

RADIATION SENSITIVE COMPOSITION FOR COLOR FILTERS, PROCESS FOR
PREPARING THE SAME, COLOR FILTER AND COLOR LIQUID CRYSTAL DISPLAY

Field of the Invention

5 The present invention relates to a radiation sensitive
composition for color filters, a color filter and a color liquid
crystal display. More specifically, it relates to a radiation
sensitive composition for color filters which is useful for the
manufacture of a color filter for use in transmission and
10 reflection color liquid crystal displays and color image pick-up
devices, a color filter having red pixels made of the radiation
sensitive composition for color filters, and a color liquid
crystal display comprising the color filter.

15 Description of the Prior Art

 As means of forming a color filter by using a colored
radiation sensitive composition, there is known a method in which
a coating film of the colored radiation sensitive composition
is formed on a substrate or a substrate comprising a light
20 screening layer having a desired pattern, exposed to radiation
through a mask having a desired pattern (to be referred to as
"exposure" hereinafter), developed with an alkali developer to
dissolve and remove an unexposed portion, and post-baked in a
clean over or on a hot plate to obtain color pixels (see JP-A
25 2-144502 and JP-A 3-53201) (the term "JP-A" as used herein means
an "unexamined published Japanese patent application").

 Since it is desired that a liquid crystal display device
comprising the above color filter should have high brightness,
demand for a color filter having high transmittance is now
30 growing.

 Along with the recent spread of digital video cameras and
high-vision TV's, demand for a color liquid crystal display device
having color density high enough to display a deep blue winter
sea or the bright red setting sun is rising. If the "blackness"

of a black display portion is not displayed clearly, an unclear blurred image is obtained. Therefore, to display high color density, pixels or a colored layer having high color density and a high contrast ratio is desired.

5 As disclosed by JP-A 10-260309, it is known that C.I. Pigment Red 254 is effective as a pigment used in red pixels to meet the above demand. However, when a radiation sensitive composition containing this pigment is used, foreign matter is produced on pixels, thereby reducing the production yield.

10 To cope with this, the development of a radiation sensitive composition for color filters which meets requirements such as high transmittance and high contract ratio in recent years and can provide red pixels with a trace amount of foreign matter produced thereon is strongly desired.

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Summary of the Invention

It is an object of the present invention to provide a radiation sensitive composition for color filters which can provide red pixels having a high transmittance and high contrast ratio without foreign matter or with a trace amount of foreign matter produced thereon at a high production yield.

20 It is another object of the present invention to provide an advantageous process for preparing the radiation sensitive composition of the present invention.

25 It is still another object of the present invention to provide a color filter made of the radiation sensitive composition of the present invention 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.

30 Firstly, the above objects and advantages of the present invention are attained by a radiation sensitive composition comprising (A) a pigment, (B) an alkali-soluble resin, (C) a polyfunctional monomer or a combination of a polyfunctional

monomer and a monofunctional monomer and (D) a radiation sensitive radical generator, wherein

the pigment (A) comprises 20 wt% or more of C.I. Pigment Red 175 and has an average particle diameter r (unit: nm) of 50 to 300, and the composition is used for color filters.

Secondly, the above objects and advantages of the present invention are attained by a radiation sensitive composition comprising (A) a pigment, (B) an alkali-soluble resin, (C) a polyfunctional monomer or a combination of a polyfunctional monomer and a monofunctional monomer and (D) a radiation sensitive radical generator, wherein

the pigment (A) comprises 20 wt% or more of C.I. Pigment Red 175, pixels made of the radiation sensitive composition and having a film thickness of 1.60 μm provide a contrast ratio of 500 or more, and the composition is used for color filters.

The radiation as used herein means visible radiation, ultraviolet radiation, far ultraviolet radiation, electron radiation or X-radiation.

Thirdly, the above objects and advantages of the present invention are attained by a process for preparing a radiation sensitive composition, comprising the step of mixing together a pigment dispersion obtained by mixing and dispersing (A) a pigment which comprises 20 wt% or more of C.I. Pigment Red 175 and has an average particle diameter larger than 300 nm in a solvent while it is ground in the solvent, (B) an alkali-soluble resin, (C) a polyfunctional monomer or a combination of a polyfunctional monomer and a monofunctional monomer and (D) a radiation sensitive radical generator.

In the fourth place, the above objects and advantages of the present invention are attained by a color filter having red pixels made of the above radiation sensitive composition.

In the fifth place, the above objects and advantages of the present invention are attained by a color liquid crystal display comprising the above color filter.

The present invention will be described in detail hereinunder.

5 (A) pigment

The pigment in the present invention contains C.I. Pigment Red 175 according to color index (C.I.; issued by The Society of Dyers and Colourists).

The pigment in the present invention may optionally further
10 contain other pigment.

The above other pigment is not particularly limited but preferably an organic pigment because high purity, highly transmitting color development and heat resistance are required for a color filter.

15 Examples of the other organic pigment include compounds classified into a group of pigments according to color index, specifically compounds having the following color index (C.I.) numbers:

C.I. Pigment Yellow 12, C.I. Pigment Yellow 13, C.I. Pigment
20 Yellow 14, C.I. Pigment Yellow 17, C.I. Pigment Yellow 20, C.I. Pigment Yellow 24, C.I. Pigment Yellow 31, C.I. Pigment Yellow 55, C.I. Pigment Yellow 83, C.I. Pigment Yellow 93, C.I. Pigment Yellow 109, C.I. Pigment Yellow 110, C.I. Pigment Yellow 138, C.I. Pigment Yellow 139, C.I. Pigment Yellow 150, C.I. Pigment
25 Yellow 153, C.I. Pigment Yellow 154, C.I. Pigment Yellow 155, C.I. Pigment Yellow 166, C.I. Pigment Yellow 168 and C.I. Pigment Yellow 211;

C.I. Pigment Orange 5, C.I. Pigment Orange 13, C.I. Pigment Orange 14, C.I. Pigment Orange 24, C.I. Pigment Orange 34, C.I. Pigment
30 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 61, C.I. Pigment Orange 64, C.I. Pigment Orange 68, C.I. Pigment Orange 70, C.I. Pigment Orange 71, C.I. Pigment Orange 72, C.I. Pigment Orange 73 and C.I. Pigment Orange

74; and

C.I. Pigment Red 1, C.I. Pigment Red 2, C.I. Pigment Red 5, C.I. Pigment Red 17, C.I. Pigment Red 31, C.I. Pigment Red 32, C.I. Pigment Red 41, C.I. Pigment Red 122, C.I. Pigment Red 123, C.I. Pigment Red 144, C.I. Pigment Red 149, C.I. Pigment Red 166, C.I. Pigment Red 168, C.I. Pigment Red 170, C.I. Pigment Red 171, 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 202, C.I. Pigment Red 206, C.I. Pigment Red 207, C.I. Pigment Red 209, C.I. Pigment Red 214, C.I. Pigment Red 220, C.I. Pigment Red 221, C.I. Pigment Red 224, C.I. Pigment Red 242, C.I. Pigment Red 243, C.I. Pigment Red 254, C.I. Pigment Red 255, C.I. Pigment Red 262, C.I. Pigment Red 264 and C.I. Pigment Red 272.

At least one selected from the group consisting of C.I. Pigment Yellow 83, C.I. Pigment Yellow 139, C.I. Pigment Red 177 and C.I. Pigment Red 254 is preferably used out of the above other organic pigments.

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

In the pigment of the present invention, the content of C.I. Pigment Red 175 is 20 wt% or more, preferably 30 wt% or more, particularly preferably 50 wt% or more. By using this pigment, red pixels having a high contrast ratio and high transmittance and free from foreign matter can be obtained.

In the present invention, C.I. Pigment Red 175 and other pigment may be optionally purified by re-crystallization, re-precipitation, solvent cleaning, sublimation, vacuum heating or a combination thereof before use.

The average particle diameter r (unit: nm) of the pigment used in the present invention is 50 to 300, preferably 50 to 200. By using the pigment having the above average particle diameter r , red pixels having a high contrast ratio and high transmittance and free from foreign matter can be obtained. The term "average

particle diameter" as used herein means the average particle diameter of secondary particles which are agglomerates of primary particles (single micro-crystals) of the pigment.

As for the particle size distribution of the secondary particles of the pigment used in the present invention (to be simply referred to as "particle size distribution" hereinafter), secondary particles having a particle diameter of (average particle diameter $\pm$ 100) nm or less accounts for 70 wt% or more, preferably 80 wt% or more based on the total of the secondary particles.

The pigment having the above average particle diameter and particle size distribution can be prepared by mixing commercially available C.I. Pigment Red 175 (generally having an average particle diameter larger than 300 nm) and optionally other pigment (generally having an average particle diameter larger than 300 nm) preferably with a dispersant and a solvent as a pigment mixed solution while it is ground with a mill such as a bead mill or roll mill to disperse in the solvent. The obtained pigment is generally in the form of a pigment dispersion.

The dispersant used for the preparation of the pigment dispersion is suitably selected from cationic, anionic, amphoteric and nonionic dispersants. Out of these, a dispersant containing a compound having an urethane bond (to be referred to as "urethane-based dispersant" hereinafter) is preferred.

The above urethane bond is represented by the formula $R-NH-COO-R'$ (R and R' are each an aliphatic, alicyclic or aromatic monovalent or polyvalent organic group, and the polyvalent organic group is bonded to a group having another urethane bond or other group) and may be existent in a lipophilic group and/or a hydrophilic group contained in the urethane-based dispersant. It may also be existent in the main chain and/or side chain of the urethane-based dispersant and at least one urethane bond may be existent in the urethane-based dispersant. When two or more urethane bonds are existent in the urethane-based dispersant,

they may be the same or different.

The urethane-based dispersant is a reaction product of a diisocyanate and/or a triisocyanate, and a polyester having a hydroxyl group at one terminal and/or a polyester having a hydroxyl group at both terminals.

Examples of the above diisocyanate include aromatic diisocyanates such as benzene diisocyanates including benzene-1,3-diisocyanate and benzene-1,4-diisocyanate; toluene diisocyanates including toluene-2,4-diisocyanate, toluene-2,5-diisocyanate, toluene-2,6-diisocyanate and toluene-3,5-diisocyanate; and xylene diisocyanates including 1,2-xylene-3,5-diisocyanate, 1,2-xylene-3,6-diisocyanate, 1,3-xylene-2,4-diisocyanate, 1,3-xylene-2,5-diisocyanate, 1,3-xylene-4,6-diisocyanate, 1,4-xylene-2,5-diisocyanate and 1,4-xylene-2,6-diisocyanate.

Examples of the above triisocyanate include aromatic triisocyanates such as benzene triisocyanates including benzene-1,2,4-triisocyanate, benzene-1,2,5-triisocyanate and benzene-1,3,5-triisocyanate; toluene triisocyanates including toluene-2,3,5-triisocyanate, toluene-2,3,6-triisocyanate, toluene-2,4,5-triisocyanate and toluene-2,4,6-triisocyanate; and xylene triisocyanates including 1,2-xylene-3,4,5-triisocyanate, 1,2-xylene-3,4,6-triisocyanate, 1,3-xylene-2,4,5-triisocyanate, 1,3-xylene-2,4,6-triisocyanate, 1,3-xylene-4,5,6-triisocyanate, 1,4-xylene-2,3,5-triisocyanate and 1,4-xylene-2,3,6-triisocyanate.

These diisocyanates and triisocyanates may be used alone or in combination of two or more.

Further, the polyester having a hydroxyl group at one terminal and the polyester having a hydroxyl group at both terminals are selected from polylactones having a hydroxyl group

at one terminal or both terminals such as a polycaprolactone having a hydroxyl group at one terminal or both terminals, polyvalerolactone having a hydroxyl group at one terminal or both terminals, and polypropiolactone having a hydroxyl group at one terminal or both terminals; and polycondensation polyesters having a hydroxyl group at one terminal or both terminals such as polyethylene terephthalate having a hydroxyl group at one terminal or both terminals and polybutylene terephthalate having a hydroxyl group at one terminal or both terminals.

10 The above polyesters having a hydroxyl group at one terminal and the above polyesters having a hydroxyl group at both terminal may be used alone or in combination of two or more.

 The urethane-based dispersant in the present invention is preferably a reaction product of an aromatic diisocyanate and a polylactone having a hydroxyl group at one terminal and/or polylactone having a hydroxyl group at both terminals, particularly preferably a reaction product of toluene diisocyanate and a polycaprolactone having a hydroxyl group at one terminal and/or a polycaprolactone having a hydroxyl group at both terminals.

20 Commercially available products of the urethane-based dispersant include EFKA (EFKA Chemical B.V.), Disperbyk (BYK Chemie. Co., Ltd.) and Disbaron (Kusumoto Kasei Co., Ltd.) under known series of Tradenames.

25 The weight average molecular weight in terms of polystyrene measured by gel permeation chromatography (GPC) of the urethane-based dispersant in the present invention is preferably 5,000 to 50,000, more preferably 7,000 to 20,000.

 The above urethane-based dispersants may be used alone or in combination of two or more.

30 The amount of the urethane-based dispersant for the preparation of the pigment dispersion is preferably 100 parts or less by weight, more preferably 0.5 to 100 parts by weight, much more preferably 1 to 70 parts by weight, particularly

preferably 10 to 50 parts by weight based on 100 parts by weight of the pigment. When the amount of the urethane-based dispersant is larger than 100 parts by weight, developability may be impaired.

5 The solvent used for the preparation of the pigment dispersion may be identical to the solvent which will be described hereinafter for the radiation sensitive composition for color filters of the present invention.

10 The amount of the solvent used for the preparation of the pigment dispersion is preferably 500 to 1,000 parts by weight, more preferably 700 to 900 parts by weight based on 100 parts by weight of the pigment.

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

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

 To prepare the pigment dispersion with a roll mill, a three-roll mill or two-roll mill may be used to process the pigment mixed solution while it is cooled with cooling water or the like.

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

30 The average particle diameter and particle size distribution of the pigment in the pigment dispersion thus prepared can be measured by a dynamic light scattering method.

(B) alkali-soluble resin

 The alkali-soluble resin in the present invention is not particularly limited if it serves as a binder for the pigment

(A) and has solubility in a developer, preferably an alkali developer used in the development step for the manufacture of a color filter. The alkali-soluble resin is, for example, a copolymer of a polymerizable unsaturated monomer having an acid functional group such as carboxyl group, phenolic hydroxyl group or sulfonic acid group and other copolymerizable unsaturated monomer (to be referred to as "copolymerizable unsaturated monomer" hereinafter).

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

Out of these carboxyl group-containing unsaturated monomers, (meth)acrylic acid, mono[2-(meth)acryloyloxyethyl]succinate and ω -carboxypolycaprolactone mono(meth)acrylate are preferred.

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

Examples of the polymerizable unsaturated monomer having a phenolic hydroxyl group include o-hydroxystyrene, m-hydroxystyrene, p-hydroxystyrene, o-hydroxy- α -methylstyrene, m-hydroxy- α -methylstyrene, p-hydroxy- α -methylstyrene,

N-o-hydroxyphenylmaleimide, N-m-hydroxyphenylmaleimide and N-p-hydroxyphenylmaleimide.

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

5 Examples of the polymerizable unsaturated monomer having a sulfonic acid group include isoprene sulfonic acid and p-styrene sulfonic acid.

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

10 Examples of the copolymerizable unsaturated monomer include macromonomers having a (meth)acryloyl group at one terminal of a polymer molecular chain such as polystyrene, polymethyl (meth)acrylate, poly-n-butyl (meth)acrylate and polysiloxane (to be referred to as "macromonomer" hereinafter) ;

15 N-(substituted) aryl maleimides such as N-phenylmaleimide, N-o-hydroxyphenylmaleimide, N-m-hydroxyphenylmaleimide, N-p-hydroxyphenylmaleimide, N-o-methylphenylmaleimide, N-m-methylphenylmaleimide, N-p-methylphenylmaleimide, N-o-methoxyphenylmaleimide, N-m-methoxyphenylmaleimide and

20 N-p-methoxyphenylmaleimide, and N-substituted maleimides such as N-cyclohexylmaleimide; aromatic vinyl compounds such as styrene, α -methylstyrene, o-vinyltoluene, m-vinyltoluene, p-vinyltoluene, p-chlorostyrene, o-methoxystyrene, m-methoxystyrene, p-methoxystyrene, o-vinylbenzylmethyl ether,

25 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,

30 i-propyl (meth)acrylate, n-butyl (meth)acrylate, i-butyl (meth)acrylate, sec-butyl (meth)acrylate, t-butyl (meth)acrylate, 2-hydroxyethyl (meth)acrylate, 2-hydroxypropyl (meth)acrylate, 3-hydroxypropyl (meth)acrylate, 2-hydroxybutyl (meth)acrylate, 3-hydroxybutyl (meth)acrylate, 4-hydroxybutyl

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

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

Out of the above copolymerizable unsaturated monomers, macromonomers, N-substituted maleimides, 2-hydroxyethyl (meth)acrylate, benzyl (meth)acrylate and glycerol (meth)acrylate are preferred. Out of the macromonomers, polystyrene macromonomer and polymethyl (meth)acrylate macromonomer are particularly preferred, and out of N-substituted maleimides, N-phenylmaleimide and N-cyclohexylmaleimide are particularly preferred.

The alkali-soluble resin in the present invention is

preferably a copolymer (to be referred to as "carboxyl group-containing copolymer" hereinafter) of a carboxyl group-containing unsaturated monomer and a copolymerizable unsaturated monomer.

- 5 The carboxyl group-containing copolymer is preferably a copolymer (to be referred to as "carboxyl group-containing copolymer (I)" hereinafter) of (a) a carboxyl group-containing unsaturated monomer component and (b) at least one selected from the group consisting of polystyrene macromonomer, polymethyl
10 (meth)acrylate macromonomer, N-phenylmaleimide, N-cyclohexylmaleimide, 2-hydroxyethyl (meth)acrylate, benzyl (meth)acrylate and glycerol (meth)acrylate and optionally (c) a monomer mixture containing at least one selected from the group consisting of styrene, methyl (meth)acrylate, allyl
15 (meth)acrylate and phenyl (meth)acrylate.

- It is particularly preferably a copolymer (to be referred to as "carboxyl group-containing copolymer (II)" hereinafter) of (a) a carboxyl group-containing unsaturated monomer component containing (meth)acrylic acid as an essential component and
20 optionally mono[2-(meth)acryloyloxyethyl]succinate, (b) at least one selected from the group consisting of polystyrene macromonomer, polymethyl (meth)acrylate macromonomer, N-phenylmaleimide, N-cyclohexylmaleimide, 2-hydroxyethyl (meth)acrylate, benzyl (meth)acrylate and glycerol
25 (meth)acrylate and optionally (c) a monomer mixture containing at least one selected from the group consisting of styrene, methyl (meth)acrylate, allyl (meth)acrylate and phenyl (meth)acrylate.

- Illustrative examples of the carboxyl group-containing copolymer (II) include a copolymer of (meth)acrylic acid,
30 mono[2-(meth)acryloyloxyethyl]succinate, benzyl (meth)acrylate and glycerol mono(meth)acrylate, copolymer of (meth)acrylic acid, mono[2-(meth)acryloyloxyethyl]succinate, N-phenylmaleimide, styrene and allyl (meth)acrylate, copolymer of (meth)acrylic acid, mono[2-(meth)acryloyloxyethyl]succinate, N-phenylmaleimide,

- benzyl (meth)acrylate and styrene, copolymer of (meth)acrylic acid, mono[2-(meth)acryloyloxyethyl]succinate, N-cyclohexylmaleimide, styrene and allyl (meth)acrylate, copolymer of (meth)acrylic acid,
- 5 mono[2-(meth)acryloyloxyethyl]succinate, N-cyclohexylmaleimide, benzyl (meth)acrylate and styrene, copolymer of (meth)acrylic acid, mono[2-(meth)acryloyloxyethyl]succinate, N-phenylmaleimide, benzyl (meth)acrylate, glycerol mono(meth)acrylate and styrene,
- 10 copolymer of (meth)acrylic acid, ω -carboxypolycaprolactone mono(meth)acrylate, N-phenylmaleimide, benzyl (meth)acrylate, glycerol mono(meth)acrylate and styrene, copolymer of (meth)acrylic acid and 2-hydroxyethyl (meth)acrylate, copolymer of (meth)acrylic acid, polystyrene macromonomer and benzyl
- 15 (meth)acrylate, copolymer of (meth)acrylic acid, polymethyl (meth)acrylate macromonomer and benzyl (meth)acrylate, copolymer of (meth)acrylic acid, benzyl (meth)acrylate, glycerol mono(meth)acrylate, copolymer of (meth)acrylic acid, 2-hydroxyethyl (meth)acrylate and benzyl (meth)acrylate,
- 20 copolymer of (meth)acrylic acid, 2-hydroxyethyl (meth)acrylate and phenyl (meth)acrylate, copolymer of (meth)acrylic acid, 2-hydroxyethyl (meth)acrylate and styrene, copolymer of (meth)acrylic acid, N-cyclohexylmaleimide, benzyl (meth)acrylate and styrene, copolymer of (meth)acrylic acid,
- 25 polystyrene macromonomer, 2-hydroxyethyl (meth)acrylate and benzyl (meth)acrylate, copolymer of (meth)acrylic acid, polymethyl (meth)acrylate macromonomer, 2-hydroxyethyl (meth)acrylate and benzyl (meth)acrylate, copolymer of (meth)acrylic acid, N-phenylmaleimide, benzyl (meth)acrylate
- 30 and styrene, and copolymer of (meth)acrylic acid, N-phenylmaleimide, benzyl (meth)acrylate, glycerol mono(meth)acrylate and styrene.

The content of the carboxyl group-containing unsaturated monomer in the carboxyl group-containing copolymer is preferably

5 to 50 wt%, more preferably 10 to 40 wt%. When the above content is lower than 5 wt%, the solubility in an alkali developer of the obtained radiation sensitive composition may lower. When the content is higher than 50 wt%, the solubility in the alkali developer of the composition becomes too high, whereby when the composition is developed with the alkali developer, pixels may fall off from the substrate or the film surface of the pixels may be roughened.

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

By using this alkali-soluble resin having specific Mw or Mn, a radiation sensitive composition having excellent developability is obtained, whereby pixels having a sharp pattern edge can be formed, and the residue, stain and film residue are hardly produced on the substrate or light screening layer of an unexposed portion during development.

The Mw/Mn ratio of the alkali-soluble resin in the present invention is preferably 1 to 5, more preferably 1 to 4.

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

The amount of the alkali-soluble resin in the present invention is preferably 10 to 1,000 parts by weight, more preferably 20 to 500 parts by weight based on 100 parts by weight of the pigment (A). When the amount of the alkali-soluble resin is smaller than 10 parts by weight, alkali developability may lower, or a stain and the film residue may be produced on the

substrate or light screening layer of the unexposed portion. When the amount is larger than 1,000 parts by weight, the concentration of the pigment lowers, whereby it may be difficult to achieve the target color density of a thin film.

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(C) polyfunctional monomer or a combination of polyfunctional monomer and monofunctional monomer

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

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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 having two or more ethyleneoxy groups and polypropylene glycol having two or more propyleneoxy groups; 15 poly(meth)acrylates of a polyhydric alcohol having 3 or more hydroxyl groups and dicarboxylic acid modified products thereof such as glycerin, trimethylolpropane, pentaerythritol and dipentaerythritol; oligo(meth)acrylates such as polyester, epoxy resin, urethane resin, alkyd resin, silicone resin and 20 spiran resin; di(meth)acrylates of a polymer having a hydroxyl group at both terminals such as poly-1,3-butadiene having a hydroxyl group at both terminals, polyisoprene having a hydroxyl group at both terminals and polycaprolactone having a hydroxyl group at both terminals; and 25 tris[2-(meth)acryloyloxyethyl]phosphate.

Out of these polyfunctional monomers, poly(meth)acrylates of a polyhydric alcohol having 3 or more hydroxyl groups and dicarboxylic acid modified products thereof are preferred, as exemplified by trimethylolpropane tri(meth)acrylate, 30 pentaerythritol tri(meth)acrylate, pentaerythritol tetra(meth)acrylate, dipentaerythritol penta(meth)acrylate and dipentaerythritol hexa(meth)acrylate. Out of these, trimethylolpropane triacrylate, pentaerythritol triacrylate and dipentaerythritol hexaacrylate are particularly preferred

because the obtained pixels have high strength and a smooth surface and a stain and the film residue are hardly produced on the substrate or light screening layer of the unexposed portion. The above functional monomers may be used alone or in combination
5 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 alkali-soluble resin (B). When the amount of the polyfunctional
10 monomer is smaller than 5 parts by weight, the strength and surface smoothness of the obtained pixels may lower. When the amount is larger than 500 parts by weight, alkali developability may deteriorate, or a stain and the film residue are readily produced on the substrate or light screening layer of the unexposed
15 portion.

In the present invention, part of the polyfunctional monomer may be substituted by a monofunctional monomer having one polymerizable unsaturated bond.

Examples of the above monofunctional monomer include
20 carboxyl group-containing unsaturated monomers and copolymerizable unsaturated monomers enumerated for the above alkali-soluble resin (B), N-vinyl containing nitrogen heterocyclic compounds such as N-vinylsuccinimide, N-vinylpyrrolidone, N-vinylphthalimide, N-vinyl-2-piperidone,
25 N-vinyl-ε-caprolactam, N-vinylpyrrole, N-vinylpyrrolidine, N-vinylimidazole, N-vinylimidazolidine, N-vinylindole, N-vinylindoline, N-vinylbenzimidazole, N-vinylcarbazole, N-vinylpiperidine, N-vinylpiperazine, N-vinylmorpholine and N-vinylphenoxazine; N-(meth)acryloylmorpholine and
30 commercially available M-5300, M-5400 and M-5600 (trade names; of Toagosei Chemical Industry Co., Ltd.).

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

The amount of the monofunctional monomer is preferably 90

wt% or less, more preferably 50 wt% or less based on the total of the polyfunctional monomer and the monofunctional monomer. When the amount of the monofunctional monomer is larger than 90 wt%, the strength and surface smoothness of the obtained pixels
5 may deteriorate.

(D) radiation sensitive radical generator

The radiation sensitive radical generator in the present invention (to be simply referred to as "radical generator"
10 hereinafter) is a compound which can form a radical capable of initiating the polymerization of the above component (C) through exposure to radiation such as visible radiation, ultraviolet radiation, far ultraviolet radiation, electron radiation or X-radiation.

15 Examples of the radical generator include an acetophenone-based compound, biimidazole-based compound, triazine-based compound, benzoin-based compound, benzophenone-based compound, α -diketone-based compound, polynuclear quinone-based compound, xanthone-based compound and
20 diazo-based compound.

In the present invention, the above radical generators may be used alone or in combination of two or more. The radical generator in the present invention is preferably at least one selected from the group consisting of an acetophenone-based
25 compound, biimidazole-based compound and triazine-based compound.

The amount of the radical generator in the present invention is preferably 0.01 to 80 parts by weight, more preferably 1 to 60 parts by weight based on 100 parts by weight of the component
30 (C). When the amount of the radical generator is smaller than 0.01 part by weight, it may be difficult to obtain a color filter having a predetermined pixel pattern due to incomplete curing by exposure. When the amount is larger than 80 parts by weight, the formed pixels may fall off from the substrate during

development.

Examples of the acetophenone-based compound out of the preferred radical generators in the present invention include 2-hydroxy-2-methyl-1-phenylpropan-1-one,
 5 2-methyl-1-[4-methylthio)phenyl]-2-morpholinopropanone-1,
 2-benzyl-2-dimethylamino-1-(4-morpholinophenyl)butanone-1,
 1-hydroxycyclohexyl·phenyl ketone,
 2,2-dimethoxy-1,2-diphenylethan-1-one, 1,2-octanedione and
 1-[4-(phenylthio)phenyl]-2-(O-benzoyloxime).

10 Out of these acetophenone-based compounds,
 2-methyl-1-[4-(methylthio)phenyl]-2-morpholinopropanone-1,
 2-benzyl-2-dimethylamino-1-(4-morpholinophenyl)butanone-1,
 1,2-octanedione and
 1-[4-(phenylthio)phenyl]-2-(O-benzoyloxime) are particularly
 15 preferred.

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

When the acetophenone-based compound is used as the radical generator in the present invention, the amount of the
 20 acetophenone-based compound is preferably 0.01 to 80 parts by weight, more preferably 1 to 60 parts by weight, particularly preferably 1 to 30 parts by weight based on 100 parts by weight of the component (C). When the amount of the acetophenone-based compound is smaller than 0.01 part by weight, it may be difficult
 25 to obtain a color filter having a predetermined pixel pattern due to incomplete curing by exposure. When the amount is larger than 80 parts by weight, the formed pixels may fall off from the substrate during development.

Examples of the biimidazole-based compound include
 30 2,2'-bis(2-chlorophenyl)-4,4',5,5'-tetrakis(4-ethoxycarbonyl phenyl)-1,2'-biimidazole,
 2,2'-bis(2-bromophenyl)-4,4',5,5'-tetrakis(4-ethoxycarbonyl phenyl)-1,2'-biimidazole,
 2,2'-bis(2-chlorophenyl)-4,4',5,5'-tetraphenyl-1,2'-

biimidazole,

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

biimidazole,

2,2'-bis(2,4,6-trichlorophenyl)-4,4',5,5'-tetraphenyl-1,2'-

5 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

10 2,2'-bis(2,4,6-tribromophenyl)-4,4',5,5'-tetraphenyl-1,2'-
biimidazole.

Out of these biimidazole-based compounds,

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

biimidazole,

15 2,2'-bis(2,4-dichlorophenyl)-4,4',5,5'-tetraphenyl-1,2'-
biimidazole and

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

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

20 biimidazole is particularly preferred.

The above biimidazole-based compounds have excellent solubility in a solvent, do not produce foreign matter such as an undissolved product and precipitate, have high sensitivity, can fully promote a curing reaction by exposure with a small amount
25 of energy and does not cause a curing reaction in an unexposed portion. Therefore, the coating film after exposure is clearly divided into a cured portion insoluble in a developer and an uncured portion having high solubility in a developer, thereby making it possible to form a high-definition color filter having
30 a predetermined pixel pattern which is not undercut.

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

When the biimidazole-based compound is used as the radical generator in the present invention, the amount of the

biimidazole-based compound is preferably 0.01 to 40 parts by weight, more preferably 1 to 30 parts by weight, particularly preferably 1 to 20 parts by weight based on 100 parts by weight of the component (C). When the amount of the biimidazole-based compound is smaller than 0.01 part by weight, it may be difficult to obtain a color filter having a predetermined pixel pattern due to incomplete curing by exposure. When the amount is larger than 40 parts by weight, the formed pixels may fall off from the substrate or the film surface of the pixels may be roughened during development.

- hydrogen donor -

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

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

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

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

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

The hydrogen donor may have a mercapto group and an amino group at the same time.

A detailed description is subsequently given of these hydrogen donors.

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

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

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

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

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

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

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

phenoxy carbonyl group, substituted phenoxy carbonyl group or nitrile group at a position other than the amino group(s).

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

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

The amine-based hydrogen donor serves as a sensitizer when a radical generator other than a biimidazole-based compound is
 15 used.

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

Examples of the combination of the mercaptan-based hydrogen donor and the amine-based hydrogen donor include a combination of 2-mercaptobenzothiazole and
 25 4,4'-bis(dimethylamino)benzophenone, combination of
 2-mercaptobenzothiazole and 4,4'-bis(diethylamino)benzophenone,
 combination of 2-mercaptobenzoxazole and
 4,4'-bis(dimethylamino)benzophenone, and combination of
 2-mercaptobenzoxazole and 4,4'-bis(diethylamino)benzophenone.
 30 A combination of 2-mercaptobenzothiazole and
 4,4'-bis(diethylamino)benzophenone and a combination of
 2-mercaptobenzoxazole and 4,4'-bis(diethylamino)benzophenone
 are preferred, and a combination of 2-mercaptobenzothiazole and
 4,4'-bis(diethylamino)benzophenone is particularly preferred.

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

5 When the hydrogen donor is used in combination with the biimidazole-based compound in the present invention, the amount of the hydrogen donor is preferably 0.01 to 40 parts by weight, more preferably 1 to 30 parts by weight, particularly preferably 1 to 20 parts by weight based on 100 parts by weight of the component
10 (C). When the amount of the hydrogen donor is smaller than 0.01 part by weight, its effect of improving sensitivity may lower. When the amount is larger than 40 parts by weight, the formed pixels may fall off from the substrate during development.

 Examples of the above triazine-based compound include
15 triazine-based compounds having a halomethyl group such as
 2,4,6-tris(trichloromethyl)-s-triazine,
 2-methyl-4,6-bis(trichloromethyl)-s-triazine,
 2-[2-(5-methylfuran-2-yl)ethenyl]-4,6-bis(trichloromethyl)-
 s-triazine,
20 2-[2-(furan-2-yl)ethenyl]-4,6-bis(trichloromethyl)-s-
 triazine,
 2-[2-(4-diethylamino-2-methylphenyl)ethenyl]-4,6-
 bis(trichloromethyl)-s-triazine,
 2-[2-(3,4-dimethoxyphenyl)ethenyl]-4,6-bis(trichloromethyl)-
25 s-triazine,
 2-(4-methoxyphenyl)-4,6-bis(trichloromethyl)-s-triazine,
 2-(4-ethoxystyryl)-4,6-bis(trichloromethyl)-s-triazine and
 2-(4-n-butoxyphenyl)-4,6-bis(trichloromethyl)-s-triazine.

 Out of these triazine-based compounds,
30 2-[2-(3,4-dimethoxyphenyl)ethenyl]-4,6-bis(trichloromethyl)-
 s-triazine is preferred.

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

 When the triazine-based compound is used as the radical

generator in the present invention, the amount of the triazine-based compound is preferably 0.01 to 40 parts by weight, more preferably 1 to 30 parts by weight, particularly preferably 1 to 20 parts by weight based on 100 parts by weight of the component (C). When the amount of the triazine-based compound is smaller than 0.01 part by weight, it may be difficult to obtain a color filter having a predetermined pixel pattern due to incomplete curing by exposure. When the amount is larger than 40 parts by weight, the formed pixels may fall off from the substrate during development.

Other additives

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

The above additives include a filler such as glass or alumina; polymer compound such as polyvinyl alcohol or poly(fluoroalkylacrylate); nonionic, cationic or anionic surfactant; adhesion accelerator such as vinyl trimethoxysilane, vinyl triethoxysilane, vinyl tris(2-methoxyethoxy)silane, N-(2-aminoethyl)-3-aminopropyl·methyl·dimethoxysilane, N-(2-aminoethyl)-3-aminopropyltrimethoxysilane, 3-aminopropyltriethoxysilane, 3-glycidoxypropyltrimethoxysilane, 3-glycidoxypropyl·methyl·dimethoxysilane, 2-(3,4-epoxycyclohexyl)ethyltrimethoxysilane, 3-chloropropyl·methyl·dimethoxysilane, 3-chloropropyltrimethoxysilane, 3-methacryloyloxypropyltrimethoxysilane or 3-mercaptopropyltrimethoxysilane; antioxidant such as 2,2-thiobis(4-methyl-6-t-butylphenol) or 2,6-di-t-butylphenol; ultraviolet light absorber such as 2-(3-t-butyl-5-methyl-2-hydroxyphenyl)-5-chlorobenzotriazole or alkoxybenzophenone; and cohesion inhibitor such as sodium

polyacrylate.

Solvent

The radiation sensitive composition for color filters of the present invention comprises the above components (A) to (D) and optionally other additives and is preferably prepared as a liquid composition by adding a solvent.

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

Examples of the solvent include propylene glycol monoalkyl ethers such as propylene glycol monomethyl ether, and propylene glycol monoethyl ether; (poly)alkylene glycol monoalkyl ether acetates such as ethylene glycol monomethyl ether acetate, ethylene glycol monoethyl ether acetate, diethylene glycol monomethyl ether acetate, diethylene glycol monoethyl ether acetate, propylene glycol monomethyl ether acetate and propylene glycol monoethyl ether acetate; other ethers such as diethylene glycol dimethyl ether, diethylene glycol methyl ethyl ether, diethylene glycol diethyl ether and tetrahydrofuran; ketones such as methyl ethyl ketone, cyclohexanone, 2-heptanone and 3-heptanone; ketoalcohols such as diacetone alcohol (that is, 4-hydroxy-4-methylpentan-2-one) and 4-hydroxy-4-methylhexan-2-one; alkyl lactates such as methyl lactate and ethyl lactate; other esters such as ethyl 2-hydroxy-2-methylpropionate, ethyl hydroxyacetate, methyl 2-hydroxy-3-methylbutanoate, methyl 3-methoxypropionate, ethyl 3-methoxypropionate, methyl 3-ethoxypropionate, ethyl 3-ethoxypropionate, ethyl ethoxyacetate, 3-methyl-3-methoxybutyl acetate, 3-methyl-3-methoxybutyl propionate, ethyl acetate, n-propyl acetate, i-propyl acetate, n-butyl acetate, i-butyl acetate, n-pentyl formate, i-pentyl 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 such as N-methylpyrrolidone,
5 N,N-dimethylformamide and N,N-dimethylacetamide.

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
10 methyl ethyl ether, cyclohexanone, 2-heptanone, 3-heptanone, ethyl 3-methoxypropionate, methyl 3-ethoxypropionate, ethyl 3-ethoxypropionate, 3-methyl-3-methoxybutylpropionate, n-butyl acetate, i-butyl acetate, n-pentyl formate, i-pentyl acetate, n-butyl propionate, ethyl butyrate, i-propyl butyrate, n-butyl
15 butyrate and ethyl pyruvate are preferred from the viewpoints of solubility, pigment dispersibility and coatability.

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

Further, a high-boiling solvent such as benzyl ethyl ether,
20 di-n-hexyl ether, acetonylacetone, isophorone, caproic acid, caprylic acid, 1-octanol, 1-nonanol, benzyl alcohol, benzyl acetate, ethyl benzoate, diethyl oxalate, diethyl maleate, γ -butyrolactone, ethylene carbonate, propylene carbonate or ethylene glycol monophenyl ether acetate may be used in
25 combination with the 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
30 components excluding the solvent of the composition is preferably 5 to 50 wt%, particularly preferably 10 to 40 wt% from the viewpoints of coatability and stability of the obtained radiation sensitive composition.

Method of forming a color filter

A description is subsequently given of the method of forming the color filter of the present invention by using the radiation sensitive composition for color filters of the present invention.

5 The method of forming a color filter comprises at least the following steps (1) to (4) which are carried out in the mentioned order:

- (1) forming a coating film of the radiation sensitive composition of the present invention on a substrate;
- 10 (2) exposing at least part of the coating film;
- (3) developing the coating film after exposure; and
- (4) heating the coating film after development (to be referred to as "post-baking" hereinafter).

A detailed description is subsequently given of each step.

15 - step (1)-

A light screening layer for defining a portion for forming pixels is optionally formed on the surface of the substrate, and the liquid radiation sensitive composition of the present invention is applied to the substrate and prebaked to evaporate
20 the solvent so as to form a coating film.

The substrate used in this step is made of glass, silicon, polycarbonate, polyester, aromatic polyamide, polyamide-imide, polyimide, polyether sulfone, ring open polymer of a cyclic olefin or hydrogenated product thereof.

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

To apply the liquid composition to the substrate, a suitable
30 coating technique such as rotational coating, cast coating or roll coating may be employed.

As for prebaking conditions, the resin composition is preferably prebaked at 70 to 110°C for 2 to 4 minutes.

The thickness of the coating film of the resin composition

is preferably 0.1 to 10 μm , more preferably 0.2 to 8.0 μm , particularly preferably 0.2 to 6.0 μm after the removal of the solvent.

- step (2) -

5 Thereafter, the formed coating film is exposed to radiation through a photomask having a suitable pattern.

 The radiation used in this step may be visible radiation, ultraviolet radiation, far ultraviolet radiation, electron radiation or X-radiation. The radiation preferably has a
10 wavelength of 190 to 450 nm.

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

- step (3) -

 The coating film is then developed with preferably an alkali
15 developer to remove an unexposed portion of the coating film.

 The above alkali developer is preferably an aqueous solution of sodium carbonate, sodium hydroxide, potassium hydroxide, tetramethylammonium hydroxide, choline, 1,8-diazabicyclo-[5.4.0]-7-undecene or
20 1,5-diazabicyclo-[4.3.0]-5-nonene.

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

25 Shower development, spray development, dip (immersion) development, puddle development or the like may be employed.

 As for development conditions, development is preferably carried out at normal temperature for 5 to 300 sec.

- step (4) -

30 By post-baking the developed coating film, a substrate having a predetermined red pixel pattern made of cured product of the radiation sensitive composition for color filters can be obtained.

 As for post-baking conditions, the coating film is

preferably heated at 180 to 230°C for 20 to 40 minutes.

The thickness of the formed pixel film is preferably 0.5 to 5.0 μm , more preferably 1.5 to 3.0 μm .

Further, by repeating the above steps (1) to (4) for liquid
5 compositions containing green and blue pigments dispersed therein,
a blue pixel pattern and a green pixel pattern are formed on the
same substrate, thereby making it possible to form a colored layer
having predetermined red, green and blue pixel patterns on the
substrate.

10 In the present invention, the order of forming color pixel
patterns is not limited to the above order.

Color filter

The color filter of the present invention has red pixels
15 made of the radiation sensitive composition of the present
invention.

The red pixels of the color filter of the present invention
have high light transmittance and a high contrast ratio of 500
or more, preferably 1,000 or more when they have a film thickness
20 of 1.60 μm .

In addition, the red pixels of the color filter of the
present invention do not have or rarely have foreign matter
thereon.

A color filter having red pixels with a high contrast ratio
25 of 500 or more and free from foreign matter produced thereon cannot
be obtained from the radiation sensitive composition for color
filters of the prior art.

The color filter of the present invention is extremely
useful in transmission and reflection color liquid crystal
30 displays, color image pick-up devices, color sensors, etc.

Color liquid crystal display

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

The color liquid crystal display of the present invention may have a suitable structure. For example, the color filter is formed on a substrate separate from a drive substrate having a thin film transistor (TFT), and the drive substrate and the substrate having the color filter are joined together in such a matter that they are opposed to each other with a liquid crystal layer interposed therebetween. Or, a substrate manufactured by forming the color filter on a drive substrate having a thin film transistor (TFT) formed thereon and a substrate having ITO (tin doped indium oxide) electrodes are opposed to each other with a liquid crystal layer interposed therebetween. The latter structure can significantly improve the numerical aperture, thereby making it possible to obtain a bright high-definition liquid crystal display device.

The radiation sensitive composition of the present invention can provide red pixels having a high transmittance and a high contrast ratio without foreign matter or with a trace amount of foreign matter produced thereon at a high production yield.

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.

Synthetic Example 1

1 part by weight of 2,2'-azobis(2,4-dimethylvaleronitrile) and 200 parts by weight of diethylene glycol monomethyl ether acetate were fed to a flask equipped with a cooling tube and a stirrer, 15 parts by weight of methacrylic acid, 25 parts by weight of N-phenylmaleimide, 35 parts by weight of benzyl methacrylate, 10 parts by weight of glycerol monomethacrylate, 15 parts by weight of styrene and 2.5 parts by weight of α -methylstyrene dimer as a chain transfer agent were then fed to the flask, the inside of the flask was

substituted by nitrogen, the resulting solution was stirred gently, and the temperature of the reaction solution was raised to 80° C to polymerize the solution by maintaining that temperature for 3 hours. Thereafter, the temperature of the reaction
5 solution was further elevated to 100° C, and 0.5 part by weight of 2,2'-azobis(2,4-dimethylvaleronitrile) was added to further continue polymerization for another 1 hour so as to obtain a resin solution (solid content of 33.1 wt%). The obtained resin had an Mw of 30,000 and an Mn of 10,000. This resin is designated as
10 resin (B-1).

Synthetic Example 2

2.7 parts by weight of 2,2'-azobis(2,4-dimethylvaleronitrile) and 200 parts by weight
15 of diethylene glycol monomethyl ether acetate were fed to a flask equipped with a cooling tube and a stirrer, 15 parts by weight of methacrylic acid, 10 parts by weight of ω -carboxypolycaprolactone monoacrylate, 18.75 parts by weight of N-phenylmaleimide, 35 parts by weight of benzyl methacrylate,
20 10 parts by weight of glycerol monomethacrylate, 11.25 parts by weight of styrene and 5 parts by weight of α -methylstyrene dimer as a chain transfer agent were then fed to the flask, the inside of the flask was substituted by nitrogen, the resulting solution was stirred gently, and the temperature of the reaction solution
25 was raised to 80° C to polymerize the solution by maintaining that temperature for 3 hours. Thereafter, the temperature of the reaction solution was further elevated to 100° C, and 0.3 part by weight of 2,2'-azobis(2,4-dimethylvaleronitrile) was added to further continue polymerization for another 1 hour so as to
30 obtain a resin solution (solid content of 33.0 wt%). The obtained resin had an Mw of 15,000 and an Mn of 7,000. This resin is designated as resin (B-2).

Example 1

A mixed solution consisting of 40 parts by weight of a mixture of C.I. Pigment Red 175 and C.I. Pigment Yellow 254 in a weight ratio of 50/50 as a pigment (A), 10 parts by weight of EFKA-47 as a dispersant and 100 parts by weight of ethyl

5 3-ethoxypropionate as a solvent were mixed and dispersed together with Diamond Fine Mill (trade name, a bead mill having a bead diameter of 1.0 mm manufactured by Mitsubishi Materials Co., Ltd.) for 12 hours to prepare a pigment dispersion.

When the average particle diameter of the pigment contained
10 in the obtained pigment dispersion was measured by a dynamic light scattering method, it was 140 nm.

100 parts by weight of the obtained pigment dispersion, 70 parts by weight of the resin (B-1) as an alkali-soluble resin (B), 80 parts by weight of dipentaerythritol hexaacrylate as a
15 polyfunctional monomer (C), 50 parts by weight of 2-benzyl-2-dimethylamino-1-(4-morpholinophenyl)butanone-1 as a radical generator (D) and 1,000 parts by weight of propylene glycol monomethyl ether acetate as a solvent were mixed together to prepare a liquid composition (R1).

20 Thereafter, this liquid composition (R1) was applied to the surface of a soda-lime glass substrate having an SiO₂ film for preventing the elution of sodium ions formed on the surface with a spin coater and prebaked in a clean oven heated at 90°C for 10 minutes to form a 2.0 µm-thick coating film.

25 Thereafter, this substrate was cooled to room temperature and the coating film on the substrate was exposed to 5,000 J/m² of radiation having wavelengths of 365 nm, 405 nm and 436 nm with a high-pressure mercury lamp through a photomask. This substrate was then immersed in a 0.04 wt% aqueous solution of potassium
30 hydroxide having the temperature of 23 °C as a developer for 1 minute to be developed, rinsed with super pure water, dried with air and post-baked at 250°C for 30 minutes to form a red striped pixel pattern on the substrate. This pixel pattern had a film thickness of 1.60 µm.

Evaluation of foreign matter and chromaticity

When the formed pixel pattern was observed through an optical microscope, foreign matter was not observed on the pixels.

5 When the chromaticity of the pixels was evaluated with the TC-1800M color analyzer (of Tokyo Denshoku Co., Ltd.), (x, y, Y) = (0.650, 0.340, 20.0).

Evaluation of contrast ratio

10 The obtained substrate was sandwiched between two deflecting plates and the deflecting plate on the front side was turned while illuminated by a fluorescent lamp (wavelength of 380 to 780 nm) from the back to measure the maximum and minimum values of transmitted light intensity. The contrast ratio which
15 was obtained by dividing the maximum value by the minimum value was 1,800.

Example 2

20 A liquid composition (R2) was prepared in the same manner as in Example 1 except that 40 parts by weight of C.I. Pigment Red 175 as the pigment (A) and 10 parts by weight of BYK-2001 as the dispersant were used.

25 When the average particle diameter of the pigment contained in the obtained pigment dispersion was measured by a dynamic light scattering method, it was 140 nm.

A red striped pixel pattern having a film thickness of 1.60 μm was formed on the substrate and evaluated in the same manner as in Example 1 except that the liquid composition (R2) was used.

30 As a result, foreign matter was not observed on the pixels. The chromaticity of the pixels was (x, y, Y) = (0.650, 0.345, 19.0) and the contrast ratio was 2,500.

Example 3

A liquid composition (R3) was prepared in the same manner

as in Example 1 except that 40 parts by weight of a mixture of C.I. Pigment Red 175 and C.I. Pigment Yellow 254 in a weight ratio of 40/60 as the pigment (A) and 70 parts by weight of the resin (B-2) as the alkali-soluble resin (B) were used and mixing and dispersion were carried out for 4 hours to prepare a pigment dispersion. When the average particle diameter of the pigment contained in the obtained pigment dispersion was measured by a dynamic light scattering method, it was 250 nm.

A red striped pixel pattern having a film thickness of 1.60 μm was formed on the substrate and evaluated in the same manner as in Example 1 except that the liquid composition (R3) was used.

As a result, foreign matter was not observed on the pixels. The chromaticity of the pixels was (x, y, Y) = (0.650, 0.338, 18.0) and the contrast ratio was 500.

15

Example 4

A liquid composition (R4) was prepared in the same manner as in Example 1 except that 40 parts by weight of a mixture of C.I. Pigment Red 175 and C.I. Pigment Red 177 in a weight ratio of 80/20 as the pigment (A), 70 parts by weight of the resin (B-2) as the alkali-soluble resin (B) and 10 parts by weight of BYK-2000 as the dispersant were used and mixing and dispersion were carried out for 16 hours to prepare a pigment dispersion.

When the average particle diameter of the pigment contained in the obtained pigment dispersion was measured by a dynamic light scattering method, it was 80 nm.

A red striped pixel pattern having a film thickness of 1.60 μm was formed on the substrate and evaluated in the same manner as in Example 1 except that the liquid composition (R4) was used.

As a result, foreign matter was not observed on the pixels. The chromaticity of the pixels was (x, y, Y) = (0.650, 0.342, 18.0) and the contrast ratio was 2,200.

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Example 5

A liquid composition (R5) was prepared in the same manner as in Example 1 except that 40 parts by weight of a mixture of C.I. Pigment Red 175 and C.I. Pigment Red 177 in a weight ratio of 35/65 as the pigment (A) and 10 parts by weight of BYK-165 as the dispersant were used and mixing and dispersion were carried out for 8 hours to prepare a pigment dispersion. When the average particle diameter of the pigment contained in the obtained pigment dispersion was measured by a dynamic light scattering method, it was 200 nm.

10 A red striped pixel pattern having a film thickness of 1.60 μm was formed on the substrate and evaluated in the same manner as in Example 1 except that the liquid composition (R5) was used.

As a result, foreign matter was not observed on the pixels. The chromaticity of the pixels was $(x, y, Y) = (0.650, 0.323, 16.0)$ and the contrast ratio was 1,000.

Comparative Example 1

A liquid composition (r1) was prepared in the same manner as in Example 1 except that 40 parts by weight of a mixture of C.I. Pigment Red 175 and C.I. Pigment Red 254 in a weight ratio of 15/85 was used as the pigment (A) and 10 parts by weight of BYK-2001 was used as the dispersant.

When the average particle diameter of the pigment contained in the obtained pigment dispersion was measured by a dynamic light scattering method, it was 140 nm.

A red striped pixel pattern having a film thickness of 1.60 μm was formed on the substrate and evaluated in the same manner as in Example 1 except that the liquid composition (r1) was used.

The chromaticity of the pixels was $(x, y, Y) = (0.650, 0.336, 19.0)$ and the contrast ratio was 940. However, the number of foreign substances on the pixels was 20 on the average in a 100 $\mu\text{m} \times 100 \mu\text{m}$ area, which means that the obtained product could not be used as a color filter.

Comparative Example 2

A liquid composition (r2) was prepared in the same manner as in Example 1 except that a mixture of 40 parts by weight of C.I. Pigment Red 254 as the pigment (A) and 10 parts by weight of BYK-2000 as the dispersant were used and mixing and dispersion were carried out for 16 hours to prepare a pigment dispersion.

When the average particle diameter of the pigment contained in the obtained pigment dispersion was measured by a dynamic light scattering method, it was 100 nm.

10 A red striped pixel pattern having a film thickness of 1.60 μm was formed on the substrate and evaluated in the same manner as in Example 1 except that the liquid composition (r2) was used.

The chromaticity of the pixels was (x, y, Y) = (0.650, 0.335, 18.0) and the contrast ratio was 1,500. However, the number of foreign substances on the pixels was 80 on the average in a 100 $\mu\text{m} \times 100 \mu\text{m}$ area, which means that the obtained product could not be used as a color filter.

Comparative Example 3

20 A liquid composition (r3) was prepared in the same manner as in Example 1 except that a mixture of 40 parts by weight of C.I. Pigment Red 208 as the pigment (A) and 10 parts by weight of SOLSPERSE24000 as the dispersant were used.

When the average particle diameter of the pigment contained in the obtained pigment dispersion was measured by a dynamic light scattering method, it was 140 nm.

A red striped pixel pattern having a film thickness of 1.60 μm was formed on the substrate and evaluated in the same manner as in Example 1 except that the liquid composition (r3) was used.

30 As a result, foreign matter was not observed on the pixels. The chromaticity of the pixels was (x, y, Y) = (0.650, 0.306, 12.5) and the contrast ratio was 250.

Comparative Example 4

A liquid composition (r4) was prepared in the same manner as in Example 2 except that mixing and dispersion were carried out for 30 minutes to prepare a pigment dispersion.

5 When the average particle diameter of the pigment contained in the obtained pigment dispersion was measured by a dynamic light scattering method, it was 400 nm.

A red striped pixel pattern having a film thickness of 1.60 μm was formed on the substrate and evaluated in the same manner as in Example 1 except that the liquid composition (r4) was used.

10 As a result, foreign matter was not observed on the pixels. The chromaticity of the pixels was $(x, y, Y) = (0.650, 0.343, 15.0)$ and the contrast ratio was 350.

What is claimed is:

1. A radiation sensitive composition comprising (A) a pigment, (B) an alkali-soluble resin, (C) a polyfunctional monomer or a combination of a polyfunctional monomer and a monofunctional monomer and (D) a radiation sensitive radical generator, wherein

the pigment (A) comprises 20 wt% or more of C.I. Pigment Red 175 and has an average particle diameter r (unit: nm) of 50 to 300, and the composition is used for color filters.

2. The radiation sensitive composition according to claim 1, wherein the pigment (A) further comprises at least one selected from the group consisting of C.I. Pigment Yellow 83, C.I. Pigment Yellow 139, C.I. Pigment Red 177 and C.I. Pigment Red 254.

3. A process for preparing the radiation sensitive composition of claim 1, comprising the step of mixing together a pigment dispersion obtained by mixing and dispersing (A) a pigment which comprises 20 wt% or more of C.I. Pigment Red 175 and has an average particle diameter larger than 300 nm in a solvent while it is ground in the solvent, (B) an alkali-soluble resin, (C) a polyfunctional monomer or a combination of a polyfunctional monomer and a monofunctional monomer and (D) a radiation sensitive radical generator.

4. A color filter having red pixels made of the radiation sensitive composition of claim 1 or 2.

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

6. The radiation sensitive composition according to claim 1, wherein the pigment (A) comprises 50 wt% or more of C.I. Pigment Ref 175.

7. A radiation sensitive composition comprising (A) a pigment, (B) an alkali-soluble resin, (C) a polyfunctional monomer or a combination of a polyfunctional monomer and a monofunctional monomer and (D) a radiation sensitive radical generator, wherein

the pigment (A) comprises 50 wt% or more of C.I. Pigment Red 175, pixels made of the radiation sensitive composition and having a film thickness or 1.60 μm provide a contrast ratio of 1,000 or more, and the composition is used for color filters.

8. The process according to claim 3, wherein the pigment (A) comprises 50 wt% or more of C.I. Pigment Red 175.