

RADIATION SENSITIVE COMPOSITION FOR COLOR FILTER, COLOR
FILTER, AND COLOR LIQUID CRYSTAL DISPLAY DEVICE

Technical Field

5 This invention relates to a radiation sensitive
composition for color filters, a color filter, and a
color liquid crystal display device. More
specifically, the present invention relates to a
radiation sensitive composition used in production of
10 a color filter used in a transmissive or reflective
color liquid crystal display, a color image pickup tube
device and the like, a color filter having blue pixels
formed from the radiation sensitive composition, and
a color liquid crystal display device comprising the
15 color filter.

Background Art

As a method for forming a color filter by use of
a radiation sensitive composition for color filters,
20 there is known a method which comprises forming a
coating film of a colored radiation sensitive
composition on a substrate with or without a light
blocking layer of a predetermined pattern formed on the
substrate, irradiating the coating film with radiation
25 through a photomask having a predetermined pattern
(hereinafter referred to as "exposure"), developing the
coating film to dissolve and remove unexposed portions,
and postbaking the resulting film to obtain pixels of
different colors (refer to JP-A 02-144502 (the term
30 "JP-A" as used herein means an "unexamined published
Japanese patent application") and JP-A 03-53201).

Since a liquid crystal display device comprising
such a color filter has been desired to have higher
brightness, the color filter has also been desired to

have increasingly high light transmittance in recent years.

Further, along with popularization of digital video cameras and high-definition televisions in recent years, color liquid crystal display devices have been
5 desired to process a high color density so as to be able to display dark blue as of the ocean in winter or flaming red of the setting sun. To achieve such a high color density, a radiation sensitive composition for color
10 filters which has higher pigment concentration is apt to be desired. When such a radiation sensitive composition for color filters which has high pigment concentration is used, materials which do not dissolve in a developer (hereinafter referred to as "undissolved
15 materials") are liable to remain in areas other than those where pixels are formed in a development process in production of a color filter. Thus, development of a radiation sensitive composition for color filters which can control remaining of undissolved materials
20 in the development process effectively and can form blue pixels having high color purity has been strongly desired.

Disclosure of the Invention

25 An object of the present invention is to provide a radiation sensitive composition for color filters which can control remaining of undissolved materials in a development process effectively and can form blue pixels having high color purity.

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

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

According to the present invention, firstly, the
5 above objects and advantages of the present invention are achieved by a radiation sensitive composition for color filters which comprises:

- (A) a pigment which contains C. I. Pigment Blue 80,
- (B) an alkali soluble resin,
- 10 (C) a polyfunctional monomer, and
- (D) a radiation sensitive radical generator.

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

15 Further, according to the present invention, secondly, the above objects and advantages of the present invention are achieved by a color filter formed from the above radiation sensitive composition for color filters.

20 Further, according to the present invention, thirdly, the above objects and advantages of the present invention are achieved by a color liquid crystal display device comprising the above color filter.

25 Best Mode for Carrying out the Invention

Hereinafter, the present invention will be further described.

Radiation Sensitive Composition for Color Filters

- (A) Pigment -

30 The pigment in the present invention contains C. I. Pigment Blue 80 according to Color Index (C. I.: published by The Society of Dyers and Colourists. The same will apply to the following description.)

The pigment in the present invention may also

contain other pigment in some cases.

The above other pigment may be an organic pigment or an inorganic pigment. However, since a color filter is required to show color development of high purity and high light transmission and heat resistance, the
5 organic pigment is preferred.

Illustrative examples of the other organic pigment include compounds classified as pigments in the Color Index. Specific examples thereof include those
10 with the following color index (C. I.) numbers, i.e., C. I. Pigment Violet 1, C. I. Pigment Violet 19, C. I. Pigment Violet 23, C. I. Pigment Violet 29, C. I. Pigment Violet 32, C. I. Pigment Violet 36 and C. I. Pigment Violet 38; and C. I. Pigment Blue 15, C. I. Pigment Blue
15 15:3, C. I. Pigment Blue 15:4, C. I. Pigment Blue 15:6 and C. I. Pigment Blue 60.

Of these other organic pigments, as other organic pigments when blue pixels are formed, C. I. Pigment Blue 15:6, C. I. Pigment Blue 60, C. I. Pigment Violet 23
20 and the like are preferred, and C. I. Pigment Blue 15:6 is particularly preferred.

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

The content of C. I. Pigment Blue 80 in the pigment
25 in the present invention is preferably 1 wt% or higher, more preferably 1 to 50 wt%, particularly preferably 2 to 30 wt%. By use of such a pigment, there can be provided a radiation sensitive composition for color filters which can control remaining of undissolved
30 materials in a development process effectively and can form blue pixels having high color purity.

C. I. Pigment Blue 80 and other pigments used in the present invention can be purified by recrystallization, reprecipitation, solvent cleaning,

sublimation, vacuum heating or a combination of these processes as required before use.

The average particle diameter (r [unit: nm]) of the pigment used in the present invention is preferably 50 to 300 nm, more preferably 100 to 300 nm, particularly preferably 50 to 200 nm. By use of such a pigment having an average particle diameter r , blue pixels showing a high contrast ratio and high light transmittance can be obtained. The term "average particle diameter" as used herein refers to the average particle diameter of secondary particles resulting from agglomeration of primary particles (single microcrystals) of the pigment.

Further, the particle size distribution (hereinafter simply referred to as "particle size distribution") of the secondary particles of the pigment used in the present invention is such that secondary particles having a size of (average particle diameter ± 100) nm preferably constitute 70 wt% or higher, more preferably 80 wt% or higher, of all secondary particles.

The pigment having the above average particle diameter and particle size distribution can be prepared by mixing and dispersing commercially available C. I. Pigment Blue 80 (average particle diameter is generally larger than 300 nm) with other pigments used as required (average particle diameter is generally larger than 300 nm), preferably as a pigment mixture resulting from mixing the pigments with a dispersant and a solvent, while milling the pigments by use of a grinder such as a bead mill or a roll mill. The thus obtained pigment generally takes a pigment dispersion form.

The dispersant used to prepare the pigment dispersion may be any proper dispersant such as a

cationic dispersant, anionic dispersant, amphoteric dispersant or nonionic dispersant. These dispersants preferably contain a compound having an urethane bond (hereinafter referred to as "urethane-based dispersant").

The above urethane bond is represented by a formula $R-NH-COO-R'$ (wherein R and R' are an aliphatic, alicyclic or aromatic monovalent or polyvalent organic group, and the polyvalent organic group is bonded to another group having an urethane bond or other groups) and can be included in a lipophilic group and/or a hydrophilic group in the urethane-based dispersant or included in the principal chain and/or a side chain of the urethane-based dispersant. At least one urethane bond can be included in the urethane-based dispersant. When two or more urethane bonds are included in the urethane-based dispersant, the urethane bonds may be the same or different.

An example of such an urethane-based dispersant is a reaction product of a diisocyanate and/or a triisocyanate and a polyester having a hydroxyl group at one end and/or a polyester having a hydroxyl group at both ends.

Illustrative examples of the above diisocyanate include other aromatic diisocyanates, e.g., 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, toluene-2,6-diisocyanate and toluene-3,5-diisocyanate; and xylene diisocyanates such as 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.

Illustrative examples of the above triisocyanate
 5 include other aromatic triisocyanates, e.g., benzene
 triisocyanates such as benzene-1,2,4-triisocyanate,
 benzene-1,2,5-triisocyanate and
 benzene-1,3,5-triisocyanate; toluene triisocyanates
 such as toluene-2,3,5-triisocyanate,
 10 toluene-2,3,6-triisocyanate,
 toluene-2,4,5-triisocyanate and
 toluene-2,4,6-triisocyanate; and xylene
 triisocyanates such as 1,2-xylene-3,4,5-triisocyanate,
 1,2-xylene-3,4,6-triisocyanate,
 15 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.

20 These diisocyanates and triisocyanates can be
 used alone or in admixture of two or more.

Further, illustrative examples of the above
 polyester having a hydroxyl group at one end and the
 above polyester having a hydroxyl group at both ends
 25 include polylactones having a hydroxyl group at one end
 or both ends such as a polycaprolactone having a
 hydroxyl group at one end or both ends, a
 polyvalerolactone having a hydroxyl group at one end
 or both ends and a polypropiolactone having a hydroxyl
 30 group at one end or both ends; and polycondensed
 polyesters having a hydroxyl group at one end or both
 ends such as a polyethylene terephthalate having a
 hydroxyl group at one end or both ends and a polybutylene
 terephthalate having a hydroxyl group at one end or both

ends.

These polyesters having a hydroxyl group at one end and polyesters having a hydroxyl group at both ends can be used alone or in admixture of two or more.

5 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 end and/or a polylactone having a hydroxyl group at both ends, particularly preferably
10 a reaction product of a toluene diisocyanate and a polycaprolactone having a hydroxyl group at one end and/or a polycaprolactone having a hydroxyl group at both ends.

Specific examples such an urethane-based
15 dispersant include, under trade names, EFKA (product of EFKA Chemicals BV Co., Ltd.), Disperbyk (product of BYK Chemie Co., Ltd.), and DISPARLON (product of Kusumoto Chemicals, Ltd.).

The weight average molecular weight in terms of
20 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
25 alone or in admixture of two or more.

The amount of the urethane-based dispersant used to prepare the pigment dispersant is preferably not larger than 100 parts by weight, more preferably 0.5 to 100 parts by weight, much more preferably 1 to 70
30 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 exceeds 100 parts by weight, developability may be impaired.

Further, illustrative examples of the solvent used to prepare the pigment dispersant include the same solvents as those which will be described later with regard to the radiation sensitive composition for color
5 filters in the present invention.

The amount of the solvent used to prepare the pigment dispersant is preferably 500 to 1,000 parts by weight based on 100 parts by weight of the pigment.

When the pigment dispersant is prepared by means
10 of a bead mill, it can be implemented by mixing and dispersing the pigment mixture by means of, for example, glass beads or titania beads each having a diameter of about 0.5 to 10 mm, preferably while cooling the pigment mixture with cooling water or the like.

15 In this case, the beads preferably fill 50% to 80% of the capacity of the mill. The pigment mixture preferably fills 20% to 50% of the capacity of the mill. Further, processing time is preferably 2 to 50 hours, more preferably 2 to 25 hours.

20 Meanwhile, when the pigment dispersant is prepared by means of a roll mill, the pigment dispersant can be processed by use of, for example, a three-roll mill or a two-roll mill, preferably while cooling the pigment dispersant with cooling water or the like.

25 In this case, the distance between the rolls is preferably not larger than 10 μm . Shear force is preferably about 10^8 dyn/sec. Further, 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 thus prepared pigment dispersant can be determined by a dynamic light scattering method.

The alkali soluble resin in the present invention is a resin which acts on the pigment (A) as a binder and is soluble in a developer, preferably an alkali developer, used in a development process in production of a color filter. An example of such a resin is a
5 copolymer of a polymerizable unsaturated monomer having an acidic functional group such as a carboxyl group, a phenolic hydroxyl group or a sulfonic group and other copolymerizable unsaturated monomer (hereinafter referred to as "copolymerizable unsaturated monomer").
10

Illustrative examples of a polymerizable unsaturated monomer having a carboxyl group (hereinafter referred to as "carboxyl-group-containing unsaturated monomer")
15 include unsaturated monocarboxylic acids such as (meth)acrylic acid, crotonic acid, α -chloracrylic acid and cinnamic acid; unsaturated dicarboxylic acids and acid anhydrides thereof such as maleic acid, maleic anhydride, fumaric
20 acid, itaconic acid, itaconic anhydride, citraconic acid, citraconic anhydride and mesaconic acid; unsaturated polycarboxylic acids having three or more carboxyl groups and acid anhydrides thereof; mono[(meth)acryloyloxyalkyl]esters of polycarboxylic
25 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 polymer having a carboxyl group and a hydroxyl group at both ends such as
30 ω -carboxypolycaprolactone mono(meth)acrylate.

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

particularly preferred.

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

5 Further, illustrative examples of a polymerizable unsaturated monomer having a phenolic hydroxyl group include o-hydroxystyrene, m-hydroxystyrene, p-hydroxystyrene, o-hydroxy- α -methyl styrene, m-hydroxy- α -methyl styrene, p-hydroxy- α -methyl
10 styrene, N-o-hydroxyphenyl maleimide, N-m-hydroxyphenyl maleimide, and N-p-hydroxyphenyl maleimide.

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

Further, illustrative examples of a polymerizable unsaturated monomer having a sulfonic group include isoprene sulfonic acid and p-styrene sulfonic acid.

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

Further, illustrative examples of the copolymerizable unsaturated monomer include macromonomers having a (meth)acryloyl group at one end
25 of polymer molecular chain (hereinafter simply referred to as "macromonomers") such as a polystyrene, polymethyl (meth)acrylate, poly-n-butyl (meth)acrylate and polysiloxane; N-position substituted maleimides such as
30 N-(substituted)aryl maleimide and N-cyclohexyl maleimide, e.g., N-phenyl maleimide, N-o-hydroxyphenyl maleimide, N-m-hydroxyphenyl maleimide, N-p-hydroxyphenyl maleimide, N-o-methylphenyl maleimide, N-m-methylphenyl

maleimide, N-p-methylphenyl maleimide,
 N-o-methoxyphenyl maleimide, N-m-methoxyphenyl
 maleimide, and N-p-methoxyphenyl maleimide;
 aromatic vinyl compounds such as styrene, α -methyl
 5 styrene, o-vinyl toluene, m-vinyl toluene, p-vinyl
 toluene, p-chlor styrene, o-methoxy styrene, m-methoxy
 styrene, p-methoxy styrene, o-vinylbenzylmethyl ether,
 m-vinylbenzylmethyl ether, p-vinylbenzylmethyl ether,
 o-vinylbenzylglycidyl ether, m-vinylbenzylglycidyl
 10 ether, and p-vinylbenzylglycidyl ether;
 indenenes such as indene and 1-methyl indene;
 unsaturated carboxylic acid esters such as methyl
 (meth)acrylate, ethyl (meth)acrylate, n-propyl
 (meth)acrylate, i-propyl (meth)acrylate, n-butyl
 15 (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
 20 (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,
 methoxy diethylene glycol (meth)acrylate, methoxy
 25 triethylene glycol (meth)acrylate, methoxy propylene
 glycol (meth)acrylate, methoxy dipropylene glycol
 (meth)acrylate, isobornyl (meth)acrylate,
 dicyclopentadienyl (meth)acrylate,
 2-hydroxy-3-phenoxypropyl (meth)acrylate, and
 30 glycerol (meth)acrylate;
 unsaturated carboxylic acid amino alkyl esters such as
 2-aminoethyl (meth)acrylate, 2-dimethylaminoethyl
 (meth)acrylate, 2-aminopropyl (meth)acrylate,
 2-dimethylaminopropyl acrylate, 3-aminopropyl

(meth)acrylate, and 3-dimethylaminopropyl (meth)acrylate;
unsaturated carboxylic acid glycidyl esters such as glycidyl (meth)acrylate;
5 carboxylic acid vinyl esters 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,
10 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,
15 isoprene and chloroprene.

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

Of the above copolymerizable unsaturated monomers, the macromonomers, N-position substituted maleimides,
20 2-hydroxyethyl (meth)acrylate, benzyl (meth)acrylate and glycerol (meth)acrylate are preferred. Further, of the macromonomers, a polystyrene macromonomer and a polymethyl (meth)acrylate macromonomer are particularly preferred. And, of N-position
25 substituted maleimides, N-phenyl maleimide and N-cyclohexyl maleimide are particularly preferred.

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

The carboxyl-group-containing copolymer is preferably a copolymer (hereinafter referred to as "carboxyl-group-containing copolymer (I)") of a

monomer mixture which comprises (a) a carboxyl-group-containing unsaturated monomer and (b) at least one selected from the group consisting of a polystyrene macromonomer, a polymethyl (meth)acrylate macromonomer, N-phenyl maleimide, N-cyclohexyl maleimide, 2-hydroxyethyl (meth)acrylate, benzyl (meth)acrylate and glycerol (meth)acrylate and further comprises (c) at least one selected from the group consisting of styrene, methyl (meth)acrylate, allyl (meth)acrylate and phenyl (meth)acrylate as required.

The carboxyl-group-containing copolymer is particularly preferably a copolymer (hereinafter referred to as "carboxyl-group-containing copolymer (II)") of a monomer mixture which comprises (a) a carboxyl-group-containing unsaturated monomer component which contains (meth)acrylic acid as an essential component and further contains mono[2-(meth)acryloyloxyethyl]succinate and/or ω -carboxypolycaprolactone mono(meth)acrylate in some cases and (b) at least one selected from the group consisting of a polystyrene macromonomer, a polymethyl (meth)acrylate macromonomer, N-phenyl maleimide, N-cyclohexyl maleimide, 2-hydroxyethyl (meth)acrylate, benzyl (meth)acrylate and glycerol (meth)acrylate and further comprises (c) at least one selected from the group consisting of styrene, methyl (meth)acrylate, allyl (meth)acrylate and phenyl (meth)acrylate as required.

Specific examples of the carboxyl-group-containing copolymer (II) include a copolymer of (meth)acrylic acid/mono[2-(meth)acryloyloxyethyl]succinate/benzyl (meth)acrylate/glycerol mono(meth)acrylate, a copolymer of (meth)acrylic acid/

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

- maleimide/benzyl(meth)acrylate/styrene,
a copolymer of (meth)acrylic acid/polystyrene
macromonomer/2-hydroxyethyl (meth)acrylate/benzyl
(meth)acrylate,
- 5 a copolymer of (meth)acrylic acid/polymethyl
(meth)acrylate macromonomer/2-hydroxyethyl
(meth)acrylate/benzyl (meth)acrylate,
a copolymer of (meth)acrylic acid/N-phenyl
maleimide/benzyl (meth)acrylate/styrene, and
- 10 a copolymer of (meth)acrylic acid/N-phenyl
maleimide/benzyl (meth)acrylate/glycerol
mono(meth)acrylate/styrene.

The content of the carboxyl-group-containing
unsaturated monomer in the carboxyl-group-containing
15 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 radiation sensitive composition to be obtained
20 is liable to be low, while when it is higher than 50
wt%, its solubility in the alkali developer becomes so
high that pixels are liable to come off the substrate
or the surfaces of the pixels are liable to be roughened
during development by use of the alkali developer.

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

The number average molecular weight (hereinafter
refers to as "Mn") in terms of polystyrene measured by
gel permeation chromatography (GPC, elution 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.

By use of the alkali soluble resin having such specific Mw and Mn, a radiation sensitive composition having excellent developability is obtained, whereby pixels having sharp pattern edges can be formed, and residues, scums and film remnants are hardly left on the substrate or the light blocking layer in unexposed portions at the time of development.

Further, the ratio of Mw to Mn (Mw/Mn) 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 may be used alone or in admixture of two or more.

In the present invention, the alkali soluble resin is used in an amount of 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 be impaired or scums or film remnants may be left on the substrate or the light blocking layer in unexposed portions, for example. Meanwhile, when the amount thereof is larger than 1,000 parts by weight, the pigment concentration is lowered relatively, so that it may become difficult to achieve desired color density as a thin film.

- (C) Polyfunctional Monomer -

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

Illustrative examples of such a polyfunctional monomer include di(meth)acrylates of alkylene glycols such as ethylene glycol and propylene glycol;

di(meth)acrylates of polyalkylene glycols such as polyethylene glycols including diethylene glycol and polypropylene glycols including dipropylene glycol; poly(meth)acrylates of polyhydric alcohols having
5 three or more hydroxyl groups such as glycerine, trimethylolpropane, pentaerythritol and dipentaerythritol, and the poly(meth)acrylates modified by dicarboxylic acids;
oligo(meth)acrylates such as a polyester, an epoxy
10 resin, an urethane resin, an alkyd resin, a silicone resin and a spiran resin;
di(meth)acrylates of polymers having a hydroxyl group at both ends such as a poly-1,3-butadiene having a hydroxyl group at both ends, a polyisoprene having a
15 hydroxyl group at both ends and a polycaprolactone having a hydroxyl group at both ends; and
tris[2-(meth)acryloyloxyethyl]phosphate.

Of these polyfunctional monomers, the poly(meth)acrylates of polyhydric alcohols having
20 three or more hydroxyl groups and the poly(meth)acrylates modified by dicarboxylic acids are preferred. More specifically, trimethylolpropane tri(meth)acrylate, pentaerythritol tri(meth)acrylate, pentaerythritol tetra(meth)acrylate,
25 dipentaerythritol penta(meth)acrylate, and dipentaerythritol hexa(meth)acrylate are preferred. In particular, trimethylolpropane triacrylate, pentaerythritol triacrylate and dipentaerythritol hexaacrylate are preferred since they provide a
30 composition which produces pixels having high strength and excellent surface smoothness and hardly leaves scums and film remnants on the substrate and the light blocking layer in unexposed portions. The polyfunctional monomers may be used alone or in

admixture of two or more.

The amount of the polyfunctional monomer used 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). In this case, when the amount of the polyfunctional monomer is smaller than 5 parts by weight, the strength and surface smoothness of the pixels are liable to deteriorate, while when it is larger than 500 parts by weight, alkali developability is liable to deteriorate, or scums and film remnants are liable to be left on the substrate or on the light blocking layer in unexposed portions, for example.

In the present invention, a monofunctional monomer having one polymerizable unsaturated bond may also be used in addition to the polyfunctional monomer.

Illustrative examples of the above monofunctional monomer include the carboxyl-group-containing unsaturated monomers and copolymerizable unsaturated monomers presented as examples with respect to the above alkali soluble resin (B), N-vinyl nitrogen-containing heterocyclic compounds such as N-vinyl succinimide, N-vinyl pyrrolidone, N-vinyl phthalimide, N-vinyl-2-piperidone, N-vinyl- ϵ -caprolactam, N-vinyl pyrrole, N-vinyl pyrrolidine, N-vinyl imidazole, N-vinyl imidazolidine, N-vinyl indole, N-vinyl indoline, N-vinyl benzimidazole, N-vinyl carbazole, N-vinyl piperidine, N-vinyl piperazine, N-vinyl morpholine and N-vinyl phenoxazine; N-(meth)acryloyl morpholine, and as commercial products, M-5300, M-5400 and M-5600 (trade names, products of TOAGOSEI CO., LTD.).

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

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

5 In this case, when the amount of the monofunctional monomer is larger than 90 wt%, the strength and surface smoothness of the pixels are liable to deteriorate.

- (D) Radiation Sensitive Radical Generator -

The radiation sensitive radical generator
10 (hereinafter simply referred to as "radical generator") in the present invention is a compound that generates a radical which can initiate polymerization of the above polyfunctional monomer (C) and the monofunctional monomer used in some cases when exposed to radiation
15 such as visible light, ultraviolet radiation, far ultraviolet radiation, an electron beam or an X-ray.

Illustrative examples of such a radical generator include an acetophenone-based compound, a biimidazole-based compound, a triazine-based compound,
20 a benzoin-based compound, a benzophenone-based compound, an α -diketone-based compound, a polynuclear-quinone-based compound, a xanthone-based compound, and a diazo-based compound.

In the present invention, the radical generators
25 may be used alone or in admixture 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 compound, a biimidazole-based compound and a triazine-based
30 compound.

The amount of the radical generator used 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 polyfunctional monomer

(C) or the total of the polyfunctional monomer (C) and the monofunctional monomer. When the amount of the radical generator is smaller than 0.01 parts by weight, curing by exposure to radiation is insufficient, so that
 5 it may become difficult to obtain a color filter having pixel patterns arranged in accordance with a predetermined arrangement, while when the amount is larger than 80 parts by weight, the formed pixels are liable to fall off the substrate at the time of
 10 development.

Of the preferred radical generators in the present invention, specific examples of the acetophenone-based compound include
 2-hydroxy-2-methyl-1-phenylpropane-1-one,
 15 2-methyl-1-[4-(methylthio)phenyl]-2-morpholinopropanone-1,
 2-benzyl-2-dimethylamino-1-(4-morpholinophenyl) butanone-1, 1-hydroxycyclohexyl phenylketone,
 2,2-dimethoxy-1,2-diphenylethane-1-one,
 20 1,2-octanedione, and
 1-[4-(phenylthio)phenyl]-2-(O-benzoyloxime).

Of these acetophenone-based compounds,
 2-methyl-1-[4-(methylthio)phenyl]-2-morpholinopropanone-1,
 25 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
 30 used alone or in admixture of two or more.

The amount of the acetophenone-based compound used as a radical generator in the present invention is preferably 0.01 to 80 parts by weight, more preferably 1 to 60 parts by weight, much more preferably

1 to 30 parts by weight, based on 100 parts by weight of the polyfunctional monomer (C) or the total of the polyfunctional monomer (C) and the monofunctional monomer. When the amount of the acetophenone-based compound is smaller than 0.01 parts by weight, curing by exposure to radiation is insufficient, so that it may become difficult to obtain a color filter having pixel patterns arranged in accordance with a predetermined arrangement, while when the amount is larger than 80 parts by weight, the formed pixels are liable to fall off the substrate at the time of development.

Further, specific 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.

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

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

These biimidazole-based compounds have excellent
solubility in solvents, do not produce foreign matters
10 such as undissolved materials and precipitates, have
high sensitivity, cause a curing reaction to fully
proceed with low energy exposure, and cause no curing
reaction to occur in unexposed portions. Accordingly,
on an exposed coating film, a cured portion which is
15 insoluble in a developer and an uncured portion having
high solubility in the developer are distinctly
partitioned, and a high-definition color filter having
pixel patterns without undercuts arranged in accordance
with a predetermined arrangement can be formed thereby.

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

The amount of the biimidazole-based compound used
as a radical generator in the present invention is
preferably 0.01 to 40 parts by weight, more preferably
25 1 to 30 parts by weight, much more preferably 1 to 20
parts by weight, based on 100 parts by weight of the
polyfunctional monomer (C) or the total of the
polyfunctional monomer (C) and the monofunctional
monomer. When the amount of the biimidazole-based
30 compound is smaller than 0.01 parts by weight, curing
by exposure to radiation is insufficient, so that it
may become difficult to obtain a color filter having
pixel patterns arranged in accordance with a
predetermined arrangement, while when the amount is

larger than 40 parts by weight, the formed pixels are liable to fall off the substrate and the surfaces of the pixels are liable to be roughened at the time of development.

5 - Hydrogen Donor -

 In the present invention, when the biimidazole-based compound is used as a radical generator, it is preferable to use the following hydrogen donor together with the radical initiator
10 because sensitivity can be further improved.

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

15 As the hydrogen donor in the present invention, a mercaptan-based compound and an amine-based compound which will be defined below are preferred, for example.

 The above mercaptan-based compound comprises a compound (hereinafter referred to as "mercaptan-based
20 hydrogen donor") having a benzene ring or a heterocyclic ring as a mother nucleus and at least one, preferably 1 to 3, more preferably 1 or 2 mercapto groups which are directly bonded to the mother nucleus.

 The above amine-based compound comprises a
25 compound (hereinafter referred to as "amine-based hydrogen donor") having a benzene ring or a heterocyclic ring as a mother nucleus and at least one, preferably 1 to 3, more preferably 1 or 2 amino groups which are directly bonded to the mother nucleus.

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

 Hereinafter, the hydrogen donors will be further described.

 The mercaptan-based hydrogen donor may have one

or more benzene rings or heterocyclic rings and may have both the benzene ring and the heterocyclic ring, and when it has two or more of these rings, they may form or may not form a condensed ring.

5 Further, in the case where the mercaptan-based hydrogen donor has two or more mercapto groups, as long as at least one free mercapto group remains, one or more of the remaining mercapto groups may be substituted with an alkyl, aralkyl or aryl group. Further, as long as
10 at least one free mercapto group remains, one or more of the remaining mercapto groups may have a structural unit in which two sulfur atoms are bonded to each other through a divalent organic group such as an alkylene group or a structural unit in which two sulfur atoms
15 are bonded to each other in the form of disulfide.

Further, the mercaptan-based hydrogen donor may be substituted with, for example, a carboxyl group, an alkoxycarbonyl group, a substituted alkoxycarbonyl group, a phenoxycarbonyl group, a substituted
20 phenoxycarbonyl group or a nitrile group at sites other than the mercapto groups.

Specific examples of such a mercaptan-based hydrogen donor include 2-merpcatobenzothiazole, 2-mercaptobenzoxazole, 2-merpcatobenzimidazole,
25 2,5-dimercapto-1,3,4-thiadiazole, and 2-mercapto-2,5-dimethylaminopyridine.

Of these mercaptan-based hydrogen donors, 2-merpcatobenzothiazole and 2-mercaptobenzoxazole are preferred, and 2-merpcatobenzothiazole is
30 particularly preferred.

Further, the amine-based hydrogen donor may have one or more benzene rings or heterocyclic rings and may have both the benzene ring and the heterocyclic ring, and when it has two or more of these rings, they may

form or may not form a condensed ring.

Further, the amine-based hydrogen donor may have one or more amino groups substituted with an alkyl group or a substituted alkyl group. In addition, the amine-based hydrogen donor may be substituted with, for example, a carboxyl group, an alkoxycarbonyl group, a substituted alkoxycarbonyl group, a phenoxycarbonyl group, a substituted phenoxycarbonyl group or a nitrile group at sites other than the amino groups.

Specific examples of such an 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.

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

The amine-based hydrogen donor serves as a sensitizer even in the case of radical generators other than the biimidazole-based compound.

In the present invention, the hydrogen donors may be used alone or in admixture of two or more. A combination of one or more mercaptan-based hydrogen donors and one or more amine-based hydrogen donors is preferably used since formed pixels hardly fall off the substrate during development and the strength and sensitivity of the pixels are high.

Specific examples of a combination of the mercaptan-based hydrogen donor and the amine-based

hydrogen donor include 2-merpcatobenzothiazole/4,4'-bis(dimethylamino)benzophenone, 2-merpcatobenzothiazole/4,4'-bis(diethylamino)benzophenone, 2-mercaptobenzoxazole/4,4'-bis(dimethylamino)benzophenone, and 2-mercaptobenzoxazole/4,4'-bis(diethylamino)benzophenone. More preferred combinations are 2-merpcatobenzothiazole/4,4'-bis(diethylamino)benzophenone and 2-mercaptobenzoxazole/4,4'-bis(diethylamino)benzophenone. A particularly preferred combination is 2-merpcatobenzothiazole/4,4'-bis(diethylamino)benzophenone.

The weight ratio between the mercaptan-based hydrogen donor and the amine-based hydrogen donor in a 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.

In the present invention, the amount of the hydrogen donor when the hydrogen donor is used in combination with the biimidazole-based compound is preferably 0.01 to 40 parts by weight, more preferably 1 to 30 parts by weight, much more preferably 1 to 20 parts by weight, based on 100 parts by weight of the polyfunctional monomer (C) or the total of the polyfunctional monomer (C) and the monofunctional monomer. When the amount of the hydrogen donor is smaller than 0.01 parts by weight, the sensitivity improving effect is liable to be degraded, while when the amount is larger than 40 parts by weight, formed pixels are liable to fall off the substrate during development.

Meanwhile, specific examples of the above triazine-based compound include 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
 5 (trichloromethyl)-s-triazine,
 2-[2-(furan-2-yl)ethenyl]-
 4,6-bis(trichloromethyl)-s-triazine,
 2-[2-(4-diethylamino-
 2-methylphenyl)ethenyl]-4,6-bis(trichloromethyl)-s-
 10 triazine, 2-[2-(3,4-dimethoxyphenyl)ethenyl]-4,6-bis
 (trichloromethyl)-s-triazine,
 2-(4-methoxyphenyl)-4,6-bis
 (trichloromethyl)-s-triazine,
 2-(4-ethoxystyryl)-4,6-bis
 15 (trichloromethyl)-s-triazine, and
 2-(4-n-butoxyphenyl)-4,6-bis(trichloromethyl)-s-tri
 azine.

Of these triazine-based compounds,
 2-[2-(3,4-dimethoxyphenyl)ethenyl]-4,6-bis
 20 (trichloromethyl)-s-triazine is particularly
 preferred.

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

The amount of the triazine-based compound used as
 25 a radical generator in the present invention is
 preferably 0.01 to 40 parts by weight, more preferably
 1 to 30 parts by weight, much more preferably 1 to 20
 parts by weight, based on 100 parts by weight of the
 polyfunctional monomer (C) or the total of the
 30 polyfunctional monomer (C) and the monofunctional
 monomer. When the amount of the triazine-based
 compound is smaller than 0.01 parts by weight, curing
 by exposure to radiation is insufficient, so that it
 may become difficult to obtain a color filter having

pixel patterns arranged in accordance with a predetermined arrangement, while when the amount is larger than 40 parts by weight, the formed pixels are liable to fall off the substrate at the time of

5 development.

- Other Additives -

The radiation sensitive composition for color filters according to the present invention may further comprise other additives as required, in addition to
10 the above components (A) to (D).

Illustrative examples of the above other additives include fillers such as glass and alumina; polymer compounds such as a polyvinyl alcohol and a poly(fluoroalkylacrylate); surfactants such as a
15 nonionic surfactant, a cationic surfactant and an anionic surfactant; adhesion accelerators such as vinyl trimethoxysilane, vinyl triethoxysilane, vinyl tris(2-methoxyethoxy)silane, N-(2-aminoethyl)-3-aminopropylmethyl dimethoxysilane, N-(2-aminoethyl)-3-aminopropyl trimethoxysilane,
20 3-aminopropyl triethoxysilane, 3-glycidoxypropyl trimethoxysilane, 3-glycidoxypropylmethyl dimethoxysilane, 2-(3,4-epoxycyclohexyl)ethyl trimethoxysilane, 3-chloropropylmethyl dimethoxysilane, 3-chloropropyl trimethoxysilane,
25 3-methacryloyloxypropyl trimethoxysilane, and 3-mercaptopropyl trimethoxysilane; antioxidants such as 2,2-thiobis(4-methyl-6-t-butylphenol) and 2,6-di-t-butylphenol; ultraviolet absorbers such as
30 2-(3-t-butyl-5-methyl-2-hydroxyphenyl)-5-chlorobenzotriazole and alkoxybenzophenone; and cohesion inhibitors such as sodium polyacrylate.

Solvents

The radiation sensitive composition for color

filters according to the present invention is generally prepared as a liquid composition by adding a solvent to the above components (A) to (D) and the other additives which are optionally added.

5 As the above solvent, any solvent can be selected and used as appropriate as long as the solvent disperses or dissolves the components (A) to (D) and other additive components which constitute the radiation sensitive composition, dose not react with these
10 components and has moderate volatility.

 Illustrative examples of the solvent include alcohols such as methanol, ethanol, and benzyl alcohol; (poly)alkylene glycol monoalkyl ethers such as ethylene glycol monomethyl ether, ethylene glycol monoethyl
15 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
20 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
25 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
30 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,
 5 diethylene glycol methylethyl ether, diethylene glycol diethyl ether, and tetrahydrofuran;

ketones such as methyl ethyl ketone, cyclohexanone, 2-heptanone, 3-heptanone, diacetone alcohol(4-hydroxy-4-methylpentane-2-one), and

10 4-hydroxy-4-methylhexane-2-one;

lactate alkyl esters 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,
 15 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
 20 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
 25 2-hydroxy-3-methylbutyrate, and ethyl 2-oxobutyrate; aromatic hydrocarbons such as toluene and xylene; and amides such as N-methyl pyrrolidone, N,N-dimethyl formamide, and N,N-dimethyl acetamide.

Of these solvents, from the viewpoints of
 30 solubility, pigment dispersibility and coatability, 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 glycol monomethyl ether acetate, propylene
glycol monoethyl ether acetate, diethylene glycol
dimethyl ether, diethylene glycol methylethyl ether,
5 cyclohexanone, 2-heptanone, 3-heptanone, n-butyl
acetate, 1-butyl acetate, n-pentyl formate, 1-pentyl
acetate, 3-methoxybutyl acetate, n-butyl propionate,
ethyl butyrate, 1-propyl butyrate, n-butyl butyrate,
ethyl 3-methoxypropionate, methyl 3-ethoxypropionate,
10 ethyl 3-ethoxypropionate, 3-methyl-3-methoxybutyl
propionate, and ethyl pyruvate.

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

Further, together with the above solvents,
15 high-boiling-point solvents such as benzyl ethyl ether,
di-n-hexyl ether, acetonylacetone, isophorone,
caproic acid, caprylic acid, 1-octanol, 1-nonanol,
benzyl acetate, ethyl benzoate, diethyl oxalate,
diethyl maleate, γ -butyrolactone, ethylene carbonate,
20 propylene carbonate, and ethylene glycol monophenyl
ether acetate can be used.

The above high-boiling-point solvents may be used
alone or in admixture of two or more.

The amount of the solvent is not particularly
25 limited. However, from the viewpoint of the
coatability and storage stability of the radiation
sensitive composition to be obtained, the amount
thereof is desirably such an amount that ensures that
the total concentration of the components excluding the
30 solvent of the composition is preferably 5 to 50 wt%,
more preferably 10 to 40 wt%.

Method for Forming Color Filter

Next, a method for forming the color filter of the
present invention by use of the radiation sensitive

composition for color filters according to the present invention will be described.

The method for forming the color filter preferably comprises at least the following steps (1) to (4):

- 5 (1) a step of forming a coating film of the radiation sensitive composition for color filters according to the present invention on a substrate,
- (2) a step of exposing at least a portion of the above coating film to radiation,
- 10 (3) a step of developing the exposed coating film, and
- (4) a step of postbaking the developed coating film.

Hereinafter, these steps will be described in turn.

- Step (1) -

- 15 First, on a surface of a substrate, a light blocking layer is formed as required such that it partitions a portion where pixels are formed, and on the substrate, a radiation sensitive composition for color filters according to the present invention which
- 20 contains, for example, a green pigment (A) is applied preferably as a liquid composition, and the coated substrate is then prebaked to evaporate and remove the solvent, thereby forming a coating film.

- Illustrative examples of the substrate used in
- 25 this step include glass, silicon, polycarbonate, polyester, aromatic polyamide, polyamide-imide, polyimide, polyether sulfone, a ring-opened polymer of cyclic olefin, and a hydrogenated version of the polymer.

- 30 Further, these substrates may be subjected to an appropriate pretreatment such as a chemical treatment using a silane coupling agent or the like, a plasma treatment, ion plating, sputtering, a gas phase reaction process or vacuum deposition as required.

To apply the liquid composition to the substrate, an appropriate coating method such as spin coating, cast coating, roll coating or a coating method using a slit die coater can be employed. Of these, spin coating and
5 the coating method using a slit die coater are preferred.

Prebaking is preferably conducted at 70 to 110°C for about 2 to 4 minutes.

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

- Step (2) -

Then, at least a portion of the formed coating film
15 is exposed to radiation. In this case, a portion of the coating film is exposed to radiation preferably through a photomask having a predetermined pattern.

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

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

25 - Step (3) -

Then, the exposed coating film is developed by use of a developer, preferably an alkali developer, to dissolve and remove unexposed portions of the coating film.

30 Preferable examples of the above alkali developer include aqueous solutions of sodium carbonate, sodium hydroxide, potassium hydroxide, tetramethylammonium hydroxide, choline, 1,8-diazabicyclo-[5.4.0]-7-undecene, and

1,5-diazabicyclo-[4.3.0]-5-nonene.

To the above alkali developer, a proper amount of a water-soluble organic solvent such as methanol or ethanol or a surfactant may be added. The alkali
5 developer is generally rinsed with water.

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

Development is preferably carried out at room
10 temperature for about 10 to 300 seconds.

- Step (4) -

Then, the developed coating film is postbaked, whereby a substrate on which green pixel patterns formed from a cured product of the radiation sensitive
15 composition are arranged in a predetermined arrangement can be obtained.

Postbaking is preferably carried out at, for example, 180 to 230°C for about 20 to 40 minutes.

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

By forming red, green and blue pixel patterns on the same substrate by repeating the above steps (1) to (4) by use of radiation sensitive compositions having
25 red, green and blue pigments dispersed therein, a pixel array in which pixel patterns of three primary colors, i.e., red, green and blue, are arranged in a predetermined arrangement can be formed on the substrate. In the present invention, the order of
30 formation of the pixel patterns of the three colors can be selected arbitrarily.

Color Filter

The color filter of the present invention has pixels formed from the radiation sensitive composition

for color filters according to the present invention.

The color filter of the present invention is extremely useful for a transmissive or reflective color liquid crystal display, a color image pickup tube device, a color sensor and the like.

Color Liquid Crystal Display Device

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

10 The color liquid crystal display device of the present invention may have any appropriate structure. For example, it may have a structure in which a substrate for driving that has a thin-film transistor (TFT) provided thereon and a substrate that has the color
15 filter formed thereon face each other via a liquid crystal layer or a structure in which a substrate having the color filter formed on the surface of a substrate for driving that has a thin-film transistor (TFT) provided thereon and a substrate that has ITO (indium
20 oxide doped with tin) electrodes formed thereon face each other via a liquid crystal layer. The latter structure has advantages of improving an aperture ratio significantly and providing a bright, high-definition liquid crystal display device.

25 As described above, the radiation sensitive composition for color filters according to the present invention are characterized in that it can control remaining of undissolved materials at the time of development effectively and can form blue pixels having
30 high color purity.

Examples

Hereinafter, the mode for carrying out the present invention will be described more specifically with

reference to Examples. However, the present invention shall not be limited to the following Examples.

Synthesis Example 1

2.7 parts by weight of
5 2,2'-azobis(2,4-dimethylvaleronitrile) and 200 parts by weight of diethylene glycol monomethyl ether acetate were charged into a flask equipped with a cooling pipe and an agitator. Then, 15 parts by weight of methacrylic acid, 25 parts by weight of N-phenyl
10 maleimide, 45 parts by weight of benzyl methacrylate, 15 parts by weight of styrene and 5 parts by weight of α -methyl styrene dimer (chain transfer agent) were added. After the inside of the flask was substituted with nitrogen, the reaction solution was heated to 80°C
15 under moderate agitation, and polymerization was carried out at 80°C for three hours. Then, the reaction solution was heated to 100°C, 0.5 parts by weight of 2,2'-azobis(2,4-dimethylvaleronitrile) was further added, and the polymerization was continued for another
20 one hour to obtain a resin solution (solid concentration = 33.1 wt%). The obtained resin showed $M_w = 15,000$ and $M_n = 7,000$. This resin solution will be referred to as "resin solution (B-1)".

Comparative Example 1

25 Preparation of Pigment Dispersion

A mixed solution comprising 30 parts by weight of C. I. Pigment Blue 15:6 as the pigment (A), 10 parts by weight (or about 4.51 parts by weight in terms of solid) of BYK2001 (Disperbyk: product of BYK Chemie Co.,
30 Ltd., solid concentration: 45.1 wt%) as a dispersant, 10 parts by weight (or 3.31 parts by weight in terms of solid) of the resin solution (B-1) as the alkali soluble resin (B) and 100 parts by weight of propylene glycol monomethyl ether acetate as a solvent was mixed

and dispersed by means of a bead mill for 12 hours to prepare a pigment dispersion (p1).

When the average particle diameter of the pigment in the pigment dispersion (p1) was measured by a dynamic light scattering method, it was found to be 250 nm.

Preparation of Liquid Composition for Examining Coating Conditions

225 parts by weight of the pigment dispersion (p1), 190 parts by weight (or 62.89 parts by weight in terms of solid) of the resin solution (B-1) as the alkali soluble resin (B), 60 parts by weight of dipentaerythritol hexaacrylate as the polyfunctional monomer (C), 40 parts by weight of 2-benzyl-2-dimethylamino-1-(4-morpholinophenyl) butanone-1 as the 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 (b1). (The pigment concentration (percentage (%)) of the pigment in all solids) of this liquid composition (b1) was 20.5%.)

Determination of Pigment Concentration for Measurement of Chromaticity

To evaluate the chromaticity of blue pixels, a pigment concentration showing a constant film thickness (film thickness: 2.00 μm) and a constant color tone ($y = 0.110$) must be defined.

The liquid composition (b1) was coated on soda glass substrates each having a size of 15 cm x 15 cm on which an SiO_2 film for preventing elution of sodium ions was formed, at 500 rpm, 750 rpm and 1,000 rpm, by use of a spin coater. The coated substrates were then prebaked in a clean oven of 90°C for 10 minutes. Then, these substrates were cooled to room temperature, and then the coating films were exposed to 5,000 J/m^2 of

radiations having wavelengths of 365 nm, 405 nm and 436 nm by use of a high-pressure mercury lamp without a photomask. Then, the substrates were postbaked at 220°C for 30 minutes to prepare three substrates for measuring chromaticity which differed in film thickness.

Then, when the film thickness at positions (4 points) on the diagonals each of which was 6 cm away from the center of the substrate was measured by use of α STEP500 of TENCOL, the average film thicknesses of the 500-rpm, 750-rpm and 1,000-rpm substrates were 3.15 μ m, 2.08 μ m and 1.59 μ m, respectively. Further, chromaticity at the positions where the film thickness was measured on the three substrates was evaluated by use of Color Analyzer TC-1800M (product of TOKYO DENSHOKU CO., LTD.).

When a film thickness with $y = 0.110$ was estimated by an interpolation method based on the above film thickness measurement results and chromaticity measurement results, it was found to be 2.81 μ m. Consequently, the pigment concentration required to achieve $y = 0.110$ at 2.00 μ m was estimated to be 28.8%.
Preparation of Liquid Composition for Evaluation

A liquid composition (b2) was prepared in the same manner as the above liquid composition for examining coating conditions was prepared expect that 368 parts by weight of the pigment dispersion (p1) was used. (The pigment concentration (percentage (%)) of the pigment in all solids) of this liquid composition (b2) was 28.8%.)

Evaluation of Film Thickness and Chromaticity

From measurement values of the film thicknesses of substrates obtained through the steps of spin coating at different spinning speeds, exposure, development and

postbaking in the same procedure as that of "Determination of Pigment Concentration for Measurement of Chromaticity" by use of the liquid composition (b2), a condition with which a film thickness of 2.00 μm was achieved was determined by an interpolation method, and the film thickness and chromaticity of a substrate obtained through the steps of coating, exposure, development and postbaking under the condition were determined.

10 As a result, the film thickness was 2.00 μm , and the chromaticity was $(x, y, Y) = (0.134, 0.110, 12.8)$.

Evaluation of Developability

15 The liquid composition (b2) was coated on soda glass substrates on which an SiO_2 film for preventing elution of sodium ions was formed under the same conditions as used for the above evolution of chromaticity by use of a spin coater. The coated substrates were then prebaked in a clean oven of 90°C for 10 minutes to form coating films.

20 Then, the substrates were cooled to room temperature, and then the coating films were exposed to 5,000 J/m^2 of radiations having wavelengths of 365 nm, 405 nm and 436 nm by use of a high-pressure mercury lamp through a photomask. Then, the substrates were shower-developed with a developer comprising a 0.04-wt% potassium hydroxide aqueous solution of 23°C for 80 seconds by use of a shower-type development apparatus. When the time required to become able to see the substrate during development was observed visually, it was 60 seconds.

30 After development, the substrates were rinsed with ultrapure water, air-dried, and then postbaked at 220°C for 30 minutes to form blue striped pixel patterns on the substrates.

Then, when the level of residues between the patterns was examined by a scanning electron microscope (SEM), a large quantity of residues were observed.

Example 1

5 Preparation of Pigment Dispersion

A pigment dispersion (P1) was prepared in the same manner as in Comparative Example 1 except that 30 parts by weight of mixture comprising C. I. Pigment Blue 80 and C. I. Pigment Blue 15:6 in a weight ratio of 10/90
10 was used as the pigment (A).

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

15 Preparation of Liquid Composition for Examining Coating Conditions

A liquid composition (B1) was prepared in the same manner as in Comparative Example 1 except that the pigment dispersion (P1) was used (The pigment concentration (percentage (%)) of the pigment in all
20 solids) of this liquid composition (b1) was 20.5%.)

Determination of Pigment Concentration for Measurement of Chromaticity

When a film thickness with $y = 0.110$ was estimated by an interpolation method based on film thickness
25 measurement results and chromaticity measurement results in the same manner as in Comparative Example 1 except that the liquid composition (B1) was used in place of the liquid composition (b1), it was found to be $1.64 \mu\text{m}$. Consequently, the pigment concentration
30 required to achieve $y = 0.110$ at $2.00 \mu\text{m}$ was estimated to be 16.8%.

Preparation of Liquid Composition for Evaluation

A liquid composition (B2) was prepared in the same manner as the above liquid composition for examining

coating conditions was prepared expect that 174 parts by weight of the pigment dispersion (P1) was used. (The pigment concentration (percentage (%)) of the pigment in all solids) of this liquid composition (B2) was 16.8%.)

Evaluation of Film Thickness and Chromaticity

A condition with which a film thickness of 2.00 μm was achieved was determined in the same manner as in Comparative Example 1 except that the liquid composition (B2) was used in place of the liquid composition (b2), and the film thickness and chromaticity of a substrate obtained through the steps of coating, exposure, development and postbaking under the condition were determined.

As a result, the film thickness was 2.00 μm , and the chromaticity was (x, y, Y) = (0.138, 0.110, 13.2).

Evaluation of Developability

Developability was evaluated in the same manner as in Comparative Example 1 except that the liquid composition (B2) was used in place of the liquid composition (b2). When the time required to become able to see the substrate during development was observed visually, it was 20 seconds.

After development, the substrates were rinsed with ultrapure water, air-dried, and then postbaked at 220°C for 30 minutes to form blue striped pixel patterns on the substrates.

Then, when the level of residues between the patterns was examined by a scanning electron microscope (SEM), no residues were observed.

What is claimed is:

1. A radiation sensitive composition for color filters which comprises:

- 5 (A) a pigment which contains C. I. Pigment Blue 80,
(B) an alkali soluble resin,
(C) a polyfunctional monomer, and
(D) a radiation sensitive radical generator.

10 2. A color filter formed from the radiation sensitive composition of claim 1.

3. A color liquid crystal display device comprising the color filter of claim 2.