

RADIATION SENSITIVE COMPOSITION FOR FORMING A COLORED LAYER  
AND COLOR FILTER

Field of the Invention

5           The present invention relates to a radiation sensitive composition for forming a colored layer, a method of forming a colored layer, a color filter and a color liquid crystal display device. More specifically, it relates to a radiation sensitive composition used to form a colored layer useful  
10 for the manufacture of a color filter for use in a transmission or reflection type color liquid crystal display or a color image pick-up device, a method of forming a colored layer from the radiation sensitive composition, a color filter comprising a colored layer formed from the radiation  
15 sensitive composition and a color liquid crystal display device comprising the color filter.

Description of the Prior Art

20           For the manufacture of a color filter by using a radiation sensitive composition for forming a colored layer, there is known a method for obtaining color pixels by forming a coating film of the radiation sensitive composition for forming a colored layer on a substrate or a substrate comprising a light screening layer having a desired pattern,  
25 exposing the coating film to radiation through a photomask having a desired pattern (to be referred to as "exposure" hereinafter), developing the exposed coating film to dissolve and remove an unexposed portion and post-baking the developed coating film in a clean oven or on a hot plate (see  
30 JP-A 2-144502 and JP-A 3-53201) (the term "JP-A" as used herein means an "unexamined published Japanese Patent Application"). When a color filter is manufactured by this method, the radiation sensitive composition for forming a colored layer is generally applied to the substrate by spin

coating. As the size of a substrate is becoming bigger, the coating technique is shifting to slit-and-spin coating or spinless coating.

However, as a slit nozzle is used in the slit-and-spin  
5 coating and spinless coating, coatability and yield problems arise due to the use of the slit nozzle. That is, as the contamination of the slit nozzle by the radiation sensitive composition for forming a colored layer cannot be avoided, the step of cleaning the slit nozzle is required. In this  
10 cleaning step, the slit nozzle is generally cleaned with a prime solvent for the radiation sensitive composition for forming a colored layer. However, when the radiation sensitive composition for forming a colored layer has low solubility in the prime solvent, it remains in a nozzle  
15 portion as a bump, thereby causing problems that a streak is formed in the traveling direction of the nozzle when it is applied to the substrate and that a dried product of the radiation sensitive composition for forming a colored layer drops and adheres to the substrate to become a defect with  
20 the result of a reduction in yield. Therefore, the solvent re-solubility of the dried product of the radiation sensitive composition for forming a colored layer is important.

Although the formation of the dried product can be suppressed by using a high-boiling point solvent in the  
25 radiation sensitive composition for forming a colored layer, it is difficult to evaporate the high-boiling point solvent completely, whereby sticking occurs or the vacuum baking time is prolonged, thereby reducing productivity. According to the selection of the type and the amount of the high-boiling  
30 point solvent, there arises a problem that, in the step of vacuum baking the radiation sensitive composition for forming a colored layer after coating, fine air bubbles contained in the composition appear to the surface of the coating film during the evaporation of the solvent and remain

as crater-like defects (to be referred to as "bumping holes" hereinafter) after drying.

#### Summary of the Invention

5           It is an object of the present invention to provide a radiation sensitive composition for forming a colored layer which has solved the above problems and rarely produces a bumping hole and whose dried product of the composition formed in a slit nozzle has high solvent re-solubility.

10           It is another object of the present invention to provide a method of forming a colored layer from the above radiation sensitive composition of the present invention.

          It is still another object of the present invention to provide a color filter having a colored layer formed from  
15           the above radiation sensitive composition of the present invention and a liquid crystal display device comprising the color filter.

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

20           The inventors of the present invention have conducted intensive studies to achieve the above objects and have found that when a solvent comprising cyclohexyl acetate as an essential component is used as the solvent used in the radiation sensitive composition for forming a colored layer,  
25           the solvent re-solubility of a dried product of the radiation sensitive composition is significantly improved and the formation of a bumping hole can be significantly suppressed. The present invention has been accomplished based on this finding.

30           According to the present invention, firstly, the above objects and advantages of the present invention are attained by a radiation sensitive composition for forming a colored layer, comprising (A) a colorant, (B) an alkali-soluble resin, (C) a polyfunctional monomer, (D) a photopolymerization

initiator and (E) a solvent, wherein

the solvent (E) contains 5 to 40 wt% of cyclohexyl acetate.

The expression "colored layer" used herein means a  
5 layer composed of pixels and/or a black matrix for use in a color filter.

According to the present invention, secondly, the above objects and advantages of the present invention are attained by a method of forming a colored layer, comprising  
10 the following steps (1) to (4):

(1) forming a coating film of the above radiation sensitive composition for forming a colored layer on a substrate;

(2) exposing at least part of the coating film to  
15 radiation;

(3) developing the coating film after exposure; and

(4) heating the coating film after development.

According to the present invention, thirdly, the above objects and advantages of the present invention are attained  
20 by a color filter having a colored layer formed from the above radiation sensitive composition for forming a colored layer.

According to the present invention, in the fourth place, the above objects and advantages of the present invention are attained by a color liquid crystal display device  
25 comprising the above color filter.

The present invention will be described in detail hereinunder.

Radiation sensitive composition for forming a colored layer

30 - (A) colorant -

The colorant in the present invention is not limited to a particular color and is suitably selected according to the application purpose of the obtained color filter. It may be a pigment, dye or natural coloring matter.

Since the development of a high-purity and high-transmission color and heat resistance are required for a color filter, a colorant having high color developability and high resistance to thermal decomposition is preferred as the colorant in the present invention. An organic or inorganic pigment is preferred, and an organic pigment and/or carbon black are/is particularly preferred.

Examples of the above organic pigment are 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 color index (C.I.) numbers:

C.I. Pigment Yellow 83, C.I. Pigment Yellow 128, C.I. Pigment Yellow 138, C.I. Pigment Yellow 139, C.I. Pigment Yellow 150, C.I. Pigment Yellow 151, C.I. Pigment Yellow 152, C.I. Pigment Yellow 153, C.I. Pigment Yellow 154, C.I. Pigment Yellow 155, C.I. Pigment Yellow 156, C.I. Pigment Yellow 166, C.I. Pigment Yellow 168, C.I. Pigment Yellow 175 and C.I. Pigment Yellow 185;

C.I. Pigment Violet 19, C.I. Pigment Violet 23, C.I. Pigment Violet 29, C.I. Pigment Violet 32, C.I. Pigment Violet 36 and C.I. Pigment Violet 38;

C.I. Pigment Red 177, C.I. Pigment Red 202, C.I. Pigment Red 206, C.I. Pigment Red 207, C.I. Pigment Red 208, C.I. Pigment Red 209, C.I. Pigment Red 215, C.I. Pigment Red 216, C.I. Pigment Red 220, C.I. Pigment Red 224, C.I. Pigment Red 226, C.I. Pigment Red 242, C.I. Pigment Red 243, C.I. Pigment Red 245, C.I. Pigment Red 254, C.I. Pigment Red 255, C.I. Pigment Red 264 and C.I. Pigment Red 265;

C.I. Pigment Blue 15, C.I. Pigment Blue 15:3, C.I. Pigment Blue 15:4, C.I. Pigment Blue 15:6 and C.I. Pigment Blue 60; C.I. Pigment Green 7 and C.I. Pigment Green 36; and C.I. Pigment Black 1 and C.I. Pigment Black 7.

The above organic pigments may be used alone or in

combination of two or more.

The above organic pigments may be purified by sulfuric acid re-crystallization, solvent cleaning or a combination thereof before use.

5        Examples of the above 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  
10    black, synthetic iron black and carbon black.

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

When the radiation sensitive composition for forming a colored layer of the present invention is used to form pixels,  
15    one or more organic pigments are preferably used as the colorant and when the radiation sensitive composition for forming a colored layer is used to form a black matrix, two or more organic pigments and/or carbon blacks are preferably used as the colorant.

20        Examples of the carbon black used for the formation of a black matrix include furnace blacks such as SAF, SAF-HS, ISAF, ISAF-LS, ISAF-HS, HAF, HAF-LS, HAF-HS, NAF, FEF, FEF-HS, SRF, SRF-LM, SRF-LS, GPF, ECF, N-339 and N-351; thermal blacks such as FT and MT; and acetylene black.

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

In the present invention, the surface of the particle of the pigment may be optionally modified by a polymer before use. Examples of the polymer used to modify the surface of  
30    the particle of the pigment include polymers disclosed by JP-A 8-259876 and commercially available polymers and oligomers for dispersing a pigment.

The colorant in the present invention may be optionally used in conjunction with a dispersant.

The dispersant is, for example, a cationic, anionic, nonionic, ampholytic, silicone-based or fluorine-based surfactant.

Examples of the above surfactant include

5 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  
10 polyethylene glycol dilaurate and polyethylene glycol distearate; sorbitan fatty acid esters; fatty acid modified polyesters; tertiary amine modified polyurethanes; and polyethylene imines. These surfactants are available on the market under the trade names of KP (of Shin-Etsu Chemical,  
15 Co., Ltd.), Polyflow (of Kyoeisha Chemical Co., Ltd.), F Top (of Tokem Products Co., Ltd.), Megafac (of Dainippon Ink and Chemicals, Inc.), Florade (of Sumitomo 3M Limited), Asahi Guard and Surflon (of Asahi Glass Co., Ltd.), Disperbyk-101, 103, 107, 110, 111, 115, 130, 160, 161, 162, 163, 164, 165,  
20 166, 170, 180, 182, 2000 and 2001 (of BYK Chemie Japan KK), Solsperse S5000, S12000, S13240, S13940, S17000, S20000, S22000, S24000, S24000GR, S26000, S27000 and S28000 (of Avicia Co., Ltd.), and EFKA46, 47, 48, 745, 4540, 4550 and 6750, EFKA LP4008, 4009, 4010, 4015, 4050, 4055, 4560 and  
25 4800, and EFKA Polymer400, 401, 402, 403, 450, 451 and 453 (of EFKA Chemicals, Co., Ltd.).

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

30 The amount of the surfactant is preferably 50 parts or less by weight, more preferably 0 to 30 parts by weight based on 100 parts by weight of the colorant.

In the present invention, the radiation sensitive resin composition can be prepared by a suitable method. When a pigment is used as the colorant, preferably, it is mixed

with and dispersed into a solvent in the presence of a dispersant while it is ground by a bead mill or roll mill together with the alkali-soluble resin (B) which will be described hereinafter as required to prepare a pigment dispersion which is then mixed with the components (B) to (E) which will be described hereinafter.

The amount of the dispersant for the preparation of the pigment dispersion is preferably 100 parts or less by weight, more preferably 0.5 to 100 parts by weight, much more preferably 1 to 70 parts by weight, particularly preferably 10 to 50 parts by weight based on 100 parts by weight of the pigment. When the amount of the dispersant is larger than 100 parts by weight, developability may be impaired.

The solvent used for the preparation of the pigment dispersion may be identical to the solvent (E) which will be described hereinafter and may be the same or different from a solvent which is added to the pigment dispersion in the step of preparing the final radiation sensitive composition for forming a colored layer.

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

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

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

To prepare the pigment dispersion by using a roll mill,

a three-roll mill or two-roll mill is used to mix and disperse the pigment mixed solution preferably while it is cooled with cooling water or the like.

The interval between rolls is preferably 10  $\mu\text{m}$  or less, and the shearing force is preferably about  $10^8$  dyn/sec. The treating time is preferably 2 to 50 hours, more preferably 2 to 25 hours.

- (B) alkali-soluble resin -

The alkali-soluble resin in the present invention is not particularly limited if it serves as a binder for the colorant (A) and has solubility in a developer, particularly preferably an alkali developer, which is used in the development step of a color filter manufacturing process. For example, it is preferably a copolymer of a polymerizable unsaturated monomer having an acid functional group such as carboxyl group, phenolic hydroxyl group or sulfonic acid and other copolymerizable unsaturated monomer (to be referred to as "copolymerizable unsaturated monomer" hereinafter).

Examples of the polymerizable unsaturated monomer having a carboxyl group (to be referred to as "carboxyl group-containing unsaturated monomer" hereinafter) include unsaturated monocarboxylic acids such as (meth)acrylic acid, crotonic acid,  $\alpha$ -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  $\omega$ -carboxypolycaprolactone mono(meth)acrylate.

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

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

10 Examples of the polymerizable unsaturated monomer having a phenolic hydroxyl group include o-hydroxystyrene, m-hydroxystyrene, p-hydroxystyrene, o-hydroxy- $\alpha$ -methylstyrene, m-hydroxy- $\alpha$ -methylstyrene, p-hydroxy- $\alpha$ -methylstyrene, N-o-hydroxyphenylmaleimide,  
 15 N-m-hydroxyphenylmaleimide and N-p-hydroxyphenylmaleimide.

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

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

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

Examples of the copolymerizable unsaturated monomer include macromonomers having a mono(meth)acryloyl group at a terminal of a polymer molecular chain such as polystyrene, polymethyl (meth)acrylate, poly-n-butyl (meth)acrylate and  
 30 polysiloxane (to be simply referred to as "macromonomers" hereinafter); N-substituted maleimides such as N-(substituted)arylmaleimides including N-phenylmaleimide, N-o-methylphenylmaleimide, N-m-methylphenylmaleimide, N-p-methylphenylmaleimide, N-o-methoxyphenylmaleimide,

N-m-methoxyphenylmaleimide and N-p-methoxyphenylmaleimide, and N-cyclohexylmaleimide; aromatic vinyl compounds such as styrene,  $\alpha$ -methylstyrene, o-vinytoluene, m-vinytoluene, p-vinytoluene, 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, benzyl (meth)acrylate, cyclohexyl (meth)acrylate, phenyl (meth)acrylate, 2-methoxyethyl (meth)acrylate, 2-phenoxyethyl (meth)acrylate, methoxydiethylene glycol (meth)acrylate, methoxytriethylene glycol (meth)acrylate, methoxypropylene glycol (meth)acrylate, methoxydipropylene glycol (meth)acrylate, isobornyl (meth)acrylate, dicyclopentadienyl (meth)acrylate, 2-hydroxy-3-phenoxypropyl (meth)acrylate and glycerol mono(meth)acrylate; unsaturated aminoalkyl carboxylates such as 2-aminoethyl (meth)acrylate, 2-dimethylaminoethyl (meth)acrylate, 2-aminopropyl (meth)acrylate, 2-dimethylaminopropyl acrylate, 3-aminopropyl (meth)acrylate and 3-dimethylaminopropyl (meth)acrylate; unsaturated glycidyl carboxylates such as glycidyl (meth)acrylate; vinyl carboxylates such as vinyl acetate, 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,  $\alpha$ -chloroacrylonitrile and vinylidene cyanide; unsaturated amides such as (meth)acrylamide,  $\alpha$ -chloroacrylamide and N-2-hydroxyethyl (meth)acrylamide; and aliphatic conjugated dienes such as 1,3-butadiene, isoprene and chloroprene.

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

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

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

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

"carboxyl group-containing copolymer (II)" hereinafter) of a monomer mixture containing (a) a carboxyl group-containing unsaturated monomer comprising (meth)acrylic acid as an essential ingredient and optionally

5 mono[2-(meth)acryloyloxyethyl]succinate and/or  $\omega$ -carboxypolycaprolactone mono(meth)acrylate and (b) at least one selected from the group consisting of polystyrene macromonomer, polymethyl (meth)acrylate macromonomer, N-phenylmaleimide, N-cyclohexylmaleimide, 2-hydroxyethyl  
10 (meth)acrylate, benzyl (meth)acrylate and glycerol (meth)acrylate and optionally (c) at least one selected from the group consisting of styrene,  $\alpha$ -methylstyrene, methyl (meth)acrylate, allyl (meth)acrylate and phenyl (meth)acrylate.

15 Illustrative examples of the carboxyl group-containing copolymer (II) include a copolymer of (meth)acrylic acid/ 2-hydroxyethyl (meth)acrylate, copolymer of (meth)acrylic acid/ styrene/ 2-hydroxyethyl (meth)acrylate, copolymer of (meth)acrylic acid/  
20 2-hydroxyethyl (meth)acrylate/ benzyl (meth)acrylate, copolymer of (meth)acrylic acid/ 2-hydroxyethyl (meth)acrylate/ phenyl (meth)acrylate, copolymer of (meth)acrylic acid/ benzyl (meth)acrylate/ glycerol mono(meth)acrylate, copolymer of (meth)acrylic acid/ benzyl  
25 (meth)acrylate/ polystyrene macromonomer, copolymer of (meth)acrylic acid/ benzyl (meth)acrylate/ polymethyl (meth)acrylate macromonomer, copolymer of (meth)acrylic acid/ N-phenylmaleimide/ styrene/ benzyl (meth)acrylate, copolymer of (meth)acrylic acid/ N-phenylmaleimide/  
30  $\alpha$ -methylstyrene/ benzyl (meth)acrylate, copolymer of (meth)acrylic acid/ N-cyclohexylmaleimide/ styrene / benzyl (meth)acrylate, copolymer of (meth)acrylic acid/ N-cyclohexylmaleimide/  $\alpha$ -methylstyrene/ benzyl (meth)acrylate, copolymer of (meth)acrylic acid/

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

30        The copolymerization amount 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 copolymerization amount  
 of the carboxyl group-containing unsaturated monomer is

smaller than 5 wt%, the solubility in an alkali developer of the obtained radiation sensitive composition may lower and when the copolymerization amount is larger than 50 wt%, the solubility in an alkali developer of the radiation sensitive composition may become too high. As a result, when the composition is developed with an alkali developer, the colored layer may fall off from the substrate and the film surface of the colored layer may be roughened.

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

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

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

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

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

The amount of the alkali-soluble resin in the present

invention is preferably 10 to 1,000 parts by weight, more preferably 20 to 500 parts by weight based on 100 parts by weight of the colorant (A). When the amount of the alkali-soluble resin is smaller than 10 parts by weight, the alkali developability of the obtained radiation sensitive composition may lower, or a stain or the film residue may be produced on the substrate and light screening layer of an unexposed portion. When the amount is larger than 1,000 parts by weight, the concentration of the colorant becomes relatively low, whereby it may be difficult to achieve the target color density of a thin film.

- (C) polyfunctional monomer -

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

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

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

hydroxyl groups and dicarboxylic acid modified products thereof are preferred, as exemplified by trimethylolpropane tri(meth)acrylate, pentaerythritol tri(meth)acrylate, pentaerythritol tetra(meth)acrylate, dipentaerythritol  
5 penta(meth)acrylate and dipentaerythritol hexa(meth)acrylate. Out of these, trimethylolpropane triacrylate, pentaerythritol triacrylate and dipentaerythritol hexaacrylate are particularly preferred because they provide a colored layer having high strength  
10 and excellent surface smoothness and rarely produce a stain or the film residue on the substrate and light screening layer of an unexposed portion.

In the present invention, the above polyfunctional monomers may be used alone or in combination of two or more.  
15 The amount of the polyfunctional monomer in the present invention is preferably 5 to 500 parts by weight, more preferably 20 to 300 parts by weight based on 100 parts by weight of the alkali-soluble resin (B). When the amount of the polyfunctional monomer is smaller than 5 parts by weight,  
20 the strength and surface smoothness of the colored layer may deteriorate and when the amount is larger than 500 parts by weight, the alkali developability of the obtained radiation sensitive composition may lower, or a stain or the film residue may be produced on the substrate and light screening  
25 layer of an unexposed portion.

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

Examples of the above monofunctional monomer include  
30 the above carboxyl group-containing unsaturated monomers and copolymerizable unsaturated monomers enumerated for the above alkali-soluble resin (B), N-vinyl derivatives such as N-vinylsuccinimide, N-vinylpyrrolidone, N-vinylphthalimide, N-vinyl-2-piperidone,

N-vinyl- $\epsilon$ -caprolactam, N-vinylpyrrole, N-vinylpyrrolidine, N-vinylimidazole, N-vinylimidazolidine, N-vinylindole, N-vinylindoline, N-vinylbenzimidazole, N-vinylcarbazole, N-vinylpiperidine, N-vinylpiperazine, N-vinylmorpholine  
5 and N-vinylphenoxazine; N-(meth)acryloylmorpholine; and commercially available products such as M-5300, M-5400 and M-5600 (of Toagosei Chemical Industry Co., Ltd.).

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

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

- (D) photopolymerization initiator -

The photopolymerization initiator in the present invention is a compound which can form active species capable  
20 of initiating the polymerization of the above polyfunctional monomer (C) and the optionally used monofunctional monomer upon exposure to visible radiation, ultraviolet radiation, far ultraviolet radiation, electron radiation or X-radiation.

25 The photopolymerization initiator is, for example, an acetophenone-based compound, biimidazole-based compound, triazine-based compound, benzoin-based compound, benzophenone-based compound,  $\alpha$ -diketone-based compound, polynuclear quinine-based compound, xanthone-based  
30 compound or diazo-based compound.

In the present invention, the above photopolymerization initiators may be used alone or in combination of two or more. At least one selected from the group consisting of an acetophenone-based compound,

biimidazole-based compound and triazine-based compound is preferably used as the photopolymerization initiator in the present invention.

The amount of the photopolymerization initiator in the present invention is preferably 0.01 to 80 parts by weight, more preferably 1 to 60 parts by weight based on 100 parts by weight of the polyfunctional monomer (C) or the total of the polyfunctional monomer and the monofunctional monomer. When the amount of the photopolymerization initiator is smaller than 0.01 part by weight, it may be difficult to obtain a color filter having a predetermined colored layer pattern due to incomplete curing by exposure and when the amount is larger than 80 parts by weight, the formed colored layer may fall off from the substrate during development.

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

Out of these acetophenone compounds, 2-methyl-1-[4-(methylthio)phenyl]-2-morpholinopropan-1-one, 2-benzyl-2-dimethylamino-1-(4-morpholinophenyl)butan-1-one and 1,2-octanedione-1-[4-(phenylthio)phenyl]-2-(O-benzoyloxime) are 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 photopolymerization initiator in the present invention, the

amount of the acetophenone-based compound is preferably 0.01 to 80 parts by weight, more preferably 1 to 60 parts by weight, particularly preferably 1 to 30 parts by weight based on 100 parts by weight of the polyfunctional monomer (C) or the total  
 5 of the polyfunctional monomer and the monofunctional monomer. When the amount of the acetophenone-based compound is smaller than 0.01 part by weight, it may be difficult to obtain a color filter having a predetermined colored layer pattern due to incomplete curing by exposure. When the amount is  
 10 larger than 80 parts by weight, the formed colored layer may fall off from the substrate during development.

Examples of the above biimidazole-based compound include 2,2'-bis(2-chlorophenyl)-4,4',5,5'-tetrakis(4-ethoxycarbonylphenyl)-1,2'-biimidazole,  
 15 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'-  
 20 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,  
 25 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,  
 30 2,2'-bis(2-chlorophenyl)-4,4',5,5'-tetraphenyl-1,2'-biimidazole,  
 2,2'-bis(2,4-dichlorophenyl)-4,4',5,5'-tetraphenyl-1,2'-biimidazole and  
 2,2'-bis(2,4,6-trichlorophenyl)-4,4',5,5'-tetraphenyl-1,

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

The above biimidazole-based compounds have excellent  
5 solubility in a solvent, do not form foreign matter such as  
an undissolved product and a precipitate, have high  
sensitivity and high contrast, fully promote a curing  
reaction by exposure with a small amount of energy and do  
not cause a curing reaction in an unexposed portion.  
10 Therefore, the coating film obtained after exposure is  
clearly divided into a cured portion insoluble in a developer  
and an uncured portion having high solubility in a developer,  
thereby making it possible to form a high-definition color  
filter having a predetermined colored layer pattern which  
15 is not undercut. The above biimidazole-based compounds may  
be used alone or in combination of two or more.

When the biimidazole-based compound is used as the  
photopolymerization initiator in the present invention, the  
amount of the biimidazole-based compound is preferably 0.01  
20 to 40 parts by weight, more preferably 1 to 30 parts by weight,  
particularly preferably 1 to 20 parts by weight based on 100  
parts by weight of the polyfunctional monomer (C) or the total  
of the polyfunctional monomer and the monofunctional monomer.  
When the amount of the biimidazole-based compound is smaller  
25 than 0.01 part by weight, it may be difficult to obtain a  
color filter having a predetermined colored layer pattern  
due to incomplete curing by exposure. When the amount is  
larger than 40 parts by weight, the formed colored layer may  
fall off from the substrate and the film surface of the colored  
30 layer may be roughened during development.

When the biimidazole-based compound is used as the  
photopolymerization initiator 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 upon exposure.

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

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

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

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

A detailed description is subsequently given of these hydrogen donors.

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

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

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

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

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

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

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

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

preferred.

The amine-based hydrogen donor serves as a sensitizer even when a photopolymerization initiator 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 because the formed colored layer hardly falls off from  
10 the substrate during development and has high strength and sensitivity.

Preferred examples of the combination of the mercaptan-based hydrogen donor and the amine-based hydrogen donor include a combination of 2-mercaptobenzothiazole/  
15 4,4'-bis(dimethylamino)benzophenone, combination of 2-mercaptobenzothiazole/  
4,4'-bis(diethylamino)benzophenone, combination of 2-mercaptobenzoxazole/  
4,4'-bis(dimethylamino)benzophenone, and combination of  
20 2-mercaptobenzoxazole/  
4,4'-bis(diethylamino)benzophenone. Out of these combinations, a combination of 2-mercaptobenzothiazole/  
4,4'-bis(diethylamino)benzophenone and a combination of 2-mercaptobenzoxazole/  
25 4,4'-bis(diethylamino)benzophenone are more preferred, and a combination of 2-mercaptobenzothiazole/  
4,4'-bis(diethylamino)benzophenone is particularly preferred.

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

When the hydrogen donor is used in conjunction with the biimidazole-based compound in the present invention, the

amount of the hydrogen donor is preferably 0.01 to 40 parts by weight, more preferably 1 to 30 parts by weight, particularly preferably 1 to 20 parts by weight based on 100 parts by weight of the polyfunctional monomer (C) or the total  
 5 of the polyfunctional monomer and the monofunctional monomer. When the amount of the hydrogen donor is smaller than 0.01 part by weight, its effect of improving sensitivity may lower. When the amount is larger than 40 parts by weight, the formed colored layer may fall off from the substrate during  
 10 development.

Examples of the above triazine-based compound include triazine-based compounds having a halomethyl group such as 2,4,6-tris(trichloromethyl)-s-triazine, 2-methyl-4,6-bis(trichloromethyl)-s-triazine,  
 15 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  
 20 (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  
 25 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 particularly preferred.

30 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 photopolymerization initiator 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 polyfunctional monomer (C) or the total of the polyfunctional monomer and the monofunctional monomer.

5 When the amount of the triazine-based compound is smaller than 0.01 part by weight, it may be difficult to obtain a color filter having a predetermined colored layer pattern due to incomplete curing by exposure. When the amount is larger than 40 parts by weight, the formed colored layer may

10 fall off from the substrate during development.

- (E) solvent -

The solvent in the present invention comprises cyclohexyl acetate as an essential ingredient.

15 The content of cyclohexyl acetate in the solvent is 5 to 40 wt%, preferably 15 to 35 wt%, particularly preferably 20 to 30 wt%. When the content of cyclohexyl acetate is too low, its effect of suppressing the formation of a dried product of the radiation sensitive composition and a bumping

20 hole may lower and when the content is too high, an undissolved product may separate out due to a reduction in the solubility of the solvent.

The solvent in the present invention contains a solvent (to be referred to as "other solvent" hereinafter) other than

25 cyclohexyl acetate in an amount of 60 to 95 wt%, preferably 65 to 85 wt%, particularly preferably 70 to 80 wt%.

A suitable solvent may be selected and used as the other solvent as far as it disperses or dissolves the above components (A) to (D) and additives constituting the

30 radiation sensitive composition for forming a colored layer, does not react with these components and has suitable volatility. A solvent having a boiling point of preferably lower than 150°C, more preferably 130°C or higher and lower than 150°C (to be referred to as "low-boiling point solvent"

hereinafter) is desirably contained. The term "boiling point" as used herein means a value at 1 atm.

Examples of the low-boiling point solvent include propylene glycol monomethyl ether, propylene glycol  
5 monoethyl ether, propylene glycol monomethyl ether acetate, 2-pentanone, n-butyl acetate, i-butyl acetate, i-pentyl acetate, ethyl butyrate, n-propyl butyrate, i-propyl butyrate and ethyl pyruvate.

Out of these low-boiling point solvents, propylene  
10 glycol monomethyl ether, propylene glycol monoethyl ether, propylene glycol monomethyl ether acetate, 2-pentanone, i-pentyl acetate and ethyl pyruvate are preferred, and propylene glycol monomethyl ether, propylene glycol monoethyl ether and propylene glycol monomethyl ether  
15 acetate are particularly preferred.

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

The content of the low-boiling point solvent in the solvent is preferably 10 to 60 wt%, more preferably 20 to  
20 50 wt%, particularly preferably 20 to 45 wt%. When the content of the low-boiling point solvent is too low, productivity may lower due to the occurrence of sticking or the prolonged vacuum baking time. When the content is too high, the effect of suppressing the formation of a dried  
25 product of the radiation sensitive composition may become unsatisfactory.

In the present invention, a solvent having a boiling point of preferably 150°C or higher and lower than 180°C, more preferably 155°C or higher and lower than 180°C  
30 (excluding cyclohexyl acetate) (to be referred to as "middle-boiling point solvent" hereinafter) is desirably further contained.

Examples of the middle-boiling point solvent include ethylene glycol mono-n-butyl ether, ethylene glycol

monoethyl ether acetate, propylene glycol monoethyl ether acetate, 3-methoxybutyl acetate, diethylene glycol dimethyl ether, diethylene glycol methyl ethyl ether, cyclohexanone, ethyl 3-ethoxypropionate, n-butyl butyrate and methyl  
5 acetoacetate.

Out of these middle-boiling point solvents, ethylene glycol mono-n-butyl ether, ethylene glycol monoethyl ether acetate, propylene glycol monoethyl ether acetate, 3-methoxybutyl acetate, diethylene glycol dimethyl ether,  
10 diethylene glycol methyl ethyl ether, cyclohexanone and ethyl 3-ethoxypropionate are preferred, and propylene glycol monoethyl ether acetate, 3-methoxybutyl acetate, diethylene glycol dimethyl ether, diethylene glycol methyl ethyl ether, cyclohexanone and ethyl 3-ethoxypropionate are particularly  
15 preferred.

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

The content of the middle-boiling point solvent in the solvent is preferably 30 to 70 wt%, more preferably 30 to  
20 60 wt%, particularly preferably 30 to 50 wt%. When the content of the middle-boiling point solvent is too low, the effect of suppressing the formation of a dried product of the radiation sensitive composition may become unsatisfactory, and when the content is too high,  
25 productivity may lower due to the occurrence of sticking or the prolonged vacuum baking time.

Further, in the present invention, a solvent having a boiling point higher than 180°C (to be referred to as "high-boiling point solvent" hereinafter) may further be  
30 used in conjunction with the above solvents.

Examples of the high-boiling point solvent include benzyl ethyl ether, dihexyl ether, acetonylacetone, isophorone, caproic acid, caprylic acid, 1-octanol, 1-nonanol, benzyl alcohol, benzyl acetate, ethyl benzoate,

diethyl oxalate, diethyl maleate,  $\gamma$ -butyrolactone, ethylene carbonate, propylene carbonate and ethylene glycol monophenyl ether acetate.

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

As for the more specific contents of the above solvents in the solvent in the present invention, preferably, the content of cyclohexyl acetate is 5 to 40 wt%, the content of the low-boiling point solvent is 10 to 60 wt%, the content  
10 of the middle-boiling point solvent is 30 to 70 wt%, and the content of the high-boiling point solvent is 20 wt% or less. More preferably, the content of cyclohexyl acetate is 15 to 35 wt%, the content of the low-boiling point solvent is 20 to 50 wt%, the content of the middle-boiling point solvent  
15 is 30 to 60 wt%, and the content of the high-boiling point solvent is 20 wt% or less. Particularly preferably, the content of cyclohexyl acetate is 20 to 30 wt%, the content of the low-boiling point solvent is 20 to 45 wt%, the content of the middle-boiling point solvent is 30 to 50 wt%, and the  
20 content of the high-boiling point solvent is 20 wt% or less. When such a mixed solvent is used, the formation of a dried product of the radiation sensitive composition and a bumping hole is greatly suppressed, a reduction in productivity caused by the occurrence of sticking and the prolonged vacuum  
25 baking time is prevented, and a satisfactory radiation sensitive composition for forming a colored layer which is excellent in the solvent re-solubility of a dried product of the radiation sensitive composition and from which an undissolved product does not separate out can be obtained.

30 The total amount of the solvents in the radiation sensitive composition for forming a colored layer of the present invention which is not particularly limited is desirably such that the total amount of all the components excluding the solvents of the composition becomes preferably

5 to 50 wt%, particularly preferably 10 to 40 wt% from the viewpoints of the coatability and stability of the obtained composition.

5 - other additives -

The radiation sensitive composition for forming a colored layer of the present invention contains the above components (A) to (E) and optionally other additives.

The other additives include a filler such as glass or  
 10 alumina; polymer compound such as polyvinyl alcohol or poly(fluoroalkylacrylate); nonionic, cationic or anionic surfactant; adhesion accelerator such as vinyl trimethoxysilane, vinyl triethoxysilane, vinyl tri(2-methoxyethoxy)silane,  
 15 N-(2-aminoethyl)-3-aminopropyl·methyl·dimethoxysilane, N-(2-aminoethyl)-3-aminopropyltrimethoxysilane, 3-aminopropyltriethoxysilane, 3-glycidoxypropyltrimethoxysilane, 3-glycidoxypropyl·methyl·dimethoxysilane,  
 20 2-(3,4-epoxycyclohexyl)ethyltrimethoxysilane, 3-chloropropyl·methyl·dimethoxysilane, 3-chloropropyltrimethoxysilane, 3-methacryloyloxypropyltrimethoxysilane or 3-mercaptopropyltrimethoxysilane; antioxidant such as  
 25 2,2-thiobis(4-methyl-6-t-butylphenol) or 2,6-di-t-butylphenol; ultraviolet light absorber such as 2-(3-t-butyl-5-methyl-2-hydroxyphenyl)-5-chlorobenzotriazole or alkoxybenzophenone; and cohesion inhibitor such as sodium polyacrylate.

30

Method of forming a colored layer

A description is subsequently given of the method of forming a colored layer from the radiation sensitive composition for forming a colored layer of the present

invention (may be simply referred to as "composition for forming a colored layer" hereinafter).

The method of forming a colored layer of the present invention comprises the following steps (1) to (4):

- 5 (1) forming a coating film of the composition for forming a colored layer on a substrate;
  - (2) exposing at least part of the coating film to radiation;
  - (3) developing the coating film after exposure; and
  - (4) heating the coating film after development.
- 10 Each of the above steps will be described hereinbelow.

- step (1) -

A light screening layer is optionally formed on the surface of the substrate to define a portion for the formation of pixels, and then the composition for forming a colored  
15 layer is applied to the substrate and vacuum baked under reduced pressure to evaporate the solvent so as to form a coating film.

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

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

As means of applying the composition for forming a colored layer to the substrate, which is not particularly limited, a coating technique using a slit nozzle such as  
30 slit-and-spin coating or spinless coating (to be referred to as "slit nozzle coating technique" hereinafter) is preferred.

As for coating conditions in the slit nozzle coating technique which differ according to the slit-and-spin

coating, spinless coating and the size of the substrate to be coated, when a fifth-generation glass substrate (1,100 mm x 1,250 mm) is coated by spinless coating, for example, the delivery rate of the composition for forming a colored  
5 layer from the slit nozzle is preferably 500 to 2,000 micro-liters/sec, more preferably 800 to 1,500 micro-liters/sec, and the coating speed is preferably 500 to 1,500 mm/sec, more preferably 700 to 1,200 mm/sec.

The solid content of the composition for forming a  
10 colored layer used in the slit nozzle coating technique is preferably 10 to 20 wt%, more preferably 13 to 18 wt%.

As for vacuum baking conditions, the degree of vacuum is preferably about 0.1 to 1.0 torr, more preferably about 0.2 to 0.5 torr, the temperature is preferably about 60 to  
15 120°C, more preferably about 70 to 110°C, and the baking time is preferably about 1 to 5 minutes, more preferably about 2 to 4 minutes.

The thickness of the formed coating film after the removal of the solvent is preferably 0.1 to 10  $\mu\text{m}$ , more  
20 preferably 0.2 to 8.0  $\mu\text{m}$ , particularly preferably 0.2 to 6.0  $\mu\text{m}$ .

- step (2) -

Thereafter, at least part of the formed coating film  
25 is exposed to radiation. To expose part of the coating film, a photomask having a suitable pattern is used.

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

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

- step (3) -

Thereafter, the coating film is developed with a developer to dissolve and remove an unexposed portion of the coating film.

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

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

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

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

20 - step (4) -

By heating (to be referred to as "post-baking" hereinafter) the developed coating film, a colored layer can be formed on the substrate.

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

In the method of forming a colored layer of the present invention, by repeating the above steps (1) to (4) using each of compositions for forming a colored layer containing red, green and blue pigments dispersed therein, red, green and  
30 blue pixel patterns are formed on the same substrate, thereby making it possible to obtain a substrate having predetermined red, green and blue pixel patterns thereon. In the present invention, the order of forming these color pixel patterns is not particularly limited.

By conducting the above steps (1) to (4) in this order using a composition for forming a colored layer containing a black pigment dispersed therein, a substrate having a predetermined black matrix pattern can be obtained.

5       The film thickness of the formed colored layer is preferably 0.5 to 5.0  $\mu\text{m}$ , more preferably 1.5 to 3.0  $\mu\text{m}$ .

#### Color filter

10       The color filter of the present invention comprises the colored layer formed as described above.

#### Color liquid crystal display device

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

20       As one example of the color liquid crystal display device of the present invention, a color liquid crystal display device having excellent characteristic properties can be manufactured by forming pixels and/or a black matrix on a thin film transistor substrate array from the radiation sensitive composition for forming a colored layer of the present invention as described above.

25       As described above, the radiation sensitive composition for forming a colored layer of the present invention comprises (A) a colorant, (B) an alkali-soluble resin, (C) a polyfunctional monomer, (D) a photopolymerization initiator and (E) a solvent as essential ingredients, and the solvent (E) contains 5 to 40 wt% of cyclohexyl acetate. Particularly preferred examples (i) to 30 (ix) of the composition are given below.

- (i) a radiation sensitive composition for forming a colored layer in which the component (B) contains the carboxyl group-containing copolymer (II) and the component (D) contains at least one selected from the

group consisting of an acetophenone-based compound, biimidazole-based compound and triazine-based compound

- (ii) the radiation sensitive composition for forming a colored layer (i) in which the component (B) contains the carboxyl group-containing copolymer (II) and the acetophenone-based compound in the component (D) contains at least one selected from the group consisting of 2-methyl-1-[4-(methylthio)phenyl]-2-morpholinopropan-1-one, 2-benzyl-2-dimethylamino-1-(4-morpholinophenyl)butan-1-one and 1,2-octandione-1-[4-(phenylthio)phenyl]-2-(O-benzoyloxime), the biimidazole-based compound in the component (D) contains at least one selected from the group consisting of 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, and the triazine-based compound in the component (D) contains 2-[2-(3,4-dimethoxyphenyl)ethenyl]-4,6-bis(trichloromethyl)-s-triazine
- (iii) the radiation sensitive composition for forming a colored layer (i) or (ii) in which the carboxyl group-containing copolymer (II) in the component (B) contains at least one selected from the group consisting of a copolymer of (meth)acrylic acid/ 2-hydroxyethyl (meth)acrylate, copolymer of (meth)acrylic acid/ styrene/ 2-hydroxyethyl (meth)acrylate, copolymer of (meth)acrylic acid/ 2-hydroxyethyl (meth)acrylate/ benzyl (meth)acrylate,

copolymer of (meth)acrylic acid/ 2-hydroxyethyl  
 (meth)acrylate/ phenyl (meth)acrylate, copolymer of  
 (meth)acrylic acid/ benzyl (meth)acrylate/ glycerol  
 mono(meth)acrylate, copolymer of (meth)acrylic acid/  
 5 benzyl (meth)acrylate/ polystyrene macromonomer,  
 copolymer of (meth)acrylic acid/ benzyl  
 (meth)acrylate/ polymethyl (meth)acrylate  
 macromonomer, copolymer of (meth)acrylic acid/  
 N-phenylmaleimide/ styrene/ benzyl (meth)acrylate,  
 10 copolymer of (meth)acrylic acid/ N-phenylmaleimide/  
 $\alpha$ -methylstyrene/ benzyl (meth)acrylate, copolymer of  
 (meth)acrylic acid/ N-cyclohexylmaleimide/ styrene/  
 benzyl (meth)acrylate, copolymer of (meth)acrylic  
 acid/ N-cyclohexylmaleimide/  $\alpha$ -methylstyrene/ benzyl  
 15 (meth)acrylate, copolymer of (meth)acrylic acid/  
 2-hydroxyethyl (meth)acrylate/ benzyl  
 (meth)acrylate/ polystyrene macromonomer, copolymer  
 of (meth)acrylic acid/ 2-hydroxyethyl (meth)acrylate/  
 benzyl (meth)acrylate/ polymethyl (meth)acrylate  
 20 macromonomer, copolymer of (meth)acrylic acid/  
 N-phenylmaleimide/ styrene/ benzyl (meth)acrylate/  
 glycerol mono(meth)acrylate, copolymer of  
 (meth)acrylic acid/ N-phenylmaleimide/ styrene/  
 2-hydroxyethyl (meth)acrylate/ phenyl  
 25 (meth)acrylate/ polystyrene macromonomer, copolymer  
 of (meth)acrylic acid/ N-phenylmaleimide/ styrene/  
 2-hydroxyethyl (meth)acrylate/ phenyl  
 (meth)acrylate/ polymethyl methacrylate macromonomer,  
 copolymer of (meth)acrylic acid/  
 30 mono[2-(meth)acryloyloxyethyl]succinate/ benzyl  
 (meth)acrylate/ glycerol mono(meth)acrylate,  
 copolymer of (meth)acrylic acid/  
 mono[2-(meth)acryloyloxyethyl]succinate/  
 N-phenylmaleimide/ styrene/ allyl (meth)acrylate,

- copolymer of (meth)acrylic acid/  
 mono[2- (meth)acryloyloxyethyl]succinate/  
 N-phenylmaleimide/ styrene/ benzyl (meth)acrylate,  
 copolymer of (meth)acrylic acid/  
 5 mono[2- (meth)acryloyloxyethyl]succinate/  
 N-cyclohexylmaleimide/ styrene/ allyl (meth)acrylate,  
 copolymer of (meth)acrylic acid/  
 mono[2- (meth)acryloyloxyethyl]succinate/  
 N-cyclohexylmaleimide/ styrene/ benzyl  
 10 (meth)acrylate, and copolymer of (meth)acrylic acid/  
 $\omega$ -carboxypolycaprolactone mono(meth)acrylate/  
 N-phenylmaleimide/ styrene/ benzyl (meth)acrylate/  
 glycerol mono(meth)acrylate
- (iv) the radiation sensitive composition for forming a  
 15 colored layer (i), (ii) or (iii) in which the component  
 (C) contains at least one selected from the group  
 consisting of trimethylolpropane triacrylate,  
 pentaerythritol triacrylate and dipentaerythritol  
 hexaacrylate
- 20 (v) the radiation sensitive composition for forming a  
 colored layer (i), (ii), (iii) or (iv) in which the  
 component (A) contains an organic pigment and/or  
 carbon black
- (vi) the radiation sensitive composition for forming a  
 25 colored layer (i), (ii), (iii), (iv) or (v) in which  
 the component (E) contains 10 to 60 wt% of a low-boiling  
 point solvent
- (vii) the radiation sensitive composition for forming a  
 30 colored layer (vi) in which the low-boiling point  
 solvent contains at least one selected from the group  
 consisting of propylene glycol monomethyl ether,  
 propylene glycol monoethyl ether and propylene glycol  
 monomethyl ether acetate
- (viii) the radiation sensitive composition for forming a

colored layer (vi) or (vii) in which the component (E) further contains 30 to 70 wt% of a middle-boiling point solvent

- (ix) the radiation sensitive composition for forming a colored layer (viii) in which the middle-boiling point solvent contains at least one selected from the group consisting of propylene glycol monoethyl ether acetate, 3-methoxybutyl acetate, diethylene glycol dimethyl ether, diethylene glycol methyl ethyl ether, cyclohexanone and ethyl 3-ethoxypropionate

The preferred color filter (x) of the present invention comprises pixels and/or black matrix formed from the radiation sensitive composition for forming a colored layer (i), (ii), (iii), (iv), (v), (vi), (vii), (viii) or (ix).

The preferred color liquid crystal display device (xi) of the present invention comprises the above color filter (x).

The more preferred color liquid crystal display device (xii) of the present invention comprises the color filter (x) on a thin film transistor substrate array.

Since a dry product of the radiation sensitive composition for forming a colored layer of the present invention has high solvent re-solubility and the composition suppresses the formation of a bumping hole completely as described above, it can be extremely advantageously used for the formation of a colored layer using the slit nozzle coating technique.

#### 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.

#### Example 1

15 parts by weight of a mixture of C.I. Pigment Red

254/ C.I. Pigment Red 177 (weight ratio of 80/20) as the colorant (A), 4 parts by weight (solid content) of Disperbyk-2001 as a dispersant, 6 parts by weight of a copolymer of methacrylic acid/ N-phenylmaleimide/ styrene/ benzyl methacrylate (copolymerization weight ratio = 20/30/20/30, Mw = 9,500, Mn = 5,000) as the alkali-soluble resin (B), and 75 parts by weight of propylene glycol monomethyl ether acetate as the solvent (E) were mixed together by means of a bead mill to prepare a pigment dispersion (R1).

Thereafter, 100 parts by weight of the pigment dispersion (R1), 5 parts by weight of a copolymer of methacrylic acid/ mono(2-methacryloyloxyethyl)succinate/ N-phenylmaleimide/ styrene/ benzyl methacrylate as the alkali-soluble resin (B) (copolymerization weight ratio = 25/10/30/20/15, Mw = 12,000, Mn = 6,500), 10 parts by weight of dipentaerythritol hexaacrylate as the polyfunctional monomer (C), 5 parts by weight of 2-methyl-(4-methylthiophenyl)-2-morpholino-1-propan-1-one as the photopolymerization initiator (D), and 25 parts by weight (10 wt%) of cyclohexyl acetate, 25 parts by weight (40 wt%) of propylene glycol monomethyl ether acetate, 75 parts by weight (30 wt%) of 3-methoxybutyl acetate and 50 parts by weight (20 wt%) of cyclohexanone as the solvents (E) were mixed together to prepare a composition for forming a colored layer (R1-1). The content (wt%) of each solvent is a value including the solvent contained in the pigment dispersion (the same shall apply hereinafter).

The obtained composition for forming a colored layer (R1-1) was evaluated in accordance with the following procedure. The evaluation results are shown in Table 1.

Evaluation of solvent re-solubility of dried product

After the composition for forming a colored layer (R1-1) was applied to a glass substrate and dried with air

at 23°C and a humidity of 50 % for 30 minutes, the glass substrate having the dried coating film adhered thereto was immersed in propylene glycol monomethyl ether acetate for 10 minutes. The solvent re-solubility of the dried coating film was evaluated according to the re-dissolved state of the dried coating film based on the following criteria.

○: The dried coating film is completely dissolved during immersion.

△: Part of the dried coating film remains after 10 minutes of immersion.

×: The dried coating film rarely dissolves or does not dissolve at all after 10 minutes of immersion.

#### Evaluation of bumping hole

The composition for forming a colored layer (R1-1) was applied to a soda-lime glass substrate (300 mm x 400 mm) having a SiO<sub>2</sub> film for preventing the dissolution of sodium ions on the surface with a spin coater and vacuum baked until the degree of vacuum reached 0.3 torr to form a coating film as thick as 2.5 μm.

Thereafter, the obtained substrate was observed through an optical microscope to count bumping holes in a 5 mm x 400 mm specified square area of the coating film so as to evaluate the composition based on the following criteria.

○: less than 500 bumping holes

△: 500 or more and less than 1,000 bumping holes

×: 1,000 or more bumping holes

#### Example 2

The procedure of Example 1 was repeated except that the solvents (E) to be added to 100 parts by weight of the pigment dispersion (R1) were changed to 50 parts by weight (20 wt%) of cyclohexyl acetate and 125 parts by weight (50 wt%) of ethyl 3-ethoxypropionate to prepare and evaluate a

composition for forming a colored layer (R1-2) in the same manner as in Example 1. The composition for forming a colored layer (R1-2) also contained 75 parts by weight (30 wt%) of propylene glycol monomethyl ether acetate. The evaluation results are shown in Table 1.

#### Example 3

The procedure of Example 1 was repeated except that the solvents (E) to be added to 100 parts by weight of the pigment dispersion (R1) were changed to 50 parts by weight (20 wt%) of cyclohexyl acetate, 50 parts by weight (50 wt%) of propylene glycol monomethyl ether acetate, 25 parts by weight (10 wt%) of diethylene glycol methyl ethyl ether and 50 parts by weight (20 wt%) of 3-methoxybutyl acetate to prepare and evaluate a composition for forming a colored layer (R1-3) in the same manner as in Example 1. The evaluation results are shown in Table 1.

#### Example 4

The procedure of Example 1 was repeated except that the solvents (E) to be added to 100 parts by weight of the pigment dispersion (R1) were changed to 37 parts by weight (20 wt%) of cyclohexyl acetate, 17 parts by weight (about 49.7 wt%) of propylene glycol monomethyl ether acetate, 19 parts by weight (about 10.3 wt%) of diethylene glycol methyl ethyl ether and 37 parts by weight (20 wt%) of 3-methoxybutyl acetate to prepare and evaluate a composition for forming a colored layer (R1-4) in the same manner as in Example 1. The evaluation results are shown in Table 1.

30

#### Comparative Example 1

The procedure of Example 1 was repeated except that the solvents (E) to be added to 100 parts by weight of the pigment dispersion (R1) were changed to 25 parts by weight

of propylene glycol monomethyl ether acetate, 75 parts by weight of 3-methoxybutyl acetate and 75 parts by weight of cyclohexanone to prepare and evaluate a composition for forming a colored layer (R1-5) in the same manner as in Example 1. The evaluation results are shown in Table 1.

#### Comparative Example 2

The procedure of Example 1 was repeated except that the solvents (E) to be added to 100 parts by weight of the pigment dispersion (R1) were changed to 50 parts by weight of propylene glycol monomethyl ether acetate, 75 parts by weight of ethyl 3-ethoxypropionate and 50 parts by weight of diethylene glycol methyl ethyl ether to prepare and evaluate a composition for forming a colored layer (R1-6) in the same manner as in Example 1. The evaluation results are shown in Table 1.

Table 1

| Red colored layer                      | Ex. 1 | Ex. 2 | Ex. 3 | Ex. 4 | C. Ex. 1 | C. Ex. 2 |
|----------------------------------------|-------|-------|-------|-------|----------|----------|
| Solvent re-solubility of dried product | ○     | ○     | ○     | △     | △        | ×        |
| Bumping holes                          | ○     | ○     | ○     | ○     | △        | ○        |

Ex. : Example C.Ex.: Comparative Example

#### Example 5

15 parts by weight of a mixture of C.I. Pigment Green 36/ C.I. Pigment Yellow 138/ C.I. Pigment Yellow 150 (weight ratio = 50/40/10) as the colorant (A), 4 parts by weight (solid content) of Disperbyk-2001 as a dispersant, 5 parts by weight of a copolymer of methacrylic acid/  
 ω-carboxypolycaprolactone monoacrylate/  
 N-phenylmaleimide/ styrene/ benzyl methacrylate/ glycerol

monomethacrylate (copolymerization weight ratio = 15/10/20/10/35/10,  $M_w = 6,000$ ,  $M_n = 3,000$ ) as the alkali-soluble resin (B), and 76 parts by weight of propylene glycol monomethyl ether acetate as the solvent (E) were mixed  
 5 together by means of a bead mill to prepare a pigment dispersion (G1).

Thereafter, 100 parts by weight of the pigment dispersion (G1), 5 parts by weight of a copolymer of methacrylic acid/ N-phenylmaleimide/ styrene/ benzyl  
 10 methacrylate/ glycerol monomethacrylate (copolymerization weight ratio = 15/25/15/35/10,  $M_w = 13,500$ ,  $M_n = 6,000$ ) as the alkali-soluble resin (B), 10 parts by weight of dipentaerythritol hexaacrylate as the polyfunctional monomer (C), 5 parts by weight of  
 15 2-benzyl-2-dimethylamino-1-(4-morpholinophenyl)butan-1-one as the photopolymerization initiator (D), and 75 parts by weight (about 29.9 wt%) of cyclohexyl acetate, 50 parts by weight (about 50.2 wt%) of propylene glycol methyl ether acetate and 50 parts by weight (about 19.9 wt%) of  
 20 3-methoxybutyl acetate as the solvents (E) were mixed together to prepare a composition for forming a colored layer (G1-1).

The obtained composition for forming a colored layer (G1-1) was evaluated in the same manner as in Example 1. The  
 25 evaluation results are shown in Table 2.

#### Example 6

The procedure of Example 5 was repeated except that the solvents (E) to be added to 100 parts by weight of the  
 30 pigment dispersion (G1) were changed to 50 parts by weight (about 19.9 wt%) of cyclohexyl acetate, 25 parts by weight (about 40.2 wt%) of propylene glycol monomethyl ether acetate and 100 parts by weight (about 39.8 wt%) of ethyl 3-ethoxypropionate to prepare a composition for forming a

colored layer (G1-2) which was then evaluated in the same manner as in Example 1. The evaluation results are shown in Table 2.

5    Example 7

The procedure of Example 5 was repeated except that the solvents (E) to be added to 100 parts by weight of the pigment dispersion (G1) were changed to 75 parts by weight (about 29.9 wt%) of cyclohexyl acetate, 25 parts by weight  
10 (about 40.2 wt%) of propylene glycol monomethyl ether acetate, 50 parts by weight (about 19.9 wt%) of ethyl 3-ethoxypropionate and 25 parts by weight (about 10.0 wt%) of diethylene glycol methyl ethyl ether to prepare a composition for forming a colored layer (G1-3) which was then  
15 evaluated in the same manner as in Example 1. The evaluation results are shown in Table 2.

Example 8

The procedure of Example 5 was repeated except that  
20 the solvents (E) to be added to 100 parts by weight of the pigment dispersion (G1) were changed to 25 parts by weight (about 10.0 wt%) of cyclohexyl acetate, 75 parts by weight (about 60.2 wt%) of propylene glycol monomethyl ether acetate and 75 parts by weight (about 29.9 wt%) of ethyl  
25 3-ethoxypropionate to prepare a composition for forming a colored layer (G1-4) which was then evaluated in the same manner as in Example 1. The evaluation results are shown in Table 2.

30    Example 9

The procedure of Example 5 was repeated except that the solvents (E) to be added to 100 parts by weight of the pigment dispersion (G1) were changed to 75 parts by weight (about 29.9 wt%) of cyclohexyl acetate, 50 parts by weight

(about 50.2 wt%) of propylene glycol monomethyl ether acetate and 50 parts by weight (about 19.9 wt%) of diethylene glycol methyl ethyl ether to prepare a composition for forming a colored layer (G1-5) which was then evaluated in the same manner as in Example 1. The evaluation results are shown in Table 2.

#### Example 10

The procedure of Example 5 was repeated except that the solvents (E) to be added to 100 parts by weight of the pigment dispersion (G1) were changed to 54 parts by weight (about 30.2 wt%) of cyclohexyl acetate, 14 parts by weight (about 50.3 wt%) of propylene glycol methyl ether acetate and 35 parts by weight (about 19.6 wt%) of 3-methoxybutyl acetate to prepare a composition for forming a colored layer (G1-6) which was then evaluated in the same manner as in Example 1. The evaluation results are shown in Table 2.

#### Comparative Example 3

The procedure of Example 5 was repeated except that the solvents (E) to be added to 100 parts by weight of the pigment dispersion (G1) were changed to 75 parts by weight of propylene glycol monomethyl ether acetate, 50 parts by weight of ethyl 3-ethoxypropionate and 50 parts by weight of diethylene glycol methyl ethyl ether to prepare a composition for forming a colored layer (G1-7) which was then evaluated in the same manner as in Example 1. The evaluation results are shown in Table 2.

#### Comparative Example 4

The procedure of Example 5 was repeated except that the solvents (E) to be added to 100 parts by weight of the pigment dispersion (G1) were changed to 125 parts by weight of ethyl 3-ethoxypropionate and 50 parts by weight of

3-methoxybutyl acetate to prepare a composition for forming a colored layer (G1-8) which was then evaluated in the same manner as in Example 1. The evaluation results are shown in Table 2.

5

Table 2

| Green colored layer                    | Ex.5 | Ex.6 | Ex.7 | Ex.8 | Ex.9 | Ex.10 | C. Ex.3 | C. Ex.4 |
|----------------------------------------|------|------|------|------|------|-------|---------|---------|
| Solvent re-solubility of dried product | ○    | ○    | △    | ○    | △    | △     | ×       | △       |
| Bumping holes                          | ○    | ○    | ○    | △    | ○    | ○     | ○       | △       |

Ex.: Example C.Ex.: Comparative Example

#### Example 11

10            15 parts by weight of a mixture of C.I. Pigment Blue 15/ C.I. Pigment Violet 23 (weight ratio = 90/10) as the colorant (A), 5 parts by weight (solid content) of Disperbyk-2001 as a dispersant, 4 parts by weight of a copolymer of acrylic acid/ N-phenylmaleimide/ styrene/ 15 2-hydroxyethyl methacrylate/ phenyl methacrylate/ polymethyl methacrylate macromonomer (copolymerization weight ratio = 15/10/20/10/35/10, Mw = 23,000, Mn = 11,000) as the alkali-soluble resin (B) and 76 parts by weight of propylene glycol monomethyl ether acetate as the solvent (E) 20 were mixed together by means of a bead mill to prepare a pigment dispersion (B1).

              Thereafter, 100 parts by weight of the pigment dispersion (B1), 10 parts by weight of a copolymer of methacrylic acid/ N-phenylmaleimide/ α-methylstyrene/ 25 benzyl methacrylate (copolymerization weight ratio = 20/25/25/30, Mw = 43,000, Mn = 21,000) as the alkali-soluble resin (B), 20 parts by weight of dipentaerythritol hexaacrylate as the polyfunctional monomer (C), 5 parts by weight of

2-methyl-(4-methylthiophenyl)-2-morpholino-1-propan-1-one as the photopolymerization initiator (D), and 65 parts by weight (about 19.9 wt%) of cyclohexyl acetate, 88 parts by weight (about 50.3 wt%) of propylene glycol methyl ether acetate and 97 parts by weight (about 29.8 wt%) of ethyl 3-ethoxypropionate as the solvents (E) were mixed together to prepare a composition for forming a colored layer (B1-1).

The obtained composition for forming a colored layer (B1-1) was evaluated in the same manner as in Example 1. The evaluation results are shown in Table 3.

#### Example 12

The procedure of Example 11 was repeated except that the solvents (E) to be added to 100 parts by weight of the pigment dispersion (B1) were changed to 65 parts by weight (about 19.9 wt%) of cyclohexyl acetate, 23 parts by weight (about 30.4 wt%) of propylene glycol monomethyl ether acetate, 32 parts by weight (about 9.8 wt%) of diethylene glycol methyl ethyl ether and 130 parts by weight (about 39.9 wt%) of 3-methoxybutyl acetate to prepare a composition for forming a colored layer (B1-2) which was then evaluated in the same manner as in Example 1. The evaluation results are shown in Table 3.

#### Example 13

The procedure of Example 11 was repeated except that the solvents (E) to be added to 100 parts by weight of the pigment dispersion (B1) were changed to 32 parts by weight (about 9.8 wt%) of cyclohexyl acetate, 23 parts by weight (about 30.4 wt%) of propylene glycol monomethyl ether acetate, 32 parts by weight (about 9.8 wt%) of diethylene glycol methyl ethyl ether, 131 parts by weight (about 40.2 wt%) of 3-methoxybutyl acetate and 32 parts by weight (about 9.8 wt%) of cyclohexanone to prepare a composition for forming a

colored layer (B1-3) which was then evaluated in the same manner as in Example 1. The evaluation results are shown in Table 3.

5 Example 14

The procedure of Example 11 was repeated except that the solvents (E) to be added to 100 parts by weight of the pigment dispersion (B1) were changed to 50 parts by weight (about 19.8 wt%) of cyclohexyl acetate, 26 parts by weight  
10 (about 40.5 wt%) of diethylene glycol methyl ethyl ether and 100 parts by weight (about 39.7 wt%) of 3-methoxybutyl acetate to prepare a composition for forming a colored layer (B1-4) which was then evaluated in the same manner as in Example 1. The evaluation results are shown in Table 3.

15

Comparative Example 5

The procedure of Example 11 was repeated except that the solvents (E) to be added to 100 parts by weight of the pigment dispersion (B1) were changed to 56 parts by weight  
20 of propylene glycol monomethyl ether acetate and 194 parts by weight of ethyl 3-ethoxypropionate to prepare a composition for forming a colored layer (B1-5) which was then evaluated in the same manner as in Example 1. The evaluation results are shown in Table 3.

25

Comparative Example 6

The procedure of Example 11 was repeated except that the solvents (E) to be added to 100 parts by weight of the pigment dispersion (B1) were changed to 88 parts by weight  
30 of propylene glycol monomethyl ether acetate, 97 parts by weight of 3-methoxybutyl acetate and 65 parts by weight of cyclohexanone to prepare a composition for forming a colored layer (B1-6) which was then evaluated in the same manner as in Example 1. The evaluation results are shown in Table 3.

Table 3

| Blue colored layer                     | Ex.11 | Ex.12 | Ex.13 | Ex.15 | C.Ex.5 | C.Ex.6 |
|----------------------------------------|-------|-------|-------|-------|--------|--------|
| Solvent re-solubility of dried product | ○     | ○     | ○     | △     | ○      | ×      |
| Bumping hole                           | ○     | ○     | ○     | ○     | ×      | △      |

Ex.: Example C.Ex.: Comparative Example

What is claimed is:

1. A radiation sensitive composition for forming a colored layer, comprising (A) a colorant, (B) an alkali-soluble resin, (C) a polyfunctional monomer, (D) a photopolymerization initiator and (E) a solvent, wherein  
5 the solvent (E) contains 5 to 40 wt% of cyclohexyl acetate.
2. The radiation sensitive composition according to claim  
10 1, wherein the solvent (E) contains 10 to 60 wt% of a solvent having a boiling point lower than 150°C.
3. The radiation sensitive composition according to claim  
15 2, wherein the solvent (E) further contains 30 to 70 wt% of a solvent having a boiling point of 150°C or higher and lower than 180°C (excluding cyclohexyl acetate).
4. A method of forming a colored layer, comprising the following steps (1) to (4):  
20 (1) forming a coating film of the radiation sensitive composition for forming a colored layer of any one of claims 1 to 3 on a substrate;  
(2) exposing at least part of the coating film to radiation;  
25 (3) developing the coating film after exposure; and  
(4) heating the coating film after development.
5. The method according to claim 4, wherein the coating film is formed by applying the radiation sensitive  
30 composition for forming a colored layer to the substrate by using a slit nozzle in the step (1).
6. A color filter having a colored layer formed from the radiation sensitive composition for forming a colored layer

of any one of claims 1 to 3.

7. A color liquid crystal display device comprising the color filter of claim 6.