

RADIATION SENSITIVE COMPOSITION FOR REPAIRING A COLOR FILTER
DEFECT AND METHOD OF REPAIRING A COLOR FILTER DEFECT

Field of the Invention

5 The present invention relates to a radiation sensitive resin composition used to repair a defect in a color filter for use in transmission and reflection color liquid crystal displays and color image pick-up devices and a method of repairing a color filter defect.

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Description of the Prior Art

 As means of forming a color filter for use in color liquid crystal displays and color image pick-up devices, lithography for forming a colored layer having a
15 predetermined pattern on a substrate by applying a colored radiation sensitive resin composition, exposing it to radiation and developing it has been widely employed. However, this technique has a problem such as a colorless or low color density defect in the colored layer due to an
20 exposure failure caused by the adhesion of foreign matter to a mask or substrate during the above treatment or the adhesion of foreign matter to the colored layer from a nozzle when the colored radiation sensitive resin composition is applied, thereby reducing the production yield. It is
25 practically impossible to eliminate the above problem completely even when a measure for preventing it is taken. Therefore, in order to improve the production yield, a defective colored layer must be repaired.

 As means of repairing the above defect, there are
30 proposed various methods according to the type of the defect. As a typical example, JP-A 2002-258025 (the term "JP-A" as used herein means an "unexamined published Japanese patent application") discloses a method in which a colored layer at a defective site is burnt off by the application of a laser

beam and a repair liquid is filled into the formed hole and cured. However, when a colored radiation sensitive resin composition for color filters of the prior art is used in the repair liquid, the repair liquid wet spreads over a portion around the hole and cannot be filled only into the hole with the result that the performance of the repaired portion may become unsatisfactory or a new problem may occur in the wet spread portion around the hole.

10 Summary of the Invention

It is an object of the present invention to provide a radiation sensitive resin composition for repairing a color filter defect, which fully wet spreads only into a hole formed by removing a color filter defect when it is filled into the hole and can repair the defect with a small difference in chromaticity between the repaired portion and a normal portion, and a method of repairing a color filter defect.

The inventors of the present invention have conducted intensive studies on the above problem which is encountered when a color filter defect is repaired and have found that the ratio of the alkali-soluble resin component to the polyfunctional monomer component, the average vapor pressure of the solvent and the solid content of a radiation sensitive resin composition used to repair the defect are closely connected with reparability and performance after repair. The present invention has been accomplished based on this finding.

According to the present invention, firstly, the above object can be attained by a radiation sensitive resin composition which comprises (A) a pigment, (B) an alkali-soluble resin, (C) a polyfunctional monomer or a combination of a polyfunctional monomer and a monofunctional monomer, (D) a photoinitiator and (E) a solvent, wherein the amount of the component (C) is 350 to 1,000 parts

by weight based on 100 parts by weight of the component (B), the average vapor pressure at 20°C of the component (E) is lower than 3.0 mmHg, and the composition has a solid content of 25 to 50 wt% and is used to repair a color filter defect.

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

According to the present invention, secondly, the above object is attained by a method of repairing a color
10 filter defect, comprising the following steps in this order:

- (1) removing a color filter defect, filling the above radiation sensitive resin composition for repairing a color filter defect into the formed hole, and removing the solvent;
- 15 (2) exposing the filled portion to radiation; and
- (3) heating the filled portion after exposure.

The present invention will be described in detail hereinafter.

20 Radiation sensitive resin composition for repairing a color filter defect

- (A) pigment -

An organic pigment, inorganic pigment, dye or natural coloring matter has been used as a colorant in a colored
25 radiation sensitive resin composition for use in color filters. Out of these, a pigment is preferred and an organic pigment is particularly preferred from the viewpoints of color characteristics and heat resistance. An organic pigment is particularly preferred as the pigment in the
30 radiation sensitive resin composition for repairing a color filter defect of the present invention because a portion where a defect has been repaired (to be referred to as "repaired portion" hereinafter) needs the same color characteristics and heat resistance as a normal portion.

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

- C.I. Pigment Yellow 12, C.I. Pigment Yellow 13, C.I. Pigment Yellow 14, C.I. Pigment Yellow 17, C.I. Pigment Yellow 20, C.I. Pigment Yellow 24, C.I. Pigment Yellow 31, C.I. Pigment Yellow 55, C.I. Pigment Yellow 83, C.I. Pigment Yellow 93,
 10 C.I. Pigment Yellow 109, C.I. Pigment Yellow 110, C.I. Pigment Yellow 138, C.I. Pigment Yellow 139, C.I. Pigment Yellow 150, C.I. Pigment Yellow 153, C.I. Pigment Yellow 154, C.I. Pigment Yellow 155, C.I. Pigment Yellow 166, C.I. Pigment Yellow 168 and C.I. Pigment Yellow 211;
- 15 C.I. Pigment Orange 36, C.I. Pigment Orange 43, C.I. Pigment Orange 51, C.I. Pigment Orange 61 and C.I. Pigment Orange 71;
- C.I. Pigment Red 9, C.I. Pigment Red 97, C.I. Pigment Red 122, C.I. Pigment Red 123, C.I. Pigment Red 149, C.I. Pigment
 20 Red 168, C.I. Pigment Red 176, C.I. Pigment Red 177, C.I. Pigment Red 180, C.I. Pigment Red 207, C.I. Pigment Red 208, C.I. Pigment Red 209, C.I. Pigment Red 215, C.I. Pigment Red 224, C.I. Pigment Red 242 and C.I. Pigment Red 254;
- C.I. Pigment Violet 19, C.I. Pigment Violet 23 and C.I.
 25 Pigment Violet 29;
- C.I. Pigment Blue 15, C.I. Pigment Blue 60, C.I. Pigment Blue 15:3, C.I. Pigment Blue 15:4 and C.I. Pigment Blue 15:6;
 C.I. Pigment Green 7, C.I. Pigment Green 36, C.I. Pigment Green 136 and C.I. Pigment Green 210; and
 30 C.I. Pigment Brown 23 and C.I. Pigment Brown 25.

These organic pigments may be used alone or in combination of two or more. Optionally, it may be used in combination with an inorganic pigment which is listed below.

In the present invention, the organic pigment may be

purified by re-crystallization, re-precipitation, solvent cleaning, sublimation, vacuum heating or a combination thereof before use.

5 Examples of the inorganic pigment include titanium oxide, barium sulfate, calcium carbonate, zinc white, lead sulfate, yellow lead, zinc yellow, red iron oxide (red iron oxide (III)), cadmium red, ultramarine, Prussian blue, chromium oxide green, cobalt green, amber, titanium black, synthetic iron black and carbon black.

10 These inorganic pigments may be used alone or in combination of two or more.

 Further, in the present invention, the above pigment may be optionally used in combination with at least one dye or natural coloring matter.

15 In the present invention, the pigment particle may have optionally surface modified by a polymer before use. The polymer for modifying the surface of the pigment particle is, for example, a polymer disclosed by JP-A 8-259876, or a commercially available polymer or oligomer for dispersing
20 a pigment.

 In the present invention, a pigment having the same chromaticity and heat resistance as the pigment which has been used in a defective portion to be repaired is preferably selected, and the same type of pigment as the pigment used
25 in the defective portion is desirably used in the same ratio.

 In the present invention, the pigment may be optionally used in combination with a dispersant.

 The dispersant is a cationic, anionic, nonionic, amphoteric, silicone-based or fluorine-based surfactant.

30 Examples of the surfactant include polyoxyethylene alkyl ethers such as polyoxyethylene lauryl ether, polyoxyethylene stearyl ether and polyoxyethylene oleyl ether; polyoxyethylene alkylphenyl ethers such as polyoxyethylene n-octylphenyl ether and polyoxyethylene

n-nonylphenyl ether; polyethylene glycol diesters such as polyethylene glycol dilaurate and polyethylene glycol distearate; sorbitan fatty acid esters; fatty acid modified polyesters; tertiary amine modified polyurethanes; and
5 polyethylene imines. These surfactants are available on the market under the trade names of KP (of Shin-Etsu Chemical, Co., Ltd.), Polyflow (of Kyoeisha Yushi Kagaku Co., Ltd.), F Top (of Tokem Products Co., Ltd.), Megafac (of Dainippon Ink and Chemicals, Inc.), Florade (of Sumitomo 3M Limited),
10 Asahi Guard and Surflon (of Asahi Glass Co., Ltd.), Disperbyk (of Byk Chemie Japan Co., Ltd.), and Solsperse (of Zeneca Co., Ltd.).

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

15 The amount of the dispersant is preferably 50 parts or less by weight, more preferably 30 parts or less by weight based on 100 parts by weight of the pigment.

- (B) alkali-soluble resin -

20 The alkali-soluble resin in the present invention has an acid functional group such as a carboxyl group or phenolic hydroxyl group, is soluble in an alkaline aqueous solution and preferably serves as a binder for the pigment (A).

The alkali-soluble resin in the present invention is
25 preferably a carboxyl group-containing resin, particularly preferably a copolymer (to be referred to as "carboxyl group-containing copolymer" hereinafter) of an ethylenically unsaturated monomer having at least one carboxyl group (to be referred to as "carboxyl
30 group-containing unsaturated monomer" hereinafter) and another copolymerizable ethylenically unsaturated monomer (to be referred to as "copolymerizable unsaturated monomer" hereinafter).

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; unsaturated polycarboxylic acids having three or more carboxyl groups and anhydrides thereof; mono[(meth)acryloyloxyalkyl]esters of a polycarboxylic acid having two or more carboxyl groups such as mono[2-(meth)acryloyloxyethyl]succinate and mono[2-(meth)acryloyloxyethyl]phthalate; and mono(meth)acrylates of a polymer having a carboxyl group and a hydroxyl group at both terminals such as ω -carboxypolycaprolactone mono(meth)acrylate.

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

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

Examples of the copolymerizable unsaturated monomer include aromatic vinyl compounds such as styrene, α -methylstyrene, o-vinyltoluene, m-vinyltoluene, p-vinyltoluene, p-chlorostyrene, o-methoxystyrene, m-methoxystyrene, p-methoxystyrene, o-vinylbenzylmethyl ether, m-vinylbenzylmethyl ether, p-vinylbenzylmethyl ether, o-vinylbenzylglycidyl ether, m-vinylbenzylglycidyl ether and p-vinylbenzylglycidyl ether; indenenes such as indene and 1-methylindene; unsaturated carboxylates such as methyl (meth)acrylate, ethyl (meth)acrylate, n-propyl (meth)acrylate, i-propyl (meth)acrylate, n-butyl (meth)acrylate, i-butyl (meth)acrylate, sec-butyl (meth)acrylate, t-butyl (meth)acrylate, 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, 5 benzyl (meth)acrylate, cyclohexyl (meth)acrylate, phenyl (meth)acrylate, 2-methoxyethyl (meth)acrylate, 2-phenoxyethyl (meth)acrylate, methoxydiethylene glycol (meth)acrylate, methoxytriethylene glycol (meth)acrylate, methoxypropylene glycol (meth)acrylate, methoxydipropylene 10 glycol (meth)acrylate, isobornyl (meth)acrylate, tricyclo[5.2.1.0^{2,5}]decan-8-yl (meth)acrylate, 2-hydroxy-3-phenoxypropyl (meth)acrylate and glycerol mono(meth)acrylate; unsaturated aminoalkyl carboxylates such as 2-aminoethyl (meth)acrylate, 2-dimethylaminoethyl 15 (meth)acrylate, 2-aminopropyl (meth)acrylate, 2-dimethylaminopropyl (meth)acrylate, 3-aminopropyl (meth)acrylate and 3-dimethylaminopropyl (meth)acrylate; unsaturated glycidyl carboxylates such as glycidyl (meth)acrylate; vinyl carboxylates such as vinyl acetate, 20 vinyl propionate, vinyl butyrate and vinyl benzoate; unsaturated ethers such as vinyl methyl ether, vinyl ethyl ether and allyl glycidyl ether; vinyl cyanide compounds such as (meth)acrylonitrile, α -chloroacrylonitrile and vinylidene cyanide; unsaturated amides such as 25 (meth)acrylamide, α -chloroacrylamide and N-2-hydroxyethyl (meth)acrylamide; unsaturated imides such as maleimide, N-phenylmaleimide and N-cyclohexylmaleimide; aliphatic conjugated dienes such as 1,3-butadiene, isoprene and chloroprene; and macromonomers having a mono(meth)acryloyl 30 group at a terminal of a polymer molecular chain such as polystyrene, polymethyl (meth)acrylate, poly-n-butyl (meth)acrylate and polysiloxane.

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

The carboxyl group-containing copolymer in the present invention is preferably a copolymer of (a) a carboxyl group-containing unsaturated monomer component comprising (meth)acrylic acid as an essential component and optionally
 5 at least one compound selected from the group consisting of mono[2-(meth)acryloyloxyethyl]succinate and ω -carboxypolycaprolactone mono(meth)acrylate and (b) at least one selected from the group consisting of styrene, methyl (meth)acrylate, 2-hydroxyethyl (meth)acrylate,
 10 allyl (meth)acrylate, benzyl (meth)acrylate, glycerol mono(meth)acrylate, N-phenylmaleimide, polystyrene macromonomer and polymethyl methacrylate macromonomer (to be referred to as "carboxyl group-containing copolymer (A1)" hereinafter).

15 Illustrative examples of the carboxyl group-containing copolymer (A1) include a copolymer of (meth)acrylic acid and methyl (meth)acrylate, copolymer of (meth)acrylic acid and benzyl (meth)acrylate, copolymer of (meth)acrylic acid, 2-hydroxyethyl (meth)acrylate and
 20 benzyl (meth)acrylate, copolymer of (meth)acrylic acid, methyl (meth)acrylate and polystyrene macromonomer, copolymer of (meth)acrylic acid, methyl (meth)acrylate and polymethyl methacrylate macromonomer, copolymer of (meth)acrylic acid, benzyl (meth)acrylate and polystyrene
 25 macromonomer, copolymer of (meth)acrylic acid, benzyl (meth)acrylate and polymethyl methacrylate macromonomer, copolymer of (meth)acrylic acid, 2-hydroxyethyl (meth)acrylate, benzyl (meth)acrylate and polystyrene macromonomer, copolymer of (meth)acrylic acid,
 30 2-hydroxyethyl (meth)acrylate, benzyl methacrylate and polymethyl methacrylate macromonomer, copolymer of (meth)acrylic acid, styrene, benzyl (meth)acrylate and N-phenylmaleimide, copolymer of (meth)acrylic acid, mono[2-(meth)acryloyloxyethyl]succinate, styrene, benzyl

(meth)acrylate and N-phenylmaleimide, copolymer of (meth)acrylic acid, mono[2-(meth)acryloyloxyethyl]succinate, styrene, allyl (meth)acrylate and N-phenylmaleimide, copolymer of (meth)acrylic acid, styrene, benzyl (meth)acrylate, glycerol mono(meth)acrylate and N-phenylmaleimide, and copolymer of (meth)acrylic acid, ω -carboxypolycaprolactone mono(meth)acrylate, styrene, benzyl (meth)acrylate, glycerol mono(meth)acrylate and N-phenylmaleimide.

10 In the present invention, the content of the carboxyl group-containing unsaturated monomer in the carboxyl group-containing copolymer is preferably 5 to 50 wt%, more preferably 10 to 40 wt%. When the above content is lower than 5 wt%, the storage stability of the obtained radiation
15 sensitive resin composition may lower and when the content is higher than 50 wt%, the radiation sensitive resin composition may gel during polymerization.

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

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

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

 In the present invention, by using this alkali-soluble resin having specific Mw and Mn, the dispersibility of the pigment becomes high, thereby making it possible to obtain the composition having excellent storage stability of the

present invention.

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

The amount of the alkali-soluble resin in the present invention is preferably 10 to 1,000 parts by weight, more preferably 20 to 500 parts by weight based on 100 parts by weight of the pigment (A). When the amount of the alkali-soluble resin is smaller than 10 parts by weight, the pigment may settle while it is stored due to the unstable dispersibility of the pigment. When the amount is larger than 1,000 parts by weight, the viscosity of the composition may become too high, whereby the liquid may be hardly removed from the needle of an apparatus or device used for repair.

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

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

20 Examples of the polyfunctional monomer include di(meth)acrylates of an alkylene glycol such as ethylene glycol and propylene glycol; di(meth)acrylates of a polyalkylene glycol such as polyethylene glycol having two or more ethyleneoxy groups and polypropylene glycol having two or more propyleneoxy groups; poly(meth)acrylates of a polyhydric alcohol having 3 or more hydroxyl groups and dicarboxylic acid modified products thereof such as glycerin, trimethylolpropane, pentaerythritol and dipentaerythritol; oligo(meth)acrylates such as polyester, epoxy resin, 25 urethane resin, alkyd resin, silicone resin and spiran resin; di(meth)acrylates of a polymer having a hydroxyl group at both terminals of its molecular chain such as poly-1,3-butadiene having a hydroxyl group at both terminals, polyisoprene having a hydroxyl group at both terminals and

polycaprolactone having a hydroxyl group at both terminals;
and tris[2-(meth)acryloyloxyethyl]phosphate.

Out of these polyfunctional monomers,
poly(meth)acrylates of a polyhydric alcohol having 3 or more
5 hydroxyl groups and dicarboxylic acid modified products
thereof are preferred, as exemplified by trimethylolpropane
tri(meth)acrylate, pentaerythritol tri(meth)acrylate,
pentaerythritol tetra(meth)acrylate, dipentaerythritol
penta(meth)acrylate and dipentaerythritol
10 hexa(meth)acrylate. Trimethylolpropane triacrylate,
pentaerythritol triacrylate and dipentaerythritol
hexaacrylate are particularly preferred because they are
polymerized and cured swiftly upon exposure to radiation to
become non-fluidized.

15 The above functional monomers may be used alone or in
combination of two or more.

The amount of the polyfunctional monomer in the present
invention is preferably 350 to 1,000 parts by weight, more
preferably 350 to 700 parts by weight based on 100 parts by
20 weight of the alkali-soluble resin (B). When the amount of
the polyfunctional monomer is smaller than 350 parts by
weight, curing by exposure may become unsatisfactory and the
repaired portion may be thereby fluidized after curing. When
the amount is larger than 1,000 parts by weight, the viscosity
25 of the obtained composition becomes too low, whereby the
composition may hardly adhere to the needle of the apparatus
or device used for repair when it is to be filled into the
hole.

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

Examples of the above monofunctional monomer include
carboxyl group-containing unsaturated monomers and
copolymerizable unsaturated monomers enumerated for the

above carboxyl group-containing copolymer,
N-(meth)acryloylmorpholine, N-vinylpyrrolidone,
N-vinyl-ε-caprolactam and commercially available M-5300,
M-5400 and M-5600 (of Toagosei Chemical Industry Co., Ltd.).

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

 The amount of the monofunctional monomer is preferably
90 wt% or less, more preferably 50 wt% or less based on the
total of the polyfunctional monomer and the monofunctional
10 monomer. When the amount of the monofunctional monomer is
larger than 90 wt%, the strength and surface smoothness of
the repaired portion may become unsatisfactory.

 The total amount of the polyfunctional monomer and the
monofunctional monomer in the present invention is 350 to
15 1,000 parts by weight, preferably 350 to 700 parts by weight
based on 100 parts by weight of the alkali-soluble resin (B).
When the above total amount is smaller than 350 parts by weight,
the strength and surface smoothness of the repaired portion
may lower and when the total amount is larger than 1,000 parts
20 by weight, the viscosity of the obtained composition becomes
too low, whereby the composition may hardly adhere to the
needle of the apparatus or device used for repair when it
is to be filled into the hole.

25 - (D) photoinitiator -

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

 Examples of the photoinitiator include an
acetophenone-based compound, biimidazole-based compound,

triazine-based compound, benzoin-based compound, benzophenone-based compound, α -diketone-based compound, polynuclear quinone-based compound, xanthone-based compound and diazo-based compound.

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

 The amount of the photoinitiator in the present invention is preferably 0.01 to 80 parts by weight, more preferably 1 to 60 parts by weight based on 100 parts by weight of the component (C). When the amount of the photoinitiator
15 is smaller than 0.01 part by weight, the repaired portion may be fluidized after curing due to incomplete curing by exposure. When the amount is larger than 80 parts by weight, the optical radical generator hardly dissolves in the composition, whereby the characteristic properties of the
20 repaired portion as a color filter may be impaired.

 Examples of the acetophenone-based compound out of the preferred photoinitiators in the present invention include 2-hydroxy-2-methyl-1-phenylpropanone-1,
2-methyl-1-(4-methylthiophenyl)-2-morpholinopropanone-1,
25 2-benzyl-2-dimethylamino-1-(4-morpholinophenyl)butanone-1, 1-hydroxycyclohexyl phenyl ketone and
2,2-dimethoxy-1,2-diphenylethanone-1.

 Out of these acetophenone-based compounds,
2-methyl-1-(4-methylthiophenyl)-2-morpholinopropanone-1
30 and
2-benzyl-2-dimethylamino-1-(4-morpholinophenyl)butanone-1 are particularly preferred.

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

When the acetophenone-based compound is used as the photoinitiator in the present invention, the amount of the acetophenone-based compound is preferably 0.01 to 80 parts by weight, more preferably 1 to 60 parts by weight, particularly preferably 1 to 30 parts by weight based on 100 parts by weight of the component (C). When the amount of the acetophenone-based compound is smaller than 0.01 part by weight, the repaired portion may be fluidized after curing due to incomplete curing by exposure. When the amount is larger than 80 parts by weight, the acetophenone-based compound hardly dissolves in the composition, whereby the characteristic properties of the repaired portion as a color filter may be impaired.

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

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

biimidazole and

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

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

The above biimidazole-based compounds have excellent solubility in a solvent, do not produce foreign matter such as an undissolved product and precipitate, have high sensitivity, can fully promote a curing reaction by exposure
10 with a small amount of energy and can effectively prevent the fluidization of the repaired portion after curing.

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

When the biimidazole-based compound is used as the
15 photoinitiator in the present invention, the amount of the biimidazole-based compound is preferably 0.01 to 40 parts by weight, more preferably 1 to 30 parts by weight, particularly preferably 1 to 20 parts by weight based on 100 parts by weight of the component (C). When the amount of
20 the biimidazole-based compound is smaller than 0.01 part by weight, the repaired portion may be fluidized after curing due to incomplete curing by exposure. When the amount is larger than 40 parts by weight, the biimidazole-based compound hardly dissolves in the composition and the
25 characteristic properties of the repaired portion as a color filter may be impaired.

- hydrogen donor -

When the biimidazole-based compound is used as the
30 photoinitiator in the present invention, it is preferably used in combination with the following hydrogen donor to further improve sensitivity. The term "hydrogen donor" as used herein means a compound which can provide a hydrogen atom to a radical formed from the biimidazole-based compound

through exposure.

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

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

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

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

 A detailed description is subsequently given of these hydrogen donors.

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

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

 Further, the mercaptan-based hydrogen donor may be

substituted by a carboxyl group, alkoxycarbonyl group, substituted alkoxycarbonyl group, phenoxycarbonyl group, substituted phenoxycarbonyl group or nitrile group at a position other than the mercapto group(s).

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

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

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

 At least one amino group of the amine-based hydrogen donor may be substituted by an alkyl group or substituted
20 alkyl group. The amine-based hydrogen donor may be substituted by a carboxyl group, alkoxycarbonyl group, substituted alkoxycarbonyl group, phenoxycarbonyl group, substituted phenoxycarbonyl group or nitrile group at a position other than the amino group(s).

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

 Out 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 when a photoinitiator other than a biimidazole-based compound is used.

5 In the present invention, the above hydrogen donors may be used alone or in combination of two or more. A combination of at least one mercaptan-based hydrogen donor and at least one amine-based hydrogen donor is preferably used to prevent fluidization by curing by exposure.

10 Examples of the combination of the mercaptan-based hydrogen donor and the amine-based hydrogen donor include a combination of 2-mercaptobenzothiazole and 4,4'-bis(dimethylamino)benzophenone, combination of 2-mercaptobenzothiazole and
15 4,4'-bis(diethylamino)benzophenone, combination of 2-mercaptobenzooxazole and 4,4'-bis(dimethylamino)benzophenone, and combination of 2-mercaptobenzooxazole and 4,4'-bis(diethylamino)benzophenone. A combination of
20 2-mercaptobenzothiazole and 4,4'-bis(diethylamino)benzophenone and a combination of 2-mercaptobenzooxazole and 4,4'-bis(diethylamino)benzophenone are preferred, and a combination of 2-mercaptobenzothiazole and
25 4,4'-bis(diethylamino)benzophenone is particularly preferred.

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

When the hydrogen donor is used in combination with the biimidazole-based compound in the present invention, the amount of the hydrogen donor is preferably 0.01 to 40 parts by weight, more preferably 1 to 30 parts by weight,

particularly preferably 1 to 20 parts by weight based on 100 parts by weight of the component (C). When the amount of the hydrogen donor is smaller than 0.01 part by weight, its effect of improving sensitivity may lower. When the amount is larger than 40 parts by weight, the hydrogen donor may hardly dissolve in the composition and the characteristic properties of the repaired portion as a color filter may be impaired.

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

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

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

When the triazine-based compound is used as the photoinitiator in the present invention, the amount of the triazine-based compound is preferably 0.01 to 40 parts by weight, more preferably 1 to 30 parts by weight, particularly preferably 1 to 20 parts by weight based on 100 parts by weight

of the component (C). When the amount of the triazine-based compound is smaller than 0.01 part by weight, the repaired portion may be fluidized after curing due to incomplete curing by exposure. When the amount is larger than 40 parts
 5 by weight, the triazine-based compound may hardly dissolve in the composition and the characteristic properties of the repaired portion as a color filter may be impaired.

- additives -

10 Various additives may be added to the radiation sensitive resin composition for repairing a color filter defect of the present invention as required.

The above additives include a dispersion aid such as a blue pigment derivative or yellow pigment derivative, i.e.,
 15 a copper phthalocyanine derivative; filler such as glass or alumina; polymer compound such as polyvinyl alcohol, polyethylene glycol monoalkyl ether or poly(fluoroalkylacrylate); nonionic, cationic or anionic surfactant; adhesion accelerator such as vinyl
 20 trimethoxysilane, vinyl triethoxysilane, vinyl tris(2-methoxyethoxy)silane, N-(2-aminoethyl)-3-aminopropyl·methyl·dimethoxysilane, N-(2-aminoethyl)-3-aminopropyltrimethoxysilane, 3-aminopropyltriethoxysilane,
 25 3-glycidoxypropyltrimethoxysilane, 3-glycidoxypropyl·methyl·dimethoxysilane, 2-(3,4-epoxycyclohexyl)ethyltrimethoxysilane, 3-chloropropyl·methyl·dimethoxysilane, 3-chloropropyltrimethoxysilane,
 30 3-methacryloyloxypropyltrimethoxysilane or 3-mercaptopropyltrimethoxysilane; antioxidant such as 2,2-thiobis(4-methyl-6-t-butylphenol) or 2,6-di-t-butylphenol; ultraviolet light absorber such as 2-(3-t-butyl-5-methyl-2-hydroxyphenyl)-5-

chlorobenzotriazole or alkoxybenzophenone; cohesion inhibitor such as sodium polyacrylate; and heat radical generator such as 1,1'-azobis(cyclohexane-1-carbonitrile) or 2-phenylazo-4-methoxy-2,4-dimethylvaleronitrile.

5

- (E) solvent -

Preferably, the solvent in the present invention disperses or dissolves the components (A) to (D) constituting the radiation sensitive resin composition and additives and
10 does not react with these.

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,
15 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
20 monoethyl ether, propylene glycol mono-n-propyl ether, propylene glycol mono-n-butyl ether, dipropylene glycol monomethyl ether, dipropylene glycol monoethyl ether, dipropylene glycol mono-n-propyl ether, dipropylene glycol mono-n-butyl ether, tripropylene glycol monomethyl ether and
25 tripropylene glycol monoethyl ether; (poly)alkylene glycol monoalkyl ether acetates such as ethylene glycol monomethyl ether acetate, ethylene glycol monoethyl ether acetate, ethylene glycol mono-n-propyl ether acetate, ethylene glycol mono-n-butyl ether acetate, diethylene glycol monomethyl
30 ether acetate, diethylene glycol monoethyl ether acetate, propylene glycol monomethyl ether acetate and propylene glycol monoethyl ether acetate; other ethers such as diethylene glycol dimethyl ether, diethylene glycol methyl ethyl ether, diethylene glycol diethyl ether,

tetrahydrofuran, benzyl ethyl ether and di-n-hexyl ether; ketones such as methyl ethyl ketone, 2-heptanone, 3-heptanone and cyclohexanone; alkyl lactates such as methyl lactate and ethyl lactate; other esters such as ethyl

5 2-hydroxy-2-methylpropionate, methyl 3-methoxypropionate, ethyl 3-methoxypropionate, methyl 3-ethoxypropionate, ethyl 3-ethoxypropionate, ethyl ethoxyacetate, ethyl hydroxyacetate, methyl 2-hydroxy-3-methylbutanoate, 3-methoxybutyl acetate, 3-methyl-3-methoxybutylacetate,

10 3-methyl-3-methoxybutylpropionate, ethyl acetate, n-propyl acetate, i-propyl acetate, n-butyl acetate, i-butyl acetate, n-amyl formate, i-amyl acetate, n-butyl propionate, ethyl butyrate, n-propyl butyrate, i-propyl butyrate, n-butyl butyrate, methyl pyruvate, ethyl pyruvate, n-propyl pyruvate,

15 methyl acetoacetate, ethyl acetoacetate, ethyl 2-oxobutanoate, benzyl acetate, ethyl benzoate, diethyl oxalate and diethyl maleate; aromatic hydrocarbons such as toluene and xylene; amides such as N-methylpyrrolidone, N,N-dimethylformamide and N,N-dimethylacetamide; and

20 acetonylacetone, isophorone, caproic acid, caprylic acid, 1-octanol, 1-nonanol, benzyl alcohol, diacetone alcohol, 3-methoxy-3-methyl-1-butanol, γ -butyrolactone, ethylene carbonate, propylene carbonate, ethylene glycol monophenyl ether acetate and 3-methoxy-3-methyl-1-butanol.

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

It was found from studies conducted by the inventors of the present invention that when the radiation sensitive resin composition to be filled into the hole formed by

30 removing a defective portion becomes dry too fast, it is not suitable for repair because it is dried and solidified before the needle of the apparatus or device used for repair reaches the portion to be filled. Therefore, the average vapor pressure at 20° C of the solvent used in the radiation

sensitive resin composition for repairing a color filter defect of the present invention (to be simply referred to as "average vapor pressure" hereinafter) must be lower than 3.0 mmHg. The average vapor pressure is preferably 0.1 or
5 higher and lower than 3.0 mmHg, more preferably 1.0 or higher and lower than 3.0 mmHg.

To set the average vapor pressure of the solvent to a value smaller than 3.0 mmHg in the present invention, at least one selected from the group consisting of ethylene
10 glycol mono-n-butyl ether acetate, diethylene glycol methyl ethyl ether, ethyl 3-ethoxypropionate, N-methylpyrrolidone, diacetone alcohol, 3-methoxy-3-methyl-1-butanol and γ -butyrolactone, preferably at least one selected from the group consisting of ethylene glycol monobutyl ether acetate,
15 diethylene glycol methyl ethyl ether and ethyl 3-ethoxypropionate is desirably used as a solvent. These solvents do not have a bad influence upon the dispersibility of the pigment. In the present invention, one of the above solvents may be optionally used in combination with another
20 solvent listed above.

The amount of the solvent in the present invention is a value which ensures that the solid content of the radiation sensitive resin composition is preferably 25 to 50 wt%, more preferably 25 to 35 wt% to minimize a difference in
25 chromaticity between the repaired portion and a normal portion and from the viewpoints of the fluidity and stability of the composition. The solid content of the radiation sensitive resin composition is a value calculated from (total weight of components other than solvent)/(total weight of
30 composition) x 100.

Method of repairing a color filter defect

A color filter is composed of a colored layer comprising three red, green and blue primary color pixel arrays formed

on a substrate. Therefore, the expression "a color filter defect" as used herein means a defect in the colored layer comprising three red, green and blue primary color pixel arrays.

5 The method of repairing a color filter defect of the present invention comprises the following steps in this order:

- (1) removing a color filter defect, filling the radiation sensitive resin composition for repairing a color
10 filter defect of the present invention (to be also referred to as "liquid resin composition" hereinafter) into the formed hole, and removing the solvent;
- (2) exposing the filled portion to radiation; and
- (3) heating the filled portion after exposure.

15 A detailed description is subsequently given of each step.

 In the first step (1), a defective portion of the colored layer comprising three red, green and blue primary color pixel arrays formed on the substrate is burnt off by
20 applying a laser beam, for example, to be removed. A hole devoid of the colored layer is formed in the removed portion and the surface of the underlying substrate is exposed therefrom.

 Thereafter, the liquid resin composition is applied
25 to the needle of an apparatus or device having a thin needle to be filled into the formed hole. This filling operation may be carried out several times until a required amount of the liquid resin composition is filled into the hole. Another means of filling the liquid resin composition into
30 the hole is extrusion with a dispenser or dripping by an ink jet system.

 Subsequently, the filled liquid resin composition is prebaked to vaporize the solvent so as to form a layer of the radiation sensitive resin composition (to be also

referred to as "resin composition" hereinafter) containing no solvent in the hole.

As for the prebaking conditions, the resin composition is prebaked at 70 to 110°C for 1 to 5 minutes.

5 As for the thickness of the layer of the resin composition, the thickness of the repaired portion is preferably the same or almost the same as the thickness of the colored layer of the normal portion, and filling and prebaking may be repeated as required.

10 The substrate of the color filter to be repaired by the method of repairing a color filter defect of the present invention is made of glass, silicon, polycarbonate, polyester, aromatic polyamide, polyamide-imide, polyimide, polyether sulfone, ring open polymer of a cyclic olefin or
15 hydrogenated product thereof.

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

20 In the subsequent step (2), the resin composition layer in the hole is exposed to radiation to be polymerized and cured.

The radiation used for exposure may be visible radiation, ultraviolet radiation, far ultraviolet radiation,
25 electron radiation or X-radiation. The radiation preferably has a wavelength of 190 to 450 nm.

The dose of radiation is preferably about 10 to 10,000 J/m².

In the following step (3), the exposed filled portion
30 is heated (to be referred to as "post-baked" hereinafter) to completely polymerize and cure the resin composition and completely decompose the residual photoinitiator (D) so as to form a colored layer where the defect has been repaired.

As for the post-baking conditions, the filled portion

is post-baked at 200 to 250°C for 20 to 60 minutes.

In the present invention, when there is a difference in chromaticity between the repaired portion and the normal portion after one cycle of the steps (1) to (3) is carried
5 out, the cycle is preferably repeated to eliminate the difference in chromaticity between them as much as possible.

In the present invention, when a defective portion is existent in two or more different color phases of a color filter, the defective portion in each color phase is removed
10 and a liquid resin composition having the same color phase as that of the removed defective portion is used for repair in the same manner as described above. When a defective portion in a certain color phase is extremely small, it may be repaired simultaneously with a defective portion in an
15 adjacent different color phase if there is no problem with the performance of the color filter.

According to the present invention, since the liquid composition fully wet spreads only into the hole formed by removing the defective portion and is fully polymerized and
20 cured when a color filter defect is to be repaired, there is no difference or there is an extremely small difference in chromaticity between the repaired portion and the normal portion, whereby the repaired portion can have almost the same performance as the normal portion without causing a new
25 problem in a portion around the defective portion.

Consequently, the radiation sensitive resin composition for repairing a color filter defect and the method of repairing a color filter defect of the present invention can be applied to the repair of various color
30 filters including a color filter for use in color liquid crystal displays in the field of the electronic industry.

Examples

The following examples are provided for the purpose

of further illustrating the present invention but are in no way to be taken as limiting. "Parts" in Synthetic Examples means "parts by weight".

5 Synthetic Example 1

1 part of 2,2'-azobis(2,4-dimethylvaleronitrile) and 200 parts of propylene glycol monomethyl ether acetate were fed to a flask equipped with a cooling tube and a stirrer, 15 parts of methacrylic acid, 15 parts of styrene, 30 parts
10 of benzyl methacrylate, 20 parts of glycerol monomethacrylate, 20 parts of N-phenylmaleimide and 2.5 parts of α -methylstyrene dimer as a chain transfer agent were then fed to the flask, the inside of the flask was substituted by nitrogen, the resulting solution was stirred gently, and
15 the temperature of the reaction solution was raised to 80° C to polymerize the solution by maintaining that temperature for 3 hours. Thereafter, the temperature was raised to 100° C, 0.5 part of 2,2'-azobis(2,4-dimethylvaleronitrile) was added, and polymerization was carried out for another 1 hour
20 to obtain a copolymer solution (solid content of 33.2 wt%). This copolymer solution was designated as copolymer solution (b1). The obtained copolymer had an Mw of 14,000 and an Mn of 6,800.

25 Synthetic Example 2

1 part of 2,2'-azobis(2,4-dimethylvaleronitrile) and 200 parts of cyclohexanone were fed to a flask equipped with a cooling tube and a stirrer, 15 parts of methacrylic acid, 15 parts of mono(2-methacryloyloxyethyl)succinate, 20 parts
30 of styrene, 25 parts of benzyl methacrylate, 25 parts of N-phenylmaleimide and 2.5 parts of α -methylstyrene dimer as a chain transfer agent were then fed to the flask, the inside of the flask was substituted by nitrogen, the resulting solution was stirred gently, and the temperature of the

reaction solution was raised to 80°C to polymerize the solution by maintaining that temperature for 3 hours. Thereafter, the temperature was raised to 100°C, 0.5 part of 2,2'-azobis(2,4-dimethylvaleronitrile) was added, and
5 polymerization was carried out for another 1 hour to obtain a copolymer solution (solid content of 32.9 wt%). This copolymer solution was designated as copolymer solution (b2). The obtained copolymer had an Mw of 15,000 and an Mn of 7,400.

10 Synthetic Example 3

1 part of 2,2'-azobis(2,4-dimethylvaleronitrile) and 200 parts of propylene glycol monomethyl ether acetate were fed to a flask equipped with a cooling tube and a stirrer, 15 parts of methacrylic acid, 10 parts of
15 ω-carboxycaprolactone monomethacrylate, 15 parts of styrene, 30 parts of benzyl methacrylate, 15 parts of glycerol monomethacrylate, 15 parts of N-phenylmaleimide and 2.5 parts of α-methylstyrene dimer as a chain transfer agent were then fed to the flask, the inside of the flask was substituted
20 by nitrogen, the resulting solution was stirred gently, and the temperature of the reaction solution was raised to 80°C to polymerize the solution by maintaining that temperature for 3 hours. Thereafter, the temperature was raised to 100°C, 0.5 part of 2,2'-azobis(2,4-dimethylvaleronitrile) was
25 added, and polymerization was carried out for another 1 hour to obtain a copolymer solution (solid content of 33.0 wt%). This copolymer solution was designated as copolymer solution (b3). The obtained copolymer had an Mw of 12,000 and an Mn of 5,700.

30

Example 1

<formation of normal portion and hole>

90 parts by weight of a mixture of C.I. Pigment Red 254 and C.I. Pigment Yellow 139 (weight ratio of 82/18) as

a pigment (A'), 20 parts by weight (8 parts by weight in terms of solid content) of Disperbyk-2000 (solid content: 40.0 wt%, solvent: mixed solvent of methoxypropanol acetate and 2-butoxyethanol in a weight ratio of 1:1) as a dispersant, 5 210.8 parts by weight (70 parts by weight in terms of solid content) of the copolymer solution (b1) (solid content of 33.2 wt%) as an alkali-soluble resin (B'), 80 parts by weight of dipentaerythritol hexaacrylate as a polyfunctional monomer (C'), 30 parts by weight of 10 2-benzyl-2-dimethylamino-1-(4-morpholinophenyl)butanone-1 as a photoinitiator (D') and 859.2 parts by weight of a mixed solvent of ethyl 3-ethoxypropionate and propylene glycol monomethyl ether acetate (weight ratio of 34.9/65.1) as a solvent (E') were mixed together to prepare a liquid 15 resin composition (CFR1).

This liquid resin composition (CFR1) was applied to the surface of a soda-lime glass substrate (150 mm x 150 mm) having an SiO₂ film for preventing the elution of sodium ions formed on the surface with a spin coater and prebaked on a 20 hot plate heated at 80° C for 2 minutes to vaporize the solvent and form a 2.0 μm-thick coating film. Thereafter, this substrate was exposed to 100 mJ/cm² of ultraviolet radiation and post-baked in a clean oven heated at 220° C for 30 minutes to form a 1.6 μm-thick normal red colored layer.

25 Thereafter, a laser beam is applied by a laser repair device (of NTN Co., Ltd.) to burn off the red colored layer in order to form a 90 μm square hole at the center of the substrate.

30 <evaluation of defect reparability>

100 parts by weight of a mixture of C.I. Pigment Red 254 and C.I. Pigment Yellow 139 (weight ratio of 82/18) as a pigment (A), 25 parts by weight (10 parts by weight in terms of solid content) of Disperbyk-2000 as a dispersant, 60.2

parts by weight (20 parts by weight in terms of solid content) of the copolymer solution (b1) (solid content of 33.2 wt%) as an alkali-soluble resin (B), 130 parts by weight of dipentaerythritol hexaacrylate as a polyfunctional monomer (C), 20 parts by weight of 2-benzyl-2-dimethylamino-1-(4-morpholinophenyl)butanone-1 as a photoinitiator (D) and 759.8 parts by weight of a mixed solvent of ethyl 3-ethoxypropionate, propylene glycol monomethyl ether acetate and diethylene glycol mono-n-butyl ether acetate (weight ratio of 59.0/9.4/31.6) as a solvent (E) were mixed together to prepare a liquid resin composition (RR1).

This liquid resin composition (RR1) had a component (C) content of 650 parts by weight based on 100 parts by weight of the component (B), a solid content of 25.6 wt% and an average vapor pressure of 1.4 mmHg.

Thereafter, the liquid resin composition (RR1) was applied to the needle of the above laser repair device to be filled into the center of the hole 4 times. The filled portion was then exposed to 100 mJ/cm² of ultraviolet radiation and post-baked in a clean oven heated at 220°C for 30 minutes to form an about 1.6 μm-thick red colored layer having the same color phase as the normal portion in the hole.

When the chromaticities of the repaired portion and the normal portion were measured with the MCPD-2000 color analyzer of Ohtsuka Electronic Co., Ltd., they were (0.641, 0.344, 23.5) and (0.640, 0.344, 23.6). Thus, there was an extremely small difference in chromaticity between the repaired portion and the normal portion. Therefore, the liquid resin composition of Example 1 had no problem in its practical use.

Comparative Example 1

<formation of normal portion and hole>

A substrate having a normal red colored layer and a hole was obtained in the same manner as in Example 1.

<evaluation of defect reparability>

100 parts by weight of a mixture of C.I. Pigment Red
5 254 and C.I. Pigment Yellow 139 (weight ratio of 82/18) as
a pigment (a), 25 parts by weight (10 parts by weight in terms
of solid content) of Disperbyk-2000 as a dispersant, 60.2
parts by weight (20 parts by weight in terms of solid content)
of the copolymer solution (b1) (solid content of 33.2 wt%)
10 as an alkali-soluble resin (b), 130 parts by weight of
dipentaerythritol hexaacrylate as a polyfunctional monomer
(c), 20 parts by weight of
2-benzyl-2-dimethylamino-1-(4-morpholinophenyl)butanone-
1 as a photoinitiator (d) and 1,259.8 parts by weight of a
15 mixed solvent of ethyl 3-ethoxypropionate, propylene glycol
monomethyl ether acetate and diethylene glycol mono-n-butyl
ether acetate (weight ratio of 57.8/11.2/31.0) as a solvent
(e) were mixed together to prepare a liquid resin composition
(rr1).

20 This liquid resin composition (rr1) had a component
(c) content of 650 parts by weight based on 100 parts by weight
of the component (b), a solid content of 17.6 wt% and an
average vapor pressure of 1.4 mmHg.

The hole was repaired in the same manner as in Example
25 1 except that the liquid resin composition (rr1) was used.
When the chromaticities of the formed repaired portion and
the normal portion were measured, they were (0.641, 0.344,
23.5) and (0.632, 0.344, 24.4). Thus, there was a larger
difference in chromaticity between the repaired portion and
30 the normal portion than in Example 1. Therefore, the liquid
resin composition of Comparative Example 1 was inferior in
reparability.

Comparative Example 2

<formation of normal portion and hole>

A substrate having a normal red colored layer and a hole was obtained in the same manner as in Example 1.

<evaluation of defect reparability>

- 5 The hole was repaired in the same manner as in Example 1 except that the liquid resin composition (CFR1) used to form the red colored layer in Example 1 was used.

 The liquid resin composition (CFR1) had a polyfunctional monomer content of about 114 parts by weight
10 based on 100 parts by weight of the alkali-soluble resin, a solid content of 21.6 wt% and an average vapor pressure of 2.6 mmHg.

 As the liquid resin composition (CFR1) had high dryness, it was dried and solidified before the needle reached the
15 portion to be filled. Therefore, it was not suitable for repair.

Example 2

<formation of normal portion and hole>

- 20 90 parts by weight of a mixture of C.I. Pigment Green 36 and C.I. Pigment Yellow 150 (weight ratio of 60/40) as a pigment (A'), 25 parts by weight (11.5 parts by weight in terms of solid content) of Disperbyk-2001 (solid content: 46.0 wt%, solvent: mixed solvent of methoxypropanol acetate,
25 2-butoxyethanol and methoxypropanol in a weight ratio of 2:2:1) as a dispersant, 180.7 parts by weight (60 parts by weight in terms of solid content) of the copolymer solution (b1) (solid content of 33.2 wt%) as an alkali-soluble resin (B'), 90 parts by weight of dipentaerythritol hexaacrylate
30 as a polyfunctional monomer (C'), 35 parts by weight of 2-benzyl-2-dimethylamino-1-(4-morpholinophenyl)butanone-1 as a photoinitiator (D') and 679.3 parts by weight of a mixed solvent of 3-methoxybutyl acetate and propylene glycol monomethyl ether acetate (weight ratio of 58.9/41.1) as a

solvent (E') were mixed together to prepare a liquid resin composition (CFG1).

A 1.6 μ m-thick normal green colored layer and a 90 μ m square hole at the center of the substrate were formed in the same manner as in Example 1 except that this liquid resin composition (CFG1) was used.

<evaluation of defect reparability>

90 parts by weight of a mixture of C.I. Pigment Green 36 and C.I. Pigment Yellow 150 (weight ratio of 60/40) as a pigment (A), 25 parts by weight (11.5 parts by weight in terms of solid content) of Disperbyk-2001 as a dispersant, 76.0 parts by weight (25 parts by weight in terms of solid content) of the copolymer solution (b2) (solid content of 32.9 wt%) as an alkali-soluble resin (B), 125 parts by weight of dipentaerythritol hexaacrylate as a polyfunctional monomer (C), 20 parts by weight of 2-benzyl-2-dimethylamino-1-(4-morpholinophenyl)butanone-1 as a photoinitiator (D) and 649.0 parts by weight of a mixed solvent of 3-methoxybutyl acetate, cyclohexanone and diethylene glycol mono-n-butyl ether acetate (weight ratio of 60.4/7.2/32.4) as a solvent (E) were mixed together to prepare a liquid resin composition (RG1).

This liquid resin composition (RG1) had a component (C) content of 500 parts by weight based on 100 parts by weight of the component (B), a solid content of 27.6 wt% and an average vapor pressure of 2.2 mmHg.

When the hole was repaired in the same manner as in Example 1 except that the liquid resin composition (RG1) was used and the chromaticities of the repaired portion and the normal portion were measured, they were (0.293, 0.560, 60.7) and (0.294, 0.558, 61.2). Thus, there was an extremely small difference in chromaticity between the repaired portion and the normal portion. The liquid resin composition of Example 2 had no problem in its practical use.

Comparative Example 3

<formation of normal portion and hole>

A substrate having a normal green colored layer and
5 a hole was obtained in the same manner as in Example 2.

<evaluation of defect reparability>

90 parts by weight of a mixture of C.I. Pigment Green
36 and C.I. Pigment Yellow 150 (weight ratio of 60/40) as
a pigment (a), 25 parts by weight (11.5 parts by weight in
10 terms of solid content) of Disperbyk-2001 as a dispersant,
76.0 parts by weight (25 parts by weight in terms of solid
content) of the copolymer solution (b2) (solid content of
32.9 wt%) as an alkali-soluble resin (b), 125 parts by weight
of dipentaerythritol hexaacrylate as a polyfunctional
15 monomer (c), 20 parts by weight of
2-benzyl-2-dimethylamino-1-(4-morpholinophenyl)butanone-
1 as a photoinitiator (d) and 649.0 parts by weight of a mixed
solvent of 3-methoxybutyl acetate and cyclohexanone (weight
ratio of 86.3/13.7) as a solvent (e) were mixed together to
20 prepare a liquid resin composition (rg1).

This liquid resin composition (rg1) had a component
(c) content of 500 parts by weight based on 100 parts by weight
of the component (b), a solid content of 27.6 wt% and an
average vapor pressure of 3.1 mmHg.

25 The hole was repaired in the same manner as in Example
1 except that the liquid resin composition (rg1) was used.
However, as the liquid resin composition (rg1) had high
dryness, it was dried and solidified before the needle
reached the portion to be filled. Therefore, it was not
30 suitable for repair.

Example 3

<formation of normal portion and hole>

90 parts by weight of a mixture of C.I. Pigment Blue

15:6 and C.I. Pigment Violet 23 (weight ratio of 95/5) as a pigment (A'), 25 parts by weight (11.5 parts by weight in terms of solid content) of Disperbyk-2001 as a dispersant, 180.7 parts by weight (60 parts by weight in terms of solid content) of the copolymer solution (b1) (solid content of 33.2 wt%) as an alkali-soluble resin (B'), 90 parts by weight of dipentaerythritol hexaacrylate as a polyfunctional monomer (C'), 20 parts by weight of 2-benzyl-2-dimethylamino-1-(4-morpholinophenyl)butanone-1 as a photoinitiator (D') and 879.3 parts by weight of a mixed solvent of ethyl 3-ethoxypropionate and propylene glycol monomethyl ether acetate (weight ratio of 68.2/31.8) as a solvent (E') were mixed together to prepare a liquid resin composition (CFB1).

15 A 1.6 μm -thick normal blue colored layer and a 90 μm square hole at the center of the substrate were formed in the same manner as in Example 1 except that this liquid resin composition (CFB1) was used.

<evaluation of defect reparability>

20 80 parts by weight of a mixture of C.I. Pigment Blue 15:6 and C.I. Pigment Violet 23 (weight ratio of 95/5) as a pigment (A), 20 parts by weight (9.2 parts by weight in terms of solid content) of Disperbyk-2001 as a dispersant, 90.9 parts by weight (30 parts by weight in terms of solid content) of the copolymer solution (b3) (solid content of 33.0 wt%) as an alkali-soluble resin (B), 120 parts by weight of dipentaerythritol hexaacrylate as a polyfunctional monomer (C), 20 parts by weight of 2-benzyl-2-dimethylamino-1-(4-morpholinophenyl)butanone-1 as a photoinitiator (D) and 639.1 parts by weight of a mixed solvent of ethyl 3-ethoxypropionate, propylene glycol monomethyl ether acetate and diethylene glycol mono-n-butyl ether acetate (weight ratio of 21.9/45.2/32.9) as a solvent (E) were mixed together to prepare a liquid resin composition

(RB1).

This liquid resin composition (RB1) had a component (C) content of 400 parts by weight based on 100 parts by weight of the component (B), a solid content of 26.7 wt% and an
5 average vapor pressure of 2.3 mmHg.

When the hole was repaired in the same manner as in Example 1 except that the liquid resin composition (RB1) was used and the chromaticities of the repaired portion and the normal portion were measured, they were (0.136, 0.107, 12.4)
10 and (0.136, 0.108, 12.6). Thus, there was an extremely small difference in chromaticity between the repaired portion and the normal portion. The liquid resin composition of Example 3 had no problem in its practical use.

15 Comparative Example 4

<formation of normal portion and hole>

A substrate having a normal blue colored layer and a hole was obtained in the same manner as in Example 3.

<evaluation of defect reparability>

20 80 parts by weight of a mixture of C.I. Pigment Blue 15:6 and C.I. Pigment Violet 23 (weight ratio of 95/5) as a pigment (a), 20 parts by weight (9.2 parts by weight in terms of solid content) of Disperbyk-2001 as a dispersant, 227.3 parts by weight (75 parts by weight in terms of solid
25 content) of the copolymer solution (b3) (solid content of 33.0 wt%) as an alkali-soluble resin (b), 75 parts by weight of dipentaerythritol hexaacrylate as a polyfunctional monomer (c), 20 parts by weight of
2-benzyl-2-dimethylamino-1-(4-morpholinophenyl)butanone-
30 1 as a photoinitiator (d) and 547.7 parts by weight of a mixed solvent of ethyl 3-ethoxypropionate, propylene glycol monomethyl ether acetate and diethylene glycol mono-n-butyl ether acetate (weight ratio of 25.6/36.1/38.3) as a solvent (e) were mixed together to prepare a liquid resin composition

(rb1).

This liquid resin composition (rb1) had a component (c) content of 100 parts by weight based on 100 parts by weight of the component (b), a solid content of 26.7 wt% and an
5 average vapor pressure of 2.3 mmHg.

The hole was repaired in the same manner as in Example 1 except that the liquid resin composition (rb1) was used. However, as the liquid resin composition (rb1) was not fully cured after the component (e) was vaporized, its fluidity
10 remained after curing. Therefore, it was not suitable for repair.

What is claimed is:

1. A method of repairing a color filter defect, comprising the steps of:

- (1) removing a color filter defect, filling into the formed hole, a radiation sensitive resin composition for repairing a color filter defect, which comprises (A) a pigment, (B) an alkali-soluble resin, (C) a polyfunctional monomer having two or more polymerizable unsaturated bonds or a combination of a polyfunctional monomer having two or more polymerizable unsaturated bonds and a monofunctional monomer having one polymerizable unsaturated bond, (D) a photoinitiator and (E) a solvent, wherein the amount of the component (C) is 350 to 1,000 parts by weight based on 100 parts by weight of the component (B), the average vapor pressure at 20°C of the component (E) is lower than 3.0 mmHg, and the composition has a solid content of 25 to 50 wt%, and removing the solvent;
- (2) exposing the filled portion to radiation; and
- (3) heating the filled portion after exposure.

2. Use of a radiation sensitive resin composition for repairing a color filter defect, said radiation sensitive resin composition comprising (A) a pigment, (B) an alkali-soluble resin, (C) a polyfunctional monomer having two or more polymerizable unsaturated bonds or a combination of a polyfunctional monomer having two or more polymerizable unsaturated bonds and a monofunctional monomer having one polymerizable unsaturated bond, (D) a photoinitiator and (E) a solvent, wherein the amount of the component (C) is 350 to

1,000 parts by weight based on 100 parts by weight of the component (B), the average vapor pressure at 20°C of the component (E) is lower than 3.0 mmHg, and the composition has a solid content of 25 to 50 wt%.