

RADIATION SENSITIVE COMPOSITION AND METHOD FOR THE
PREPARATION OF THE SAME

Field of the Invention

5 The present invention relates to a radiation sensitive composition, a method for the preparation of the same, a color filter and a color liquid crystal display device. More specifically, it relates to a radiation sensitive composition used for the manufacture of a color filter for
10 use in transmission and reflection color liquid crystal display devices and color image pick-up devices, a method for the preparation of the same, a color filter having pixels formed from the radiation sensitive composition, and a color liquid crystal display device having the above color filter.

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Description of the Prior Art

 As means of manufacturing a color filter from a colored radiation sensitive composition, there is known a method in which a coating film of the colored radiation sensitive
20 composition is formed on a substrate or a substrate comprising a light screening layer having a desired pattern, exposed to radiation through a photomask having a desired pattern (to be referred to as "exposure" hereinafter), developed to dissolve and remove an unexposed portion, and
25 post-baked 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").

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

 Along with the recent spread of digital video cameras and high-vision TV's, demand for a color liquid crystal display device capable of displaying a deep color such as a deep blue winter sea or bright red setting sun is rising.

If the "blackness" of a black display portion is not displayed clearly, an unclear blurred image will be obtained.

Therefore, pixels having high color strength and high contrast ratio are in demand. Then, the development of a radiation sensitive composition for color filters which can provide red and green pixels having a high transmittance and high contrast ratio is strongly desired.

It is generally known that red and green pixels contain a yellow pigment which has a great influence upon transmittance and contrast ratio. Although C.I. Pigment Yellow 83 has been mainly used as a yellow pigment, it cannot be said that pixels obtained from a colored radiation sensitive composition containing C.I. Pigment Yellow 83 have a sufficiently high transmittance and contrast ratio, and accordingly, the above colored radiation sensitive composition is not suitable for providing high-quality images.

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 and green pixels having a high transmittance and high contrast ratio.

It is another object of the present invention to provide a method of preparing the above radiation sensitive composition for color filters.

It is still another object of the present invention to provide a color filter having pixels formed from the above radiation sensitive composition for color filters and a color liquid crystal display device having the color filter.

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

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

by a radiation sensitive composition comprising (A) a pigment which contains 5 wt% or more of C.I. Pigment Yellow 219 and has an average particle diameter "r" of 50 to 300 nm, (B) an alkali-soluble resin, (C) a polyfunctional monomer and
5 (D) a radiation sensitive radical generating agent, and used for the manufacture of a color filter.

The term "radiation" as used herein includes visible radiation, ultraviolet radiation, far ultraviolet radiation, electron radiation and X-radiation.

10 According to the present invention, secondly, the above objects and advantages of the present invention are attained by a method of preparing a radiation sensitive composition, comprising mixing a pigment dispersion which has (A) a pigment having an average particle diameter "r"
15 of 50 to 300 nm, which is obtained by mixing and dispersing a pigment which contains 5 wt% or more of C.I. Pigment Yellow 219 and has an average particle diameter larger than 300 nm while it is milled in a solvent, with (B) an alkali-soluble resin, (C) a polyfunctional monomer and (D) a radiation
20 sensitive radical generating agent to form a radiation sensitive composition for color filters.

According to the present invention, thirdly, the above objects and advantages of the present invention are attained by a color filter having red pixels and/or green pixels formed
25 from the above radiation sensitive composition.

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 having the above color filter.

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Detailed Description of the Preferred Embodiments

The present invention will be described in detail hereinunder.

Radiation sensitive composition for color filters

- (A) pigment -

The pigment in the present invention contains C.I. Pigment Yellow 219 according to color index (C.I.; issued by The Society of Dyers and Colourists, the same shall apply
5 hereinafter).

The pigment in the present invention may further contain other pigment as the case may be.

Although the above other pigment is not particularly limited, it is preferably an organic pigment because high
10 purity, the development of a highly transparent color and heat resistance are required for a color filter.

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

C.I. Pigment Yellow 12, C.I. Pigment Yellow 13, C.I. Pigment Yellow 14, C.I. Pigment Yellow 17, C.I. Pigment Yellow 20, C.I. Pigment Yellow 24, C.I. Pigment Yellow 31, C.I. Pigment Yellow 55, C.I. Pigment Yellow 83, C.I. Pigment Yellow 93,
20 C.I. Pigment Yellow 109, C.I. Pigment Yellow 110, C.I. Pigment Yellow 138, C.I. Pigment Yellow 139, C.I. Pigment Yellow 150, C.I. Pigment Yellow 153, C.I. Pigment Yellow 154, C.I. Pigment Yellow 155, C.I. Pigment Yellow 166, C.I. Pigment Yellow 168 and C.I. Pigment Yellow 211;
25 C.I. Pigment Green 7 and C.I. Pigment Green 36;
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 Orange 36, C.I. Pigment Orange 38, C.I. Pigment Orange 40, C.I. Pigment Orange 43, C.I. Pigment Orange 46,
30 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, 5 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 10 220, 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.

Out of these other organic pigments, C.I. Pigment Red 15 177, C.I. Pigment Red 242 and C.I. Pigment Red 254 are preferred as the other organic pigment for forming red pixels. C.I. Pigment Yellow 138, C.I. Pigment Yellow 150 and C.I. Pigment Green 36 are preferred as the other organic pigment for forming green pixels.

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

The content of C.I. Pigment Yellow 219 in the pigment of the present invention is 5 wt% or more, preferably 20 to 90 wt%, particularly preferably 35 to 75 wt%. By using this 25 pigment, red and green pixels which exhibit excellent developability, have a high contrast ratio and high transmittance and are free from foreign matter can be obtained.

In the present invention, C.I. Pigment Yellow 219 and 30 other pigment may be purified by re-crystallization, re-precipitation, solvent cleaning, sublimation, vacuum heating or a combination thereof before use as required.

The average particle diameter "r" of the pigment used in the present invention is 50 to 300 nm, preferably 100 to

300 nm, particularly preferably 50 to 200 nm. By using a pigment having the above average particle diameter "r", red and green pixels having a high contrast ratio and high transmittance can be obtained. The term "average particle diameter" as used herein means the average particle diameter of secondary particles which are agglomerates of the primary particles (fine monocrystals) of the pigment.

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

The pigment having the above average particle diameter and particle size distribution can be prepared by mixing and dispersing a pigment mixed solution obtained by mixing commercially available C.I. Pigment Yellow 219 (its average particle diameter is generally larger than 300 nm) and optionally other pigment (its average particle diameter is generally larger than 300 nm) preferably with a dispersant and a solvent by means of a mill such as a bead mill or roll mill while it is milled in the solvent. The thus obtained pigment is generally prepared as a pigment dispersion.

The dispersant used for the preparation of the pigment dispersion is, for example, a cationic, anionic, ampholytic or nonionic dispersant, preferably a dispersant containing a compound having an urethane bond (may be referred to as "urethane-based dispersant" hereinafter).

The above urethane bond may be existent in a lipophilic and/or hydrophilic group contained in the urethane-based dispersant preferably represented by the formula $R-NH-COO-R'$ (R and R' are an aliphatic, alicyclic or aromatic monovalent or polyvalent organic group, and the polyvalent organic group is further bonded to a group having another urethane bond

or other group) and further in the main chain and/or side chain of the urethane-based dispersant, and one or more of the urethane bonds may be existent in the urethane-based dispersant. When two or more of the urethane bonds are
5 existent in the urethane-based dispersant, they may be the same or different.

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

Examples of the above diisocyanate include benzene diisocyanates such as benzene-1,3-diisocyanate and benzene-1,4-diisocyanate; toluene diisocyanates such as toluene-2,4-diisocyanate, toluene-2,5-diisocyanate,
15 toluene-2,6-diisocyanate and toluene-3,5-diisocyanate; and other aromatic diisocyanates such as 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,
20 1,4-xylene-2,5-diisocyanate and 1,4-xylene-2,6-diisocyanate.

Examples of the above triisocyanate include benzene triisocyanates such as benzene-1,2,4-triisocyanate, benzene-1,2,5-triisocyanate and
25 benzene-1,3,5-triisocyanate; toluene triisocyanates such as toluene-2,3,5-triisocyanate, toluene-2,3,6-triisocyanate, toluene-2,4,5-triisocyanate and toluene-2,4,6-triisocyanate; and other aromatic triisocyanates such as xylene triisocyanates including
30 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.

5 Further, examples of the polyester having a hydroxyl group at one terminal and the polyester having a hydroxyl group at both terminals include polylactones having a hydroxyl group at one terminal or both terminals such as polycaprolactone having a hydroxyl group at one terminal or
10 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
15 terephthalate having a hydroxyl group at one terminal or both terminals and polybutylene terephthalate having a hydroxyl group having one terminal or both terminals.

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

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

Examples of the above urethane-based dispersant include EFKA (of EFKA Chemicals BV Co., Ltd.), Disperbyk (of BYK Co., Ltd.) and Disparon (of Kusumoto Kasei Co., Ltd.) series.

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.

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, the developability may be impaired.

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

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

To prepare the pigment dispersion by using 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 preferably while it is cooled with cooling water or the like.

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 about 20 to 50 % of the capacity of the mill. The treating time is preferably 2 to 50 hours, more preferably 2 to 25 hours.

To prepare the pigment dispersion by using a roll mill, a three-roll mill or two-roll mill is used to mix the pigment

mixed solution preferably while it is cooled with cooling water or the like.

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

The average particle diameter and particle size distribution of the pigment contained in the thus prepared pigment dispersion 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. It 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

5 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
 10 particularly 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,
 15 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.

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

Examples of the polymerizable unsaturated monomer
 having a sulfonic acid group include isoprenesulfonic acid
 25 and p-styrenesulfonic acid.

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

Examples of the copolymerizable unsaturated monomer
 30 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 simply referred to as "macromonomer"
 hereinafter); 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,
 5 N-m-methoxyphenylmaleimide and N-p-methoxyphenylmaleimide,
 and N-substituted maleimides such as N-cyclohexylmaleimide;
 aromatic vinyl compounds such as styrene, α -methylstyrene,
 o-vinytoluene, m-vinytoluene, p-vinytoluene,
 p-chlorostyrene, o-methoxystyrene, m-methoxystyrene,
 10 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
 15 (meth)acrylate, ethyl (meth)acrylate, n-propyl
 (meth)acrylate, i-propyl (meth)acrylate, n-butyl
 (meth)acrylate, i-butyl (meth)acrylate, sec-butyl
 (meth)acrylate, t-butyl (meth)acrylate, 2-hydroxyethyl
 (meth)acrylate, 2-hydroxypropyl (meth)acrylate,
 20 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,
 25 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,
 30 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; 5 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 10 (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, 15 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 the 20 N-substituted maleimides, N-phenylmaleimide and N-cyclohexylmaleimide are particularly preferred.

The preferred alkali-soluble resin in the present invention is a copolymer of a carboxyl group-containing unsaturated monomer and a copolymerizable unsaturated 25 monomer (to be referred to as "carboxyl group-containing copolymer" hereinafter).

The carboxyl group-containing copolymer is preferably a copolymer of a monomer mixture comprising (a) a carboxyl group-containing unsaturated monomer and (b) at least one 30 selected from the group consisting of polystyrene macromonomer, polymethyl (meth)acrylate macromonomer, N-phenylmaleimide, N-cyclohexylmaleimide, 2-hydroxyethyl (meth)acrylate, benzyl (meth)acrylate and glycerol (meth)acrylate and optionally (c) at least one selected from

the group consisting of styrene, methyl (meth)acrylate, allyl (meth)acrylate and phenyl (meth)acrylate (to be referred to as "carboxyl group-containing copolymer (I)" hereinafter).

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

- 20 Illustrative examples of the carboxyl group-containing copolymer (II) include a copolymer of (meth)acrylic acid, mono[2-(meth)acryloyloxyethyl]succinate, benzyl (meth)acrylate and glycerol mono(meth)acrylate, copolymer
- 25 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,
- 30 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,

- mono[2-(meth)acryloyloxyethyl]succinate,
 N-cyclohexylmaleimide, benzyl (meth)acrylate and styrene,
 copolymer of (meth)acrylic acid,
 mono[2-(meth)acryloyloxyethyl]succinate,
- 5 N-phenylmaleimide, benzyl (meth)acrylate, glycerol
 mono(meth)acrylate and styrene, 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
- 10 acid and 2-hydroxyethyl (meth)acrylate, copolymer of
 (meth)acrylic acid, polystyrene macromonomer and benzyl
 (meth)acrylate, copolymer of (meth)acrylic acid, polymethyl
 (meth)acrylate macromonomer and benzyl (meth)acrylate,
 copolymer of (meth)acrylic acid, benzyl (meth)acrylate and
- 15 glycerol mono(meth)acrylate, copolymer of (meth)acrylic
 acid, 2-hydroxyethyl (meth)acrylate and benzyl
 (meth)acrylate, copolymer of (meth)acrylic acid,
 2-hydroxyethyl (meth)acrylate and phenyl (meth)acrylate,
 copolymer of (meth)acrylic acid, 2-hydroxyethyl
- 20 (meth)acrylate and styrene, copolymer of (meth)acrylic acid,
 N-cyclohexylmaleimide, benzyl (meth)acrylate and styrene,
 copolymer of (meth)acrylic acid, polystyrene macromonomer,
 2-hydroxyethyl (meth)acrylate and benzyl (meth)acrylate,
 copolymer of (meth)acrylic acid, polymethyl (meth)acrylate
- 25 macromonomer, 2-hydroxyethyl (meth)acrylate and benzyl
 (meth)acrylate, copolymer of (meth)acrylic acid,
 N-phenylmaleimide, benzyl (meth)acrylate and styrene, and
 copolymer of (meth)acrylic acid, N-phenylmaleimide, benzyl
 (meth)acrylate, glycerol mono(meth)acrylate and styrene.
- 30 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 content of the carboxyl group-containing
 unsaturated monomer is lower than 5 wt%, the solubility in

an alkali developer of the obtained radiation sensitive composition may lower and when the content is higher than 50 wt%, the solubility in an alkali developer of the radiation sensitive composition may become too high. As a result, when
5 the radiation sensitive composition is developed with an alkali developer, the pixels may fall off from the substrate and the film surface of the formed pixels may be roughened.

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

20 By using this alkali-soluble resin having specific Mw and Mn, a radiation sensitive composition having excellent developability is obtained. Thereby, a pixel pattern having a sharp edge can be formed, and the residue, stain or film residue is hardly produced on the substrate and light
25 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 alkali-soluble resins
30 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, the 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. When the amount is larger than 1,000 parts by weight, the concentration of the pigment becomes relatively low, whereby it may be difficult to achieve the target color strength of a thin film.

- (C) polyfunctional monomer -

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

Examples of the polyfunctional monomer include di(meth)acrylates of an alkylene glycol such as ethylene glycol and propylene glycol; di(meth)acrylates of a polyalkylene glycol exemplified by polyethylene glycols such as a diethylene glycol obtained by the condensation of two or more ethylene glycol molecules and polypropylene glycols such as a dipropylene glycol obtained by the condensation of two or more propylene glycol molecules; poly(meth)acrylates of a polyhydric alcohol having 3 or more hydroxyl groups and dicarboxylic acid modified products thereof such as glycerin, trimethylolpropane, pentaerythritol and dipentaerythritol; oligo(meth)acrylates such as polyester, epoxy resin, urethane resin, alkyd resin, silicone resin and spiran resin; di(meth)acrylates of a polymer having a hydroxyl group at both terminals such as poly-1,3-butadiene having a hydroxyl group at both terminals, polyisoprene having a hydroxyl group at both terminals and polycaprolactone having a hydroxyl group at both terminals; and tris[2-(meth)acryloyloxyethyl]phosphate.

Out of these polyfunctional monomers, poly(meth)acrylates of a polyhydric alcohol having 3 or more

hydroxyl groups and dicarboxylic acid modified products thereof are preferred, as exemplified by trimethylolpropane tri(meth)acrylate, pentaerythritol tri(meth)acrylate, pentaerythritol tetra(meth)acrylate, dipentaerythritol
5 penta(meth)acrylate and dipentaerythritol hexa(meth)acrylate. Trimethylolpropane triacrylate, pentaerythritol triacrylate and dipentaerythritol hexaacrylate are particularly preferred because they provide pixels having excellent strength and surface smoothness and
10 rarely produce a stain or the film residue on the substrate and light screening layer of an unexposed portion. The above functional monomers may be used alone or in combination of two or more.

The amount of the polyfunctional monomer in the present
15 invention is preferably 5 to 500 parts by weight, more preferably 20 to 300 parts by weight based on 100 parts by weight of the alkali-soluble resin (B). When the amount of the polyfunctional monomer is smaller than 5 parts by weight, the strength and surface smoothness of the formed pixels may
20 deteriorate and when the amount is larger than 500 parts by weight, the 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.

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

Examples of the above monofunctional monomer include carboxyl group-containing unsaturated monomers and copolymerizable unsaturated monomers enumerated for the
30 above alkali-soluble resin (B), N-vinyl-containing nitrogen heterocyclic compounds such as N-vinylsuccinimide, N-vinylpyrrolidone, N-vinylphthalimide, N-vinyl-2-piperidone, 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; and N-(meth)acryloylmorpholine and
5 commercially available M-5300, M-5400 and M-5600 (tradename; produced 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 in the present
10 invention is preferably 90 wt% or less, more preferably 50 wt% or less based on the total amount 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 formed pixels may
15 deteriorate.

- (D) radiation sensitive radical generating agent -

The radiation sensitive radical generating agent (to be simply referred to as "radical generating agent"
20 hereinafter) in the present invention is a compound which forms a radical capable of initiating the polymerization of the above polyfunctional monomer (C) and the optionally used monofunctional monomer upon exposure to visible radiation, ultraviolet radiation, far ultraviolet radiation, electron
25 radiation or X-radiation.

Examples of the radical generating agent include an acetophenone-based compound, biimidazole-based compound, triazine-based compound, benzoin-based compound, benzophenone-based compound, α -diketone-based compound,
30 polynuclear quinone-based compound, xanthone-based compound and diazo-based compound.

In the present invention, the above radical generating agents may be used alone or in combination of two or more. The radical generating agent in the present invention is

preferably at least one selected from the group consisting of an acetophenone-based compound, biimidazole-based compound and triazine-based compound.

In the present invention, the amount of the radical generating agent 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 polyfunctional monomer (C) or 100 parts by weight of the total of the polyfunctional monomer and the monofunctional monomer. When the amount of the radical generating agent 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 generating agents in the present invention include 2-hydroxy-2-methyl-1-phenylpropan-1-one, 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).

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 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 generating agent in the present invention, the amount

of the 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 polyfunctional monomer (C) or 100 parts by weight of the total of the polyfunctional monomer and the monofunctional monomer (when the monofunctional monomer is used). When the amount of the acetophenone-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 80 parts by weight, the formed pixels may fall off from the substrate during development.

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

Out of these biimidazole-based compounds, 2,2'-bis(2-chlorophenyl)-4,4',5,5'-tetraphenyl-1,2'-biimidazole, 2,2'-bis(2,4-dichlorophenyl)-4,4',5,5'-tetraphenyl-1,2'-biimidazole and

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

5 The above biimidazole-based compounds have excellent solubility in a solvent, do not produce foreign matter such as an undissolved product and a precipitate, have high sensitivity, can fully promote a curing reaction by exposure with a small amount of energy and does not cause a curing
10 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 a predetermined pixel
15 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 generating agent in the present invention, the amount
20 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 polyfunctional monomer (C) or 100 parts by weight of the total of the polyfunctional monomer and the
25 monofunctional monomer (when the monofunctional monomer is used). 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
30 larger than 40 parts by weight, the formed pixels may fall off from the substrate, or the film surface of the formed pixels may be roughened during development.

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

5 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 upon exposure.

 The hydrogen donor in the present invention is preferably a mercaptan-based compound or an amine-based
10 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 (to
15 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
20 directly bonded to the mother nucleus (to be referred to as "amine-based hydrogen donor" hereinafter).

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

 A detailed description is subsequently given of these
25 hydrogen donors.

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

30 When the mercaptan-based hydrogen donor has two or more mercapto groups, as far as at least one free mercapto group remains, at least one of the other mercapto groups may be substituted by an alkyl, aralkyl or aryl group. Further, as far as at least one free mercapto group remains, the

mercaptan-based hydrogen donor may have a structural unit in which two sulfur atoms are bonded together by a divalent organic group such as an alkylene group, or a structural unit in which two sulfur atoms are bonded together in the form 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 other than the mercapto group(s).

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

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

The amine-based hydrogen donor may have at least one benzene ring or hetero ring, or both of them. When it has two or more of the rings, a fused ring may 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, phenoxycarbonyl group, substituted phenoxycarbonyl 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, 4,4'-bis(diethylamino)benzophenone, 4-diethylaminoacetophenone, 4-dimethylaminopropiophenone, ethyl-4-dimethylaminobenzoate, 4-dimethylaminobenzoic

acid and 4-dimethylaminobenzonitrile.

Out of these amine-based hydrogen donors, 4,4'-bis(dimethylamino)benzophenone and 4,4'-bis(diethylamino)benzophenone are preferred, and 5 4,4'-bis(diethylamino)benzophenone is particularly preferred.

The amine-based hydrogen donor serves as a sensitizer even when a radical generating agent other than a biimidazole-based compound is used.

10 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 pixels hardly fall off from the 15 substrate during development and have high strength and sensitivity.

Preferred examples of the combination of the mercaptan-based hydrogen donor and the amine-based hydrogen donor include a combination of 2-mercaptobenzothiazole and 20 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 25 2-mercaptobenzoxazole and 4,4'-bis(diethylamino)benzophenone. Out of these combinations, a combination of 2-mercaptobenzothiazole and 4,4'-bis(diethylamino)benzophenone and a combination of 2-mercaptobenzoxazole and 30 4,4'-bis(diethylamino)benzophenone are more preferred, and a combination of 2-mercaptobenzothiazole and 4,4'-bis(diethylamino)benzophenone is particularly preferred.

The weight ratio of the mercaptan-based hydrogen donor

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

When the hydrogen donor is used in conjunction with
 5 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 polyfunctional monomer (C) or 100 parts
 10 by weight of the total of the polyfunctional monomer and the monofunctional monomer (when the monofunctional monomer is used). 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,
 15 the formed pixels may fall off from the substrate during development.

Examples of the above triazine-based compound include triazine-based compounds having a halomethyl group such as
 20 2,4,6-tris(trichloromethyl)-s-triazine,
 2-methyl-4,6-bis(trichloromethyl)-s-triazine,
 2-[2-(5-methylfuran-2-yl)ethenyl]-4,6-bis
 (trichloromethyl)-s-triazine,
 2-[2-(furan-2-yl)ethenyl]-4,6-bis(trichloromethyl)-s-
 25 triazine,
 2-[2-(4-diethylamino-2-methylphenyl)ethenyl]-4,6-bis
 (trichloromethyl)-s-triazine,
 2-[2-(3,4-dimethoxyphenyl)ethenyl]-4,6-bis(trichlorometh
 yl)-s-triazine,
 30 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,

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.

5 When the triazine-based compound is used as the radical
generating agent 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
10 of the polyfunctional monomer (C) or 100 parts by weight of
the total of the polyfunctional monomer and the
monofunctional monomer (when the monofunctional monomer is
used). When the amount of the triazine-based compound is
smaller than 0.01 part by weight, it may be difficult to obtain
15 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.

20 - other additives -

The radiation sensitive composition for color filters
of the present invention contains the above components (A)
to (D) and may further contain other additives as required.

The above other additives include a filler such as glass
25 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,
30 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
5 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
10 inhibitor such as sodium polyacrylate.

Solvent

The radiation sensitive composition for color filters
of the present invention contains the above components (A)
15 to (D) and optionally added other additives. Preferably,
it is mixed with a solvent to be prepared as a liquid
composition.

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

Examples of the solvent include alcohols such as
methanol, ethanol and benzyl alcohol; (poly)alkylene glycol
monoalkyl ethers such as ethylene glycol monomethyl ether,
25 ethylene glycol monoethyl ether, ethylene glycol
mono-n-propyl ether, ethylene glycol mono-n-butyl ether,
diethylene glycol monomethyl ether, diethylene glycol
monoethyl ether, diethylene glycol mono-n-propyl ether,
diethylene glycol mono-n-butyl ether, triethylene glycol
30 monomethyl ether, triethylene glycol monoethyl ether,
propylene glycol monomethyl ether, propylene glycol
monoethyl ether, dipropylene glycol monomethyl ether,
dipropylene glycol monoethyl ether, dipropylene glycol
mono-n-propyl ether, dipropylene glycol mono-n-butyl ether,

tripropylene glycol monomethyl ether and tripropylene glycol monoethyl ether; (poly)alkylene glycol monoalkyl ether acetates such as ethylene glycol monomethyl ether acetate, ethylene glycol monoethyl ether acetate, ethylene glycol mono-n-propyl ether acetate, ethylene glycol mono-n-butyl ether acetate, diethylene glycol monomethyl ether acetate, diethylene glycol monoethyl ether acetate, diethylene glycol mono-n-propyl ether acetate, diethylene glycol mono-n-butyl ether acetate, propylene glycol monomethyl ether acetate, propylene glycol monoethyl ether acetate and 3-methoxybutyl acetate; other ethers such as diethylene glycol dimethyl ether, diethylene glycol methyl ethyl ether, diethylene glycol diethyl ether and tetrahydrofuran; ketones such as methyl ethyl ketone, cyclohexanone, 2-heptanone, 3-heptanone, diacetone alcohol (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 acetate, n-propyl acetate, i-propyl acetate, n-butyl acetate, i-butyl acetate, n-pentyl formate, i-pentyl acetate, 3-methyl-3-methoxybutyl acetate, n-butyl propionate, 3-methyl-3-methoxybutyl propionate, ethyl butyrate, n-propyl butyrate, i-propyl butyrate, n-butyl butyrate, ethyl hydroxyacetate, ethyl ethoxyacetate, methyl 3-methoxypropionate, ethyl 3-methoxypropionate, methyl 3-ethoxypropionate, ethyl 3-ethoxypropionate, methyl pyruvate, ethyl pyruvate, n-propyl pyruvate, methyl acetoacetate, ethyl acetoacetate, ethyl 2-hydroxy-2-methylpropionate, methyl 2-hydroxy-3-methylbutyrate and ethyl 2-oxobutyrate; aromatic hydrocarbons such as toluene and xylene; and amides such as N-methylpyrrolidone, N,N-dimethylformamide and N,N-dimethylacetamide.

Out of these solvents, benzyl alcohol, ethylene glycol

mono-n-butyl ether, propylene glycol monomethyl ether,
propylene glycol monoethyl ether, ethylene glycol monomethyl
ether acetate, ethylene glycol mono-n-butyl ether acetate,
diethylene glycol mono-n-butyl ether acetate, propylene
5 glycol monomethyl ether acetate, propylene glycol monoethyl
ether acetate, diethylene glycol dimethyl ether, diethylene
glycol methyl ethyl ether, cyclohexanone, 2-heptanone,
3-heptanone, n-butyl acetate, i-butyl acetate, n-pentyl
formate, i-pentyl acetate, 3-methoxybutyl acetate, n-butyl
10 propionate, ethyl butyrate, i-propyl butyrate, n-butyl
butyrate, ethyl 3-methoxypropionate, methyl
3-ethoxypropionate, ethyl 3-ethoxypropionate,
3-methyl-3-methoxybutyl propionate and ethyl pyruvate are
particularly preferred from the viewpoints of solubility,
15 pigment dispersibility and coatability.

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

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

25 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
30 composition is preferably 5 to 50 wt%, particularly
preferably 10 to 40 wt% from the viewpoints of the coatability
and storage 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 of the present
5 invention.

Preferably, 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
10 composition of the present invention on a substrate;
- (2) exposing at least part of the coating film to radiation;
- (3) developing the coating film after exposure; and
- (4) post-baking the coating film after development.

Each of the above steps will be described hereinbelow.
15

- step (1)-

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

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

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

To apply the liquid composition to the substrate, a suitable coating technique such as rotational coating, cast coating, roll coating or coating with a slit die coater may

be employed. Rotational coating and coating with a split die coater are preferred.

As for prebaking conditions, the radiation sensitive composition is preferably heated at 70 to 110°C for 2 to 4
5 minutes.

The thickness of the coating film is preferably 1.0 to 10 μm , more preferably 1.0 to 6.0 μm , particularly preferably 1.0 to 4.0 μm as the thickness of the film after the removal of the solvent.

10

- step (2) -

Thereafter, at least part of the formed coating film is exposed to radiation. To expose part of the coating film in this step, a photomask having a predetermined pattern is
15 used.

The radiation used for exposure is suitably selected from visible radiation, ultraviolet radiation, far ultraviolet radiation, electron radiation and X-radiation. Radiation having a wavelength of 190 to 450 nm is preferred.

20

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

- step (3) -

Thereafter, the coating film is developed with a
25 developer, preferably an alkali developer to dissolve and 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,
30 1,8-diazabicyclo-[5.4.0]-7-undecene or 1,5-diazabicyclo-[4.3.0]-5-nonene.

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

rinsed with water after alkali development.

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

- 5 As for development conditions, the coating film is preferably developed at normal temperature for 10 to 300 sec.

- step (4) -

- 10 By post-baking the developed coating film, a substrate having a predetermined green pixel pattern which is composed of a cured product of the radiation sensitive composition can be obtained.

As for post-baking conditions, the coating film is preferably heated at 180 to 230°C for 20 to 40 minutes.

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

- Thereafter, by repeating the above steps (1) to (4) for the radiation sensitive composition of the present invention containing a red pigment (A), a red pixel pattern
20 is formed on the same substrate, and further by repeating the above steps (1) to (4) for a blue radiation sensitive composition containing a blue pigment, a blue pixel pattern is formed on the same substrate, thereby making it possible to form pixel arrays consisting of predetermined red, green
25 and blue pixel patterns on the substrate. Either one of the above green pixel pattern and red pixel pattern may be formed from a colored radiation sensitive composition (to be referred to as "other colored radiation sensitive
30 composition" hereinafter) other than the radiation sensitive composition of the present invention. In the present invention, the order of forming color pixel patterns is arbitrary.

 The above blue radiation sensitive composition containing a blue pigment and the other colored radiation

sensitive composition are not particularly limited but may be a composition obtained by mixing the components (B) to (D) in the present invention with a pigment other than the component (A) in the present invention. The average particle diameter "r" of the pigment in the other colored radiation sensitive composition is 50 to 300 nm, preferably 100 to 300 nm, particularly preferably 50 to 200 nm. As for the particle size distribution of the pigment, the amount of secondary particles having a particle diameter of (average particle diameter $\pm$ 100) nm is 70 wt% or more, preferably 80 wt% or more of the total. The pigment having the above average particle diameter "r" and the above particle size distribution can be obtained in the same manner as the above-described method for the preparation of the dispersion of the pigment (A) in the present invention.

Color filter

The color filter of the present invention has red pixels and/or green pixels formed from the radiation sensitive composition of the present invention.

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

Color liquid crystal display device

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

The color liquid crystal display device of the present invention may have a suitable structure. For example, it may have a structure that 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 opposed to each other with a liquid crystal layer interposed therebetween. Alternatively, it may have a structure that a substrate manufactured by forming the color filter on a drive substrate having a thin film transistor (TFT) 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.

Red pixels and green pixels having a high transmittance and high contrast ratio can be formed from the radiation sensitive composition of the present invention.

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 (chain transfer 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 gently stirred 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'-azobis(2,4-dimethylvaleronitrile) was added, and polymerization was continued for another 1 hour to obtain a resin solution (solid content of 30 wt%). The obtained resin had an Mw of 30,000 and an Mn of 10,000. This resin solution was designated as resin solution (B-1).

Example 1

Preparation of pigment dispersion

A mixed solution consisting of 40 parts by weight of a mixture of C.I. Pigment Green 36 and C.I. Pigment Yellow 219 in a weight ratio of 30/70 as a pigment (A), 10 parts by weight (about 4.51 parts by weight in terms of solid content) of BYK2001 (Disperbyk: BYK Co., Ltd., solid content of 45.1 wt%) as a dispersant and 150 parts by weight of ethyl 3-ethoxypropionate as a solvent was mixed and dispersed by a bead mill for 12 hours to prepare a pigment dispersion (P1).

When the average pigment particle diameter of the pigment dispersion (P1) was measured by the dynamic light scattering method, it was 250 nm.

Preparation of liquid composition

600 parts by weight of the pigment dispersion (P1), 200 parts by weight of the resin solution (B-1) as an alkali-soluble resin (B), 60 parts by weight of dipentaerythritol hexaacrylate as a polyfunctional monomer (C), 40 parts by weight of 2-benzyl-2-dimethylamino-1-(4-morpholinophenyl)butanone-1 as a radical generating agent (D) and 1,000 parts by weight of propylene glycol monomethyl ether acetate as a solvent were mixed together to prepare a liquid composition (G1).

Formation of pixel pattern

This liquid composition (G1) was applied to a soda-lime glass substrate having an SiO₂ film for preventing the elution

of sodium ions on the surface with a spin coater and prebaked in a clean oven heated at 90°C for 10 minutes to form a 3.2 µm-thick coating film.

Thereafter, this substrate was cooled to room
5 temperature and the coating film thereof was exposed to 5,000 J/m² of radiation having wavelengths of 365 nm, 405 nm and 436 nm through a photomask with a high-pressure mercury lamp. The substrate was then immersed in a developer comprising 0.04 wt% aqueous solution of potassium hydroxide at 23°C for
10 1 minute to be developed, rinsed with super pure water and dried with air. Thereafter, the substrate was post-baked at 250°C for 30 minutes to form a green striped pixel pattern on the substrate. The film thickness of the pixel pattern was 2.50 µm.

15

Evaluation of chromaticity

When the chromaticity of the pixels was evaluated with the TC-1800M color analyzer (of Tokyo Denshoku Co., Ltd.), it was (x, y, Y) = (0.288, 0.600, 52.3).

20

Evaluation of contrast ratio

The obtained substrate was sandwiched between two depolarizers and the depolarizer on the front side was turned while illuminated by a fluorescent lamp (wavelength of 380
25 to 780 nm) from the back to measure the maximum value and minimum value of transmitted light intensity with the LS-100 luminance meter (of Minolta Co., Ltd.). When the contrast ratio obtained by dividing the maximum value by the minimum value was evaluated, it was 1,080.

30

Comparative Example 1

Preparation of pigment dispersion

A pigment dispersion (p1) was prepared in the same manner as in Example 1 except that 30 parts by weight of a

10 mixture of C.I. Pigment Green 36 and C.I. Pigment Yellow 83
in a weight ratio of 80/20 as a pigment (A), 10 parts by weight
(4.51 parts by weight in terms of solid content) of BYK2001
(Disperbyk: BYK Co., Ltd., solid content of 45.1 wt%) as a
5 dispersant and 160 parts by weight of ethyl
3-ethoxypropionate as a solvent were used.

When the average pigment particle diameter of the
pigment dispersion (p1) was measured by the dynamic light
scattering method, it was 300 nm.

10

Preparation of liquid composition

200 parts by weight of the pigment dispersion (p1),
200 parts by weight of the resin solution (B-1) as an
alkali-soluble resin (B), 60 parts by weight of
15 dipentaerythritol hexaacrylate as a polyfunctional monomer
(C), 40 parts by weight of
2-benzyl-2-dimethylamino-1-(4-morpholinophenyl)butanone-
1 as a radical generating agent (D) and 1,000 parts by weight
of propylene glycol monomethyl ether acetate as a solvent
20 were mixed together to prepare a liquid composition (g1).

Formation and evaluation of pixel pattern

A green striped pixel pattern having a film thickness
of 2.50 μm was formed on the substrate and evaluated in the
25 same manner as in Example 1 except that the liquid composition
(g1) was used in place of the liquid composition (G1).

As a result, the chromaticity of the pixels was (x,
y, Y) = (0.288, 0.600, 48.5) and the contrast ratio was 450.

30 Example 2

Preparation of pigment dispersion

A mixed solution consisting of 30 parts by weight of
a mixture of C.I. Pigment Green 36, C.I. Pigment Yellow 150
and C.I. Pigment Yellow 219 in a weight ratio of 40/15/45

as a pigment (A), 10 parts by weight (about 4.51 parts by weight in terms of solid content) of BYK2001 (Disperbyk: BYK Co., Ltd., solid content of 45.1 wt%) as a dispersant and 160 parts by weight of ethyl 3-ethoxypropionate as a solvent was mixed and dispersed by a bead mill for 12 hours to prepare a pigment dispersion (P2).

When the average pigment particle diameter of the pigment dispersion (P2) was measured by the dynamic light scattering method, it was 200 nm.

10

Preparation of liquid composition

400 parts by weight of the pigment dispersion (P2), 200 parts by weight of the resin solution (B-1) as an alkali-soluble resin (B), 60 parts by weight of dipentaerythritol hexaacrylate as a polyfunctional monomer (C), 40 parts by weight of 2-benzyl-2-dimethylamino-1-(4-morpholinophenyl)butanone-1 as a radical generating agent (D) and 1,000 parts by weight of propylene glycol monomethyl ether acetate as a solvent were mixed together to prepare a liquid composition (G2).

Formation and evaluation of pixel pattern

A green striped pixel pattern having a film thickness of 2.50 μm was formed on the substrate and evaluated in the same manner as in Example 1 except that the liquid composition (G2) was used in place of the liquid composition (G1).

As a result, the chromaticity of the pixels was (x, y, Y) = (0.300, 0.570, 61.1) and the contrast ratio was 1,200.

30 Comparative Example 2

Preparation of pigment dispersion

A pigment dispersion (p2) was prepared in the same manner as in Example 2 except that 30 parts by weight of a mixture of C.I. Pigment Green 36, C.I. Pigment Yellow 150

and C.I. Pigment Yellow 138 in a weight ratio of 50/10/40 as a pigment (A) was used.

When the average pigment particle diameter of the pigment dispersion (p2) was measured by the dynamic light scattering method, it was 250 nm.

Preparation of liquid composition

A liquid composition (g2) was prepared in the same manner as in Example 2 except that the pigment dispersion (p2) was used in place of the pigment dispersion (P2).

Formation and evaluation of pixel pattern

A green striped pixel pattern having a film thickness of 2.50 μm was formed on the substrate and evaluated in the same manner as in Example 1 except that the liquid composition (g2) was used in place of the liquid composition (G1).

As a result, the chromaticity of the pixels was (x, y, Y) = (0.300, 0.570, 60.5) and the contrast ratio was 900.

What is claimed is:

1. A radiation sensitive composition comprising (A) a pigment which contains 5 wt% or more of C.I. Pigment Yellow 219 and has an average particle diameter "r" of 50 to 300
5 nm, (B) an alkali-soluble resin, (C) a polyfunctional monomer and (D) a radiation sensitive radical generating agent, and used for the manufacture of a color filter.
2. A method for the preparation of a radiation sensitive
10 composition, comprising mixing a pigment dispersion which has (A) a pigment having an average particle diameter "r" of 50 to 300 nm obtained by mixing and dispersing a pigment which contains 5 wt% or more of C.I. Pigment Yellow 219 and has an average particle diameter larger than 300 nm while
15 it is milled in a solvent with (B) an alkali-soluble resin, (C) a polyfunctional monomer and (D) a radiation sensitive radical generating agent to form a radiation sensitive composition for color filters.
- 20 3. A color filter having red pixels and/or green pixels formed from the radiation sensitive composition of claim 1.
4. A color liquid crystal display device having the color filter of claim 3.