

RADIATION-SENSITIVE COMPOSITION USED FOR FORMING GREEN PIXEL, COLOR FILTER, AND COLOR LIQUID CRYSTAL DISPLAY DEVICE

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to a radiation-sensitive composition used for forming a green pixel, a color filter, and a color liquid crystal display device. More specifically, the present invention relates to a radiation-sensitive composition suitably used for producing a color filter used for a transmission-type or reflection-type color liquid crystal display device, a color image pickup tube element, or the like, a color filter formed by using the radiation-sensitive composition, and a color liquid crystal display device including the color filter.

2. Description of the Related Art

In producing a color filter using a colored radiation-sensitive composition, generally, a method of obtaining a pixel pattern of each color is known, involving: forming a coating film of a colored radiation-sensitive composition on a substrate or on a substrate on which a light-shielding layer having a desired pattern is formed; irradiating the coating film through a photomask having a desired pattern form (hereinafter, referred to as "exposure"); developing the resultant to thereby dissolve and remove an unexposed part; and then post-baking the resultant (for example, see JP-A-02-144502

and JP-A-03-053201).

For such a liquid crystal display device including a color filter, achievement of higher brightness and enlargement of color reproduction area have been required. Thus, a color filter having high light transmittance and high color purity has also increasingly been required in recent years.

For a green pixel, as a material which is capable of providing a color filter having high brightness and a large color reproduction area, a pigment composition containing a polyhalogenated zinc phthalocyanine pigment has been known and has attracted attention (for example, see JP-A-2007-284589). However, the pigment composition containing a polyhalogenated zinc phthalocyanine pigment tends to generate aggregation particle because of poor dispersion stability, and hence it has been difficult to apply the pigment composition to mass production.

On the other hand, in the technical field of the color filter in recent years, coupled with the fact that the size of a substrate used for forming the color filter has grown larger, the reduction of tact time with reduced exposure dose has become a main stream. Therefore, the colored radiation-sensitive composition is required to generate neither chipping nor peeling in a pattern at the time of development even with a low exposure dose, that is, high sensitization.

From the background as described above, there has been a strong

demand for development of a radiation-sensitive composition which is capable of forming a green pixel having high brightness, has excellent dispersion stability, and besides has high sensitivity.

SUMMARY OF THE INVENTION

It is an object of the present invention to provide a radiation-sensitive composition used for forming a green pixel which is capable of forming a green pixel having high brightness, has excellent dispersion stability, and besides has high sensitivity.

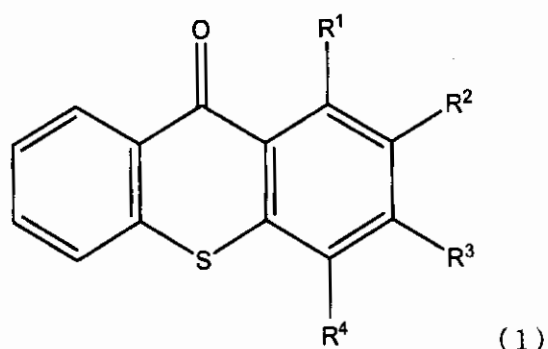
It is another object of the present invention to provide a color filter including a pixel formed by using the radiation-sensitive composition used for forming a green pixel, and a color liquid crystal display device including the color filter.

The inventors of the present invention have intensively studied in view of such actual circumstances. As a result, the inventors have unexpectedly found that the above-mentioned problems may be solved by incorporating C.I. Pigment Green 58, which is a polyhalogenated zinc phthalocyanine pigment, into a radiation-sensitive composition in combination with a particular radiation-sensitive polymerization initiator. Thus, the present invention has been accomplished.

That is, the present invention provides a radiation-sensitive composition used for forming a green pixel, including:

a colorant (A);

an alkali-soluble resin (B);
 a polyfunctional monomer (C); and
 a radiation-sensitive polymerization initiator (D), in which:
 the colorant (A) includes C.I. Pigment Green 58; and
 the radiation-sensitive polymerization initiator (D)
 includes a compound represented by the following formula (1):



where R¹ to R⁴ each independently represent one of a hydrogen atom, an alkyl group having 1 to 18 carbon atoms, and an alkoxy group having 1 to 18 carbon atoms.

According to the present invention, there are also provided a color filter including a pixel formed by using the radiation-sensitive composition, and a color liquid crystal display device including the color filter.

The radiation-sensitive composition of the present invention may be used to form a green pixel which has high brightness, generates no aggregation particle on the pixel, and besides generates neither chipping nor peeling in a pattern at the time of development even in a low exposure dose.

Further, the color filter of the present invention is extremely

useful for a transmission-type or reflection-type color liquid crystal display device, a color image pickup tube element, a color sensor, or the like.

DETAILED DESCRIPTION OF THE INVENTION

In a radiation-sensitive composition used for forming a green pixel of the present invention (hereinafter simply referred to as "radiation-sensitive composition" in some cases), a colorant (A) contains C.I. Pigment Green 58. In this case, the content of C.I. Pigment Green 58 is preferably 20 to 100% by mass and particularly preferably 35 to 75% by mass in the total colorant dose. Then, a green pixel having high brightness may be obtained by using such a colorant.

In addition, the radiation-sensitive composition of the present invention may further contain any other colorant besides C.I. Pigment Green 58. The other colorant is not particularly limited, and organic pigments are preferred because color filters are required high purity, coloring with high light transmittance, and heat resistance.

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

C.I. Pigment Green 7, C.I. Pigment Green 36;

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, 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, C.I. Pigment Yellow 211, and C.I. Pigment Yellow 219;

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, C.I. Pigment Orange 49, C.I. Pigment Orange 61, C.I. Pigment Orange 64, C.I. Pigment Orange 68, C.I. Pigment Orange 70, C.I. Pigment Orange 71, C.I. Pigment Orange 72, C.I. Pigment Orange 73, and C.I. Pigment Orange 74; and

C.I. Pigment Red 1, C.I. Pigment Red 2, C.I. Pigment Red 5, C.I. Pigment Red 17, C.I. Pigment Red 31, C.I. Pigment Red 32, C.I. Pigment Red 41, C.I. Pigment Red 122, C.I. Pigment Red 123, C.I. Pigment Red 144, C.I. Pigment Red 149, C.I. Pigment Red 166, C.I. Pigment Red 168, C.I. Pigment Red 170, C.I. Pigment Red 171, C.I. Pigment Red 176, C.I. Pigment Red 177, C.I. C.I. Pigment Red 178, C.I. Pigment Red 179, Pigment Red 180, C.I. Pigment Red 185, C.I.

Pigment Red 187, C.I. Pigment Red 202, C.I. Pigment Red 206, C.I. Pigment Red 207, C.I. Pigment Red 209, C.I. Pigment Red 214, C.I. Pigment Red 220, C.I. Pigment Red 221, C.I. Pigment Red 224, C.I. Pigment Red 242, C.I. Pigment Red 243, C.I. Pigment Red 254, C.I. Pigment Red 255, C.I. Pigment Red 262, C.I. Pigment Red 264, and C.I. Pigment Red 272.

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

Of those other organic pigments, from the viewpoint of forming green pixels, C.I. Pigment Green 7, C.I. Pigment Green 36, C.I. Pigment Yellow 138, C.I. Pigment Yellow 139, C.I. Pigment Yellow 150, C.I. Pigment Yellow 219, and the like are preferable.

In the present invention, C.I. Pigment Green 58 and other pigments purified as required by, for example, a recrystallization method, a reprecipitation method, a solvent cleaning method, a sublimation method, a vacuum heating method, or a combination thereof, may be used. Further, C.I. Pigment Green 58 and other pigments, on which the surface of the pigment particle is modified with a polymer as desired, may be used. Examples of the polymer for modifying the surface of the pigment particle include a polymer described in JP-A-08-259876 and various commercially available polymers or oligomers for dispersing a pigment.

In the present invention, the content of the colorant (A) is, in terms of forming a green pixel having high brightness, preferably

5 to 70% by mass and particularly preferably 5 to 60% by mass in the total solid content. In this case, the solid content refers to a component other than the solvent as described later.

The alkali-soluble resin (B) to be incorporated into the radiation-sensitive composition of the present invention is not particularly limited as long as the alkali-soluble resin has a solubility with respect to an alkali developer to be used in a development treatment step in forming a coloring layer, and generally is a polymer having an acid functional group such as a carboxyl group and a phenolic hydroxyl group. Of those, preferred is an alkali-soluble resin containing a polymer having a carboxyl group, and particularly preferred is a copolymer (hereinafter referred to as "carboxyl group-containing copolymer") of an ethylenic unsaturated monomer having one or more carboxyl groups (hereinafter referred to as "carboxyl group-containing unsaturated monomer") and another ethylenic unsaturated monomer which is copolymerizable with the carboxyl group-containing unsaturated monomer (hereinafter referred to as "copolymerizable unsaturated monomer").

Examples of the carboxyl group-containing unsaturated monomer include:

unsaturated monocarboxylic acids such as (meth)acrylic acid, crotonic acid, α -chloroacrylic acid, and cinnamic acid;

unsaturated dicarboxylic acids and anhydrides thereof such as maleic acid, maleic anhydride, fumaric acid, itaconic acid,

itaconic anhydride, citraconic acid, citraconic anhydride, and mesaconic acid;

mono[(meth)acryloyloxyalkyl]esters of polycarboxylic acids having at least two carboxyl groups in the molecule such as mono[2-(meth)acryloyloxyethyl]succinate, and mono[2-(meth)acryloyloxyethyl]phthalate; and

mono(meth)acrylates of polymers having a carboxyl group and a hydroxyl group at both terminals such as and ω -carboxy polycaprolactone mono(meth)acrylate.

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

In the present invention, as the carboxyl group-containing unsaturated monomers, (meth)acrylate, mono[2-(meth)acryloyloxyethyl]succinate, and ω -carboxy polycaprolactone mono(meth)acrylate are preferable, and (meth)acrylate is particularly preferable.

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

In the carboxyl group-containing copolymer, the copolymerization ratio of the carboxyl group-containing unsaturated monomer is preferably 5 to 50% by mass and more preferably 10 to 40% by mass. In this case, when the copolymerization ratio is less than 5% by mass, the solubility of the radiation-sensitive composition to be obtained with respect to an alkaline developer

tends to decrease, and on the other hand, when the copolymerization ratio exceeds 50% by mass, the solubility of the radiation-sensitive composition to be obtained with respect to the alkaline developer tends to become excessive, with the result that a pixel tends to fall off easily from a substrate and a film on the surface of the pixel tends to get rough easily, at the time of development with the alkaline developer.

Further, examples of the copolymerizable unsaturated monomers include maleimides:

N-substituted maleimides such as N-phenylmaleimide, N-o-hydroxyphenylmaleimide, N-m-hydroxyphenylmaleimide, N-p-hydroxyphenylmaleimide, N-benzylmaleimide, N-cyclohexylmaleimide, N-succinimidyl-3-maleimidebenzoate, N-succinimidyl-4-maleimidebutylate, N-succinimidyl-6-maleimidecaproate, N-succinimidyl-3-maleimidepropionate, and N-(acridinyl)maleimide;

aromatic vinyl compounds such as styrene, α -methylstyrene, o-vinyltoluene, m-vinyltoluene, p-vinyltoluene, p-chlorostyrene, o-methoxystyrene, m-methoxystyrene, p-methoxystyrene, o-vinylphenol, m-vinylphenol, p-vinylphenol, p-hydroxy- α -methylstyrene, o-vinylbenzyl methylether, m-vinylbenzyl methylether, p-vinylbenzyl methylether, o-vinylbenzyl glycidyl ether, m-vinylbenzyl glycidyl ether, and

p-vinylbenzyl glycidyl ether;

indenes such as indene and 1-methylindene;

unsaturated carboxylic esters such as methyl (meth)acrylate, ethyl (meth)acrylate, n-propyl (meth)acrylate, i-propyl (meth)acrylate, n-butyl (meth)acrylate, i-butyl (meth)acrylate, sec-butyl (meth)acrylate, t-butyl (meth)acrylate, 2-ethylhexyl (meth)acrylate, 2-hydroxyethyl (meth)acrylate, 2-hydroxypropyl (meth)acrylate, 3-hydroxypropyl (meth)acrylate, 2-hydroxybutyl (meth)acrylate, 3-hydroxybutyl (meth)acrylate, 4-hydroxybutyl (meth)acrylate, allyl (meth)acrylate, benzyl (meth)acrylate, cyclohexyl (meth)acrylate, phenyl (meth)acrylate, 2-methoxyethyl (meth)acrylate, 2-phenoxyethyl (meth)acrylate, methoxy diethylene glycol (meth)acrylate, methoxy triethylene glycol (meth)acrylate, methoxypropylene glycol (meth)acrylate, methoxydipropylene glycol (meth)acrylate, isobornyl (meth)acrylate, tricyclo[5.2.1.0^{2,6}]decane-8-yl (meth)acrylate, 2-hydroxy-3-phenoxypropyl (meth)acrylate, glycerol mono(meth)acrylate, 4-hydroxyphenyl (meth)acrylate, and ethylene oxide-modified (meth)acrylate of paracumylphenol;

unsaturated carboxylic glycidyl esters such as glycidyl (meth)acrylate;

vinyl ester carboxylates such as vinyl acetate, vinyl propionate, vinyl butyrate, and vinyl benzoate;

other unsaturated ethers such as vinylmethyl ether, vinyl ethyl

ether, and allyl glycidyl ether;

vinyl cyanide compounds such as (meth)acrylonitrile, α -chloroacrylonitrile, and vinylidene cyanide;

unsaturated amides such as (meth)acrylamide, α -chloroacrylamide, and N-2-hydroxyethyl (meth)acrylamide;

aliphatic conjugated dienes such as 1,3-butadiene, isoprene, and chloroprene; and

macromonomers having a mono(meth)acryloyl group at the terminal of a polymer molecular chain such as polystyrene, polymethyl (meth)acrylate, poly-n-butyl (meth)acrylate, and polysiloxane.

The above copolymerizable unsaturated monomers may be used alone or in a mixture of two or more.

In the present invention, preferred is a copolymerizable unsaturated monomer containing at least one kind selected from the group consisting of N-substituted maleimides, aromatic vinyl compounds, unsaturated carboxylates, and macromonomers having a mono(meth)acryloyl group at the terminal of a polymer molecular chain. More preferred is a copolymerizable unsaturated monomer containing at least one kind selected from the group consisting of N-phenylmaleimide, N-cyclohexylmaleimide, styrene, α -methylstyrene, p-hydroxy- α -methylstyrene, methyl (meth)acrylate, n-butyl (meth)acrylate, 2-ethylhexyl (meth)acrylate, 2-hydroxyethyl (meth)acrylate, allyl (meth)acrylate, benzyl (meth)acrylate, glycerol mono(meth)acrylate, 4-hydroxyphenyl

(meth)acrylate, ethylene oxide-modified (meth)acrylate of paracumylphenol, polystyrene macromonomer, and polymethylmethacrylate macromonomer. Particularly preferred is a copolymerizable unsaturated monomer containing at least one kind selected from the group consisting of N-phenylmaleimide, N-cyclohexylmaleimide, styrene, α -methylstyrene, 2-ethylhexyl (meth)acrylate, and glycerol mono(meth)acrylate.

In the present invention, for example, an alkali-soluble resin copolymerized with a copolymerizable unsaturated monomer having a hydroxyl group such as 2-hydroxyethyl(meth)acrylate is reacted with an unsaturated isocyanate compound such as 2-(meth)acryloyloxyethyl isocyanate, whereby a polymerizable unsaturated bond may be introduced into a side chain of the alkali-soluble resin.

The weight average molecular weight (hereinafter sometimes abbreviated as Mw) in terms of polystyrene measured by gel permeation chromatography (GPC; tetrahydrofuran used as an elution solvent) of the alkali-soluble resin of the present invention is generally 1,000 to 45,000, and preferably 3,000 to 20,000. When Mw is less than 1,000, a residual film rate or the like of a coating film to be obtained may be decreased, pattern shape, heat resistance, or the like may be impaired, or electrical characteristics may become worse, and on the other hand, when Mw exceeds 45,000, resolution may be decreased, pattern shape may be impaired, or dry aggregation

particle may easily generate at the time of coating by a slit nozzle system.

Further, the number average molecular weight (hereinafter sometimes abbreviated as M_n) in terms of polystyrene measured by gel permeation chromatography (GPC; tetrahydrofuran used as an elution solvent) in the alkali-soluble resin of the present invention is generally 1,000 to 45,000, and preferably 3,000 to 20,000.

Further, the ratio of M_w to M_n (M_w/M_n) of the alkali-soluble resin of the present invention is preferably 1.0 to 5.0, and more preferably 1.0 to 3.0.

The alkali-soluble resin of the present invention may be produced by polymerizing, for example, unsaturated monomers such as (meth)acrylate in an appropriate solvent in the presence of a radical polymerization initiator such as 2,2'-azobisisobutyronitrile, 2,2'-azobis(2,4-dimethylvaleronitrile), and 2,2'-azobis(4-methoxy-2,4-dimethylvaleronitrile).

Further, the alkali-soluble resin in the present invention may be produced, for example, by subjecting each unsaturated compound as a component of the resin to living radical polymerization in inactive solvents, generally at a reaction temperature of 0 to 150°C and more preferably 50 to 120°C, in the presence of molecular weight inhibitor, which function as: radical polymerization initiators such as 2,2'-azobisisobutyronitrile,

2,2'-azobis(2,4-dimethylvaleronitrile), or
 2,2'-azobis(4-methoxy-2,4-dimethylvaleronitrile); or iniferters
 such as pyrazole-1-dithiocarboxylic acid cyano(dimethyl) methyl
 ester, pyrazole-1-dithiocarboxylic acid benzyl ester,
 tetraethylthiuram disulfide,
 bis(pyrazole-1-ylthiocarbonyl)disulfide,
 bis(3-methyl-pyrazole-1-ylthiocarbonyl) disulfide,
 bis(4-methyl-pyrazole-1-ylthiocarbonyl) disulfide,
 bis(5-methyl-pyrazole-1-ylthiocarbonyl) disulfide,
 bis(3,4,5-trimethyl-pyrazole-1-ylthiocarbonyl) disulfide,
 bis(pyrrole-1-ylthiocarbonyl) disulfide, or bithiobenzoyl
 disulfide.

In addition, the alkali-soluble resin in the present invention
 may be produced by subjecting each unsaturated monomer as a component
 of the resin to radical polymerization in an appropriate solvent
 in the presence of the above-mentioned radical polymerization
 initiator and a polythiol compound which functions as a chain transfer
 agent. Here, the polythiol compound refers to a compound having
 two or more thiol groups in one molecule. Examples of the polythiol
 compound include trimethylolpropane tris(3-mercaptopropionate),
 pentaerythritol tetrakis(3-mercaptopropionate), tetraethylene
 glycol bis(3-mercaptopropionate), dipentaerythritol
 hexakis(3-mercaptopropionate), pentaerythritol tetrakis(thio
 glycolate), 1,4-bis(3-mercaptobutyryloxy)butane,

pentaerythritol tetrakis(3-mercaptopbutyrate), and 1,3,5-tris(3-mercaptopbutyloxyethyl)-1,3,5-triazine-2,4,6(1H,3H,5H)-trione.

Further, the alkali-soluble resin in the present invention may be purified by subjecting the polymerizable unsaturated compound to the radical polymerization as described above, and then undergoing a reprecipitation method in which two or more kinds of organic solvents having different polarities are used. That is, the alkali-soluble resin is purified by: pouring a solution in a good solvent after the polymerization into a large quantity (generally, 5 to 10 times the volume of the polymer solution) of precipitant (poor solvent), after the solution in the good solvent after the polymerization is subjected to filtration or centrifugal separation as required to thereby remove insoluble impurities; and reprecipitating the copolymer. On this occasion, of the impurities remaining in the polymer solution, the impurities which are soluble in the precipitant remain in the liquid phase and are separated from the purified alkali-soluble resin.

Examples of the combinations of good solvents with precipitants used in the reprecipitation method include diethylene glycol monomethyl ether acetate with n-hexane, methylethylketone with n-hexane, diethylene glycol monomethyl ether acetate with n-heptane, and methylethylketone with n-heptane.

In the present invention, the content of the alkali-soluble

resin (B) is generally preferably 10 to 1,000 parts by mass and more preferably 20 to 500 parts by mass with respect to 100 parts by mass of the colorant (A). In this case, when the content of the alkali-soluble resin is less than 10 parts by mass, for example, alkaline development property may decrease, and scum or residue may occur on the unexposed part of the substrate or on the light-shielding layer. On the other hand, when the content of the alkali-soluble resin exceeds 1,000 parts by mass, it may become difficult to achieve a target color density as a thin film, because the concentration of the colorant is relatively decreased.

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

Examples of the 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 glycol and polypropylene glycol;

poly(meth)acrylates of a polyalcohol with a valency of 3 or more such as glycerine, trimethylolpropane, pentaerythritol, and dipentaerythritol, or dicarboxylate-modified products thereof;

oligo(meth)acrylates such as polyester, an epoxy resin, a urethane resin, an alkyd resin, a silicone resin, and a spirane resin;

di(meth)acrylates of both-terminal hydroxyl polymers such as

both-terminal hydroxypoly-1,3-butadiene, both-terminal hydroxypolyisoprene, and both-terminal hydroxypolycaprolactone; and

tris[2-(meth)acryloyloxyethyl]phosphate and ethylene oxide-modified triacrylate isocyanurate.

Of those polyfunctional monomers, preferred are poly(meth)acrylate of polyhydric alcohol having a valency of 3 or more, and a dicarboxylic acid modified product thereof, specifically, trimethylolpropane triacrylate, trimethylolpropane trimethacrylate, pentaerythritol triacrylate, pentaerythritol trimethacrylate, pentaerythritol tetraacrylate, pentaerythritol tetramethacrylate, dipentaerythritol pentaacrylate, dipentaerythritol pentamethacrylate, dipentaerythritol hexaacrylate, dipentaerythritol hexamethacrylate, a monoester product of pentaerythritol triacrylate and succinic acid, a monoester product of pentaerythritol trimethacrylate and succinic acid, a monoester product of dipentaerythritol pentaacrylate and succinic acid, and a monoester product of dipentaerythritol pentamethacrylate and succinic acid, and the like. Particularly preferred are trimethylol propanetriacrylate, pentaerythritol triacrylate, dipentaerythritol pentaacrylate, dipentaerythritol hexaacrylate, a monoester product of pentaerythritol triacrylate and succinic acid, and a monoester product of dipentaerythritol pentaacrylate and succinic acid, because they are excellent in

strength and surface smoothness of a coloring layer and hardly generate scum, film residue, or the like on the unexposed part of the substrate and on the light-shielding layer.

The polyfunctional monomers may be used alone or in a mixture of two or more.

The content of the polyfunctional monomer (C) in the present invention is generally preferably 5 to 500 parts by mass and particularly preferably 20 to 300 parts by mass with respect to 100 parts by mass of the alkali-soluble resin (B). In this case, when the content of the polyfunctional monomer is less than 5 parts by mass, strength and surface smoothness of the pixel tend to be decreased, and on the other hand, when the content of the polyfunctional monomer exceeds 500 parts by mass, for example, alkaline development property tends to decrease, and scum, film residue, or the like tends to occur on the unexposed part of the substrate or on the light-shielding layer.

Further, in the present invention, a part of the polyfunctional monomer may be replaced by a monofunctional monomer having one polymerizable unsaturated bond.

Examples of the monofunctional monomers include mono[(meth)acryloyloxyalkyl]esters of polycarboxylic acids having at least two carboxyl groups in the molecule such as mono[2-(meth)acryloyloxyethyl]succinate and mono[2-(meth)acryloyloxyethyl]phthalate; and mono(meth)acrylates

of polymers having a carboxyl group and a hydroxyl group at both terminals such as ω -carboxy polycaprolactone mono(meth)acrylate; N-(meth)acryloylmorpholine; N-vinyl-pyrrolidone; N-vinyl- ϵ -caprolactam; and as commercially available products, M-5600 (manufactured by TOA GOSSEI CO., LTD.).

Those monofunctional monomers may be used alone or in a mixture of two or more.

The content of the monofunctional monomer in the present invention is preferably 90% by mass or less and more preferably 50% by mass or less with respect to the total amount of the polyfunctional monomer and the monofunctional monomer. In this case, when the ratio of the monofunctional monomer to be used exceeds 90% by mass, strength and surface smoothness of the pixel tend to decrease.

The radiation-sensitive polymerization initiator (D) to be used in the present invention refers to a compound which generates an active species that may initiate polymerization of the polyfunctional monomer (C) and the monofunctional monomer to be used in some cases by exposure of radiation such as visible light ray, ultraviolet ray, far ultraviolet ray, electron ray, or X-ray.

In the present invention, the radiation-sensitive composition having high sensitivity and excellent dispersion stability may be obtained by including the compound represented by the above formula (1) as the radiation-sensitive polymerization initiator (D).

In other words, the radiation-sensitive polymerization initiator such as a (diamino)benzophenone compound has generally multiple amino groups in the molecule in many cases. The inventors have considered that those multiple amino groups interacts with C.I. Pigment Green 58 to break a dispersion state, whereby aggregation particle is generated. As a result of an intensive study, the inventors have found that the compound represented by the above formula (1) is optimal in a combination with C.I. Pigment Green 58.

In the formula (1), R^1 and R^3 each represent preferably a hydrogen atom. R^2 and R^4 each represent preferably a hydrogen atom or an alkyl group having 1 to 12 carbon atoms, and R^2 and R^4 each represent more preferably a hydrogen atom or an alkyl group having 1 to 6 carbon atoms.

Specific examples of the thioxanthone compound represented by the above formula (1) include thioxanthone, 2-methyl thioxanthone, 2-isopropyl thioxanthone, 4-isopropyl thioxanthone, 2-dodecyl thioxanthone, 2,4-dimethyl thioxanthone, 2,4-diethyl thioxanthone, and 2,4-diisopropyl thioxanthone.

Of those thioxanthone compounds, preferred are 2-methyl thioxanthone, 2-isopropyl thioxanthone, 4-isopropyl thioxanthone, 2,4-dimethyl thioxanthone, 2,4-diethyl thioxanthone, and 2,4-diisopropyl thioxanthone.

In the present invention, the thioxanthone compounds may be

used alone or in a mixture of two or more.

In the present invention, other radiation-sensitive polymerization initiators are preferably used together with the thioxanthone compound. In this case, the content of the thioxanthone compound is, in terms of dispersion stability, preferably 1 to 75% by mass and more preferably 5 to 50% by mass in the radiation-sensitive polymerization initiator. Such a radiation-sensitive polymerization initiator may be used to afford a radiation-sensitive composition having high sensitivity and excellent dispersion stability.

Examples of the other radiation-sensitive polymerization initiators include acetophenone compounds, biimidazole compounds, triazine compounds, O-acryloxime compounds, onium salt compounds, benzoine compounds, benzophenone compounds, α -diketon compounds, multinuclear quinone compounds, xanthone compounds, diazo compounds, and imidesulfonate compounds.

In the present invention, the other radiation-sensitive polymerization initiators may be used alone or in a mixture of two or more, and the other radiation-sensitive polymerization initiators in the present invention are preferably at least one kind selected from the group consisting of an acetophenone compound, a biimidazole compound, and an O-acyloxime compound.

Of the preferable other radiation-sensitive polymerization initiators in the present invention, specific examples of the

acetophenone compounds include
2-hydroxy-2-methyl-1-phenylpropane-1-one,
2-methyl-1-(4-methylthiophenyl)-2-morpholinopropane-1-one,
2-benzyl-2-dimethylamino-1-(4-morpholinophenyl)butane-1-one,
2-(4-methylbenzyl)-2-(dimethylamino)-1-(4-morpholinophenyl)butane-1-one, 1-hydroxy cyclohexyl/phenyl ketone,
2,2-dimethoxy-1,2-diphenylethane-1-one, and 1,2-octanedione.

Of those acetophenone compounds,
2-methyl-1-(4-methylthiophenyl)-2-morpholinopropane-1-one,
2-benzyl-2-dimethylamino-1-(4-morpholinophenyl)butane-1-one,
2-(4-methylbenzyl)-2-(dimethylamino)-1-(4-morpholinophenyl)butane-1-one, and 1,2-octanedione are particularly preferable.

The above acetophenone compounds may be used alone or in a mixture of two or more.

Specific examples of the biimidazole compounds 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,

midazole,

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 those biimidazole 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,

2,2'-bis(2,4,6-trichlorophenyl)-4,4',5,5'-tetraphenyl-1,2'-biimidazole, and the like are preferable, and 2,2'-bis(2-chlorophenyl)-4,4',5,5'-tetraphenyl-1,2'-biimidazole is particularly preferable.

The above biimidazole compounds may be used alone or in a mixture of two or more.

In the present invention, in the case where the biimidazole compounds are used as the other radiation-sensitive polymerization initiators, the following hydrogen donor is preferably used in combination therewith in terms of further improving sensitivity.

The "hydrogen donor" refers to a compound which may donate a hydrogen atom to a radical that is generated from the biimidazole-based compounds by exposure.

Mercaptan compounds defined below are preferable as the hydrogen donor in the present invention.

The mercaptan compounds are each formed by using a compound which has a benzene ring or a heterocyclic ring as a mother nucleus, and has 1 or more, preferably 1 to 3, more preferably 1 or 2 mercapto groups which are each directly bonded to the mother nucleus.

The mercaptan compound may have one or more benzene rings or one or more heterocyclic rings, and may have both the benzene ring and the heterocyclic ring. When two or more rings are contained in the mercaptan compound, the rings may or may not form a condensed ring.

Further, when the mercaptan compound has two or more mercapto groups: as long as at least one free mercapto group remains, one or more of the other mercapto groups may be substituted with an alkyl group, an aralkyl group, or an aryl group; and further as long as at least one free mercapto group remains, the mercaptan compound may have a structural unit in which two sulfur atoms are bonded to each other via a divalent organic group such as an alkylene group or a structural unit in which two sulfur atoms are bonded to each other in the form of a disulfide bond.

Further, any part other than the mercapto group in the mercaptan compounds may be substituted with groups such as a carboxyl group, an alkoxycarbonyl group, a substituted alkoxycarbonyl group, a phenoxycarbonyl group, a substituted phenoxycarbonyl group, or a

nitrile group.

Specific examples of the mercaptan compounds include 2-mercaptobenzothiazole, 2-mercaptobenzooxazole, 2-mercaptobenzoimidazole, 2,5-dimercapto-1,3,4-thiadiazole, and 2-mercapto-2,5-dimethylaminopyridine.

Of those mercaptan compounds, 2-mercaptobenzothiazole and 2-mercaptobenzooxazole are preferable, and 2-mercaptobenzothiazole is particularly preferable.

In the present invention, the mercaptan compounds may be used alone or in a mixture of two or more.

In the present invention, when the mercaptan compound and the biimidazole compound are used in combination, the content of the mercaptan-based compound is preferably 1 to 300 parts by mass or less, particularly preferably 5 to 200 parts by mass or less, and still more preferably 10 to 150 parts by mass or less with respect to 100 parts by mass of the biimidazole compound. In this case, when the content of the hydrogen donor is less than 1 part by mass, an effect for improving sensitivity tends to decrease, and on the other hand, when the content of the hydrogen donor exceeds 300 parts by mass, the formed coloring layer tends to fall off easily from the substrate at the time of development.

Further, the O-acyloxime compounds refers to compounds having oxime ester structures ($>C=N-O-CO-$). Specific examples of the O-acyloxime compounds include

1,2-octanedion-1-[4-(phenylthio)phenyl]-2-(O-benzoyloxime),
 1-[9-ethyl-6-benzoyl-9.H.-carbazol-3-yl]-nonane-1,2-nonane-2-oxime-O-benzoate,
 1-[9-ethyl-6-benzoyl-9.H.-carbazol-3-yl]-nonane-1,2-nonane-2-oxime-O-acetate,
 1-[9-ethyl-6-benzoyl-9.H.-carbazol-3-yl]-pentane-1,2-pentane-2-oxime-O-acetate,
 1-[9-ethyl-6-benzoyl-9.H.-carbazol-3-yl]-octane-1-one oxime-O-acetate,
 1-[9-ethyl-6-(2-methylbenzoyl)-9.H.-carbazol-3-yl]-ethane-1-one oxime-O-benzoate,
 1-[9-ethyl-6-(1,3,5-trimethylbenzoyl)-9.H.-carbazol-3-yl]-ethane-1-one oxime-O-benzoate,
 1-[9-butyl-6-(2-ethylbenzoyl)-9.H.-carbazol-3-yl]-ethane-1-one oxime-O-benzoate, ethanone,
 1-[9-ethyl-6-(2-methylbenzoyl)-9.H.-carbazol-3-yl]-,
 1-(O-acetyloxime), and ethanone,
 1-[9-ethyl-6-[2-methyl-4-(2,2-dimethyl-1,3-dioxysolanyl)methoxybenzoyl]-9.H.-carbazol-3-yl]-, 1-(O-acetyloxime).

Of those O-acyloxime compounds,
 1,2-octanedion-1-[4-(phenylthio)phenyl]-2-(O-benzoyloxime),
 ethanone, 1-[9-ethyl-6-(2-methylbenzoyl)-9.H.-carbazol-3-yl]-,
 1-(O-acetyloxime), and ethanone,
 1-[9-ethyl-6-[2-methyl-4-(2,2-dimethyl-1,3-dioxysolanyl)methoxy

ybenzoyl]-9.H.-carbazol-3-yl]-,1-(O-acetyloxime) are preferable.

The above O-acyloxime compounds may be used alone or in a mixture of two or more.

In the present invention, the content of the radiation-sensitive polymerization initiator (D) is generally preferably 0.01 to 120 parts by mass, particularly preferably 1 to 100 parts by mass, and still more preferably 1 to 70 parts by mass with respect to 100 parts by mass of the polyfunctional monomer (C). In this case, when the content of the radiation-sensitive polymerization initiator is less than 0.01 part by mass, curing by exposure may become insufficient, with the result that it may become difficult to obtain a color filter in which a pixel pattern is placed in accordance with a predetermined arrangement, and on the other hand, when the content of the radiation-sensitive polymerization initiator exceeds 120 parts by mass, the formed pixel pattern tends to fall off easily from the substrate at the time of development.

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

Here, examples of the other additives include: fillers such as glass and alumina; polymer compounds such as polyvinyl alcohol and poly(fluoroalkylacrylate); surfactants such as nonionic surfactants, cation surfactants, and anion surfactants; adhesion

promoting agents such as vinyltrimethoxy silane, vinyltriethoxy silane, vinyltris(2-methoxyethoxy)silane, N-(2-aminoethyl)-3-aminopropylmethyldimethoxy silane, N-(2-aminoethyl)-3-aminopropyltrimethoxy silane, 3-aminopropyltriethoxysilane, 3-glycidoxypropyltrimethoxysilane, 3-glycidoxypropylmethyldimethoxy silane, 2-(3,4-epoxycyclohexyl)ethyltrimethoxy silane, 3-chloropropylmethyldimethoxy silane, 3-chloropropyltrimethoxy silane, 3-methacryloyloxypropyltrimethoxy silane, and 3-mercaptopropyltrimethoxy silane; antioxidants such as 2,2-thiobis(4-methyl-6-t-butylphenol) and 2,6-di-t-butylphenol; UV absorbers such as 2-(3-t-butyl-5-methyl-2-hydroxyphenyl)-5-chlorobenzotriazole, and alkoxybenzophenones; aggregation inhibitors such as sodium polacrylate; and alkali solubility improvers such as malonic acid, adipic acid, itaconic acid, citraconic acid, fumaric acid, and mesaconic acid.

In the present invention, the radiation-sensitive composition may be prepared by an appropriate method, for example, by mixing the component (A) and the above components (B) to (D) together with the solvent and the additive to be described later. The radiation-sensitive composition is preferably prepared by the following: a pigment dispersion liquid is obtained by mixing and dispersing, while pulverizing, the colorant (A) in the solvent in

the presence of a dispersant and a dispersion aid which is added as required, together with, in some cases, a part of the component (B), by using, for example, a beads mill and a roll mill; and the resulting pigment dispersion liquid is added with the components (B) to (D), further added with an additional solvent and additive as required, and the whole is mixed.

Examples of the dispersant used for the preparation of the pigment dispersion liquid include any appropriate dispersants such as a cationic dispersant, an anionic dispersant, a nonionic dispersant, and an amphoteric dispersant, and a polymer dispersant is preferred. Specific examples thereof include a modified acrylic copolymer, an acrylic copolymer, a polyurethane, a polyester, an alkyl ammonium salt or a phosphate salt of a high molecular copolymer, and a cationic comb graft polymer. Here, the cationic comb graft polymer refers to a polymer having a structure in which a branch polymer having two or more molecules is graft bonded to one molecule of backbone polymer having a plurality of basic groups (cationic functional groups). For example, a polymer formed by using a ring-opened polymer in which the backbone polymer part is polyethyleneimine and the branch polymer part is ϵ -caprolactone may be given. Of those dispersants, preferred are a modified acrylic copolymer, a polyurethane, and a cationic comb graft polymer.

These dispersants are commercially available. Examples of the modified acrylic copolymers include Disperbyk-2000,

Disperbyk-2001, BYK-LPN21116, and BYK-LPN21324 (all manufactured by BYK Japan KK); examples of the polyurethanes include Disperbyk-161, Disperbyk-162, Disperbyk-165, Disperbyk-167, Disperbyk-170, and Disperbyk-182 (all manufactured by BYK Japan KK); Solspers 76500 (manufactured by The Lubrizol Corporation); and examples of the cationic comb graft polymers include Solspers 24000 (manufactured by The Lubrizol Corporation), Ajisper-PB821, Ajisper-PB822, Ajisper-PB823, Ajisper-PB824, and Ajisper-PB827 (all manufactured by Ajinomoto Fine-Techno Co., Inc.).

The above dispersants may be used alone or in a mixture of two or more. The content of the dispersant is generally 100 parts by mass or less, preferably 0.5 to 100 parts by mass, more preferably 1 to 70 parts by mass, and particularly preferably 10 to 50 parts by mass, with respect to 100 parts by mass of the colorant (A). In this case, when the content of the dispersant exceeds 100 parts by mass, development property or the like may be impaired.

The radiation-sensitive composition used for forming a coloring layer of the present invention contains the above components (A) to (D) as essential components, and contains the above additive component as required. The radiation-sensitive composition may also be prepared as a liquid composition by blending a solvent.

The solvent may be appropriately selected and used as long as the solvent disperses or dissolves the components (A) to (D) and the additive component which compose the radiation-sensitive

composition, does not react those components, and has appropriate volatility.

Examples of the solvent include:

(poly)alkylene glycol monoalkyl ethers such as ethylene glycol monomethyl ether, ethylene glycol monoethyl ether, ethylene glycol mono-n-propyl ether, ethylene glycol mono-n-butyl ether, diethylene glycol monomethyl ether, diethylene glycol monoethyl ether, diethylene glycol mono-n-propyl ether, diethylene glycol mono-n-butyl ether, triethylene glycol monomethyl ether, triethylene glycol monoethyl ether, propylene glycol monomethyl ether, propylene glycol monoethyl ether, propylene glycol mono-n-propyl ether, propylene glycol mono-n-butylether, dipropylene glycol monomethyl ether, dipropylene glycol monoethyl ether, dipropylene glycol mono-n-propyl ether, dipropylene glycol mono-n-butyl ether, tripropylene glycol monomethyl ether, and tripropylene glycol monoethyl ether;

(poly)alkylene glycol monoalkyl ether acetates such as ethylene glycol monomethyl ether acetate, ethylene glycol monoethyl ether acetate, diethylene glycol monomethyl ether acetate, diethylene glycol monoethyl ether acetate, propylene glycol monomethyl ether acetate, propylene glycol monoethyl ether acetate, 3-methoxybutyl acetate, 3-methyl-3-methoxybutyl acetate, and 3-methyl-3-methoxybutyl propionate;

ethers such as diethylene glycol dimethyl ether, diethylene

glycol methylethyl ether, diethylene glycol diethyl ether, and tetrahydrofuran;

ketones such as methyl ethyl ketone, cyclohexanone, 2-heptanone, and 3-heptanone;

diacetates such as propylene glycol diacetate, 1,3-butylene glycol diacetate, and 1,6-hexanediol diacetate;

lactic acid alkyl esters such as methyl lactate and ethyl lactate;

other esters such as ethyl 2-hydroxy-2-methyl-propionate, methyl 3-methoxy-propionate, ethyl 3-methoxy-propionate, methyl 3-ethoxy-propionate, ethyl 3-ethoxy-propionate, ethyl ethoxy acetate, ethyl hydroxy acetate, methyl 2-hydroxy-3-methyl butanoate, ethyl acetate, n-propyl acetate, i-propyl acetate, n-butyl acetate, i-butyl acetate, n-amyl formate, i-amyl acetate, n-butyl propionate, ethyl butyrate, n-propyl butyrate, i-propyl butyrate, n-butyl butyrate, methyl pyruvate, ethyl pyruvate, n-propyl pyruvate, methyl acetoacetate, ethyl acetoacetate, and ethyl 2-oxobutanoate;

aromatic hydrocarbons such as toluene and xylene; and

amides or lactams such as N,N-dimethyl formamide, N,N-dimethyl acetoamide, and N-methylpyrrolidone.

Of those solvents, from the viewpoints of pigment dispersability, solubility of components other than pigments, and coating property, preferred are propylene glycol monomethyl ether, ethylene glycol monomethyl ether acetate, propylene glycol

monomethyl ether acetate, propylene glycol monoethyl ether acetate, diethylene glycol dimethyl ether, diethylene glycol methylethyl ether, cyclohexanone, 2-heptanone, 3-heptanone, propylene glycol diacetate, 1,3-butylene glycol diacetate, 1,6-hexanediol diacetate, ethyl lactate, ethyl 3-methoxy-propionate, methyl 3-ethoxy-propionate, ethyl 3-ethoxy-propionate, 3-methoxybutyl acetate, 3-methyl-3-methoxybutyl propionate, n-butyl acetate, i-butyl acetate, n-amyl formate, i-amyl acetate, n-butyl propionate, ethyl butyrate, i-propyl butyrate, n-butyl butyrate, and ethyl pyruvate.

The solvent may be used alone or in a mixture of two or more.

In addition, in combination with the solvent, a solvent having a high boiling point such as benzylethyl ether, di-n-hexyl ether, acetonyl acetone, isophorone, caproic acid, caprylic acid, 1-octanol, 1-nonanol, benzyl alcohol, benzyl acetate, ethyl benzoate, diethyl oxalate, diethyl maleate, γ -butyrolactone, ethylene carbonate, propylene carbonate, or ethylene glycol monophenyl ether acetate can be used.

The solvent having a high boiling point may be used alone or in a mixture of two or more.

The content of the solvent is, but not particularly limited to, from the viewpoint of spreadability, stability, or the like of the radiation-sensitive composition to be obtained, an amount in which the total concentration of respective components excluding

the solvent for the composition is 5 to 50% by mass is generally preferred, and an amount in which the total concentration of respective components excluding the solvent for the composition is 10 to 40% by mass is particularly desired.

The color filter of the present invention includes a green pixel formed by using the radiation-sensitive composition of the present invention.

Hereinafter, a method of forming the color filter of the present invention will be described.

First, a light-shielding layer is formed on the surface of a substrate as required so as to mark off a portion on which a pixel is formed. The liquid composition of the radiation-sensitive composition of the present invention in which a green pigment is dispersed is applied onto the substrate and then pre-baked to evaporate a solvent, thereby forming a coating film. Next, the coating film is exposed to light through a photomask and then developed by using an alkaline developer. An unexposed part of the coating film is dissolved, removed, and then post-baked to form a pixel array in which a green pixel pattern is placed in a predetermined arrangement.

After that, the liquid composition of each radiation-sensitive composition in which a red or blue pigment is dispersed is used, and, in the same manner as that described above, coating, pre-baking, exposure, development, and post-baking of the each liquid

composition are performed to form a red pixel array and a blue pixel array on the same substrate sequentially, thereby obtaining a color filter in which pixel arrays having three primary colors of red, green, and blue are placed on the substrate. It should be noted that, in the present invention, the order of forming each color pixel is not limited to that as described above.

Examples of the substrate to be used in forming the pixel may include glass, silicon, polycarbonate, polyester, aromatic polyamide, polyamide-imide, and polyimide.

Further, those substrates may be subjected to an appropriate pretreatment such as chemical treatment with a silane coupling agent or the like, plasma treatment, ion plating, sputtering, gas-phase reaction method, or vacuum deposition, as desired.

When the liquid composition of the radiation-sensitive composition is applied onto the substrate, there may be employed an appropriate coating method such as a spray method, a roll coating method, a spin coating method (spin coat method), a slit-die coating method, a bar coating method, or an ink-jet method, and the spin coat method and the slit-die coating method are particularly preferred.

The coating thickness is, as a film thickness after drying, generally 0.1 to 10 μm , preferably 0.2 to 8.0 μm , and particularly preferably 0.2 to 6.0 μm .

As radiation used in forming the pixel, for example, there

may be used visible light ray, ultraviolet ray, far ultraviolet ray, electron ray, or X-ray, and radiation having a wavelength ranging from 190 to 450 nm is preferred.

The exposure dose of radiation is generally preferably 10 to 10,000 J/m². The radiation-sensitive composition of the present invention generates neither chipping nor peeling in a pixel pattern at the time of development even in an exposure a dose of 400 J/m² or less.

In addition, examples of the alkaline developer include an aqueous solution of sodium carbonate, sodium hydroxide, potassium hydroxide, tetramethyl ammonium hydroxide, choline, 1,8-diazabicyclo-[5.4.0]-7-undecane, or 1,5-diazabicyclo-[4.3.0]-5-nonene is preferred.

The alkaline developer may be also added with a water-soluble organic solvent such as methanol or ethanol, a surfactant, or the like in an appropriate amount. It should be noted that washing is generally performed with water after alkaline development.

As a development treatment method, there may be applied, for example, a shower development method, a spray development method, a dip (immersion) development method, or a paddle (liquid heap) development method. The development condition is preferably at normal temperature for 5 to 300 seconds.

The thus obtained color filter of the present invention has high brightness and a large color reproduction area, and hence is

extremely useful for a color liquid crystal display device, a color image pickup tube element, a color sensor, or the like.

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

Further, as one embodiment of the color liquid crystal display device of the present invention, the radiation-sensitive composition used for forming a coloring layer of the present invention may be used to form a pixel on a thin film transistor substrate array as described above, thereby producing a color liquid crystal display device having particularly high brightness and a large color reproduction area.

Examples

Hereinafter, embodiments of the present invention are described more specifically by way of examples. However, the present invention is not limited to the following examples.

Preparation of pigment dispersion liquid

Preparation Example 1

The pigment dispersion liquid (A-1) was prepared by mixing and dispersing for 12 hours, in a beads mill, 40 parts by mass of a mixture of C.I. Pigment Green 58 and C.I. Pigment Yellow 150 at a ratio of 60/40 (mass ratio) as the colorant (A), 24 parts by mass of Disperbyk-2001 (manufactured by BYK Japan KK, concentration of solid 45.1% by mass) as a dispersant, and 136 parts by mass of propylene

glycol methyl ether acetate as a solvent.

Preparation Example 2

The pigment dispersion liquid (A-2) was prepared by mixing and dispersing for 12 hours, in a beads mill, 40 parts by mass of a mixture of C.I. Pigment Green 58 and C.I. Pigment Yellow 138 at a ratio of 40/60 (mass ratio) as the colorant (A), 24 parts by mass of Disperbyk-2001 (manufactured by BYK Japan KK, concentration of solid 45.1% by mass) as a dispersant, and 136 parts by mass of propylene glycol methyl ether acetate as a solvent.

Preparation Example 3

The pigment dispersion liquid (A-3) was prepared by mixing and dispersing for 12 hours, in a beads mill, 40 parts by mass of a mixture of C.I. Pigment Green 58, C.I. Pigment Green 36, and C.I. Pigment Yellow 150 at a ratio of 19/41/40 (mass ratio) as the colorant (A), 24 parts by mass of Disperbyk-2001 (manufactured by BYK Japan KK, concentration of solid 45.1% by mass) as a dispersant, and 136 parts by mass of propylene glycol methyl ether acetate as a solvent.

Preparation Example 4

The pigment dispersion liquid (A-4) was prepared by mixing and dispersing for 12 hours, in a beads mill, 40 parts by mass of a mixture of C.I. Pigment Green 36 and C.I. Pigment Yellow 150 at a ratio of 55/45 (mass ratio) as the colorant (A), 24 parts by mass of Disperbyk-2001 (manufactured by BYK Japan KK, concentration of solid 45.1% by mass) as a dispersant, and 136 parts by mass of propylene

glycol methyl ether acetate as a solvent.

Synthesis Example 1

Synthesis of alkali-soluble resin (B)

A flask equipped with a cooling condenser and a stirrer is fed with 2.5 parts by mass of 2,2'-azobis(2,4-dimethylvaleronitrile) and 200 parts by mass of ethylene glycol monomethyl ether acetate, and subsequently fed with 15 parts by mass of methacrylic acid, 10 parts by mass of ω -carboxydicaprolactone monoacrylate, 15 parts by mass of N-phenylmaleimide, 33 parts by mass of 2-ethylhexyl methacrylate, 12 parts by mass of styrene, 15 parts by mass of glycerol monomethacrylate, and 5.0 parts by mass of α -methylstyrene dimer (chain transfer agent), followed by purging with nitrogen. The reaction solution was then heated to 80°C while stirring slowly and followed by polymerizing for 3 hours while maintaining the temperature. After that, the reaction solution was heated to 100°C, added with 0.5 part by mass of 2,2'-azobis(2,4-dimethylvaleronitrile), and further continuously polymerization was undergone for 1 hour to afford a resin solution (solid concentration=30% by mass). The obtained resin had $M_w=14,000$ and $M_n=5,700$. The resin solution is taken to be a "resin solution (B-1)".

Example 1

Preparation of liquid composition

400 parts by mass of the pigment dispersion liquid (A-1), 200

parts by mass of the resin solution (B-1) as the alkali-soluble resin (B), 60 parts by mass of dipentaerythritol hexaacrylate as the polyfunctional monomer (C), 6 parts by mass of 2,4-diethylthioxanthone as the radiation-sensitive polymerization initiator (D), 5 parts by mass of ethanone, 1-[9-ethyl-6-(2-methylbenzoyl)-9.H.-carbazol-3-yl]-, 1-(O-acetyloxime) (brand name: IRGACURE OX02 manufactured by Ciba Specialty Chemicals Corp.), 2 parts by mass of 2,2'-bis(2-chlorophenyl)-4,5,4',5'-tetraphenyl-1,2'-biimidazole, and 2 parts by mass of 2-mercaptobenzothiazole, and propylene glycol monomethyl ether acetate as a solvent are used and mixed so as to achieve a solid concentration of 20.0%, to thereby prepare a liquid composition (G1).

The liquid composition (G1) was evaluated in accordance with the following procedure. The evaluation results are shown in Table 2.

Evaluation of aggregation particle and sensitivity

The liquid composition (G1) was applied onto a soda glass substrate, on which SiO_2 film for preventing a sodium ion from being eluted was formed on the surface, by using a spin coater, and then pre-baked on a hot plate at 90°C for 100 seconds to form a coating film having a film thickness of 2.5 μm .

Next, the substrate was cooled to room temperature, and then the coating film was exposed to radiation each having wavelengths

of 365 nm, 405 nm, and 436 nm in an exposure dose of 400 J/m^2 through a photomask (slit width of $90 \text{ }\mu\text{m}$) by using a high-pressure mercury lamp. Then, a shower development was performed by discharging a developer at 30°C including 0.04% by mass of a potassium hydroxide aqueous solution at 23°C onto the substrate for 90 seconds under the condition of a development pressure of 110 kPa and a developer flow of 1.2 L/min. After that, the substrate was washed with ultrapure water, air-dried, and then further post-baked in a clean oven at 220°C for 30 minutes to form a pixel array in which a green stripe-shaped pixel pattern was arranged on the substrate.

The obtained pixel pattern on the substrate was observed with a light microscope, and neither aggregation particle on the pixel pattern nor chipping on a pattern edge was confirmed.

Evaluation for chromaticity

The liquid composition (G1) was applied onto three soda glass substrate, on which SiO_2 film for preventing a sodium ion from being eluted was formed on the surface, with change of revolution speed by using a spin coater, and then pre-baked on a hot plate at 90°C for 4 minutes to form three coating films having different film thicknesses.

Next, those substrates were cooled to room temperature, and then the coating film was exposed to radiation each having wavelengths of 365 nm, 405 nm, and 436 nm in an exposure dose of 400 J/m^2 through a photomask by using a high-pressure mercury lamp. Then, a shower

development was performed by discharging a developer including 0.04% by mass of a potassium hydroxide aqueous solution at 23°C onto those substrates under a development pressure of 1 kgf/cm² (nozzle size of 1 mm). After that, the substrate was washed with ultrapure water, air-dried, and then further post-baked in a clean oven at 220°C for 30 minutes to form a dot pattern of 200 × 200 μm on the substrate.

The obtained dot pattern was measured for a chromaticity coordinate value (x, y) and a tristimulus value (Y) in a CIE colorimetric system with a C light source in two-degree field of view by using a color analyzer (MCPD2000 manufactured by Otsuka Electronics Co., Ltd.). The chromaticity coordinate value (x) and the tristimulus value (Y) at a constant chromaticity coordinate value y were determined from the measurement results. The evaluation results are shown in Table 2. The higher Y value represents higher light transmittance (brightness) was given.

Examples 2 to 6 and Comparative Examples 1 to 8

The liquid compositions (G2) to (G14) were prepared in the same manner as that in Example 1, except that types and amounts of constituent components were changed as shown in Table 2.

Next, evaluations were performed in the same manner as that in Example 1, except that the liquid compositions (G2) to (G14) were each used instead of the liquid composition (G1). The results are shown in Table 2.

Table 1

	Liquid composition	Pigment dispersion liquid				Alkali-soluble resin	Polyfunctional monomer	Photopolymerization initiator									
		A-1 A-2 A-3 A-4						D-1	D-2	D-3	D-4	D-5	D-6	D-7	D-8	D-9	
		A-1	A-2	A-3	A-4												
Example 1	G1	400	-	-	-	200	60	6	-	5	2	2	-	-	-	-	
Example 2	G2	400	-	-	-	200	60	-	6	5	2	2	-	-	-	-	
Example 3	G3	-	400	-	-	200	60	6	-	5	2	2	-	-	-	-	
Example 4	G4	-	-	400	-	200	60	6	-	5	2	2	-	-	-	-	
Example 5	G5	400	-	-	-	200	60	10	-	-	-	-	25	-	-	-	
Example 6	G6	400	-	-	-	200	60	10	-	-	-	-	-	15	-	-	
Comparative Example 1	G7	400	-	-	-	200	60	-	-	5	2	2	-	-	6	-	
Comparative Example 2	G8	400	-	-	-	200	60	-	-	5	2	2	-	-	-	6	
Comparative Example 3	G9	400	-	-	-	200	60	-	-	5	2	2	-	-	-	-	
Comparative Example 4	G10	-	400	-	-	200	60	-	-	5	2	2	-	-	6	-	
Comparative Example 5	G11	-	-	-	400	200	60	6	-	5	2	2	-	-	-	-	
Comparative Example 6	G12	-	-	400	-	200	60	-	-	5	2	2	-	-	6	-	
Comparative Example 7	G13	400	-	-	-	200	60	-	-	-	-	-	25	-	-	-	
Comparative Example 8	G14	400	-	-	-	200	60	-	-	-	-	-	-	15	6	-	

C-1: dipentaerythritol hexaacrylate

D-1: 2,4-diethylthioxanthone

D-2: a mixture of 2-isopropylthioxanthone and 4-isopropylthioxanthone (trade name: DAROCURE IDX, manufactured by Ciba Specialty Chemicals Inc.)

D-3: ethanone, 1-[9-ethyl-6-(2-methylbenzoyl)-9H-carbazol-3-yl]-, 1-(O-acetyl oxime) (trade name: IRGACURE OX02, manufactured by Ciba Specialty Chemicals Inc.)

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

D-5: 2-mercaptobenzothiazole

D-6: 2-benzyl-2-dimethylamino-1-(4-morpholinophenyl)butane-1-one (trade name: IRGACURE 369, manufactured by Ciba Specialty Chemicals Inc.)

D-7: benzophenone

D-8: 2,4-diethylaminobenzophenone

D-9: 2,4-dimethylaminobenzophenone

Table 2

	Liquid compo- sition	Aggrega- tion particle	Pattern chipping	Chromatic- ity X	Chromatic- ity Y	Y value
Example 1	G1	Absent	Absent	0.292	0.600	57.8
Example 2	G2	Absent	Absent	0.292	0.600	57.5
Example 3	G3	Absent	Absent	0.332	0.540	74.0
Example 4	G4	Absent	Absent	0.292	0.600	55.6
Example 5	G5	Absent	Absent	0.292	0.600	57.7
Example 6	G6	Absent	Present	0.292	0.600	57.6
Comparative Example 1	G7	Present	Absent	0.292	0.600	57.6
Comparative Example 2	G8	Present	Absent	0.292	0.600	57.5
Comparative Example 3	G9	Absent	Present	0.292	0.600	57.9
Comparative Example 4	G10	Present	Absent	0.332	0.540	74.2
Comparative Example 5	G11	Absent	Absent	0.292	0.600	54.6
Comparative Example 6	G12	Present	Absent	0.292	0.600	55.8
Comparative Example 7	G13	Absent	Present	0.292	0.600	57.6
Comparative Example 8	G14	Present	Present	0.292	0.600	57.5

As shown in Tables 1 and 2, when C.I. Pigment Green 58 was used as the colorant and the thioxanthone-based compound was used as the polymerization initiator, Y value of light transmittance, which was an index of brightness, was high, no aggregation particle occurred on a pixel, and no chipping was confirmed in a pattern.

WHAT IS CLAIMED IS:

1. A radiation-sensitive composition used for forming a green pixel, comprising:

a colorant (A);

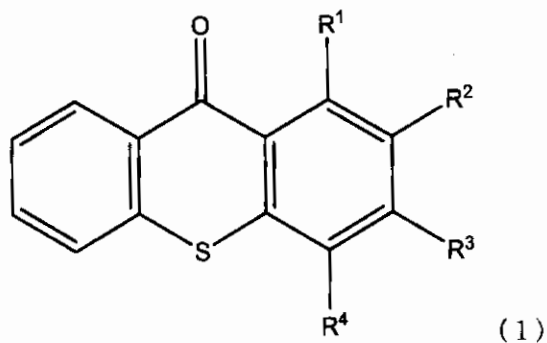
an alkali-soluble resin (B);

a polyfunctional monomer (C); and

a radiation-sensitive polymerization initiator (D), wherein:

the colorant (A) comprises C.I. Pigment Green 58; and

the radiation-sensitive polymerization initiator (D) comprises a compound represented by the following formula (1):



where R^1 to R^4 each independently represent a hydrogen atom, an alkyl group having 1 to 18 carbon atoms, or an alkoxy group having 1 to 18 carbon atoms.

2. The radiation-sensitive composition according to claim 1, wherein the radiation-sensitive polymerization initiator (D) further comprises at least one kind of a compound selected from the group consisting of an acetophenone compound, a biimidazole compound, and an O-acyloxime compound.

3. A color filter comprising a pixel which is formed by using the radiation-sensitive composition according to claim 1 or 2.

4. A color liquid crystal display device comprising the color filter according to claim 3.