

DESCRIPTION

POLYMER, RADIATION SENSITIVE COMPOSITION FOR COLOR FILTERS,
COLOR FILTER AND COLOR LIQUID CRYSTAL DISPLAY DEVICE OR PANEL

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Field of the Invention

The present invention relates to a radiation sensitive composition for forming a colored layer, a color filter and a color liquid crystal display device or panel. More specifically, it relates to a radiation sensitive composition for forming a colored layer (pixels and/or a black matrix) useful for the manufacture of a color filter for use in a transmission or reflection color liquid crystal display device or panel or a color image pick-up device, a color filter comprising a colored layer made of the radiation sensitive composition and a color liquid crystal display device comprising the color filter.

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15Description 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 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 (see JP-A 2-144502 and JP-A 3-53201) (the term "JP-A" as used herein means an "unexamined published Japanese patent application").

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Although there is a strong trend toward cutting the tact time by reducing the amount of exposure in the technical field of color filters, it is difficult to obtain an excellent pixel pattern and black matrix pattern while the tact time is shortened because the edge of a pattern obtained from the

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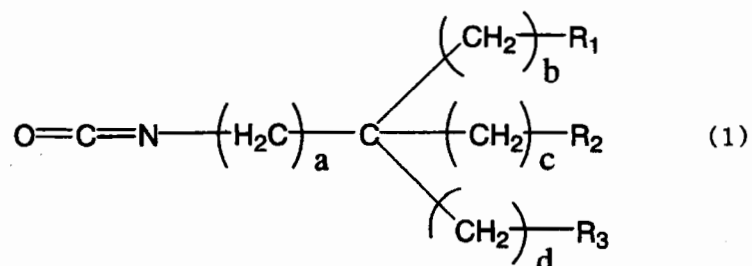
colored radiation sensitive composition of the prior art is apt to be partially missing or undercut at the time of development.

5 Summary of the Invention

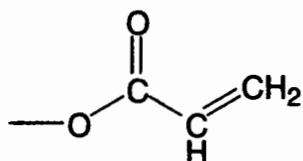
It is an object of the present invention to provide a radiation sensitive composition for forming a colored layer, which exhibits excellent developability, more specifically a novel radiation sensitive composition for color filters,
 10 which does not produce an undissolved product or scum on the pattern edge at the time of development and can provide pixels and a black matrix without a missing part or undercut of the pattern edge even when the amount of exposure is small, a polymer useful as a component of the composition, a color
 15 filter formed from the radiation sensitive composition for color filters, and a liquid crystal display device comprising the color filter.

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

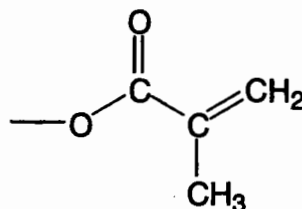
20 According to the present invention, firstly, the above objects and advantages of the present invention are attained by a polymer (to be referred to as "polymer (A)" hereinafter) obtained by reacting a copolymer of (a1) an unsaturated carboxylic acid and/or an unsaturated carboxylic anhydride,
 25 (a2) a compound containing at least one hydroxyl group in the molecule and (a3) other unsaturated compound with an isocyanate compound represented by the following formula (1):



wherein R_1 , R_2 and R_3 are each independently a hydrogen atom or a group represented by the following formula (I) or (II), with the proviso that R_1 , R_2 and R_3 cannot be hydrogen atoms at the same time, and a, b, c and d are each independently
 5 an integer of 0 to 12.



(I)



(II)

According to the present invention, secondly, the above objects and advantages of the present invention are attained by a radiation sensitive composition for color
 10 filters, which comprises (A) the above polymer, (B) a colorant, (C) a polyfunctional monomer and (D) a photopolymerization initiator.

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

According to the present invention, thirdly, the above objects and advantages of the present invention are attained by a color filter comprising a colored layer made of the above radiation sensitive composition for color filters.

20 According to the present invention, in the fourth place, the above objects and advantages of the present invention are attained by a color liquid crystal display device or panel comprising the color filter.

25 Detailed Description of the Preferred Embodiments

The present invention will be described in detail hereinafter.

(A) polymer

The polymer (A) in the present invention is obtained by reacting a copolymer (to be referred to as "alkali-soluble resin [α]" hereinafter) of (a1) an unsaturated carboxylic acid and/or an unsaturated carboxylic anhydride, (a2) an
5 unsaturated compound containing at least one hydroxyl group in the molecule and (a3) other unsaturated compound with an isocyanate compound represented by the above formula (1) (to be referred to as "unsaturated isocyanate compound (1)" hereinafter).

10 The unsaturated carboxylic acid and/or unsaturated carboxylic anhydride (a1) (to be generally referred to as "(a1) unsaturated carboxylic acid compound" hereinafter) out of the components of the alkali-soluble resin [α] is, for example, a carboxylic group-containing unsaturated monomer.
15 Examples of the carboxyl group-containing unsaturated monomer include unsaturated monocarboxylic acids such as (meth)acrylic acid, crotonic acid, α -chloroacrylic acid and cinnamic acid; unsaturated dicarboxylic acids and anhydrides thereof such as maleic acid, maleic anhydride, fumaric acid,
20 itaconic acid, itaconic anhydride, citraconic acid, citraconic anhydride and mesaconic acid; unsaturated polycarboxylic acids having three or more carboxyl groups and anhydrides thereof; mono[(meth)acryloyloxyalkyl]esters of a polycarboxylic acid having two or more carboxyl groups
25 such as mono[2-(meth)acryloyloxyethyl]succinate and mono[2-(meth)acryloyloxyethyl]phthalate; and mono(meth)acrylates of a polymer having a carboxyl group and a hydroxyl group at both terminals such as ω -carboxypolycaprolactone mono(meth)acrylate.

30 Out of these carboxyl group-containing unsaturated monomers, mono(2-acryloyloxyethyl)succinate and mono(2-acryloyloxyethyl)phthalate are available on the market under the trade names of M-5300 and M-5400 (of Toagosei Chemical Industry Co., Ltd.), respectively.

In the alkali-soluble resin [α], the above unsaturated carboxylic acid compounds (a1) may be used alone or in combination of two or more.

In the alkali-soluble resin [α], the content of a
 5 recurring unit derived from the unsaturated carboxylic acid compound (a1) is preferably 5 to 50 wt%, more preferably 5 to 40 wt%, particularly preferably 5 to 30 wt%. When the content of the recurring unit derived from the unsaturated carboxylic acid compound (a1) is lower than 5 wt%, the
 10 solubility in an alkali developer of the polymer obtained from a reaction with the unsaturated isocyanate compound (1) may lower and when the content is higher than 50 wt%, the solubility in the alkali developer of the polymer may become too high.

15 Examples of the unsaturated compound containing at least one hydroxyl group in the molecule (a2) include hydroxyalkyl acrylates such as 2-hydroxyethyl (meth)acrylate, 2-hydroxypropyl (meth)acrylate, 3-hydroxypropyl (meth)acrylate, 2-hydroxybutyl
 20 (meth)acrylate, 3-hydroxybutyl (meth)acrylate, 4-hydroxybutyl (meth)acrylate, 1,2-dihydroxyethyl acrylate, 2,3-dihydroxypropyl acrylate, 1,3-dihydroxypropyl acrylate, 3,4-dihydroxybutyl acrylate and
 3-[3-(2,3-dihydroxypropoxy)-2-hydroxypropoxy]-2-hydroxypropyl acrylate; and hydroxyalkyl methacrylates such
 25 as 1,2-dihydroxyethyl methacrylate, 2,3-dihydroxypropyl methacrylate, 1,3-dihydroxypropyl methacrylate, 3,4-dihydroxybutyl methacrylate and
 3-[3-(2,3-dihydroxypropoxy)-2-hydroxypropoxy]-2-hydroxypropyl methacrylate.
 30

Out of these unsaturated compounds containing at least one hydroxyl group (a2), 2-hydroxyethyl (meth)acrylate, 1,2-dihydroxyethyl acrylate, 2,3-dihydroxypropyl acrylate, 1,2-dihydroxyethyl methacrylate and 2,3-dihydroxypropyl

methacrylate are preferred from the viewpoint of copolymerization reactivity and reactivity with the isocyanate compound.

In the alkali-soluble resin [α], the unsaturated compounds containing at least one hydroxyl group in the molecule (a2) may be used alone or in combination of two or more.

In the alkali-soluble resin [α], the content of a recurring unit derived from the unsaturated compound containing at least one hydroxyl group in the molecule (a2) is preferably 1 to 50 wt%, more preferably 3 to 40 wt%, particularly preferably 5 to 30 wt%. When the content of the recurring unit derived from the unsaturated compound containing at least one hydroxyl group in the molecule (a2) is lower than 1 wt%, sensitivity may lower due to a reduction in the introduction rate into the polymer of the unsaturated isocyanate compound (1) and when the content is higher than 50 wt%, the storage stability of the polymer obtained from a reaction with the unsaturated isocyanate compound (1) may lower.

Example of the other unsaturated compound (a3) include aromatic vinyl compounds such as styrene, α-methylstyrene, o-vinyltoluene, m-vinyltoluene, p-vinyltoluene, p-chlorostyrene, o-methoxystyrene, m-methoxystyrene, p-methoxystyrene, o-vinylbenzylmethyl ether, m-vinylbenzylmethyl ether, p-vinylbenzylmethyl ether, o-vinylbenzylglycidyl ether, m-vinylbenzylglycidyl ether and p-vinylbenzylglycidyl ether; indenenes such as indene and 1-methylindene; 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, 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 and 2-hydroxy-3-phenoxypropyl (meth)acrylate; unsaturated aminoalkyl carboxylates such as 2-aminoethyl (meth)acrylate, 2-dimethylaminoethyl (meth)acrylate, 2-aminopropyl (meth)acrylate, 2-dimethylaminopropyl (meth)acrylate, 3-aminopropyl (meth)acrylate and 3-dimethylaminopropyl (meth)acrylate; unsaturated glycidyl carboxylates such as glycidyl (meth)acrylate; vinyl cyanide compounds such as (meth)acrylonitrile, α -chloroacrylonitrile and vinylidene cyanide; unsaturated amides such as (meth)acrylamide, α -chloroacrylamide and N-2-hydroxyethyl (meth)acrylamide; unsaturated imides such as maleimide, N-phenylmaleimide and N-cyclohexylmaleimide; vinyl carboxylates such as vinyl acetate, vinyl propionate, vinyl butyrate and vinyl benzoate; unsaturated ethers such as vinyl methyl ether, vinyl ethyl ether and allyl glycidyl ether; aliphatic conjugated dienes such as 1,3-butadiene, isoprene and chloroprene; and macromonomers having a mono(meth)acryloyl group at a terminal of a polymer molecular chain such as polystyrene, polymethyl (meth)acrylate, poly-n-butyl (meth)acrylate and polysiloxane.

Out of these other unsaturated compounds (a3), styrene, methyl (meth)acrylate, n-propyl (meth)acrylate, i-propyl (meth)acrylate, n-butyl (meth)acrylate, i-butyl (meth)acrylate, benzyl (meth)acrylate and N-phenylmaleimide are preferred from the viewpoint of copolymerization reactivity and the solubility in an alkali aqueous solution of the obtained polymer (A).

In the alkali-soluble resin $[\alpha]$, the other unsaturated compounds (a3) may be used alone or in combination of two or more.

5 In the alkali-soluble resin $[\alpha]$, the content of a recurring unit derived from the other unsaturated compound (a3) is preferably 10 to 70 wt%, more preferably 20 to 50 wt%, particularly preferably 30 to 50 wt%. When the content of the recurring unit derived from the other unsaturated compound (a3) is lower than 10 wt%, the storage stability
10 of the polymer obtained from a reaction with the unsaturated isocyanate compound (1) may lower and when the content is higher than 70 wt%, the solubility in an alkali developer of the polymer may lower.

The alkali-soluble resin $[\alpha]$ can be manufactured, for
15 example, by polymerizing the unsaturated carboxylic acid compound (a1), the hydroxyl group-containing unsaturated compound (a2) and the other unsaturated compound (a3) in a suitable solvent in the presence of a radical polymerization initiator.

20 Examples of the solvent used for the above polymerization include alcohols such as methanol, ethanol, n-propanol and i-propanol; ethers such as tetrahydrofuran and dioxane; ethylene glycol monoalkyl ethers such as ethylene glycol monomethyl ether, ethylene glycol monoethyl
25 ether, ethylene glycol mono-n-propyl ether and ethylene glycol mono-n-butyl ether; ethylene glycol monoalkyl ether acetates such as ethylene glycol monomethyl ether acetate, ethylene glycol monoethyl ether acetate, ethylene glycol mono-n-propyl ether acetate and ethylene glycol mono-n-butyl
30 ether acetate; ethylene glycol monoalkyl ether propionates such as ethylene glycol monomethyl ether propionate, ethylene glycol monoethyl ether propionate, ethylene glycol mono-n-propyl ether propionate and ethylene glycol mono-n-butyl ether propionate; diethylene glycol alkyl

ethers such as diethylene glycol monomethyl ether, diethylene glycol monoethyl ether, diethylene glycol dimethyl ether, diethylene glycol diethyl ether and diethylene glycol methyl ethyl ether; propylene glycol

5 monoalkyl ethers such as propylene glycol monomethyl ether, propylene glycol monoethyl ether, propylene glycol mono-n-propyl ether and propylene glycol mono-n-butyl ether; dipropylene glycol alkyl ethers such as dipropylene glycol monomethyl ether, dipropylene glycol monoethyl ether,

10 dipropylene glycol dimethyl ether, dipropylene glycol diethyl ether and dipropylene glycol methyl ethyl ether; propylene glycol monoalkyl ether acetates such as propylene glycol monomethyl ether acetate, propylene glycol monoethyl ether acetate, propylene glycol mono-n-propyl ether acetate

15 and propylene glycol mono-n-butyl ether acetate; propylene glycol monoalkyl ether propionates such as propylene glycol monomethyl ether propionate, propylene glycol monoethyl ether propionate, propylene glycol mono-n-propyl ether propionate and propylene glycol mono-n-butyl ether

20 propionate; aromatic hydrocarbons such as toluene and xylene;

ketones such as methyl ethyl ketone, 2-pentanone, 3-pentanone, cyclohexanone and 4-hydroxy-4-methyl-2-pentanone; alkyl alkoxypropionates

25 such as methyl 2-methoxypropionate, ethyl 2-methoxypropionate, n-propyl 2-methoxypropionate, n-butyl 2-methoxypropionate, methyl 2-ethoxypropionate, ethyl 2-ethoxypropionate, n-propyl 2-ethoxypropionate, n-butyl 2-ethoxypropionate, methyl 2-n-propoxypropionate, ethyl

30 2-n-propoxypropionate, n-propyl 2-n-propoxypropionate, n-butyl 2-n-propoxypropionate, methyl 2-n-butoxypropionate, ethyl 2-n-butoxypropionate, n-propyl 2-n-butoxypropionate, n-butyl 2-n-butoxypropionate, methyl 3-methoxypropionate, ethyl 3-methoxypropionate, n-propyl

3-methoxypropionate, n-butyl 3-methoxypropionate, methyl
 3-ethoxypropionate, ethyl 3-ethoxypropionate, n-propyl
 3-ethoxypropionate, n-butyl 3-ethoxypropionate, methyl
 3-n-propoxypropionate, ethyl 3-n-propoxypropionate,
 5 n-propyl 3-n-propoxypropionate, n-butyl
 3-n-propoxypropionate, methyl 3-n-butoxypropionate, ethyl
 3-n-butoxypropionate, n-propyl 3-n-butoxypropionate and
 n-butyl 3-n-butoxypropionate; and other esters such as
 methyl acetate, ethyl acetate, n-propyl acetate, n-butyl
 10 acetate, methyl hydroxyacetate, ethyl hydroxyacetate,
 n-propyl hydroxyacetate, n-butyl hydroxyacetate,
 4-methoxybutyl acetate, 3-methoxybutyl acetate,
 2-methoxybutyl acetate, 3-ethoxybutyl acetate,
 3-propoxybutyl acetate, methyl lactate, ethyl lactate,
 15 n-propyl lactate, n-butyl lactate, methyl
 2-hydroxy-2-methylpropionate, ethyl
 2-hydroxy-2-methylpropionate, methyl 3-hydroxypropionate,
 ethyl 3-hydroxypropionate, n-propyl 3-hydroxypropionate,
 n-butyl 3-hydroxypropionate, methyl
 20 2-hydroxy-3-methylbutanoate, methyl methoxyacetate, ethyl
 methoxyacetate, n-propyl methoxyacetate, n-butyl
 methoxyacetate, methyl ethoxyacetate, ethyl ethoxyacetate,
 n-propyl ethoxyacetate, n-butyl ethoxyacetate, methyl
 n-propoxyacetate, ethyl n-propoxyacetate, n-propyl
 25 n-propoxyacetate, n-butyl n-propoxyacetate, methyl
 n-butoxyacetate, ethyl n-butoxyacetate, n-propyl
 n-butoxyacetate and n-butyl n-butoxyacetate.

Out of these solvents, diethylene glycol alkyl ethers,
 propylene glycol monoalkyl ether acetates, alkyl
 30 alkoxypropionates and acetates are preferred.

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

The above radical polymerization initiator is not
 particularly limited. Examples of the radical

polymerization initiator include azo compounds such as
2,2'-azobisisobutyronitrile,
2,2'-azobis-(2,4-dimethylvaleronitrile),
2,2'-azobis-(4-methoxy-2,4-dimethylvaleronitrile),
5 4,4'-azobis(4-cyanovaleric acid),
dimethyl-2,2'-azobis(2-methylpropionate) and
2,2'-azobis(4-methoxy-2,4-dimethylvaleronitrile); organic
peroxides such as benzoyl peroxide, lauroyl peroxide,
t-butylperoxypivalate and
10 1,1-bis(t-butylperoxy)cyclohexane; and hydrogen peroxide.

When a peroxide is used as the radical polymerization
initiator, it may be used in combination with a reducing agent
as a redox initiator.

These radical polymerization initiators may be used
15 alone or in combination of two or more.

The weight average molecular weight in terms of
polystyrene (to be referred to as "Mw" hereinafter) measured
by gel permeation chromatography (GPC, elution solvent:
tetrahydrofuran) of the alkali-soluble resin [α] in the
20 present invention is preferably 3,000 to 300,000, more
preferably 5,000 to 100,000.

The number average molecular weight in terms of
polystyrene (to be referred to as "Mn" hereinafter) measured
by gel permeation chromatography (GPC, elution solvent:
25 tetrahydrofuran) of the alkali-soluble resin [α] in the
present invention is preferably 3,000 to 60,000, more
preferably 5,000 to 25,000.

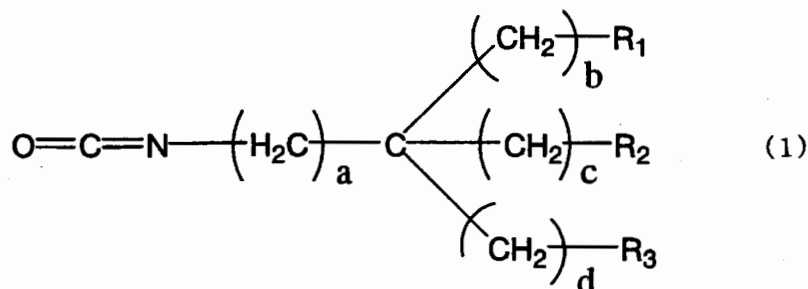
When Mw is lower than 3,000, the alkali developability
and film residual rate of the obtained film may deteriorate,
30 or the pattern shape and heat resistance may be impaired.
When Mw is higher than 300,000, the resolution may lower,
or the pattern shape may be impaired.

The polymer (A) in the present invention is obtained
by reacting the alkali-soluble resin [α] with the unsaturated

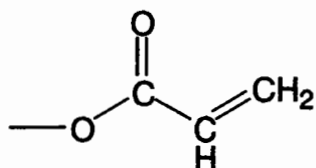
isocyanate compound (1).

The thus obtained alkali-soluble resin [α] may be used for the manufacture of the polymer (A) as a polymer solution directly or after it is separated from the solution.

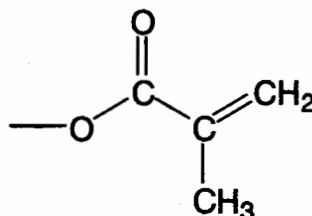
5 The unsaturated isocyanate compound (1) is represented by the following formula (1):



wherein R_1 , R_2 and R_3 are each independently a hydrogen atom or a group represented by the following formula (I) or (II),
 10 with the proviso that R_1 , R_2 and R_3 cannot be hydrogen atoms at the same time, and a , b , c and d are each independently an integer of 0 to 12.



(I)



(II)

Examples of the unsaturated isocyanate compound (1)
 15 include acryl isocyanates such as
 1,1-(bisacryloyloxymethyl)ethyl isocyanate,
 1,1-(bisacryloyloxyethyl)ethyl isocyanate and
 1,1-(bisacryloyloxypropyl)ethyl isocyanate; and methacryl
 isocyanates such as 1,1-(bismethacryloyloxymethyl)ethyl
 20 isocyanate, 1,1-(bismethacryloyloxyethyl)ethyl isocyanate
 and 1,1-(bismethacryloyloxypropyl)ethyl isocyanate.

Out of these unsaturated isocyanate compounds (1),
 1,1-(bisacryloyloxymethyl)ethyl isocyanate and

1,1-(bismethacryloyloxymethyl)ethyl isocyanate are preferred from the viewpoint of reactivity with the alkali-soluble resin [α].

Commercially available products of the above
5 1,1-(bisacryloyloxymethyl)ethyl isocyanate include Karenz BEI (trade name of Showa Denko K.K.).

In the reaction with the alkali-soluble resin [α], the unsaturated isocyanate compounds (1) may be used alone or in combination of two or more.

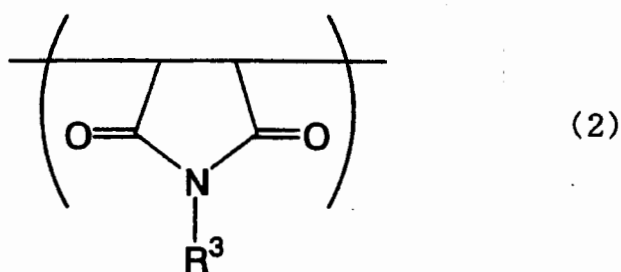
10 In the present invention, the reaction between the alkali-soluble resin [α] and the unsaturated isocyanate compound (1) can be carried out by adding the unsaturated isocyanate compound (1) dropwise to a solution of the alkali-soluble resin [α] containing a catalyst such as
15 di-n-butyltin dilaurate (IV) and a polymerization inhibitor such as p-methoxyphenol at normal temperature or at an increased temperature under agitation.

The amount of the unsaturated isocyanate compound (1) for the manufacture of the polymer (A) is preferably 0.1 to
20 90 wt%, more preferably 10 to 80 wt%, particularly preferably 25 to 75 wt% based on the amount of the hydroxyl group-containing unsaturated compound (a2) used for the synthesis of the alkali-soluble resin [α]. When the amount of the unsaturated isocyanate compound (1) is smaller than
25 0.1 wt%, the effect of improving sensitivity and elasticity is small and when the amount is larger than 90 wt%, an unreacted unsaturated isocyanate compound (1) remains and the storage stability of the obtained polymer solution or the radiation sensitive resin composition may lower.

30 The polymer (A) contains a carboxyl group and/or a carboxylic anhydride group and a polymerizable unsaturated bond, has suitable solubility in an alkali developer and can be easily cured by heating without using a special curing agent. The radiation sensitive resin composition

containing the polymer (A) does not produce an undissolved product or scum on the pattern edge at the time of development and provides pixels and a black matrix without a missing part or undercut of the pattern edge even when the amount of exposure is small.

Preferably, the polymer (A) has a structure represented by the following formula (2):



wherein R³ is an alkyl group having 1 to 12 carbon atoms or aryl group having 6 to 12 carbon atoms.

The polymer (A) having a structure represented by the above formula (2) can be obtained by using N-phenylmaleimide or N-cyclohexylmaleimide in at least part of the other unsaturated compound (a3) in the synthesis of the alkali-soluble resin [α].

(B) colorant

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

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

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

5 (C.I.) numbers:

C.I. Pigment Yellow 1, C.I. Pigment Yellow 3, C.I. Pigment Yellow 12, C.I. Pigment Yellow 13, C.I. Pigment Yellow 14, C.I. Pigment Yellow 15, C.I. Pigment Yellow 16, C.I. Pigment Yellow 17, C.I. Pigment Yellow 20, C.I. Pigment Yellow 24,
10 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
15 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.
20 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,
25 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
30 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,

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
5 Violet 23, C.I. Pigment Violet 29, C.I. Pigment Violet 32,
C.I. Pigment Violet 36 and C.I. Pigment Violet 38;

C.I. Pigment Red 1, C.I. Pigment Red 2, C.I. Pigment Red 3,
C.I. Pigment Red 4, C.I. Pigment Red 5, C.I. Pigment Red 6,
C.I. Pigment Red 7, C.I. Pigment Red 8, C.I. Pigment Red 9,
10 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
15 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.
20 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
25 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.
30 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, 5 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 10 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 15 C.I. Pigment Black 1 and C.I. Pigment Black 7.

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

Examples of the above inorganic pigment include 20 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.

25 In the present invention, the above organic pigments and inorganic pigments may be used alone or in combination of two or more, respectively, or both may be used in combination. For example, one or more organic pigments are preferably used to form pixels, and two or more organic 30 pigments and/or carbon black are preferably used to form a black matrix.

In the present invention, the surface of each particle of the pigment may be optionally modified by a polymer before use. Examples of the polymer used to modify the surface of

each particle of the pigment include polymers disclosed by JP-A 8-259876 and commercially available polymers and oligomers for dispersing a pigment.

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

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

Examples of the surfactant include polyoxyethylene
10 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
15 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,
20 Co., Ltd.), Polyflow (of Kyoisha Chemical 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.), Disperbyk (of BYK-Chemie Japan KK), and Solsperse (of Seneka Co., Ltd.).

25 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.

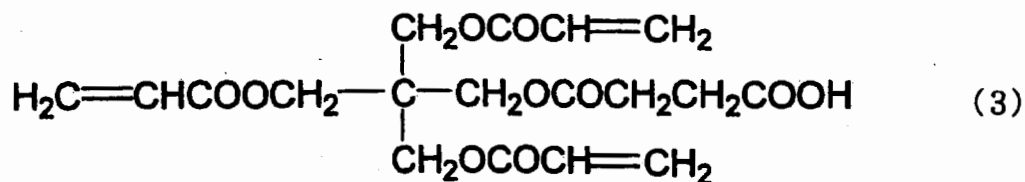
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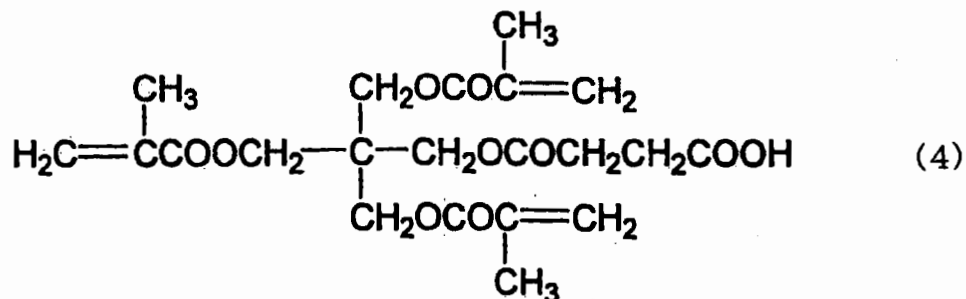
(C) polyfunctional monomer

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

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
 5 polypropylene glycol; poly(meth)acrylates of a polyhydric alcohol having 3 or more hydroxyl groups such as glycerin, trimethylolpropane, pentaerythritol and dipentaerythritol and dicarboxylic acid modified products thereof; oligo(meth)acrylates such as polyester, epoxy resin,
 10 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
 15 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
 20 thereof are preferred, as exemplified by trimethylolpropane triacrylate, trimethylolpropane trimethacrylate, pentaerythritol triacrylate, pentaerythritol trimethacrylate, pentaerythritol tetraacrylate, pentaerythritol tetramethacrylate, dipentaerythritol
 25 pentaacrylate, dipentaerythritol pentamethacrylate, dipentaerythritol hexaacrylate, dipentaerythritol hexamethacrylate and compounds represented by the following formulas (3) and (4).





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

The above polyfunctional monomers may be used alone
 10 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 weight of the polymer (A). When the amount of the
 15 polyfunctional monomer is smaller than 5 parts by weight, the strength and surface smoothness of the colored layer may deteriorate and when the amount is larger than 500 parts by weight, alkali developability may lower, or a stain or the film residue may be produced on the substrate and light
 20 screening layer of an unexposed portion.

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

Examples of the above monofunctional monomer include
 25 compounds like as the above carboxyl group-containing unsaturated monomers and copolymerizable unsaturated monomers enumerated for the above polymer (A),
 N-(meth)acryloylmorpholine, N-vinylpyrrolidone,
 N-vinyl-ε-caprolactam and commercially available M-5600

(trade name, manufactured by 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 [α]. When the above 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 and light screening layer of an unexposed portion.

(D) Photopolymerization initiator

The photopolymerization initiator in the present invention is a compound which can form active species capable of initiating the polymerization of the above polyfunctional monomer (C) and the optional monofunctional monomer upon exposure to radiation (to be referred to as "exposure" hereinafter) such as visible radiation, ultraviolet radiation, far ultraviolet radiation, electron radiation or X-radiation.

(E) Examples of the Photopolymerization initiator

include a biimidazole compound, benzoin compound, acetophenone compound, benzophenone compound, α-diketone

compound, polynuclear quinone compound, xanthone compound, phosphine compound and triazine compound.

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

10 Examples of the above biimidazole compound include
 2,2'-bis(2-chlorophenyl)-4,4',5,5'-
 tetrakis(4-ethoxycarbonylphenyl)-1,2'-biimidazole,
 2,2'-bis(2-bromophenyl)-4,4',5,5'-
 tetrakis(4-ethoxycarbonylphenyl)-1,2'-biimidazole,
 15 2,2'-bis(2-chlorophenyl)-4,4',5,5'-tetraphenyl-1,2'-
 biimidazole,
 2,2'-bis(2,4-dichlorophenyl)-4,4',5,5'-tetraphenyl-1,2'-
 biimidazole,
 2,2'-bis(2,4,6-trichlorophenyl)-4,4',5,5'-tetraphenyl-1,
 20 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
 25 2,2'-bis(2,4,6-tribromophenyl)-4,4',5,5'-tetraphenyl-
 1,2'-biimidazole.

Out of these biimidazole compounds,
 2,2'-bis(2-chlorophenyl)-4,4',5,5'-tetraphenyl-1,2'-
 biimidazole,
 30 2,2'-bis(2,4-dichlorophenyl)-4,4',5,5'-tetraphenyl-1,2'-
 biimidazole and
 2,2'-bis(2,4,6-trichlorophenyl)-4,4',5,5'-tetraphenyl-1,
 2'-biimidazole are preferred, and
 2,2'-bis(2-chlorophenyl)-4,4',5,5'-tetraphenyl-1,2'-

biimidazole is particularly preferred.

The above biimidazole compounds have excellent solubility in a solvent, do not produce foreign matter such as an undissolved product and a precipitate, have high
5 sensitivity, fully promote a curing reaction by exposure with a small amount of energy, provide high contrast and do not cause a curing reaction in an unexposed portion. Therefore, the coating film obtained after exposure is clearly divided into a cured portion insoluble in a developer and an uncured
10 portion having high solubility in a developer, thereby making it possible to form a high-definition pattern array having a predetermined pixel pattern and a predetermined black matrix pattern without an undercut.

15 - hydrogen donor -

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

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

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

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

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

hydrogen donor" hereinafter).

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

A detailed description is subsequently given of the
5 hydrogen donor.

The mercaptan hydrogen donor may have at least one benzene ring or hetero ring, or both of them. When it has two or more of the rings, a fused ring may or may not be formed.

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

Further, the mercaptan hydrogen donor may be
20 substituted by a carboxyl group, substituted or nonsubstituted alkoxy carbonyl group, substituted or nonsubstituted phenoxy carbonyl group or nitrile group at a position other than the mercapto group(s).

Examples of this mercaptan hydrogen donor include
25 2-mercaptobenzothiazole, 2-mercaptobenzoxazole, 2-mercaptobenzoimidazole, 2,5-dimercapto-1,3,4-thiadiazole and 2-mercapto-2,5-dimethylaminopyridine.

Out of these mercaptan hydrogen donors,
30 2-mercaptobenzothiazole and 2-mercaptobenzoxazole are preferred, and 2-mercaptobenzothiazole is particularly preferred.

The amine hydrogen donor may have at least one benzene ring or hetero ring, or both of them. When it has two or

more of the rings, a fused ring may or may not be formed.

At least one amino group of the amine hydrogen donor may be substituted by an alkyl group or substituted alkyl group. The amine hydrogen donor may be substituted by a
5 carboxyl group, substituted or nonsubstituted alkoxy carbonyl group, substituted or nonsubstituted phenoxy carbonyl group or nitrile group at a position other than the amino group(s).

Examples of the above amine hydrogen donor include
10 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
15 4-dimethylaminobenzonitrile.

Out of these amine hydrogen donors,
4,4'-bis(dimethylamino)benzophenone and
4,4'-bis(diethylamino)benzophenone are preferred, and
4,4'-bis(diethylamino)benzophenone is particularly
20 preferred. 4,4'-bis(dimethylamino)benzophenone and
4,4'-bis(diethylamino)benzophenone can serve as an optical
radical initiator by itself even when the biimidazole
compound is not existent.

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

30 Preferred examples of the combination of the mercaptan
hydrogen donor and the amine hydrogen donor include a
combination of 2-mercaptobenzothiazole/
4,4'-bis(dimethylamino)benzophenone, combination of
2-mercaptobenzothiazole/

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

The weight ratio of the mercaptan hydrogen donor to
 the amine hydrogen donor in the combination of the mercaptan
 hydrogen donor and the amine hydrogen donor is preferably
 15 1:1 to 1:4, more preferably 1:1 to 1:3.

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

Examples of the above acetophenone compound include
 20 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-
 25 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 compound include
 30 4,4'-bis(dimethylamino)benzophenone and
 4,4'-bis(diethylamino)benzophenone.

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

Examples of the above polynuclear quinine compound

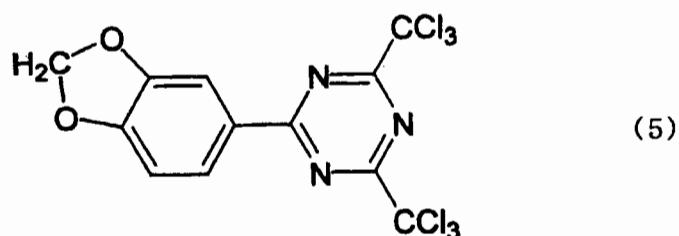
include anthraquinone, 2-ethylanthraquinone, 2-t-butylanthraquinone and 1,4-naphthoquinone.

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

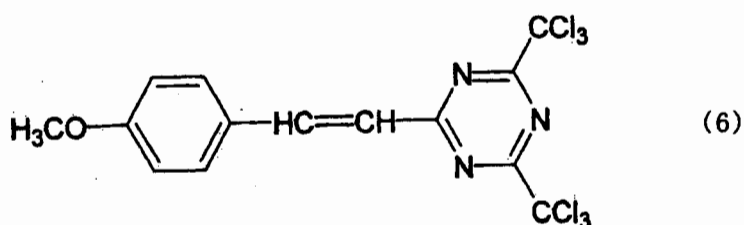
5 Examples of the above phosphine compound include bis(2,4,6-trimethylbenzoyl)phenylphosphine oxide and 2,4,6-trimethylbenzoyldiphenylphosphine oxide.

Examples of the above triazine compound include compounds having a halomethyl group such as

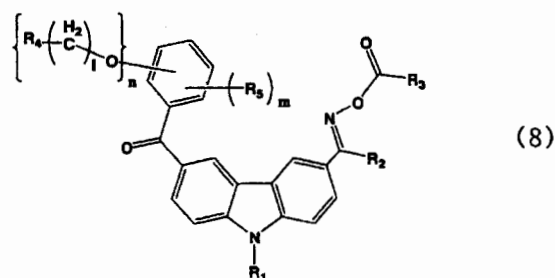
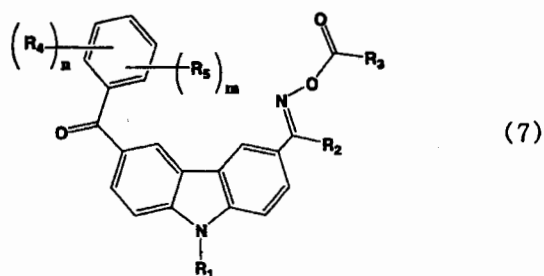
10 2,4,6-tris(trichloromethyl)-s-triazine,
 2-methyl-4,6-bis(trichloromethyl)-s-triazine,
 2-[2-(furan-2-yl)ethenyl]-4,6-bis(trichloromethyl)-s-triazine,
 2-[2-(5-methylfuran-2-yl)ethenyl]-4,6-bis(trichloromethyl)-s-triazine,
 15 2-[2-(4-diethylamino-2-methylphenyl)ethenyl]-4,6-bis(trichloromethyl)-s-triazine,
 2-[2-(3,4-dimethoxyphenyl)ethenyl]-4,6-bis(trichloromethyl)-s-triazine,
 2-(4-methoxyphenyl)-4,6-bis(trichloromethyl)-s-triazine,
 20 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 (5) and (6).



25



The above O-acyloxime compound is, for example, a compound represented by the following formula (7) or (8).



In the above formulas (7) and (8), R_1 is a linear or branched alkyl group having 1 to 20 carbon atoms, cycloalkyl group having 3 to 8 carbon atoms or phenyl group, R_2 and R_3 are each independently a hydrogen atom, linear or branched alkyl group having 1 to 20 carbon atoms, cycloalkyl group having 3 to 8 carbon atoms, phenyl group (may be substituted by at least one of an alkyl group having 1 to 6 carbon atoms, alkoxy group having 1 to 6 carbon atoms, phenyl group and halogen atom) or alicyclic group having 7 to 20 carbon atoms (excluding the above cycloalkyl group), R_4 is a group selected from hydrogen atom, oxygen-containing heterocyclic group having 4 to 20 carbon atoms, nitrogen-containing heterocyclic group having 4 to 20 carbon atoms and sulfur-containing heterocyclic group having 4 to 20 carbon atoms, R_5 is a hydrogen atom, alkyl group having 1 to 12 carbon atoms or alkoxy group having 1 to 12 carbon atoms, n is an integer of 1 to 5, m is an integer of 0 to 5, and l is an integer of 0 to 6, with the proviso that $n + m \leq 5$.

In the above formulas (7) and (8), examples of the linear or branched alkyl group having 1 to 20 carbon atoms

and the cycloalkyl group having 3 to 8 carbon atoms represented by R_1 include methyl group, ethyl group, n-propyl group, i-propyl group, n-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 or branched alkyl group having 1 to 20 carbon atoms and the cycloalkyl group having 3 to 8 carbon atoms represented by R_2 and R_3 include methyl group, ethyl group, n-propyl group, i-propyl group, n-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.

The alkyl group having 1 to 6 carbon atoms as the substituent for the phenyl group represented by R_2 and R_3 may be linear, branched or cyclic, as exemplified by methyl group, ethyl group, n-propyl group, i-propyl group, n-butyl group, sec-butyl group, t-butyl group, n-pentyl group, n-hexyl group, cyclopentyl group and cyclohexyl group.

The alkoxy group having 1 to 6 carbon atoms may be linear, branched or cyclic, as exemplified by 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 alicyclic group having 7 to 20 carbon atoms (excluding the above cycloalkyl group) include bicycloalkyl group, tricycloalkyl group, spiroalkyl group, ter-cycloalkyl group, terpene skeleton-containing group and adamantyl skeleton-containing group.

Examples of the nitrogen-containing heterocyclic group having 4 to 20 carbon atoms, oxygen-containing heterocyclic group having 4 to 20 carbon atoms and sulfur-containing heterocyclic group having 4 to 20 carbon

atoms represented by R_4 include thioranyl group, azepinyl group, dihydroazepinyl group, dioxoranyl group, triazinyl group, oxathianyl group, thiazolyl group, oxadiazinyl group, dioxaindanyl group, dihyanaphthalenyl group, furanyl group, thiophenyl group, pyrrolyl group, oxazolyl group, isooxazolyl group, thiazolyl group, isothiazolyl group, pyrazolyl group, furazanyl group, pyranyl group, pyridinyl group, pyridazinyl group, pyrimidyl group, pyrazinyl group, pyrrolinyl group, morphonyl group, piperazinyl group, quinuclidinyl group, indolyl group, isoindolyl group, benzofuranyl group, benzothiophenyl group, indolizinyl group, chromenyl group, quinolinyl group, isoquinolinyl group, purinyl group, quinazolinyl group, cinnolinyl group, phthalazinyl group, pteridinyl group, carbazolyl group, acridinyl group, phenanthridinyl group, thioxanthenyl group, phenazinyl group, phenothiazinyl group, phenoxathinyl group, phenoxazinyl group, thianthrenyl group, tetrahydrofuranyl group and tetrahydropyranyl group. Out of these, tetrahydrofuranyl group and tetrahydropyranyl group are preferred.

The alkyl group having 1 to 12 carbon atoms represented by R_5 may be linear, branched or cyclic, as exemplified by methyl group, ethyl group, n-propyl group, i-propyl group, n-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.

The alkoxy group having 1 to 12 carbon atoms may be linear, branched or cyclic, as exemplified by methoxy group, ethoxy group, n-propoxy group, i-propoxy group, n-butoxy group, t-butoxy group and n-pentyloxy group.

Out of these, methyl group, ethyl group, n-propyl group, i-propyl group, n-butyl group, methoxy group and ethoxy group are particularly preferred.

n is preferably 1. m is preferably 0, 1 or 2, particularly preferably 1. l is preferably 0, 1 or 2, particularly preferably 1.

Illustrative examples of the O-acyloxime compound
 5 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,
 10 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]-
 15 ethan-1-oneoxime-O-benzoate,
 1-[9-ethyl-6-(2-methylbenzoyl)-9.H.-carbazol-3-yl]-
 ethan-1-oneoxime-O-acetate,
 ethanone,1-[9-ethyl-6-(2-methyl-4-
 tetrahydrofuranylmethoxybenzoyl)-9.H.-carbazol-3-yl]-,1-
 20 (O-acetyloxime), ethanone,1-[9-ethyl-6-(2-methyl-4-
 tetrahydropyranylmethoxybenzoyl)-9.H.-carbazol-3-yl]-,1-
 (O-acetyloxime), ethanone,1-[9-ethyl-6-(2-methyl-5-
 tetrahydrofuranylmethoxybenzoyl)-9.H.-carbazol-3-yl]-,1-
 (O-acetyloxime) and ethanone,1-[9-ethyl-6-(2-methyl-5-
 25 tetrahydropyranylmethoxybenzoyl)-9.H.-carbazol-3-yl]-,1-
 (O-acetyloxime).

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

The total amount of the photopolymerization initiators
 30 in the present 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 based on 100 parts by weight of total of the component (C) and a

monofunctional monomer optionally used. When the total amount of the photopolymerization initiators is smaller than 0.01 part by weight, it may be difficult to obtain a pattern array having a predetermined pixel pattern and a
5 predetermined black matrix pattern due to incomplete curing by exposure. When the total amount is larger than 200 parts by weight, the formed colored layer may fall off from the substrate during development and a stain or the film residue may be produced on the substrate and light screening layer
10 of an unexposed portion.

In the present invention, the above photopolymerization initiator may be used in conjunction with at least one of a sensitizer, curing accelerator and polymer optical crosslinking/sensitizing agent as required.

15

- additives -

The radiation sensitive composition for color filters of the present invention comprises the above components (A) to (D) as essential ingredients and optionally other
20 additives.

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
25 suppress the production of the undissolved product residue after development.

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

30

Examples of the above aliphatic carboxylic acid include monocarboxylic acids such as formic acid, acetic acid, propionic acid, butyric acid, valeric acid, pivalic acid, caproic acid, diethylacetic acid, ethantic acid and caprylic acid; dicarboxylic acids such as oxalic acid, malonic acid,

succinic acid, glutaric acid, adipic acid, pimelic acid, suberic acid, azelaic acid, sebacic acid, brassylic acid, methylmalonic acid, ethylmalonic acid, dimethylmalonic acid, methylsuccinic acid, tetramethylsuccinic acid,
5 cyclohexanedicarboxylic acid, itaconic acid, citraconic acid, maleic acid, fumaric acid and mesaconic acid; and tricarboxylic acids such as tricarballic acid, aconitic acid and camphoronic acid.

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

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

25 Out of these organic acids, aliphatic dicarboxylic acids are preferred, and malonic acid, adipic acid, itaconic acid, citraconic acid, fumaric acid and mesaconic acid are particularly preferred as the aliphatic carboxylic acid from the viewpoints of alkali solubility, solubility in a solvent
30 which will be described hereinafter and the prevention of a stain or the film residue on the substrate and 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 to the substrate of the formed colored layer may lower.

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

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

tricyclohexylamine; mono(cyclo)alkanolamines such as
 2-aminoethanol, 3-amino-1-propanol, 1-amino-2-propanol,
 4-amino-1-butanol, 5-amino-1-pentanol, 6-amino-1-hexanol
 and 4-amino-1-cyclohexanol; di(cyclo)alkanolamines such as
 5 diethanolamine, di-n-propanolamine, di-i-propanolamine,
 di-n-butanolamine, di-i-butanolamine, di-n-pentanolamine,
 di-n-hexanolamine and di(4-cyclohexanol)amine;
 tri(cyclo)alkanolamines such as triethanolamine,
 tri-n-propanolamine, tri-i-propanolamine,
 10 tri-n-butanolamine, tri-i-butanolamine,
 tri-n-pentanolamine, tri-n-hexanolamine and
 tri(4-cyclohexanol)amine; amino(cyclo)alkanediols such as
 3-amino-1,2-propanediol, 2-amino-1,3-propanediol,
 4-amino-1,2-butanediol, 4-amino-1,3-butanediol,
 15 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
 20 cycloalkane methanols such as 1-aminocyclopentane methanol,
 4-aminocyclopentane methanol, 1-aminocyclohexane methanol,
 4-aminocyclohexane methanol, 4-dimethylaminocyclopentane
 methanol, 4-diethylaminocyclopentane methanol,
 4-dimethylaminocyclohexane methanol and
 25 4-diethylaminocyclohexane methanol; and aminocarboxylic
 acids such as β -alanine, 2-aminobutyric acid, 3-aminobutyric
 acid, 4-aminobutyric acid, 2-aminoisobutyric acid,
 3-aminoisobutyric acid, 2-aminovaleric acid,
 5-aminovaleric acid, 6-aminocaproic acid,
 30 1-aminocyclopropanecarboxylic acid,
 1-aminocyclohexanecarboxylic acid and
 4-aminocyclohexanecarboxylic acid.

The above phenyl group-containing amine is, for
 example, a compound having an amino group directly bonded

to a phenyl group, or a compound having an amino group bonded to a phenyl group through a carbon chain.

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

Out of these organic amino compounds, 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 and 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.

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 to the substrate of the formed colored layer 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);
 5 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,
 10 N-(2-aminoethyl)-3-aminopropyltrimethoxysilane, 3-aminopropyltriethoxysilane, 3-glycidoxypropyltrimethoxysilane, 3-glycidoxypropyl-methyl-dimethoxysilane, 2-(3,4-epoxycyclohexyl)ethyltrimethoxysilane,
 15 3-chloropropyl-methyl-dimethoxysilane, 3-chloropropyltrimethoxysilane, 3-methacryloxypropyltrimethoxysilane or 3-mercaptopropyltrimethoxysilane; antioxidant such as 2,2'-thiobis(4-methyl-6-t-butylphenol) or
 20 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)
 25 or 2-phenylazo-4-methoxy-2,4-dimethylvaleronitrile.

Solvent

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

A suitable solvent may be selected and used as the solvent as far as it disperses or dissolves the components

(A) to (D) and additives constituting the radiation sensitive composition, does not react with these and has suitable volatility.

Examples of the solvent include (poly)alkylene glycol
 5 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,
 10 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,
 15 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,
 20 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,
 25 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,
 30 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.

10 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, 15 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 20 the viewpoints of solubility, pigment dispersibility and coatability.

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

25 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, 30 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 generally 5 to 50 wt%, 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 the color filter of the present invention.

A light screening layer is optionally formed on the surface of a substrate to define a portion for forming pixels, and a liquid radiation sensitive composition comprising, for example, a red pigment dispersed therein is applied to the substrate and prebaked to vaporize the solvent so as to form a coating film. This coating film is then exposed to radiation through a photomask, developed with an alkali developer to dissolve and remove an unexposed portion of the coating film and post-baked to form a red pixel array having a predetermined pixel pattern.

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 the radiation sensitive composition for forming a colored layer of the present invention.

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
5 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),
10 slit die coating, bar coating or ink jet coating may be employed. Out of these, spin coating and split die coating are preferred.

The thickness of the coating film after drying is preferably 0.1 to 10 μm , more preferably 0.2 to 8.0 μm ,
15 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 radiation and X-radiation. Out of these, radiation having a wavelength
20 of 190 to 450 nm is preferred.

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

The above alkali developer is preferably an aqueous solution of sodium carbonate, sodium hydroxide, potassium
25 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
30 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 color liquid crystal displays, color image pick-up devices, color sensors, etc.

Color liquid crystal display device or panel

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

As an example of the color liquid crystal display device or panel of the present invention, a color liquid crystal display device or panel 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 of the composition are given below.

- (1) a radiation sensitive composition for forming a colored layer, comprising (A) a polymer having an ethylenically unsaturated double bond in the side chain
- (2) the radiation sensitive composition for forming a colored layer (1), comprising at least one selected from the group consisting of trimethylolpropane triacrylate, pentaerythritol triacrylate and dipentaerythritol hexaacrylate as the polyfunctional monomer (C)
- (3) the radiation sensitive composition for forming a

- colored layer (2), comprising at least one selected from the group consisting of
- 2-methyl-4-(4-methylthiophenyl)-2-morpholino-1-propan-1-one,
- 5 4-(2-hydroxyethoxy)phenyl-(2-hydroxy-2-propyl)ketone, 2-benzyl-2-dimethylamino-1-(4-morpholinophenyl)butan-1-one,
- 2,2'-bis(2-chlorophenyl)-4,4',5,5'-tetraphenyl-1,2'-biimidazole,
- 10 2,2'-bis(2,4-dichlorophenyl)-4,4',5,5'-tetraphenyl-1,2'-biimidazole,
- 4,4'-bis(dimethylamino)benzophenone,
- 4,4'-bis(diethylamino)benzophenone,
- 2-mercaptobenzothiazole, 2-mercaptobenzooxazole,
- 15 2-mercaptobenzoimidazole,
- 1-[9-ethyl-6-(2-methylbenzoyl)-9.H.-carbazol-3-yl]-ethan-1-oneoxime-O-acetate,
- ethanone, 1-[9-ethyl-6-(2-methyl-4-tetrahydrofuranylmethoxybenzoyl)-9.H.-carbazol-3-yl]-, 1-(O-acetyloxime),
- 20 ethanone, 1-[9-ethyl-6-(2-methyl-4-tetrahydropyranylmethoxybenzoyl)-9.H.-carbazol-3-yl]-, 1-(O-acetyloxime),
- ethanone, 1-[9-ethyl-6-(2-methyl-5-tetrahydrofuranylmethoxybenzoyl)-9.H.-carbazol-3-yl]-, 1-(O-acetyloxime) and
- 25 ethanone, 1-[9-ethyl-6-(2-methyl-5-tetrahydropyranylmethoxybenzoyl)-9.H.-carbazol-3-yl]-, 1-(O-acetyloxime) as the photopolymerization initiator (D)
- 30 (4) the radiation sensitive composition for forming a colored layer (1), (2) or (3), comprising an organic pigment and/or carbon black as the colorant (B)

The preferred color filter (5) of the present invention comprises pixels and/or a black matrix made of the radiation

sensitive composition for forming a colored layer (1), (2), (3) or (4).

The preferred color liquid crystal display device or panel (6) of the present invention comprises the above color filter (5) and the more preferred color liquid crystal display device (7) of the present invention comprises pixels and/or a black matrix made of the radiation sensitive composition for forming a colored layer (1), (2), (3) or (4) on a thin film transistor substrate array.

10 As described above, when the radiation sensitive composition for forming a colored layer of the present invention comprises a polymer having an ethylenically unsaturated double bond in the side chain, even if it contains a pigment in a high concentration, no undissolved product remains on the substrate and light screening layer of an unexposed portion during development, scum is not produced on the edges of the pixel pattern and the black matrix pattern, and an excellent pixel pattern and black matrix pattern without a missing part or undercut of the pattern edge can
15 be formed with a small amount of exposure.

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.

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

30

Examples

The following examples are provided for the purpose of further illustrating the present invention but are in no way to be taken as limiting.

"Parts" and "%" in the following examples are based on weight.

Mw and Mn of each of the resins obtained in Synthetic Examples below were measured by gel permeation chromatography (GPC).

Equipment: GPC-101 (of Showa Denko K.K.)

Column: GPC-KF-801, GPC-KF-802, GPC-KF-803 and GPC-KF-804 were used in combination.

Moving phase: tetrahydrofuran containing 0.5 wt% of phosphoric acid

Synthetic Example 1

3 parts by weight of 2,2'-azobisisobutyronitrile and 200 parts by weight of propylene glycol monomethyl ether acetate were fed to a flask equipped with a cooling tube and a stirrer, 15 parts by weight of methacrylic acid, 18.8 parts by weight of N-phenylmaleimide, 35 parts by weight of benzyl methacrylate, 11.2 parts by weight of styrene, 10 parts by weight of 2-hydroxyethyl methacrylate, 10 parts by weight of ω -carboxy-polycaprolactone monoacrylate and 5 parts by weight of α -methylstyrene dimer as a chain transfer agent and molecular weight control agent were then fed to the flask, the inside of the flask was substituted by nitrogen, and the reaction solution was heated at 80°C while it was stirred gently to be polymerized by maintaining that temperature for 3 hours. Thereafter, the reaction solution was further heated at 100°C, 0.5 part by weight of 2,2'-azobisisobutyronitrile was added, and polymerization was further continued for another 1 hour to obtain a resin solution (solid content of 33.0 wt%). The obtained resin had an Mw of 12,000 and an (Mw/Mn) ratio of 1.8. This resin was designated as alkali-soluble resin (α -1).

Thereafter, 10 parts by weight of 1,1-(bisacryloyloxymethyl)ethyl isocyanate (trade name of Karenz BEI, manufactured by Showa Denko K.K.) and 0.1 part

by weight of 4-methoxyphenol were added to the above alkali-soluble resin (α -1) solution and stirred at 40°C for 1 hour and at 60°C for 2 hours to carry out a reaction. The proceeding of the reaction between an isocyanate group
5 derived from 2-metahcryloyloxyethyl isocyanate and the hydroxyl group of the alkali-soluble resin (α -1) was confirmed by an IR (infrared ray absorption) spectrum. Along with the proceeding of the reaction, it was observed that a peak at around 2,270 cm^{-1} derived from the isocyanate group
10 of 1,1-(bisacryloyloxymethyl)ethyl isocyanate was decreasing. A polymer solution having a solid content of 35.0 wt% was obtained. This polymer was designated as polymer-1 (A).

15 Synthetic Example 2

3 parts by weight of 2,2'-azobisisobutyronitrile and 200 parts by weight of propylene glycol monomethyl ether acetate were fed to a flask equipped with a cooling tube and a stirrer, 13 parts by weight of methacrylic acid, 77 parts
20 by weight of benzyl methacrylate, 10 parts by weight of 2-hydroxyethyl methacrylate and 5 parts by weight of α -methylstyrene dimer as a chain transfer agent and molecular weight control agent were then fed to the flask, the inside of the flask was substituted by nitrogen, and the reaction
25 solution was heated at 80°C while it was stirred gently to be polymerized by maintaining that temperature for 3 hours. Thereafter, the reaction solution was further heated at 100°C, 0.5 part by weight of 2,2'-azobisisobutyronitrile was added, and polymerization was further continued for another 1 hour
30 to obtain a resin solution (solid content of 33.0 wt%). The obtained resin had an Mw of 17,000 and an (Mw/Mn) ratio of 2.5. This resin was designated as alkali-soluble resin (α -2).

Thereafter, 10 parts by weight of

1,1-(bisacryloyloxymethyl)ethyl isocyanate (trade name of Karenz BEI, manufactured by Showa Denko K.K.) and 0.1 part by weight of 4-methoxyphenol were added to the above alkali-soluble resin solution (α -2) and stirred at 40°C for 1 hour and at 60°C for 2 hours to carry out a reaction. The proceeding of the reaction between an isocyanate group derived from 1,1-(bisacryloyloxymethyl)ethyl isocyanate and the hydroxyl group of the alkali-soluble resin (α -2) was confirmed by an IR (infrared ray absorption) spectrum. Along with the proceeding of the reaction, it was observed that a peak at around 2,270 cm^{-1} derived from the isocyanate group of 1,1-(bisacryloyloxymethyl)ethyl isocyanate was decreasing. A polymer solution having a solid content of 35.0 wt% was obtained. This polymer was designated as polymer-2 (A).

Example 1

15 parts by weight of a mixture of C.I. Pigment Red 254/ C.I. Pigment Red 177 in a weight ratio of 80/20 as a colorant (B), 4 parts by weight (solid content) of Disperbyk-2001 as a dispersant, 6 parts by weight of a copolymer of methacrylic acid/ N-phenylmaleimide/ styrene/ benzyl methacrylate (copolymerization weight ratio = 20/30/20/30, $M_w = 9,500$, $M_n = 5,000$) and 75 parts by weight of propylene glycol monomethyl ether acetate as a solvent were mixed together by a bead mill to prepare a preliminary dispersion (R1).

Thereafter, 100 parts by weight of the preliminary dispersion (R1), 7.5 parts by weight of polymer-1 (A) synthesized in the above Synthetic Example 1 as a polymer (A), 7.5 parts by weight of dipentaerythritol hexaacrylate as a polyfunctional monomer (C), 0.5 part by weight of 2-benzyl-2-dimethylamino-1-(4-morpholinophenyl)butanone-1 as an photopolymerization initiator (D) and 150 parts by

weight of ethyl 3-ethoxypropionate and 25 parts by weight of propylene glycol monomethyl ether acetate as solvents were mixed together to prepare a radiation sensitive composition for color filters (R1-1).

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 and scum were not seen on the pixel pattern edge.

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

Comparative Example 1

15 (preparation of liquid composition and formation of colored layer)

A radiation sensitive composition (r1-1) was prepared in the same manner as in Example 1 except that the alkali-soluble resin (α -1) was used in place of the above
20 polymer-1 (A).

Thereafter, a pixel array having a red striped pixel pattern was formed on a substrate in the same manner as in Example 1 except that the radiation sensitive composition (r1-1) was used in place of the radiation sensitive
25 composition for color filters (R1-1).

<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 but a missing
30 part of the pixel pattern edge was seen.

When the section of the pixel pattern was observed through a scanning electron microscope (SEC), an undercut was seen.

Example 2

<preparation of liquid composition and formation of colored layer>

15 15 parts by weight of a mixture of C.I. Pigment Green 36/ C.I. Pigment Yellow 138/ C.I. Pigment Yellow 150 in a weight ratio of 50/40/10 as a colorant (B), 4 parts by weight (solid content) of Disperbyk-2001 as a dispersant, 5 parts by weight of a copolymer of methacrylic acid/
ω-carboxypolycaprolactone monoacrylate/
10 N-phenylmaleimide/ styrene/ benzyl methacrylate/ glycerol monomethacrylate (copolymerization weight ratio = 15/10/20/10/35/10, Mw = 6,000, Mn = 3,000) and 76 parts by weight of propylene glycol monomethyl ether acetate as a solvent were treated in the same manner as in Example 1 to
15 prepare a preliminary dispersion (G1).

Thereafter, 100 parts by weight of the preliminary dispersion (G1), 7 parts by weight of polymer-2 (A) synthesized in the above Synthetic Example 2 as a polymer (A), 8 parts by weight of dipentaerythritol hexaacrylate as
20 a polyfunctional monomer (C), 0.5 part by weight of 2-benzyl-2-dimethylamino-1-(4-morpholinophenyl)butanone-1 as an photopolymerization initiator (D), 0.1 part by weight of malonic acid as an additive, and 125 parts by weight of 3-methoxybutyl acetate and 50 parts by weight of propylene
25 glycol methyl ether acetate as solvents were mixed together to prepare a radiation sensitive composition for color filters (G1-1).

Thereafter, a pixel array having a green striped pixel pattern was formed on a substrate in the same manner as in
30 Example 1 except that the radiation sensitive composition for color filters (G1-1) was used in place of the radiation sensitive composition for color filters (R1-1).

<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 but a missing part and scum were not seen on the pixel pattern edge.

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

Example 3

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

15 parts by weight of a mixture of C.I. Pigment Blue 15:6/ C.I. Pigment Violet 23 in a weight ratio of 95/5 as a colorant (B), 4 parts by weight (solid content) of Disperbyk-2001 as a dispersant, 5 parts by weight of a
15 copolymer of methacrylic acid/ ω -carboxypolycaprolactone monoacrylate/ N-phenylmaleimide/ styrene/ benzyl methacrylate/ glycerol monomethacrylate (copolymerization weight ratio = 15/10/20/10/35/10, Mw = 6,000, Mn = 3,000) and 76 parts by weight of propylene glycol monomethyl ether
20 acetate as a solvent were treated in the same manner as in Example 1 to prepare a preliminary dispersion (B1).

Thereafter, 100 parts by weight of the preliminary dispersion (B1), 6 parts by weight of polymer-1 (A) synthesized in the above Synthetic Example 1 as a polymer
25 (A), 9 parts by weight of dipentaerythritol hexaacrylate as a polyfunctional monomer (C), 0.5 part by weight of 2-methyl-(4-methylthiophenyl)-2-morpholino-1-propanone-1 as an photopolymerization initiator (D), 0.5 part by weight of A-60 (trade name, nonionic surfactant of Kao Corporation)
30 as an additive, and 150 parts by weight of ethyl 3-ethoxypropionate and 25 parts by weight of propylene glycol methyl ether acetate as solvents were mixed together to prepare a radiation sensitive composition for color filters (B1-1).

Thereafter, a pixel array having a blue striped pixel pattern was formed on a substrate in the same manner as in Example 1 except that the radiation sensitive composition for color filters (B1-1) was used in place of the radiation sensitive composition for color filters (R1-1).

<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 and scum were not seen on the pixel pattern edge.

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

15 Example 4

<preparation of liquid composition and formation of colored layer>

20 parts by weight of carbon black (manufactured by Mikuni Color, Ltd.) as a colorant (B), 2 parts by weight (solid content) of Disperbyk-2001 as a dispersant, 4 parts by weight of a copolymer of methacrylic acid/
 ω -carboxypolycaprolactone monoacrylate/
 N-phenylmaleimide/ styrene/ benzyl methacrylate/ glycerol monomethacrylate (copolymerization weight ratio =
 15/10/20/10/35/10, $M_w = 6,000$, $M_n = 3,000$) and 74 parts by weight of 3-methoxybutyl acetate were treated in the same manner as in Example 1 to prepare a preliminary dispersion (BK1).

Thereafter, 100 parts by weight of the preliminary dispersion (BK1), 4.5 parts by weight of polymer-2 (A) synthesized in the above Synthetic Example 2 as a polymer (A), 5.5 parts by weight of dipentaerythritol hexaacrylate as a polyfunctional monomer (C), 1 part by weight of 2-benzyl-2-dimethylamino-1-(4-morpholinophenyl)butanone-

1 as an photopolymerization initiator (D), 0.5 part by weight of A-60 (trade name, nonionic surfactant of Kao Corporation) as an additive, and 125 parts by weight of propylene glycol methyl ether acetate and 50 parts by weight of cyclohexanone as solvents were mixed together to prepare a composition for forming a colored layer (BK1-1).

Thereafter, a pixel array having a black striped pixel pattern was formed on a substrate in the same manner as in Example 1 except that the radiation sensitive composition for color filters (BK1-1) was used in place of the radiation sensitive composition for color filters (R1-1).

<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 and scum were not seen on the pixel pattern edge.

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

Example 5

<preparation of liquid composition and formation of colored layer>

20 parts by weight of carbon black (manufactured by Mikuni Color, Ltd.) as a colorant (B), 2 parts by weight (solid content) of Disperbyk-2001 as a dispersant, 4 parts by weight of a copolymer of methacrylic acid, ω -carboxypolycaprolactone monoacrylate, N-phenylmaleimide, styrene, benzyl methacrylate glycerol monomethacrylate (copolymerization weight ratio = 15/10/20/10/35/10, Mw = 6,000, Mn = 3,000) and 74 parts by weight of 3-methoxybutyl acetate were treated in the same manner as in Example 1 to prepare a preliminary dispersion (BK2).

Thereafter, 100 parts by weight of the preliminary

dispersion (BK2), 4.5 parts by weight of polymer-2 (A) synthesized in the above Synthetic Example 2 as a polymer (A), 5.5 parts by weight of dipentaerythritol hexaacrylate as a polyfunctional monomer (C), 1 part by weight of
5 1-[9-ethyl-6-(2-methylbenzoyl)-9.H.-carbazol-3-yl]-ethan-1-oneoxime-O-acetate as a photopolymerization initiator (D), 0.5 part by weight of A-60 (trade name, nonionic surfactant of Kao Corporation) as an additive, and 125 parts by weight of propylene glycol methyl ether acetate and 50
10 parts by weight of cyclohexanone as solvents were mixed together to prepare a composition for forming a colored layer (BK2-1).

Thereafter, a pixel array having a black striped pixel pattern was formed on a substrate in the same manner as in
15 Example 1 except that the radiation sensitive composition for color filters (BK2-1) was used in place of the radiation sensitive composition for color filters (R1-1).

<evaluation>

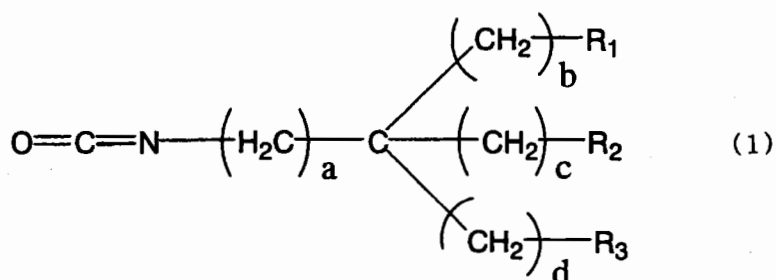
When the pixel array on the substrate was observed
20 through an optical microscope, the development residue was not seen on the substrate of an unexposed portion and a missing part and scum were not seen on the pixel pattern edge.

Further, it was confirmed that a finer pixel pattern than that of Example 4 could be formed and sensitivity was
25 improved.

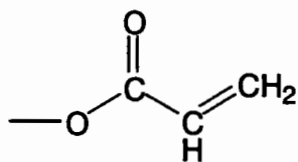
When the section of the pixel pattern was observed through a scanning electron microscope (SEM), no undercut was seen.

CLAIMS

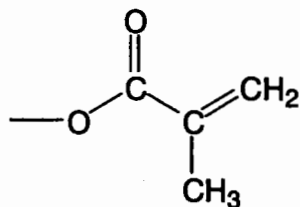
1. A polymer obtained by reacting a copolymer of (a1) an unsaturated carboxylic acid and/or an unsaturated carboxylic anhydride, (a2) a compound containing at least one hydroxyl group in the molecule and (a3) other unsaturated compound with an isocyanate compound represented by the following formula (1):



- wherein R_1 , R_2 and R_3 are each independently a hydrogen atom or a group represented by the following formula (I) or (II), with the proviso that R_1 , R_2 and R_3 cannot be hydrogen atoms at the same time, and a , b , c and d are each independently an integer of 0 to 12.



(I)



(II)

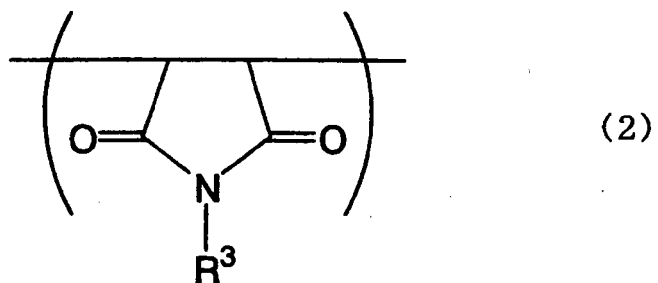
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2. A radiation sensitive composition for color filters, which comprises (A) the polymer of claim 1, (B) a colorant, (C) a polyfunctional monomer and (D) a photopolymerization initiator.

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3. The radiation sensitive composition for color filters according to claim 2, wherein the polymer (A) of claim 1 has a structure represented by the following formula (2) as a

structure derived from the other unsaturated compound (a3) :



wherein R_3 is an alkyl group having 1 to 12 carbon atoms or aryl group having 6 to 12 carbon atoms.

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4. A color filter formed from the radiation sensitive composition for color filters of claim 2 or 3.

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