.

When the section of the pixel pattern was observed through a scanning electron microscope (SEM), no undercut was seen and a pattern having a line width of 8 μm could be formed.

The above results are shown in Table 4-2.

Examples 107 to 110

<preparation of liquid compositions and formation of colored layers>

Liquid compositions (BK17) to (BK20) were prepared in the same manner as in Example 106 except that the dispersant was changed as shown in Table 4-2.

Then, black striped pixel patterns were formed on the substrates in the same manner as in Example 1 except that the liquid compositions (BK17) to (BK20) were used in place of the liquid composition (R1).

<evaluation>

When each pixel array on the substrate was observed through an optical microscope, the development residue was not seen on the substrate of an unexposed portion and a missing part of each pixel pattern edge was not seen.

When the section of each pixel pattern was observed through a scanning electron microscope (SEM), no undercut was seen and patterns having line widths of 6 μm or 5 μm could be formed.

The above results are shown in Table 4-2.

Example 111

<preparation of liquid composition and formation of colored layer>

A liquid composition (BK21) was prepared in the same manner as in Example 91 except that the alkali-soluble resin (B) was changed to the alkali-soluble resin (B-5).

Then, a black striped pixel pattern was formed on the substrate in the same manner as in Example 1 except that the liquid composition (BK21) was used in place of the liquid composition (R1).

5 <evaluation>

When the pixel array on the substrate was observed through an optical microscope, the development residue was not seen on the substrate of an unexposed portion and a missing part of the pixel pattern edge was not seen.

10 When the section of the pixel pattern was observed through a scanning electron microscope (SEM), no undercut was seen and a pattern having a line width of 6 μm could be formed.

The above results are shown in Table 4-3.

15

Examples 112 to 115

<preparation of liquid compositions and formation of colored layers>

20 Liquid compositions (BK22) to (BK25) were prepared in the same manner as in Example 111 except that the dispersant was changed as shown in Table 4-3.

25 Then, black striped pixel patterns were formed on the substrates in the same manner as in Example 1 except that the liquid compositions (BK22) to (BK25) were used in place of the liquid composition (R1).

<evaluation>

30 When each pixel array on the substrate was observed through an optical microscope, the development residue was not seen on the substrate of an unexposed portion and a missing part of each pixel pattern edge was not seen.

When the section of each pixel pattern was observed through a scanning electron microscope (SEM), no undercut was seen and patterns having line widths of 8 μm , 6 μm or 5 μm could be formed.

The above results are shown in Table 4-3.

Example 116

5 <preparation of liquid composition and formation of colored layer>

A liquid composition (BK26) was prepared in the same manner as in Example 91 except that the alkali-soluble resin (B) was changed to the alkali-soluble resin (B-6).

10 Then, a black striped pixel pattern was formed on the substrate in the same manner as in Example 1 except that the liquid composition (BK26) was used in place of the liquid composition (R1).

<evaluation>

15 When the pixel array on the substrate was observed through an optical microscope, the development residue was not seen on the substrate of an unexposed portion and a missing part of the pixel pattern edge was not seen.

20 When the section of the pixel pattern was observed through a scanning electron microscope (SEM), no undercut was seen and a pattern having a line width of 5 μm could be formed.

The above results are shown in Table 4-3.

Examples 117 to 120

25 <preparation of liquid compositions and formation of colored layers>

Liquid compositions (BK27) to (BK30) were prepared in the same manner as in Example 116 except that the dispersant was changed as shown in Table 4-3.

30 Then, black striped pixel patterns were formed on the substrates in the same manner as in Example 1 except that the liquid compositions (BK27) to (BK30) were used in place of the liquid composition (R1).

<evaluation>

When each pixel array on the substrate was observed through an optical microscope, the development residue was not seen on the substrate of an unexposed portion and a missing part of each pixel pattern edge was not seen.

5 When the section of each pixel pattern was observed through a scanning electron microscope (SEM), no undercut was seen and patterns having line widths of 8 μm or 5 μm could be formed.

The above results are shown in Table 4-3.

10

Comparative Example 1

<preparation of liquid composition >

8 parts of a mixture of C.I. Pigment Red 254 and C.I. Pigment Red 177 in a weight ratio of 80:20 as the colorant
15 (A), 4 parts (solid content) of EFKA-46 as a dispersant and 75 parts of propylene glycol monomethyl ether acetate as a solvent were mixed together by a bead mill to prepare a pigment dispersion.

87 parts of the obtained pigment dispersion, a mixture
20 of 2 parts of the alkali-soluble resin (B-7), 3 parts of the alkali-soluble resin (B-8) and 4 parts of the alkali-soluble resin (B-9) as the alkali-soluble resin (B), 2 parts of dipentaerythritol hexaacrylate and 4 parts of pentaerythritol tetraacrylate as the polyfunctional
25 monomers (C), 3 parts of 1-[9-ethyl-6-(2-methylbenzoyl)-9.H.-carbazol-3-yl]-ethan-1-oneoxime-O-acetate as the photoradical generator (D), and 70 parts of methoxybutyl acetate and 96 parts of ethyl-3-ethoxypropionate as solvents were mixed together to
30 prepare a liquid composition (CR1).

<formation of colored layer>

A red striped pixel pattern was formed on a substrate in the same manner as in Example 1 except that the liquid composition (CR1) was used in place of the liquid composition

(R1).

<evaluation>

When the pixel array on the substrate was observed through an optical microscope, the development residue was
5 seen on the substrate of an unexposed portion.

When the section of the pixel pattern was observed through a scanning electron microscope (SEM), an undercut was seen and only a pattern having a line width of 35 μm could be formed.

10 The above results are shown in Table 5.

Comparative Example 2

<preparation of liquid composition >

11 parts of a mixture of C.I. Pigment Green 36 and C.I. Pigment Yellow 150 in a weight ratio of 60:40 as the colorant
15 (A), 4 parts (solid content) of BYK-2000 as a dispersant and 75 parts of propylene glycol monomethyl ether acetate as a solvent were mixed together by a bead mill to prepare a pigment dispersion.

20 90 parts of the obtained pigment dispersion, a mixture of 2 parts of the alkali-soluble resin (B-7), 3 parts of the alkali-soluble resin (B-8) and 4 parts of the alkali-soluble resin (B-9) as the alkali-soluble resin (B), 2 parts of dipentaerythritol hexaacrylate and 4 parts of
25 pentaerythritol tetraacrylate as the polyfunctional monomers (C), 3 parts of 1-[9-ethyl-6-(2-methylbenzoyl)-9.H.-carbazol-3-yl]-ethan-1-oneoxime-O-acetate as the photoradical generator (D), and 70 parts of methoxybutyl acetate and 96 parts of
30 ethyl-3-ethoxypropionate as solvents were mixed together to prepare a liquid composition (CG1).

<formation of colored layer>

A green striped pixel pattern was formed on a substrate in the same manner as in Example 1 except that the liquid

composition (CG1) was used in place of the liquid composition (R1).

<evaluation>

When the pixel array on the substrate was observed through an optical microscope, the development residue was not seen on the substrate of an unexposed portion. However, when the section of the pixel pattern was observed through a scanning electron microscope (SEM), an undercut was seen and only a pattern having a line width of 45 μm could be formed.

The above results are shown in Table 5.

Comparative Example 3

<preparation of liquid composition >

9 parts of a mixture of C.I. Pigment Blue 15:6 and C.I. Pigment Violet 23 in a weight ratio of 95:5 as the colorant (A), 4 parts (solid content) of BYK-2001 as a dispersant and 75 parts of propylene glycol monomethyl ether acetate as a solvent were mixed together by a bead mill to prepare a pigment dispersion.

88 parts of the obtained pigment dispersion, a mixture of 2 parts of the alkali-soluble resin (B-7), 3 parts of the alkali-soluble resin (B-8) and 4 parts of the alkali-soluble resin (B-9) as the alkali-soluble resin (B), 2 parts of dipentaerythritol hexaacrylate and 4 parts of pentaerythritol tetraacrylate as the polyfunctional monomers (C), 3 parts of 1-[9-ethyl-6-(2-methylbenzoyl)-9H-carbazol-3-yl]-ethan-1-oneoxime-O-acetate as the photoradical generator (D), and 70 parts of methoxybutyl acetate and 96 parts of ethyl-3-ethoxypropionate as solvents were mixed together to prepare a liquid composition (CB1).

<formation of colored layer>

A blue striped pixel pattern was formed on a substrate in the same manner as in Example 1 except that the liquid

composition (CB1) was used in place of the liquid composition (R1).

<evaluation>

When the pixel array on the substrate was observed through an optical microscope, the development residue was not seen on the substrate of an unexposed portion. However, when the section of the pixel pattern was observed through a scanning electron microscope (SEM), an undercut was seen and only a pattern having a line width of 40 μm could be formed.

The above results are shown in Table 5.

Comparative Example 4

<preparation of liquid composition >

20 parts of carbon black as the colorant (A), 4 parts (solid content) of BYK-164 as a dispersant and 75 parts of propylene glycol monomethyl ether acetate as a solvent were mixed together by a bead mill to prepare a pigment dispersion.

99 parts of the obtained pigment dispersion, 8 parts of the alkali-soluble resin (B-1) as the alkali-soluble resin (B), 2 parts of dipentaerythritol hexaacrylate and 4 parts of pentaerythritol tetraacrylate as the polyfunctional monomers (C), 3 parts of 1-[9-ethyl-6-(2-methylbenzoyl)-9H-carbazol-3-yl]-ethan-1-oneoxime-O-acetate as the photoradical generator (D), and 150 parts of propylene glycol monomethyl ether acetate as a solvent were mixed together to prepare a liquid composition (CBK1).

<formation of colored layer>

A black striped pixel pattern was formed on a substrate in the same manner as in Example 1 except that the liquid composition (CBK1) was used in place of the liquid composition (R1).

<evaluation>

When the pixel array on the substrate was observed

through an optical microscope, the development residue was seen on the substrate of an unexposed portion.

When the section of the pixel pattern was observed through a scanning electron microscope (SEM), an undercut
5 was seen and only a pattern having a line width of 50 μm could be formed.

The above results are shown in Table 5.

Comparative Example 5

10 <preparation of liquid composition and formation of colored layer>

A liquid composition (CR2) was prepared in the same manner as in Comparative Example 1 except that the dispersant was changed to BYK-182.

15 <formation of colored layer>

Then, a red striped pixel pattern was formed on a substrate in the same manner as in Example 1 except that the liquid composition (CR2) was used in place of the liquid composition (R1).

20 <evaluation>

When the pixel array on the substrate was observed through an optical microscope, the development residue was seen on the substrate of an unexposed portion.

When the section of the pixel pattern was observed
25 through a scanning electron microscope (SEM), an undercut was seen and only a pattern having a line width of 45 μm could be formed.

The above results are shown in Table 5.

Table 1-1

	Example									
	1	2	3	4	5	6	7	8	9	10
Red pigment (*1) (parts)	8	8	8	8	8	8	8	8	8	8
Dispersant (parts)	4	-	-	-	-	4	-	-	-	-
EFKA-46	-	4	-	-	-	-	4	-	-	-
BYK-2000	-	-	4	-	-	-	-	-	-	-
BYK-2001	-	-	-	4	-	-	-	4	-	-
BYK-164	-	-	-	-	-	-	-	-	4	-
BYK-182	-	-	-	-	4	-	-	-	-	4
(B) alkali-soluble resin (parts)										
B-1	8	8	8	8	8	-	-	-	-	-
B-2	-	-	-	-	-	8	8	8	8	8
B-3	-	-	-	-	-	-	-	-	-	-
B-4	-	-	-	-	-	-	-	-	-	-
B-5	-	-	-	-	-	-	-	-	-	-
B-6	-	-	-	-	-	-	-	-	-	-
evaluation	not seen	not seen	not seen	not seen	not seen	not seen	not seen	not seen	not seen	not seen
development residue	seen	seen	seen	seen	seen	seen	seen	seen	seen	seen
undercut	not seen	not seen	not seen	not seen	not seen	not seen	not seen	not seen	not seen	not seen
line width (μm)	5	8	6	6	8	6	5	5	8	6

*1: a mixture of C.I. Pigment Red 245 and C.I. Pigment Red 177 in a weight ratio of 80:20

Table 1-2

	Example									
	11	12	13	14	15	16	17	18	19	20
Red pigment (*1) (parts)	8	8	8	8	8	8	8	8	8	8
Dispersant (parts)	4	-	-	-	-	4	-	-	-	-
EFKA-46	-	4	-	-	-	-	4	-	-	-
BYK-2000	-	-	4	-	-	-	-	4	-	-
BYK-2001	-	-	-	4	-	-	-	-	-	-
BYK-164	-	-	-	-	4	-	-	-	4	-
BYK-182	-	-	-	-	-	-	-	-	-	4
(B) alkali-soluble resin (parts)	-	-	-	-	-	-	-	-	-	-
B-1	-	-	-	-	-	-	-	-	-	-
B-2	-	-	-	-	-	-	-	-	-	-
B-3	8	8	8	8	8	-	-	-	-	-
B-4	-	-	-	-	-	8	8	8	8	8
B-5	-	-	-	-	-	-	-	-	-	-
B-6	-	-	-	-	-	-	-	-	-	-
evaluation	not seen	not seen	not seen	not seen	not seen	not seen	not seen	not seen	not seen	not seen
development residue	seen	seen	seen	seen	seen	seen	seen	seen	seen	seen
undercut	not seen	not seen	not seen	not seen	not seen	not seen	not seen	not seen	not seen	not seen
line width(μm)	5	6	6	8	6	6	5	8	6	6

*1: a mixture of C.I. Pigment Red 245 and C.I. Pigment Red 177 in a weight ratio of 80:20

Table 1-3

	Example									
	21	22	23	24	25	26	27	28	29	30
Red pigment (*1) (parts)	8	8	8	8	8	8	8	8	8	8
Dispersant (parts)	4	-	-	-	-	4	-	-	-	-
EFKA-46	-	4	-	-	-	-	4	-	-	-
BYK-2000	-	-	4	-	-	-	-	4	-	-
BYK-2001	-	-	-	4	-	-	-	-	-	-
BYK-164	-	-	-	-	-	-	-	-	4	-
BYK-182	-	-	-	-	4	-	-	-	-	4
(B) alkali-soluble resin (parts)	-	-	-	-	-	-	-	-	-	-
B-1	-	-	-	-	-	-	-	-	-	-
B-2	-	-	-	-	-	-	-	-	-	-
B-3	-	-	-	-	-	-	-	-	-	-
B-4	-	-	-	-	-	-	-	-	-	-
B-5	8	8	8	8	8	-	-	-	-	-
B-6	-	-	-	-	-	8	8	8	8	8
evaluation	not seen	not seen	not seen	not seen	not seen	not seen	not seen	not seen	not seen	not seen
development residue	8	5	8	8	6	6	5	8	6	8
undercut	not seen	not seen	not seen	not seen	not seen	not seen	not seen	not seen	not seen	not seen
line width (μm)	8	5	8	8	6	6	5	8	6	8

*1: a mixture of C.I. Pigment Red 245 and C.I. Pigment Red 177 in a weight ratio of 80:20

Table 2-1

	Example									
	31	32	33	34	35	36	37	38	39	40
Green pigment (*2) (parts)	11	11	11	11	11	11	11	11	11	11
Dispersant (parts)	4	-	-	-	-	4	-	-	-	-
EFKA-46	-	4	-	-	-	-	4	-	-	-
BYK-2000	-	-	4	-	-	-	-	4	-	-
BYK-2001	-	-	-	4	-	-	-	-	-	-
BYK-164	-	-	-	-	4	-	-	-	4	-
BYK-182	-	-	-	-	-	-	-	-	-	4
(B) alkali-soluble resin (parts)	8	8	8	8	8	-	-	-	-	-
B-1	-	-	-	-	-	8	8	8	8	8
B-2	-	-	-	-	-	-	-	-	-	-
B-3	-	-	-	-	-	-	-	-	-	-
B-4	-	-	-	-	-	-	-	-	-	-
B-5	-	-	-	-	-	-	-	-	-	-
B-6	-	-	-	-	-	-	-	-	-	-
evaluation	not seen	not seen	not seen	not seen	not seen	not seen	not seen	not seen	not seen	not seen
development residue	seen	seen	seen	seen	seen	seen	seen	seen	seen	seen
undercut	not seen	not seen	not seen	not seen	not seen	not seen	not seen	not seen	not seen	not seen
line width (μm)	6	8	6	6	6	5	6	8	8	5

*2: a mixture of C.I. Pigment Green 36 and C.I. Pigment Yellow 150 in a weight ratio of 60:40

Table 2-2

	Example									
	41	42	43	44	45	46	47	48	49	50
Green pigment (*2) (parts)	11	11	11	11	11	11	11	11	11	11
Dispersant (parts)	4	-	-	-	-	4	-	-	-	-
EFKA-46	-	4	-	-	-	-	4	-	-	-
BYK-2000	-	-	4	-	-	-	-	4	-	-
BYK-2001	-	-	-	4	-	-	-	-	-	-
BYK-164	-	-	-	-	-	-	-	-	4	-
BYK-182	-	-	-	-	4	-	-	-	-	4
(B) alkali-soluble resin (parts)										
B-1	-	-	-	-	-	-	-	-	-	-
B-2	-	-	-	-	-	-	-	-	-	-
B-3	8	8	8	8	8	-	-	-	-	-
B-4	-	-	-	-	-	8	8	8	8	8
B-5	-	-	-	-	-	-	-	-	-	-
B-6	-	-	-	-	-	-	-	-	-	-
evaluation	not seen	not seen	not seen	not seen	not seen	not seen	not seen	not seen	not seen	not seen
development residue	seen	seen	seen	seen	seen	seen	seen	seen	seen	seen
undercut	not seen	not seen	not seen	not seen	not seen	not seen	not seen	not seen	not seen	not seen
line width(μm)	5	5	5	6	6	6	6	5	5	8

*2: a mixture of C.I. Pigment Green 36 and C.I. Pigment Yellow 150 in a weight ratio of 60:40

Table 2-3

	Example									
	51	52	53	54	55	56	57	58	59	60
Green pigment (*2) (parts)	11	11	11	11	11	11	11	11	11	11
Dispersant (parts)	4	-	-	-	-	4	-	-	-	-
EFKA-46	-	4	-	-	-	-	4	-	-	-
BYK-2000	-	-	4	-	-	-	-	4	-	-
BYK-2001	-	-	-	4	-	-	-	-	-	-
BYK-164	-	-	-	-	4	-	-	-	4	-
BYK-182	-	-	-	-	-	4	-	-	-	4
(B) alkali-soluble resin (parts)										
B-1	-	-	-	-	-	-	-	-	-	-
B-2	-	-	-	-	-	-	-	-	-	-
B-3	-	-	-	-	-	-	-	-	-	-
B-4	-	-	-	-	-	-	-	-	-	-
B-5	8	8	8	8	8	-	-	-	-	-
B-6	-	-	-	-	-	8	8	8	8	8
evaluation	not seen	not seen	not seen	not seen	not seen	not seen	not seen	not seen	not seen	not seen
development residue	6	6	8	6	5	5	5	6	8	5
undercut	not seen	not seen	not seen	not seen	not seen	not seen	not seen	not seen	not seen	not seen
line width(μm)	6	6	8	6	5	5	5	6	8	5

*2: a mixture of C.I. Pigment Green 36 and C.I. Pigment Yellow 150 in a weight ratio of 60:40

Table 3-1

	Example									
	61	62	63	64	65	66	67	68	69	70
Blue pigment (*3) (parts)	9	9	9	9	9	9	9	9	9	9
Dispersant (parts)	4	-	-	-	-	4	-	-	-	-
EFKA-46	-	4	-	-	-	-	4	-	-	-
BYK-2000	-	-	4	-	-	-	-	-	-	-
BYK-2001	-	-	-	4	-	-	-	4	-	-
BYK-164	-	-	-	-	-	-	-	-	4	-
BYK-182	-	-	-	4	-	-	-	-	-	4
(B) alkali-soluble resin (parts)	8	8	8	8	8	-	-	-	-	-
B-1	-	-	-	-	-	8	8	8	8	8
B-2	-	-	-	-	-	-	-	-	-	-
B-3	-	-	-	-	-	-	-	-	-	-
B-4	-	-	-	-	-	-	-	-	-	-
B-5	-	-	-	-	-	-	-	-	-	-
B-6	-	-	-	-	-	-	-	-	-	-
evaluation	not seen	not seen	not seen	not seen	not seen	not seen	not seen	not seen	not seen	not seen
development residue	seen	seen	seen	seen	seen	seen	seen	seen	seen	seen
undercut	not seen	not seen	not seen	not seen	not seen	not seen	not seen	not seen	not seen	not seen
line width(μm)	5	5	5	6	6	6	8	8	8	5

*3: a mixture of C.I. Pigment Blue 15:6 and C.I. Pigment Violet 23 in a weight ratio of 95:5

Table 3-2

	Example									
	71	72	73	74	75	76	77	78	79	80
Blue pigment (*3) (parts)	9	9	9	9	9	9	9	9	9	9
Dispersant (parts)	4	-	-	-	-	4	-	-	-	-
EFKA-46	-	4	-	-	-	-	4	-	-	-
BYK-2000	-	-	4	-	-	-	-	4	-	-
BYK-2001	-	-	-	4	-	-	-	-	-	-
BYK-164	-	-	-	-	-	-	-	-	4	-
BYK-182	-	-	-	-	4	-	-	-	-	4
(B) alkali-soluble resin (parts)	-	-	-	-	-	-	-	-	-	-
B-1	-	-	-	-	-	-	-	-	-	-
B-2	-	-	-	-	-	-	-	-	-	-
B-3	8	8	8	8	8	-	-	-	-	-
B-4	-	-	-	-	-	8	8	8	8	8
B-5	-	-	-	-	-	-	-	-	-	-
B-6	-	-	-	-	-	-	-	-	-	-
evaluation	not seen	not seen	not seen	not seen	not seen	not seen	not seen	not seen	not seen	not seen
development residue	6	5	6	8	8	5	5	8	8	5
undercut	not seen	not seen	not seen	not seen	not seen	not seen	not seen	not seen	not seen	not seen
line width(μm)	6	5	6	8	8	5	5	8	8	5

*3: a mixture of C.I. Pigment Blue 15:6 and C.I. Pigment Violet 23 in a weight ratio of 95:5

Table 3-3

	Example									
	81	82	83	84	85	86	87	88	89	90
Blue pigment (*3) (parts)	9	9	9	9	9	9	9	9	9	9
Dispersant (parts)	4	-	-	-	-	4	-	-	-	-
EFKA-46	-	4	-	-	-	-	4	-	-	-
BYK-2000	-	-	4	-	-	-	-	4	-	-
BYK-2001	-	-	-	4	-	-	-	-	-	-
BYK-164	-	-	-	-	-	-	-	-	4	-
BYK-182	-	-	-	-	4	-	-	-	-	4
(B) alkali-soluble resin (parts)	-	-	-	-	-	-	-	-	-	-
B-1	-	-	-	-	-	-	-	-	-	-
B-2	-	-	-	-	-	-	-	-	-	-
B-3	-	-	-	-	-	-	-	-	-	-
B-4	-	-	-	-	-	-	-	-	-	-
B-5	8	8	8	8	8	-	-	-	-	-
B-6	-	-	-	-	-	8	8	8	8	8
evaluation	not seen	not seen	not seen	not seen	not seen	not seen	not seen	not seen	not seen	not seen
development residue	seen	seen	seen	seen	seen	seen	seen	seen	seen	seen
undercut	not seen	not seen	not seen	not seen	not seen	not seen	not seen	not seen	not seen	not seen
line width(μm)	5	5	8	5	5	8	8	8	8	5

*3: a mixture of C.I. Pigment Blue 15:6 and C.I. Pigment Violet 23 in a weight ratio of 95:5

Table 4-1

	Example									
	91	92	93	94	95	96	97	98	99	100
Carbon black (parts)	20	20	20	20	20	20	20	20	20	20
Dispersant (parts)	4	-	-	-	-	4	-	-	-	-
EFKA-46	-	4	-	-	-	-	4	-	-	-
BYK-2000	-	-	4	-	-	-	-	4	-	-
BYK-2001	-	-	-	4	-	-	-	-	-	-
BYK-164	-	-	-	-	-	-	-	-	4	-
BYK-182	-	-	-	-	4	-	-	-	-	4
(B) alkali-soluble resin (parts)	8	8	8	8	8	-	-	-	-	-
B-1	-	-	-	-	-	8	8	8	8	8
B-2	-	-	-	-	-	-	-	-	-	-
B-3	-	-	-	-	-	-	-	-	-	-
B-4	-	-	-	-	-	-	-	-	-	-
B-5	-	-	-	-	-	-	-	-	-	-
B-6	-	-	-	-	-	-	-	-	-	-
evaluation	not seen	not seen	not seen	not seen	not seen	not seen	not seen	not seen	not seen	not seen
development residue	seen	seen	seen	seen	seen	seen	seen	seen	seen	seen
undercut	not seen	not seen	not seen	not seen	not seen	not seen	not seen	not seen	not seen	not seen
line width(μm)	8	5	6	5	6	5	6	5	5	6

Table 4-2

	Example									
	101	102	103	104	105	106	107	108	109	110
Carbon black (parts)	20	20	20	20	20	20	20	20	20	20
Dispersant (parts)	4	-	-	-	-	4	-	-	-	-
EFKA-46	-	4	-	-	-	-	4	-	-	-
BYK-2000	-	-	4	-	-	-	-	4	-	-
BYK-2001	-	-	-	4	-	-	-	-	-	-
BYK-164	-	-	-	-	-	-	-	-	4	-
BYK-182	-	-	-	-	4	-	-	-	-	4
(B) alkali-soluble resin (parts)	-	-	-	-	-	-	-	-	-	-
B-1	-	-	-	-	-	-	-	-	-	-
B-2	-	-	-	-	-	-	-	-	-	-
B-3	8	8	8	8	8	-	-	-	-	-
B-4	-	-	-	-	-	8	8	8	8	8
B-5	-	-	-	-	-	-	-	-	-	-
B-6	-	-	-	-	-	-	-	-	-	-
evaluation	not seen	not seen	not seen	not seen	not seen	not seen	not seen	not seen	not seen	not seen
development residue	6	5	8	6	5	8	6	5	5	5
undercut	not seen	not seen	not seen	not seen	not seen	not seen	not seen	not seen	not seen	not seen
line width(μm)	6	5	8	6	5	8	6	5	5	5

Table 4-3

	Example									
	111	112	113	114	115	116	117	118	119	120
Carbon black (parts)	20	20	20	20	20	20	20	20	20	20
Dispersant (parts)	4	-	-	-	-	4	-	-	-	-
EFKA-46	-	4	-	-	-	-	4	-	-	-
BYK-2000	-	-	-	-	-	-	-	4	-	-
BYK-2001	-	-	4	-	-	-	-	-	-	-
BYK-164	-	-	-	4	-	-	-	-	4	-
BYK-182	-	-	-	-	4	-	-	-	-	4
(B) alkali-soluble resin (parts)										
B-1	-	-	-	-	-	-	-	-	-	-
B-2	-	-	-	-	-	-	-	-	-	-
B-3	-	-	-	-	-	-	-	-	-	-
B-4	-	-	-	-	-	-	-	-	-	-
B-5	8	8	8	8	8	-	-	-	-	-
B-6	-	-	-	-	-	8	8	8	8	8
evaluation	not seen	not seen	not seen	not seen	not seen	not seen	not seen	not seen	not seen	not seen
development residue	seen	seen	seen	seen	seen	seen	seen	seen	seen	seen
undercut	not seen	not seen	not seen	not seen	not seen	not seen	not seen	not seen	not seen	not seen
line width(μm)	6	8	6	5	8	5	8	8	5	5

Table 5

	Comparative Example				
	1	2	3	4	5
Red pigment (*1) (parts)	8	-	-	-	8
Green pigment (*2) (parts)	-	11	-	-	-
Blue pigment (*3) (parts)	-	-	9	-	-
Carbon black (parts)	-	-	-	20	-
Dispersant (parts)					
EFKA-46	4	-	-	-	-
BYK-2000	-	4	-	-	-
BYK-2001	-	-	4	-	-
BYK-164	-	-	-	4	-
BYK-182	-	-	-	-	4
(B) alkali-soluble resin (parts)					
B-7	2	2	2	2	2
B-8	3	3	3	3	3
B-9	4	4	4	4	4
evaluation					
development residue	seen	not seen	not seen	seen	seen
undercut	seen	seen	seen	seen	seen
line width(μm)	35	45	40	50	45

*1: a mixture of C.I. Pigment Red 245 and C.I. Pigment Red 177 in a weight ratio of 80:20

*2: a mixture of C.I. Pigment Green 36 and C.I. Pigment Yellow 150 in a weight ratio of 60:40

*3: a mixture of C.I. Pigment Blue 15:6 and C.I. Pigment Violet 23 in a weight ratio of 95:5

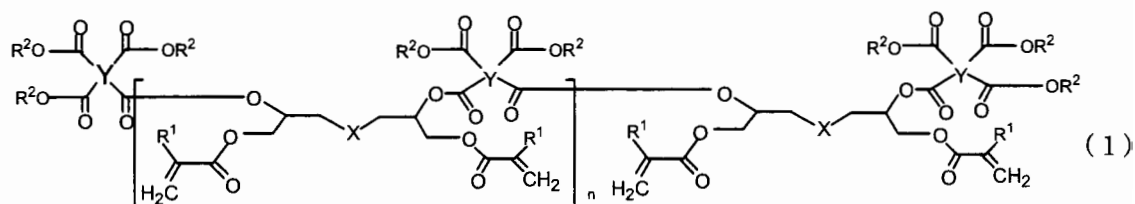
What is claimed is:

1. A radiation sensitive composition which comprises (A) a colorant, (B) an alkali-soluble resin, (C) a polyfunctional
5 monomer and (D) a photoradical generator, wherein

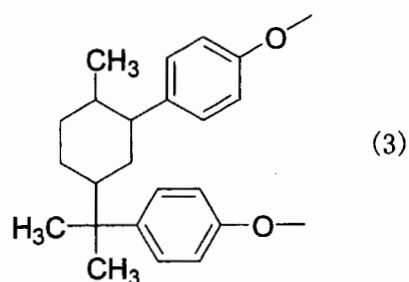
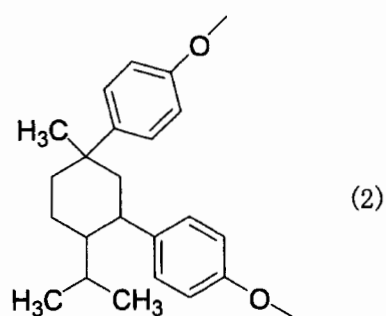
the alkali-soluble resin (B) comprises a polyester having an alicyclic hydrocarbon skeleton in the main chain and a polymerizable unsaturated bond in the side chain and the radiation sensitive composition is used to form a colored
10 layer.

2. The radiation sensitive composition according to claim 1, wherein the component (B) is a polyester represented by the following formula (1):

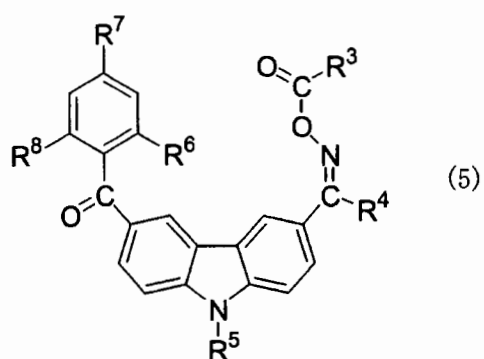
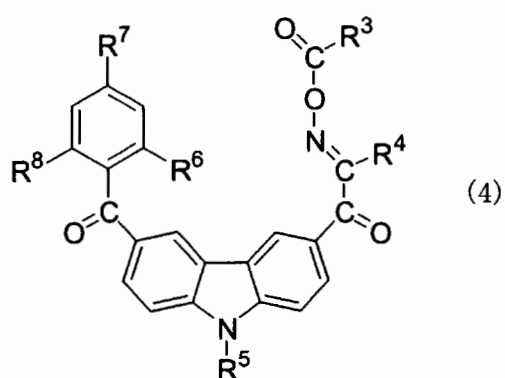
15



wherein X's are each independently a divalent group
20 represented by the following formula (2) or (3), Y's are each independently the residue obtained by excluding four carboxyl groups from an organic tetracarboxylic acid, R¹'s are each independently a hydrogen atom or methyl group, R²'s are each independently a hydrogen atom or the residue of a
25 carboxyl group capping agent, and n is an integer of 1 to 40.



3. The radiation sensitive composition according to claim
 5 1 or 2, wherein the photoradical generator (D) is a compound
 represented by the following formula (4) or (5):



10 wherein R³'s are each independently a linear, branched or

cyclic alkyl group having 1 to 12 carbon atoms or phenyl group, $R^{4'}$'s are each independently a hydrogen atom, linear, branched or cyclic alkyl group having 1 to 12 carbon atoms or phenyl group, $R^{5'}$'s are each independently a hydrogen atom or linear, 5 branched or cyclic alkyl group having 1 to 12 carbon atoms, and $R^{6'}$'s, $R^{7'}$'s and $R^{8'}$'s are each independently a hydrogen atom or linear, branched or cyclic alkyl group having 1 to 6 carbon atoms, with the proviso that the alkyl group represented by R^3 , R^4 , R^5 , R^6 , R^7 and R^8 may be substituted by a substituent 10 selected from the group consisting of a linear, branched or cyclic alkoxy group having 1 to 6 carbon atoms, phenyl group and halogen atom, and the phenyl group represented by R^3 and R^4 may be substituted by a substituent selected from the group consisting of a linear, branched or cyclic alkyl group having 15 1 to 6 carbon atoms, linear, branched or cyclic alkoxy group having 1 to 6 carbon atoms, phenyl group and halogen atom.

4. A color filter having a colored layer made of the radiation sensitive composition of any one of claims 1 to 20 3.

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