

CHEMICALLY-AMPLIFIED POSITIVE PHOTSENSITIVE RESIN
COMPOSITION, MANUFACTURING METHOD OF SUBSTRATE WITH
CASTING MOLD, AND MANUFACTURING METHOD OF ELECTROPLATED
MOLDED ARTICLE

5

BACKGROUND OF THE INVENTION

Field of the Invention

[0001] The invention relates to a chemically-amplified positive photosensitive resin
10 composition, a manufacturing method of a substrate with a casting mold, and a
manufacturing method of an electroplated molded article, and more particularly, to a
chemically-amplified positive photosensitive resin composition that can improve
rectangularity, a manufacturing method of a substrate with a casting mold formed by the
chemically-amplified positive photosensitive resin composition, and a manufacturing
15 method of an electroplated molded article formed by the substrate with a casting mold.

Description of Related Art

[0002] Currently, photoelectric processing has become the mainstream of precision
microfabrication techniques. "Photoelectric processing" is the general term for
techniques of manufacturing various precision parts such as a semiconductor packaged
20 body by coating a photoresist composition on a processed article surface to form a
photoresist layer, patterning the photoresist layer using a lithography technique, and then
performing chemical etching, electrolytic etching, or electroforming based on
electroplating using the patterned photoresist layer (photoresist pattern) as a mask, or

electroplating for the electroforming of the body.

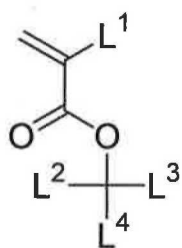
[0003] Moreover, in recent years, as electronic equipment became smaller, high-density assembly techniques of the semiconductor packaged body have advanced rapidly, and as a result, increased assembly density of multi-pin film assembly, 5 miniaturization of packaged body size, flip-chip 2D assembly techniques, and 3D assembly techniques are desired. Among these high-density assembly techniques, the connection terminal, for instance, is disposed on a substrate at high-precision density to connect a protruding electrode (assembly terminal) such as a bump protruding toward the packaged body, a wire extended from the peripheral terminal on a wafer, and a metal 10 column of an assembly terminal.

[0004] The photoelectric processing uses a photoresist composition, and such a photoresist composition includes a chemically-amplified photoresist composition containing an acid generator (refer to patent literature 1 and 2...etc.) The chemically-amplified photoresist composition generates acid via an acid generator and 15 radiation (exposure), and acid diffusion is promoted via a heat treatment to trigger an acid catalyst reaction with, for instance, the matrix resin in the composition to change the alkali solubility thereof.

[0005] Such a chemically-amplified positive photoresist composition is used in, for instance, the forming of an electroplated molded article such as a bump or metal column 20 in a plating step. Specifically, the chemically-amplified photoresist composition is used, a photoresist layer having the desired film thickness is formed on a support body such as a metal substrate, and exposure and development are performed with a predetermined mask pattern in between to form a photoresist pattern used as a template,

by the polycondensation of a cresol aromatic hydroxyl compound and an aldehyde compound, and based on 100% of the integral area of the molecular weight of the novolac resin (B) measured by gel permeation chromatography, the cresol binuclear area area in the novolac resin (B) is between 0.5% and 6%.

- 5 [0010] In an embodiment of the invention, the monomer mixture includes a monomer (a1) having the structure represented by formula (A-1) below:

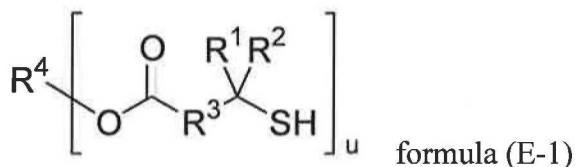


formula (A-1)

- In formula (A-1), L^1 represents a hydrogen atom, a C_1 to C_6 straight or branched alkyl group, a fluorine atom, or a C_1 to C_6 straight or branched fluorinated alkyl group; L^2 , L^3 , and L^4 respectively independently represent a C_1 to C_6 straight or branched alkyl group or a C_1 to C_6 straight or branched fluoroalkyl group, or L^3 and L^4 are bonded to each other to form a C_5 to C_{20} hydrocarbon ring.

[0011] In an embodiment of the invention, the monomer mixture includes a monomer (a2), and the monomer (a2) contains a cyclic ether group.

- 15 [0012] In an embodiment of the invention, the chemically-amplified positive photosensitive resin composition further includes a thiol compound (E) having the structure represented by formula (E-1) below:



formula (E-1)

In formula (E-1), R^1 and R^2 each independently represent a hydrogen atom or

a C₁ to C₄ alkyl group, R³ represents a single bond or a C₁ to C₁₀ alkylene group, and R⁴ represents a u-valence organic group; and u represents an integer of 2 to 6.

[0013] In an embodiment of the invention, the chemically-amplified positive photosensitive resin composition further includes an anthracene compound (F).

5 **[0014]** In an embodiment of the invention, based on a total amount of 100 parts by weight of the resin (A), the amount of the novolac resin (B) is 20 parts by weight to 150 parts by weight, the amount of the photoacid generator (C) is 0.5 parts by weight to 5 parts by weight, and the amount of the solvent (D) is 30 parts by weight to 360 parts by weight.

[0015] In an embodiment of the invention, based on a total amount of 100 parts by weight of the monomer mixture, the amount of the monomer (a1) is 10 parts by weight
10 to 60 parts by weight.

[0016] In an embodiment of the invention, based on a total amount of 100 parts by weight of the monomer mixture, the amount of the monomer (a2) is 5 parts by weight to 35 parts by weight.

15 **[0017]** In an embodiment of the invention, based on a total amount of 100 parts by weight of the resin (A), the amount of the thiol compound (E) is 0.3 parts by weight to 3 parts by weight.

[0018] In an embodiment of the invention, based on a total amount of 100 parts by weight of the resin (A), the amount of the anthracene compound (F) is 0.2 parts by
20 weight to 1.5 parts by weight.

[0019] The invention also provides a manufacturing method of a substrate with a casting mold, including: a lamination step, laminating a photosensitive resin layer

formed by the chemically-amplified positive photosensitive resin composition above on the metal surface of a substrate, an exposure step, irradiating actinic ray or radiation on the photosensitive resin layer, and a developing step, developing the photosensitive resin layer after exposure to form a casting mold forming an electroplated molded
5 article.

[0020] The invention further provides a manufacturing method of an electroplated molded article including: a step of electroplating the substrate with a casting mold formed by the manufacturing method of the substrate with a casting mold to form an electroplated molded article in the casting mold.

10 **[0021]** Based on the above, the rectangularity of the chemically-amplified positive photosensitive resin composition of the invention can be improved due to a cresol binuclear area between 0.5% and 6% in the novolac resin (B) thereof.

[0022] In order to make the aforementioned features and advantages of the disclosure more comprehensible, embodiments accompanied with figures are described in detail
15 below.

BRIEF DESCRIPTION OF THE DRAWINGS

[0023] The accompanying drawings are included to provide a further understanding of the invention, and are incorporated in and constitute a part of this specification. The
20 drawings illustrate embodiments of the invention and, together with the description, serve to explain the principles of the invention.

[0024] FIG. 1 is a schematic of the measurement of the rectangularity of a photoresist pattern.

DESCRIPTION OF THE EMBODIMENTS

[0025] <Chemically-amplified positive photosensitive resin composition>

The invention provides a chemically-amplified positive photosensitive resin composition including a resin (A), a novolac resin (B), a photoacid generator (C), and a solvent (D). The resin (A) is obtained by the copolymerization of a monomer mixture and contains an acid-dissociated protecting group. The novolac resin (B) is obtained by the polycondensation of a cresol aromatic hydroxyl compound and an aldehyde compound, and based on 100% of the integral area of the molecular weight of the novolac resin (B) measured by gel permeation chromatography, the cresol binuclear area area in the novolac resin (B) is between 0.5% and 6%. Moreover, the chemically-amplified positive photosensitive resin composition of the invention can further contain a thiol compound (E), an anthracene compound (F), and an additive (G).

[0026] In the following, the individual components used in the chemically-amplified positive photosensitive resin composition of the invention are described in detail.

[0027] It should be mentioned that, in the following, (meth)acrylic acid represents acrylic acid and/or methacrylic acid, and (meth)acrylate represents acrylate and/or methacrylate. Similarly, a (meth)acryloyl group represents an acryloyl group and/or methacryloyl group.

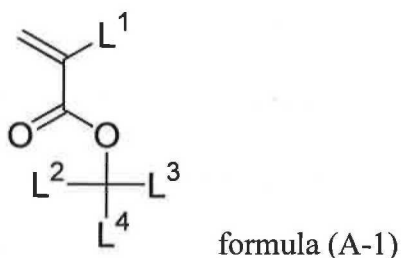
Resin (A)

[0028] The resin (A) is obtained by copolymerizing a monomer mixture and contains an acid-dissociated protecting group. Specifically, the monomer mixture can include a

monomer (a1) having the structure represented by formula (A-1), a monomer (a2) containing a cyclic ether group, a monomer (a3) having the structure represented by formula (A-2) or formula (A-3), and other monomers (a4).

5 Monomer (a1) having structure represented by formula (A-1)

[0029] The monomer (a1) having the structure represented by formula (A-1) is as shown below:



In formula (A-1), L^1 represents a hydrogen atom, a C_1 to C_6 straight or branched alkyl group, a fluorine atom, or a C_1 to C_6 straight or branched fluorinated alkyl group; L^2 , L^3 , and L^4 respectively independently represent a C_1 to C_6 straight or branched alkyl group or a C_1 to C_6 straight or branched fluoroalkyl group, or L^3 and L^4 are bonded to each other to form a C_5 to C_{20} hydrocarbon ring.

[0030] Moreover, the straight or branched alkyl group can include, for instance, a methyl group, an ethyl group, a propyl group, an isopropyl group, a n-butyl group, an isobutyl group, a tert-butyl group, a pentyl group, an isopentyl group, or a neopentyl group. Moreover, the fluorinated alkyl group refers to the alkyl group for which some or all of the hydrogen atoms are substituted by fluorine atoms.

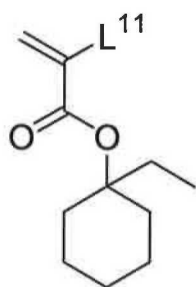
[0031] When L^3 and L^4 are not bonded to each other to form a hydrocarbon ring, L^2 , L^3 , and L^4 are preferably C_2 to C_4 straight or branched alkyl groups.

[0032] The L^3 and L^4 can form a C_5 to C_{20} aliphatic cyclic group together with a

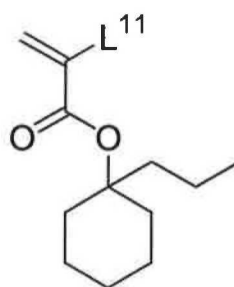
carbon atom bonded to the two. Specific examples of the aliphatic cyclic group can include groups for which 1 or more hydrogen atoms are removed from polycycloalkane such as monocycloalkane, bicycloalkane, tricycloalkane, or tetracycloalkane. Specifically, a group for which 1 or more hydrogen atoms are removed by
 5 monocycloalkane such as cyclopentane, cyclohexane, cycloheptane, or cyclooctane or polycycloalkane such as adamantane, norbornane, isobornylene, tricyclodecane, or tetracyclododecane can be used. In particular, a group (can further have a substituent) for which 1 or more hydrogen atoms are removed by cyclohexane or adamantane is preferred.

10 **[0033]** Moreover, when the aliphatic cyclic group formed by the L^3 and L^4 has a substituent on the ring skeleton thereof, examples of the substituent can include a polar group such as a hydroxyl group, carboxyl group, cyano group, or oxygen atom ($=O$), or a C_1 to C_4 straight or branched alkyl group. The polar group is preferably an oxygen atom ($=O$).

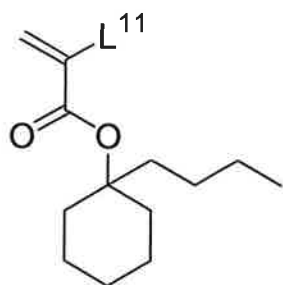
15 **[0034]** Specific examples of the monomer (a1) having the structure represented by formula (A-1) can include compounds represented by formula (A-1-1) to formula (A-1-33) below:



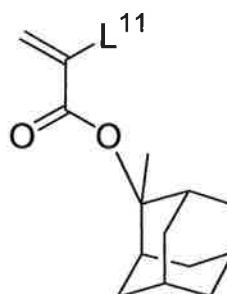
formula (A-1-1)



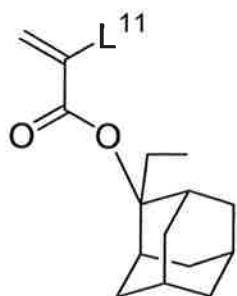
formula (A-1-2)



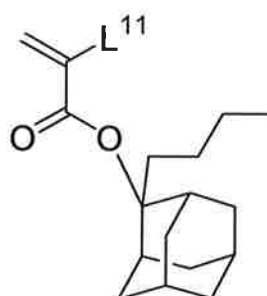
formula (A-1-3)



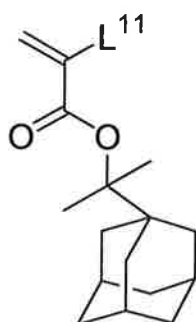
formula (A-1-4)



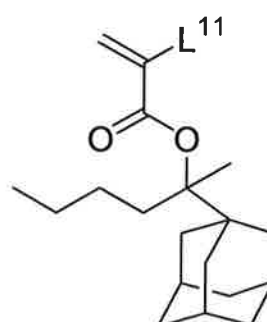
formula (A-1-5)



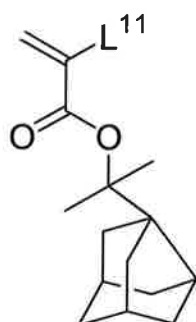
formula (A-1-6)



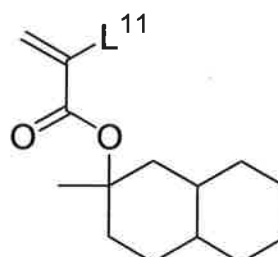
formula (A-1-7)



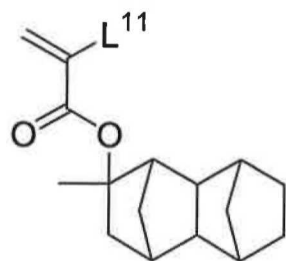
formula (A-1-8)



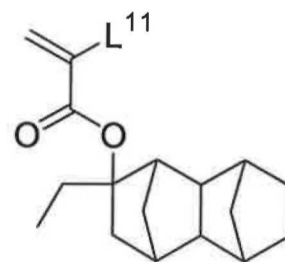
formula (A-1-9)



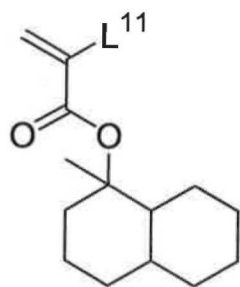
formula (A-1-10)



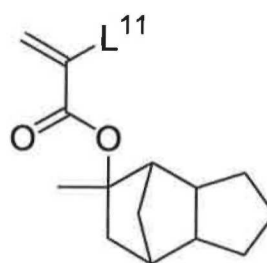
formula (A-1-11)



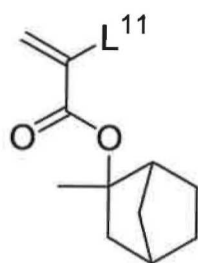
formula (A-1-12)



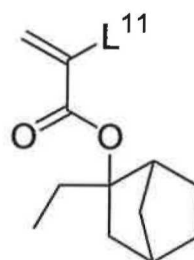
formula (A-1-13)



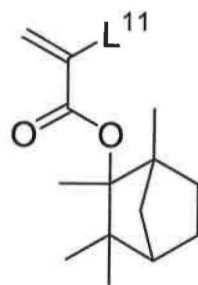
formula (A-1-14)



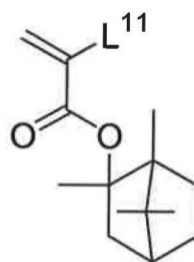
formula (A-1-15)



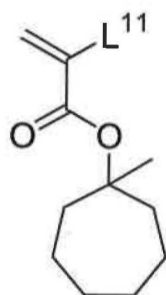
formula (A-1-16)



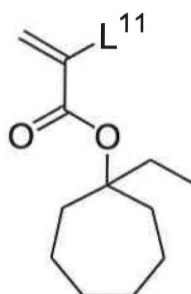
formula (A-1-17)



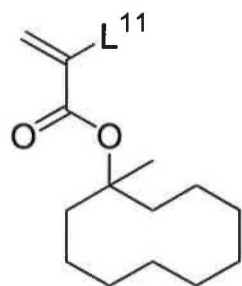
formula (A-1-18)



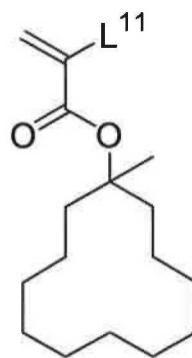
formula (A-1-19)



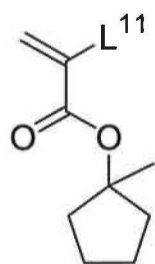
formula (A-1-20)



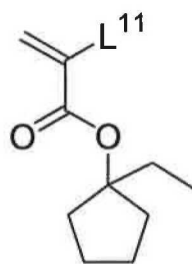
formula (A-1-21)



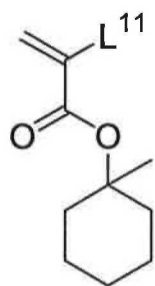
formula (A-1-22)



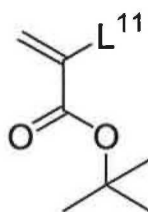
formula (A-1-23)



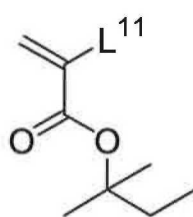
formula (A-1-24)



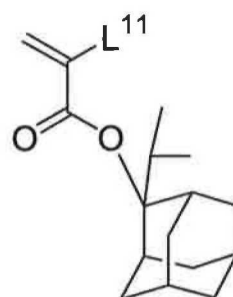
formula (A-1-25)



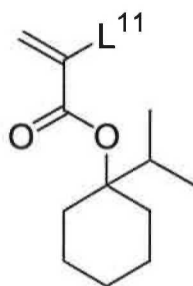
formula (A-1-26)



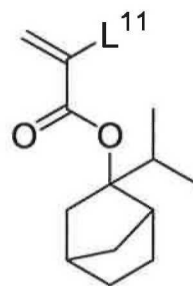
formula (A-1-27)



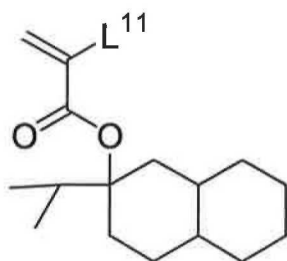
formula (A-1-28)



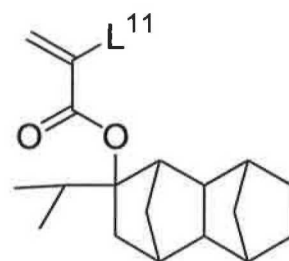
formula (A-1-29)



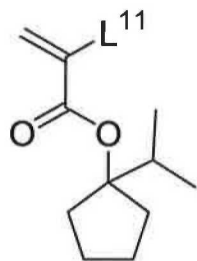
formula (A-1-30)



formula (A-1-31)



formula (A-1-32)



formula (A-1-33)

In formula (A-1-1) to formula (A-1-33), L^{11} represents a hydrogen atom or a

5 methyl group.

[0035] Based on a total amount of 100 parts by weight of the monomer mixture, the amount of the monomer (a1) is 10 parts by weight to 60 parts by weight, preferably 12 parts by weight to 55 parts by weight, and more preferably 15 parts by weight to 50 parts by weight.

10 [0036] If the monomer mixture includes the monomer (a1) having the structure represented by formula (A-1), then the rectangularity of the chemically-amplified positive photosensitive resin composition can be further improved.

Monomer (a2) containing cyclic ether group

15 [0037] Specific examples of the monomer (a2) containing a cyclic ether group can include, for instance, a three-membered ring such as glycidyl methacrylate, 2-methyl glycidyl (meth)acrylate, 3,4-epoxybutyl (meth)acrylate, 6,7-epoxyheptyl (meth)acrylate,

3,4-epoxycyclohexyl (meth)acrylate, or 3,4-epoxycyclohexyl methyl (meth)acrylate; a four-membered ring such as 3-(meth)acryloyloxymethyl oxetane, 3-(meth)acryloyloxymethyl-3-ethyl oxetane, 3-(meth)acryloyloxymethyl-2-methyl oxetane, 3-(meth)acryloyloxymethyl-2-trifluoromethyl oxetane, 5 3-(meth)acryloyloxymethyl-2-pentafluoroethyl oxetane, 3-(meth)acryloyloxymethyl-2-phenyl oxetane, 3-(meth)acryloyloxymethyl-2,2-difluoro oxetane, 3-(meth)acryloyloxymethyl-2,2,4-trifluoro oxetane, 3-(meth)acryloyloxymethyl-2,2,4,4-tetrafluoro oxetane, 3-(meth)acryloyloxyethyl oxetane, 3-(meth)acryloyloxyethyl-3-ethyl oxetane, 2-ethyl-3-(meth)acryloyloxyethyl 10 oxetane, 3-(meth)acryloyloxyethyl-2-trifluoromethyl oxetane, 3-(meth)acryloyloxyethyl-2-pentafluoroethyl oxetane, 3-(meth)acryloyloxyethyl-2-phenyl oxetane, 2,2-difluoro-3-(meth)acryloyloxyethyl oxetane, 3-(meth)acryloyloxyethyl-2,2,4-trifluoro oxetane, 3-(meth)acryloyloxyethyl-2,2,4,4-tetrafluoro oxetane, 2-(meth)acryloyloxymethyl 15 oxetane, 2-methyl-2-(meth)acryloyloxymethyl oxetane, 3-methyl-2-(meth)acryloyloxymethyl oxetane, 4-methyl-2-(meth)acryloyloxymethyl oxetane, 2-(meth)acryloyloxymethyl-2-trifluoromethyl oxetane, 2-(meth)acryloyloxymethyl-3-trifluoromethyl oxetane, 2-(meth)acryloyloxymethyl-4-trifluoromethyl oxetane, 20 2-(meth)acryloyloxymethyl-2-pentafluoroethyl oxetane, 2-(meth)acryloyloxymethyl-3-pentafluoroethyl oxetane, 2-(meth)acryloyloxymethyl-4-pentafluoroethyl oxetane, 2-(meth)acryloyloxymethyl-2-phenyl oxetane, 2-(meth)acryloyloxymethyl-3-phenyl

	oxetane,	2-(meth)acryloyloxymethyl-4-phenyl	oxetane,
	2,3-difluoro-2-(meth)acryloyloxymethyl		oxetane,
	2,4-difluoro-2-(meth)acryloyloxymethyl		oxetane,
	3,3-difluoro-2-(meth)acryloyloxymethyl		oxetane,
5	3,4-difluoro-2-(meth)acryloyloxymethyl		oxetane,
	4,4-difluoro-2-(meth)acryloyloxymethyl		oxetane,
	2-(meth)acryloyloxymethyl-3,3,4-trifluoro		oxetane,
	2-(meth)acryloyloxymethyl-3,4,4-trifluoro		oxetane,
	2-(meth)acryloyloxymethyl-3,3,4,4-tetrafluoro	oxetane,	2-(meth)acryloyloxyethyl
10	oxetane,	2-(meth)acryloyloxyethyl-2-methyl	oxetane,
	2-(meth)acryloyloxyethyl-4-methyl	oxetane,	2-(meth)acryloyloxyethyl-2-trifluoromethyl
	oxetane,	2-(meth)acryloyloxyethyl-3-trifluoromethyl	oxetane,
	2-(meth)acryloyloxyethyl-4-trifluoromethyl		oxetane,
	2-(meth)acryloyloxyethyl-2-pentafluoroethyl		oxetane,
15	2-(meth)acryloyloxyethyl-3-pentafluoroethyl		oxetane,
	2-(meth)acryloyloxyethyl-4-pentafluoroethyl		oxetane,
	2-(meth)acryloyloxyethyl-2-phenyl	oxetane,	2-(meth)acryloyloxyethyl-3-phenyl
	oxetane,	2-(meth)acryloyloxyethyl-4-phenyl	oxetane,
	2,3-difluoro-2-(meth)acryloyloxyethyl	oxetane,	2,4-difluoro-2-(meth)acryloyloxyethyl
20	oxetane,	3,3-difluoro-2-(meth)acryloyloxyethyl	oxetane,
	3,4-difluoro-2-(meth)acryloyloxyethyl	oxetane,	4,4-difluoro-2-(meth)acryloyloxyethyl
	oxetane,	2-(meth)acryloyloxyethyl-3,3,4-trifluoro	oxetane,
	2-(meth)acryloyloxyethyl-3,4,4-trifluoro		oxetane,

2-(meth)acryloyloxyethyl-3,3,4,4-tetrafluoro oxetane; a five-membered ring such as tetrahydrofurfuryl (meth)acrylate, caprolactone-modified tetrahydrofurfuryl (meth)acrylate, (2-methyl-2-isobutyl-1,3-dioxolan-4-yl)methyl (meth)acrylate, (2-ethyl-2-methyl-1,3-dioxolan-4-yl)methyl (meth)acrylate, (1,4-dioxaspiro[4,5]dec-2-yl)methyl (meth)acrylate, (2,2-dimethyl-1,3-dioxolan-4-yl)methyl (meth)acrylate; a six-membered ring such as 3-vinylcyclohexyl (meth)acrylate, 3,3,5-trimethylcyclohexyl (meth)acrylate, 1-methylcyclohexyl (meth)acrylate, 4-tert-butylcyclohexyl (meth)acrylate, 3-vinyl-2-butylcyclohexyl (meth)acrylate, cyclohexyl (meth)acrylate, (meth)acryloyl morpholine, tetrahydropyran (meth)acrylate, 2-methyltetrahydropyran (meth)acrylate.

In particular, a cyclic ether acrylate monomer having four rings or more is preferred, and a cyclic ether acrylate monomer having five rings or more is more preferred. In particular, a cyclic ether acrylate monomer having four rings or more is preferred, and a cyclic ether acrylate monomer having five rings or more is more preferred.

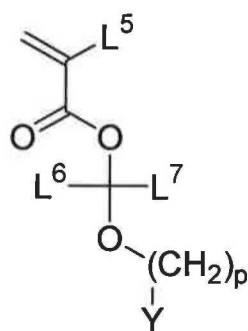
[0038] The monomer (a2) containing a cyclic ether group can be used alone or in multiple combinations.

[0039] Based on a total amount of 100 parts by weight of the monomer mixture, the amount of the monomer (a2) is 5 parts by weight to 35 parts by weight; preferably 8 parts by weight to 28 parts by weight; and more preferably 10 parts by weight to 25 parts by weight.

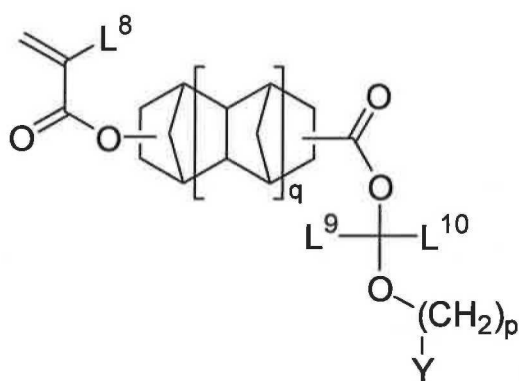
[0040] If the monomer mixture includes the monomer (a2) containing a cyclic ether group, then the sensitivity of the chemically-amplified positive photosensitive resin composition can be further improved.

Monomer (a3) having structure represented by formula (A-2) or formula (A-3)

[0041] The monomer (a3) having the structure represented by formula (A-2) or formula (A-3) is as shown below:



formula (A-2)



formula (A-3)

In formula (A-2) and formula (A-3), L^5 to L^{10} respectively independently represent a hydrogen atom, a C_1 to C_6 straight or branched alkyl group, a fluorine atom, or a C_1 to C_6 straight or branched fluorinated alkyl group; Y represents an alicyclic group or an alkyl group that can have a substituent, p represents an integer of 0 to 4, and q represents 0 or 1.

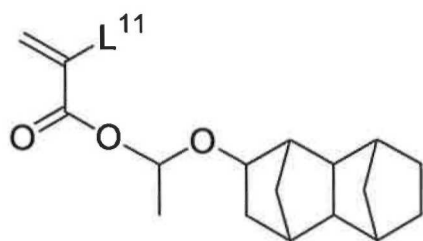
[0042] Moreover, in formula (A-2) and formula (A-3), the L^5 to L^{10} straight or branched alkyl group and straight or branched fluorinated alkyl group are defined the same as the L^1 straight or branched alkyl group and straight or branched fluorinated alkyl group in formula (A-1) and are not repeated herein.

[0043] When Y is an alicyclic group or alkyl group, groups for which 1 or more hydrogen atoms are removed from polycycloalkane such as monocycloalkane, bicycloalkane, tricycloalkane, or tetracycloalkane can be used. Specifically, a group for which 1 or more hydrogen atoms are removed by monocycloalkane such as cyclopentane, cyclohexane, cycloheptane, or cyclooctane or polycycloalkane such as adamantane, norbornane, isobornylene, tricyclodecane, or tetracyclododecane can be used. In particular, a group (can further have a substituent) for which 1 or more hydrogen atoms are removed by adamantane is preferred.

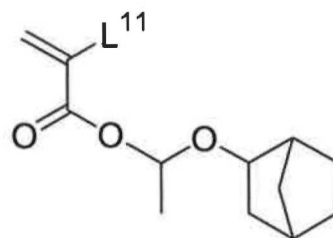
[0044] Moreover, when the alicyclic group represented by Y has a substituent on the ring skeleton thereof, examples of the substituent can include a polar group such as a hydroxyl group, carboxyl group, cyano group, or oxygen atom (=O), or a C₁ to C₄ straight or branched alkyl group. The polar group is preferably an oxygen atom (=O).

[0045] Moreover, when Y is an alkyl group, a C₁ to C₂₀, preferably C₆ to C₁₅, straight or branched alkyl group is preferred. Such an alkyl group is preferably an alkoxyalkyl group, and such an alkoxyalkyl group can include, for instance, 1-methoxyethyl, 1-ethoxyethyl, 1-n-propoxyethyl, 1-isopropoxyethyl, 1-n-butoxyethyl, 1-isobutoxyethyl, 1-tert-butoxyethyl, 1-methoxypropyl, 1-ethoxypropyl, 1-methoxy-1-methyl-ethyl, or 1-ethoxy-1-methylethyl.

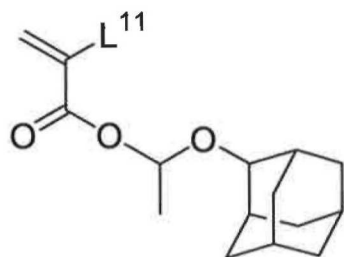
[0046] Specific examples of the monomer (a3) having the structure represented by formula (A-2) or formula (A-3) can include compounds represented by formula (A-2-1) to formula (A-2-24) and formula (A-3-1) to formula (A-3-15):



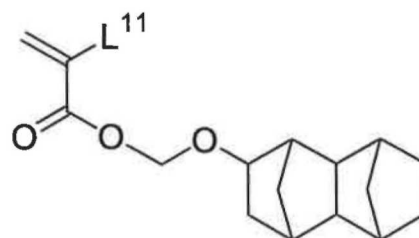
formula (A-2-1)



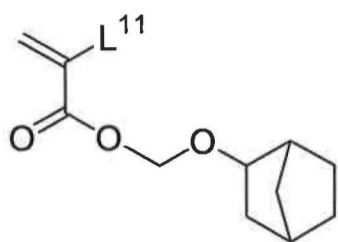
formula (A-2-2)



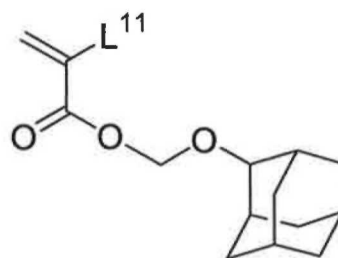
formula (A-2-3)



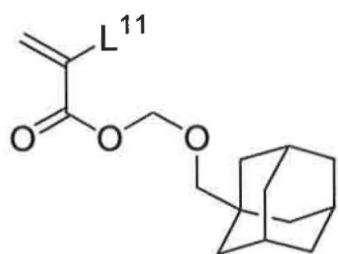
formula (A-2-4)



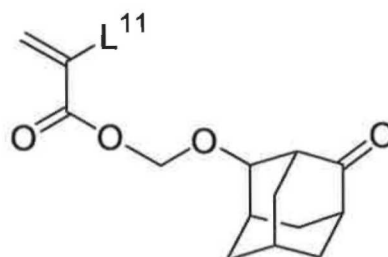
formula (A-2-5)



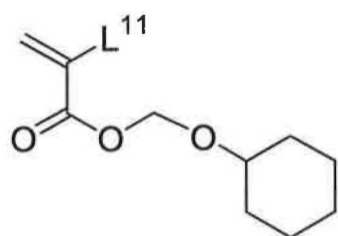
formula (A-2-6)



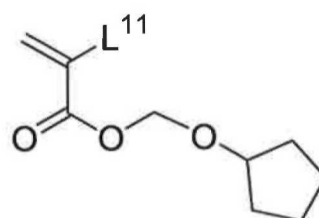
formula (A-2-7)



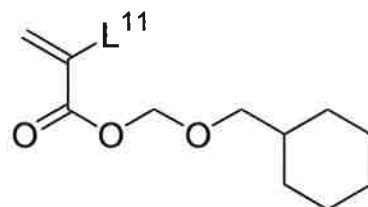
formula (A-2-8)



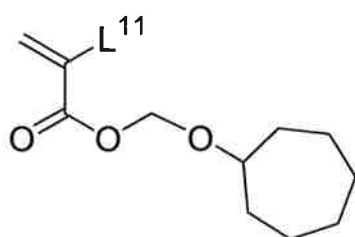
formula (A-2-9)



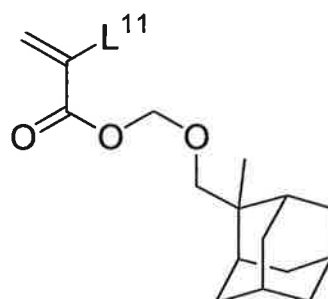
formula (A-2-10)



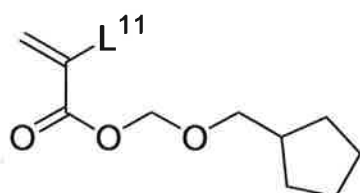
formula (A-2-11)



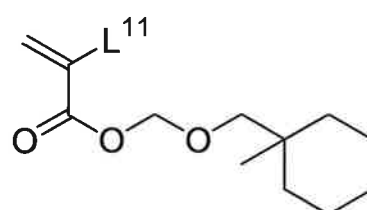
formula (A-2-12)



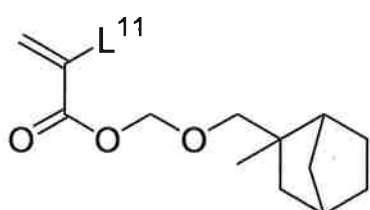
formula (A-2-13)



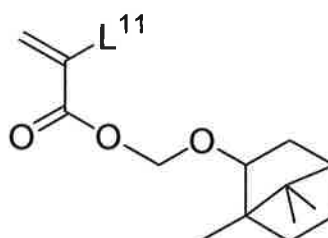
formula (A-2-14)



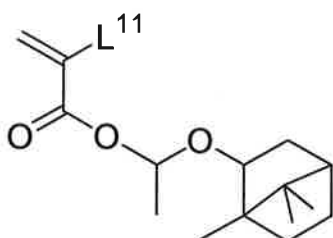
formula (A-2-15)



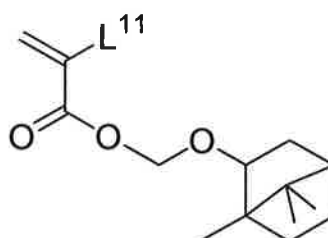
formula (A-2-16)

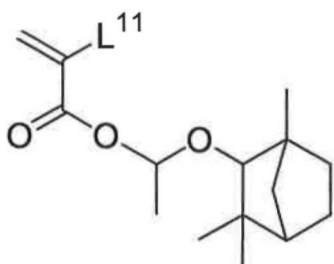


formula (A-2-17)

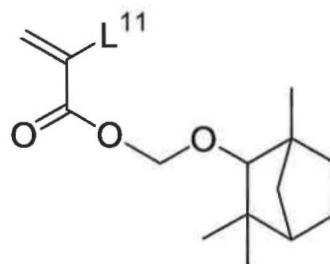


formula (A-2-18)

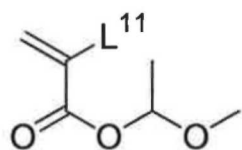




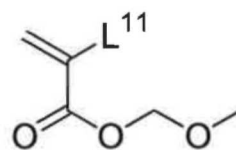
formula (A-2-19)



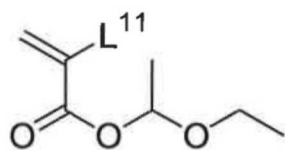
formula (A-2-20)



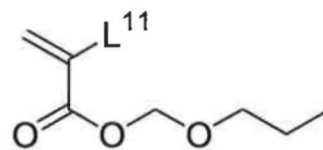
formula (A-2-21)



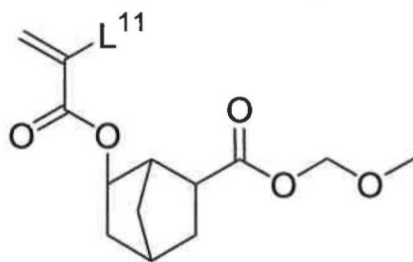
formula (A-2-22)



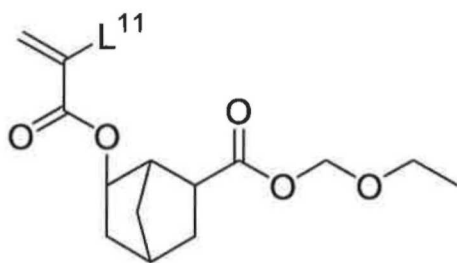
formula (A-2-23)



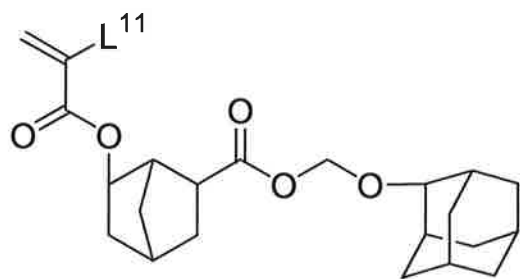
formula (A-2-24)



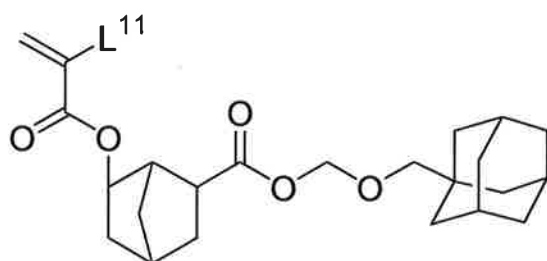
formula (A-3-1)



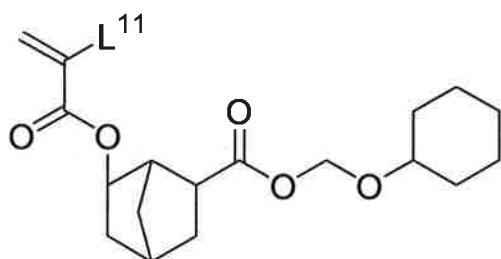
formula (A-3-2)



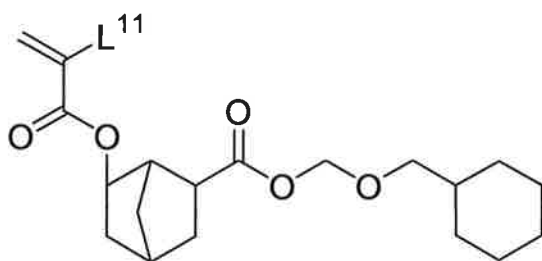
formula (A-3-3)



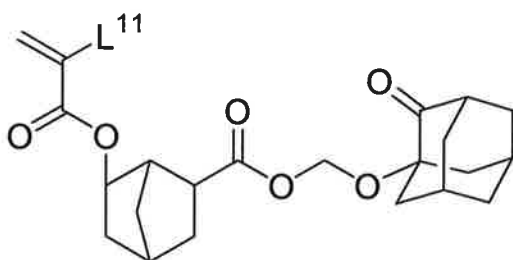
formula (A-3-4)



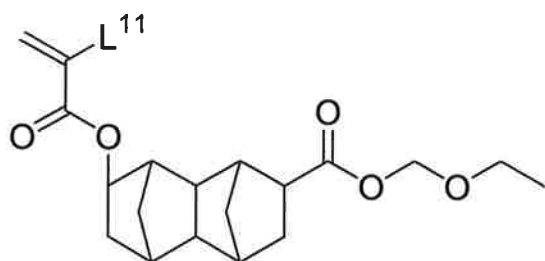
formula (A-3-5)



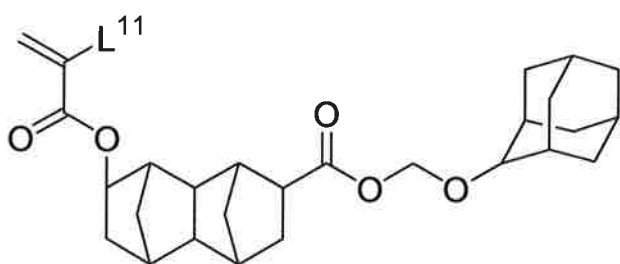
formula (A-3-6)



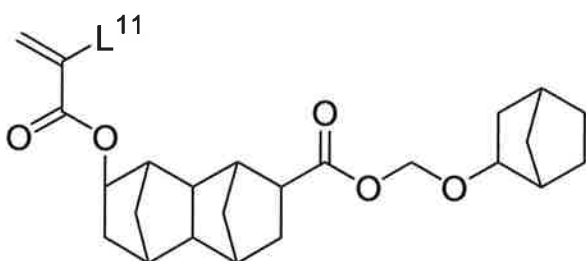
formula (A-3-7)



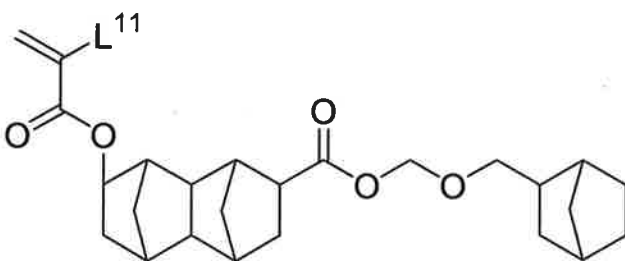
formula (A-3-8)



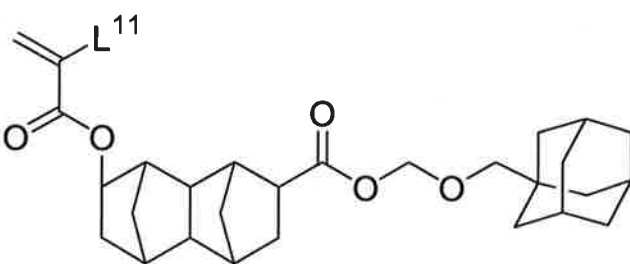
formula (A-3-9)



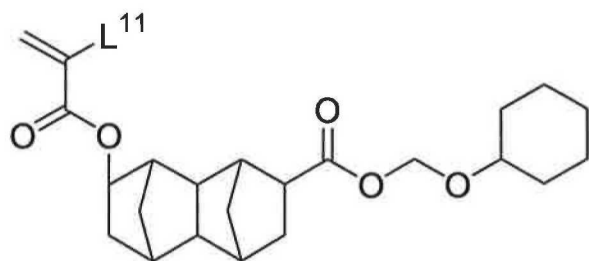
formula (A-3-10)



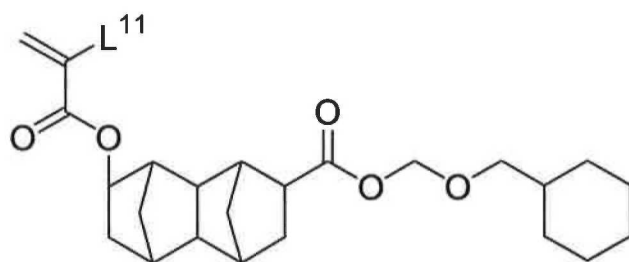
formula (A-3-11)



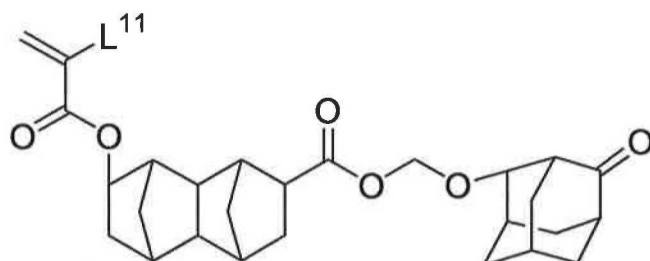
formula (A-3-12)



formula (A-3-13)



formula (A-3-14)



formula (A-3-15)

[0047] In formula (A-2-1) to formula (A-2-24) and formula (A-3-1) to formula
 5 (A-3-15), L^{11} represents a hydrogen atom or a methyl group.

Other monomers (a4)

[0048] The monomer mixture can further include other monomers (a4) other than the
 monomer (a1) to the monomer (a3) without affecting the efficacy of the invention.
 10 The other monomers (a4) are, for instance, known free radical polymerizable
 compounds or anionic polymerizable compounds.

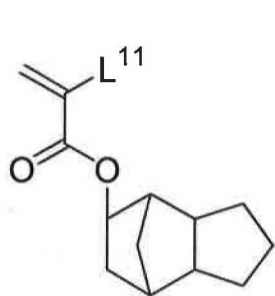
[0049] Such a polymerizable compound can include, for instance, monocarboxylic
 acid such as acrylic acid, methacrylic acid, or crotonic acid; dicarboxylic acid such as
 maleic acid, fumaric acid, or itaconic acid; methacrylic acid derivative having a

carboxyl group and an ester bond such as 2-methacryloyloxyethylsuccinic acid, 2-methacryloyloxyethylmaleic acid, 2-methacryloyloxyethyl phthalic acid, or 2-methacryloyloxyethylhexahydrophthalic acid; alkyl (meth)acrylate such as methyl (meth)acrylate, ethyl (meth)acrylate, butyl (meth)acrylate, or cyclohexyl (meth)acrylate; 5 hydroxyalkyl (meth)acrylate such as 2-hydroxyethyl (meth)acrylate or 2-hydroxypropyl (meth)acrylate; aryl (meth)acrylate such as phenyl (meth)acrylate or benzyl (meth)acrylate; dicarboxylic acid diester such as diethyl maleate or dibutyl fumarate; an aromatic compound containing a vinyl group such as styrene, α -methylstyrene, chlorostyrene, chloromethylstyrene, vinyl toluene, hydroxystyrene, 10 α -methylhydroxystyrene, or α -ethylhydroxystyrene; an aliphatic compound containing a vinyl group such as vinyl acetate; conjugated diene such as butadiene or isoprene; a polymerizable compound containing a nitrile group such as acrylonitrile or methacrylonitrile; a polymerizable compound containing chlorine such as vinyl chloride or vinylidene chloride; a polymerizable compound containing an amide bond such as 15 acrylamide or methacrylamide.

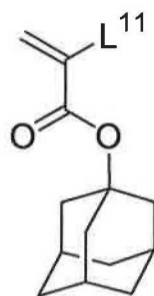
[0050] Moreover, the polymerizable compound can include, for instance, (meth)acrylate having a non-acid-dissociable aliphatic polycyclic group or an aromatic compound containing a vinyl group. The non-acid-dissociable aliphatic polycyclic group is preferably, for instance, tricyclodecanyl, adamantyl, tetracyclic dodecyl, 20 isobornyl, or norbornyl in terms of, for instance, industrial availability. Such an aliphatic polycyclic group can also have a C₁ to C₅ straight or branched alkyl group as a substituent.

[0051] The non-acid-dissociable aliphatic polycyclic group (meth)acrylate can

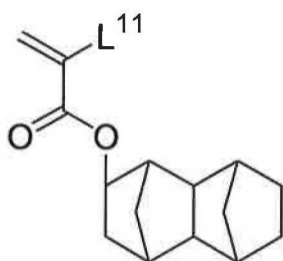
specifically include compounds represented by formula (A-4-1) to formula (A-4-5) below:



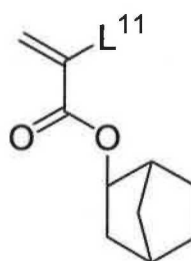
formula (A-4-1)



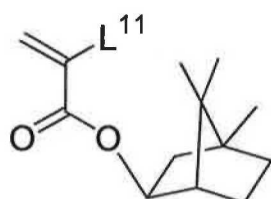
formula (A-4-2)



formula (A-4-3)



formula (A-4-4)



formula (A-4-5)

In formula (A-4-1)) to formula (A-4-5), L^{11} represents a hydrogen atom or a methyl group.

[0052] Based on a total amount of 100 parts by weight of the monomer mixture, the amount of the other monomers (a4) is 20 parts by weight to 85 parts by weight; preferably 25 parts by weight to 80 parts by weight; and more preferably 30 parts by weight to 75 parts by weight.

Manufacturing method of resin (A)

[0053] The solvent used to prepare the resin (A) includes, but is not limited to, (1) an alcohol compound such as methanol, ethanol, benzyl alcohol, 2-phenylethanol, or 3-phenyl-1-propanol; (2) an ether compound such as tetrahydrofuran; (3) a glycol ether compound such as ethylene glycol monopropyl ether, ethylene glycol monomethyl ether, or ethylene glycol monoethyl ether; (4) ethylene glycol alkyl ether acetate such as ethylene glycol butyl ether acetate, ethylene glycol ether acetate, or ethylene glycol methyl ether acetate; (5) a diethylene glycol compound such as diethylene glycol monomethyl ether, diethylene glycol monoethyl ether, diethylene glycol monobutyl ether, diethylene glycol dimethyl ether, diethylene glycol diethyl ether, or diethylene glycol methyl ethyl ether; (6) a dipropylene glycol compound such as dipropylene glycol monomethyl ether, dipropylene glycol monoethyl ether, dipropylene glycol dimethyl ether, dipropylene glycol diethyl ether, or dipropylene glycol methyl ethyl ether; (7) a propylene glycol monoalkyl ether compound such as propylene glycol monomethyl ether, propylene glycol monoethyl ether, propylene glycol monopropyl ether, or propylene glycol monobutyl ether; (8) a propylene glycol alkyl ether acetate compound such as propylene glycol monomethyl ether acetate, propylene glycol monoethyl ether acetate, propylene glycol monopropyl ether acetate, or propylene glycol monobutyl ether acetate; (9) a propylene glycol alkyl ether propionate compound such as propylene glycol methyl ether propionate, propylene glycol ethyl ether propionate, propylene glycol propyl ether propionate, or propylene glycol butyl ether propionate; (10) an aromatic hydrocarbon compound such as toluene or xylene; (11) a ketone compound such as methyl ethyl ketone, cyclohexanone, or diacetone alcohol; (12) an ester compound such as methyl acetate, ethyl acetate, propyl acetate, butyl acetate, ethyl

2-hydroxypropionate, 2-hydroxy-2-methylpropionate, 2-hydroxy-2-methylpropionate, methyl hydroxyacetate, ethyl hydroxyacetate, butyl hydroxyacetate, methyl lactate, propyl lactate, butyl lactate, methyl 3-hydroxypropionate, ethyl 3-hydroxypropionate, propyl 3-hydroxypropionate, butyl 3-hydroxypropionate, 2-hydroxy-3-methylbutanoate, methyl methoxyacetate, ethyl methoxyacetate, butyl methoxyacetate, methyl ethoxyacetate, ethyl ethoxyacetate, propyl ethoxyacetate, butyl ethoxyacetate, methyl propoxyacetate, ethyl propoxyacetate, propyl propoxyacetate, butyl propoxyacetate, methyl butoxyacetate, ethyl butoxyacetate, propyl butoxyacetate, butyl butoxyacetate, 3-methoxybutyl acetate, methyl 2-methoxypropionate, ethyl 2-methoxypropionate, propyl 2-methoxypropionate, butyl 2-methoxy propionate, methyl 2-ethoxypropionate, ethyl 2-ethoxypropionate, propyl 2-ethoxypropionate, butyl 2-ethoxypropionate, methyl 2-butoxypropionate, ethyl 2-butoxypropionate, propyl 2-butoxypropionate, butyl 2-butoxypropionate, methyl 3-methoxypropionate, ethyl 3-methoxypropionate, propyl 3-methoxypropionate, butyl 3-methoxypropionate, methyl 3-ethoxypropionate, ethyl 3-ethoxypropionate, propyl 3-ethoxypropionate, butyl 3-ethoxypropionate, methyl 3-propoxypropionate, ethyl 3-propoxypropionate, propyl 3-propoxypropionate, butyl 3-propoxypropionate, methyl 3-butoxypropionate, ethyl 3-butoxypropionate, propyl 3-butoxypropionate, or butyl 3-butoxypropionate, and the solvent can be used alone or in combination.

[0054] The polymerization initiator used to prepare the resin (A) contains, but is not limited to, an azo compound or peroxide, and can be used alone or as a mixture.

[0055] The azo compound is, but not limited to, for instance, 2,2'-azobisisobutyronitrile, 2,2'-azobis(2,4-dimethylvaleronitrile),

2,2'-azobis(4-methoxy-2,4-dimethylvaleronitrile), 2,2'-azobis-2-methyl butyronitrile, 4,4'-azobis(4-cyanovaleric acid), dimethyl 2,2'-azobis(2-methyl propionate), or 2,2'-azobis(4-methoxy-2,4-dimethylvaleronitrile).

5 [0056] The peroxide is, but not limited to, for instance: dibenzoyl peroxide, lauroyl peroxide, tert-butylperoxy-tert-valerate, 1,1-bis(t-butylperoxy)cyclohexane, or hydrogen peroxide.

[0057] The reaction temperature for preparing the resin (A) is 40 degrees to 120 degrees, and the polymerization time is 3 hours to 12 hours.

10 [0058] The weight-average molecular weight of the resin (A) is 5,000 to 50,000; preferably 6,000 to 45,000; and more preferably 7,000 to 40,000.

Novolac resin (B)

[0059] The novolac resin (B) is obtained by the polycondensation of a cresol aromatic hydroxyl compound and aldehyde.

15 [0060] In a specific example of the invention, the cresol aromatic hydroxyl compound is cresol such as m-cresol, p-cresol, or o-cresol, or xylenol such as 2,3-xylenol, 2,5-xylenol, 3,5-xylenol, or 3,4-xylenol. The compound can be used alone or in multiple combinations.

20 [0061] Without affecting the physical properties of the positive photosensitive resin composition, the novolac resin (B) of the invention can also be obtained by the polycondensation of other aromatic hydroxyl compounds and aldehydes.

[0062] In a specific example of the invention, the other aromatic hydroxyl compounds are, for instance, phenol; alkyl phenol such as m-ethylphenol, p-ethylphenol,

o-ethylphenol, 2,3,5-trimethylphenol, 2,3,5-triethylphenol, 4-tert-butylphenol, 3-tert-butylphenol, 2-tert-butylphenol, 2-tert-butyl-4-methylphenol, 2-tert-butyl-5-methylphenol, or 6-tert-butyl-3-methylphenol; alkoxy phenol such as p-methoxyphenol, m-methoxyphenol, p-ethoxyphenol, m-ethoxyphenol, 5 p-propoxyphenol, or m-propoxyphenol; isopropenyl phenol such as o-isopropenylphenol, p-isopropenylphenol, 2-methyl-4-isopropenylphenol, or 2-ethyl-4-isopropenylphenol; aryl phenol such as phenyl phenol; polyhydroxyphenol such as 4,4'-dihydroxybiphenyl, bisphenol A, resorcinol, hydroquinone, or pyrogallol.

[0063] In a specific example of the invention, the aldehyde polycondensed with the 10 cresol aromatic hydroxyl compound is, for instance: formaldehyde, paraformaldehyde, trioxane, acetaldehyde, propionaldehyde, butyraldehyde, trimethylacetaldehyde, acrolein, crotonaldehyde, cyclo hexanealdehyde, furfural, furylacrolein, benzaldehyde, terephthal aldehyde, phenylacetaldehyde, α -phenylpropanal, β -phenylpropanal, o-hydroxybenzaldehyde, m-hydroxybenzaldehyde, p-hydroxybenzaldehyde, 15 o-methylbenzaldehyde, m-methylbenzaldehyde, p-methylbenzaldehyde, o-chlorobenzaldehyde, m-chlorobenzaldehyde, p-chlorobenzaldehyde, or cinnamaldehyde. The aldehyde can be used alone or in multiple combinations. In particular, the aldehyde is preferably formaldehyde. Preferably, the novolac resin (B-2) is obtained by a condensation reaction under normal pressure in the presence of a 20 known organic acid and/or inorganic acid catalyst such as hydrochloric acid, sulfuric acid, formic acid, acetic acid, oxalic acid, or p-toluenesulfonic acid, and then performing dehydration and removing unreacted monomers. The "cresol binuclear body" of the invention refers to two m/p/o cresol monomers combined by, for instance,

m-m, o-o, or p-p and bonded by a methylene group.

[0064] In a specific example of the invention, the content of the cresol binuclear body is controlled by a fractionation technique or a vacuum distillation method. A specific example of the fractionation technique includes dissolving a synthesized novolac resin in a good solvent and then placing the mixture in a poor solvent to precipitate the novolac resin. Moreover, the vacuum distillation method includes performing vacuum distillation at a temperature of 230 °C or more, preferably 250 °C or more and a pressure of 1.3 kPa or less during the synthesis of the novolac resin.

[0065] Based on 100% of the integral area of the molecular weight of the novolac resin (B) of the invention measured by gel permeation chromatography, the cresol binuclear area in the novolac resin (B) is between 0.5% and 6%, preferably between 0.5% and 5.5%, and more preferably between 0.5% and 5.0%. If the cresol binuclear area is less than 0.5%, then the process cost is too high, and if the cresol binuclear area is greater than 6%, then rectangularity is poor.

[0066] The measurement method of the molecular weight of the novolac resin (B) of the invention is not limited, and in a specific example of the invention, the signal of a molecular weight between 200 and 150,000 of the novolac resin (B) is integrated by gel permeation chromatography, and an integral molecular weight distribution curve is obtained by molecular weight and cumulative weight percentage. In particular, the gel permeation chromatography includes a 717 plus sampling instrument made by Waters®, a 79911GP-501, 79911GP-502, 79911GP-503, or 79911GP-504 column made by Agilent Technologies® and a 2414 RI detector made by Waters®, tetrahydrofuran for the mobile phase, a flow of 1.0 mL/min, an injection volume of 100 µL, a measurement

temperature of 40 °C, a measurement time of 60 minutes, and polystyrene as the molecular weight standard.

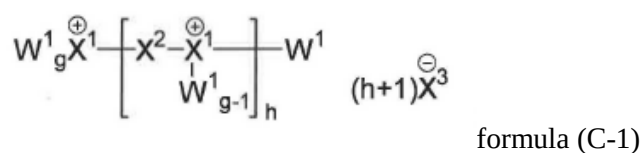
[0067] The weight-average molecular weight of the novolac resin (B) is 4,000 to 36,000; preferably 5,000 to 30,000; and more preferably 6,000 to 24,000.

- 5 **[0068]** Based on a total amount of 100 parts by weight of the resin (A), the amount of the novolac resin (B) is 20 parts by weight to 150 parts by weight, preferably 25 parts by weight to 140 parts by weight, and more preferably 30 parts by weight to 130 parts by weight.

10 **Photoacid generator (C)**

[0069] The photoacid generator (C) is a compound generating acid via actinic ray or radiation and is not particularly limited as long as it is a compound that can directly or indirectly generate acid via light. The photoacid generator (C) is preferably an acid generator of the first to fifth forms described below. In the following, the first to fifth forms of the photoacid generator (C) suitable for the photosensitive resin composition are described.

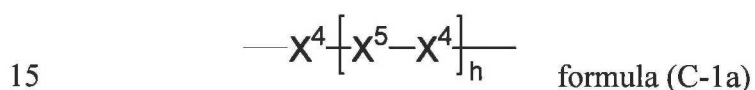
[0070] The first form of the photoacid generator (C) can include a compound represented by formula (C-1) below:



- 20 In formula (C-1), X^1 represents a g-valence sulfur atom or iodine atom, and g is 1 or 2. h represents the number of repeating units of the structure in the parenthesis. W^1 is an organic group bonded to X^1 , and represents a C_6 to C_{30} aryl group, a C_4 to C_{30}

heterocyclic group, a C₁ to C₃₀ alkyl group, a C₂ to C₃₀ alkenyl group, or a C₂ to C₃₀ alkynyl group, and W¹ can be substituted by at least 1 selected from the group consisting of an alkyl group, a hydroxyl group, an alkoxy group, an alkylcarbonyl group, an arylcarbonyl group, an alkoxycarbonyl group, an aryloxycarbonyl group, an aryl thiocarbonyl group, an acyloxy group, an arylthio group, an alkylthio group, an aryl group, a hetero ring group, an aryloxy group, an alkanesulfinyl group, an aryl sulfonamide group, an alkyl sulfonyl group, an aryl sulfonyl group, an alkoxy group, an amine group, a cyano group, a nitro group, and a halogen. The number of W¹ is g+h(g-1)+1, and W¹ can respectively be the same or different. Moreover, 2 or more W¹ can be directly bonded to one another or form a ring structure containing X¹ by bonding with -O-, -S-, -SO-, -SO₂-, -NH-, -NW²-, -CO-, -COO-, -CONH-, a C₁ to C₃ alkylene group, or a phenylene group. W² is a C₁ to C₅ alkyl group or a C₆ to C₁₀ aryl group.

[0071] X² is a structure represented by formula (C-1a) below:

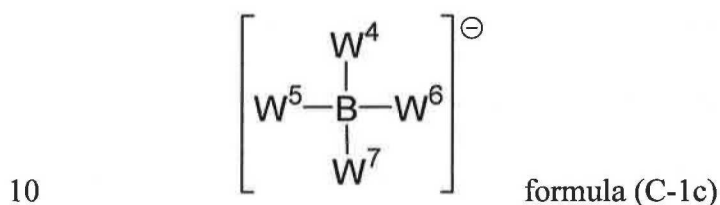


In formula (C-1a), X⁴ represents a C₁ to C₈ alkylene group, a C₆ to C₂₀ arylene group, or a C₈ to C₂₀ bivalent hybrid, and X⁴ can be substituted by at least 1 selected from the group consisting of a C₁ to C₈ alkyl group, a C₁ to C₈ alkoxy group, a C₆ to C₁₀ aryl group, a hydroxyl group, a cyano group, a nitro group, and a halogen. X⁵ represents -O-, -S-, -SO-, -SO₂-, -NH-, -NW²-, -CO-, -COO-, -CONH-, a C₁ to C₃ alkylene group, or a phenylene group. h represents the number of repeating units of the structure in the parenthesis. An h+1 number of X⁴ and h number of X⁵ can respectively be the same or different. W² is as defined above.

[0072] $(X^3)^-$ is the counter ion of onium, and the fluoroalkyl fluorophosphate anion represented by formula (C-1b) or the borate anion represented by formula (C-1c) below can be included:



In formula (C-1b), W^3 represents an alkyl group for which 80% or more of hydrogen atoms are substituted by fluorine atoms. j represents the number thereof, and is an integer of 1 to 5. A j number of W^3 can respectively be the same or different.

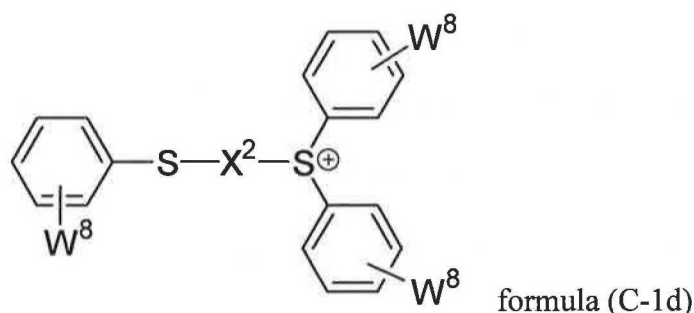


In formula (C-1c), W^4 to W^7 respectively independently represent a fluorine atom or a phenyl group, and some or all of the hydrogen atoms in the phenyl group can be substituted by at least 1 selected from the group consisting of a fluorine atom and a trifluoromethyl group.

- 15 [0073] The onium ion in the compound represented by formula (C-1) can include, for instance, triphenyl sulfonium, tri-p-tolyl sulfonium, 4-(phenylthio)phenyl diphenyl, bis[4-(diphenylchyl)phenyl]sulfide,
bis[4-{bis[4-(2-hydroxyethoxy)phenyl]sulfonium}phenyl]sulfide,
bis{4-[bis(4-fluorophenyl)sulfonium]phenyl}sulfide,
20 4-(4-benzyl-2-chlorophenylthio)phenylbis(4-fluorophenyl)sulfonium,
7-isopropyl-9-oxo-10-thia-9,10-dihydroanthracen-2-yl di-p-tolyl sulfonium,

7-isopropyl-9-oxo-10-thia-9,10-dihydroanthracen-2-yl diphenyl sulfonium,
 2-[(diphenyl)sulfonium]thioxanthone, 4-[4-(4-tert-butylbenzyl)phenylthio]phenyl
 di-p-tolylene sulfonium, 4-(4-benzylphenylphenylthio)phenyl diphenyl, diphenyl
 phenylacetyl sulfonium, 4-hydroxyphenylmethylbenzylidene sulfonium,
 5 2-naphthylmethyl(1-ethoxycarbonyl)ethyl sulfonium,
 4-hydroxyphenylmethylphenylethylidene sulfonium,
 phenyl[4-(4-biphenylthio)phenyl]4-biphenyl sulfonium,
 phenyl[4-(4-biphenylthio)phenyl]3-biphenyl sulfonium,
 [4-(4-ethylphenylthio)phenyl]diphenylphosphine sulfonium, octadecyl methyl
 10 phenylacetyl sulfonium, diphenyliodonium, di-p-tolyl iodide,
 bis(4-dodecylphenyl)iodonium, bis(4-methoxyphenyl)iodonium,
 (4-octyloxyphenyl)phenyl iodonium, bis(4-dodecyloxy)phenyl iodonium,
 4-(2-hydroxytetradecanoxy)phenylphenyl, 4-isopropylphenyl (p-tolyl)iodonium, or
 4-isobutylphenyl (p-tolyl)iodonium.

15 **[0074]** Among the onium ions in the compound represented by formula (C-1),
 preferred onium ions can include sulfonium ions represented by formula (C-1d) below:



In formula (C-1d), W^8 respectively independently represent a group selected
 from the group consisting of a hydrogen atom, an alkyl group, a hydroxyl group, an
 20 alkoxy group, an alkylcarbonyl group, an alkylcarbonyloxy group, an alkoxycarbonyl

group, a halogen atom, an aryl group that can have a substituent, and an arylcarbonyl group. X^2 is defined the same as the X^2 in formula (C-1).

[0075] Specific examples of the sulfonium ion represented by formula (C-1d) can

include 4-(phenylthio)phenyl diphenyl sulfonium,

5 4-(4-benzyl-2-chlorophenylthio)phenylbis(4-fluorophenyl)sulfonium,

4-(4-benzylphenylphenylthio)phenyl diphenyl sulfonium,

phenyl[4-(4-biphenylthio)phenyl]4-biphenyl sulfonium,

phenyl[4-(4-biphenylthio)phenyl]3-biphenyl sulfonium,

[4-(4-ethylphenylthio)phenyl]diphenylphosphine sulfonium, or

10 diphenyl[4-(p-triphenylthio)phenyl]diphenylphosphine sulfonium.

[0076] In the fluoroalkyl fluorophosphate anion represented by formula (C-1b), W^3

represents an alkyl group substituted by a fluorine atom, and is preferably C_1 to C_8 , more preferably C_1 to C_4 . Specific examples of the alkyl group can include, for

instance, a straight alkyl group such as methyl group, ethyl group, propyl group, butyl

15 group, pentyl group, or octyl group; a branched alkyl group such as isopropyl group,

isobutyl group, sec-butyl group, or tert-butyl group; a cycloalkyl group such as

cyclopropyl group, cyclobutyl group, cyclopentyl group, or cyclohexyl group. The

ratio of hydrogen atoms of the alkyl group substituted by fluorine atoms is generally

80% or more, preferably 90% or more, and more preferably 100%. If the substitution

20 rate of the fluorine atom does not reach 80%, then the acid strength of the onium

fluoroalkyl fluorophosphate represented by formula (C-1) is reduced.

[0077] More preferably, W^3 is C_1 to C_4 , and the substitution rate of the fluorine atom

is 100% of a straight or branched perfluoroalkyl group. Specific examples can include

CF₃, CF₃CF₂, (CF₃)₂CF, CF₃CF₂CF₂, CF₃CF₂CF₂CF₂, (CF₃)₂CFCF₂, CF₃CF₂(CF₃)CF, (CF₃)₃C. The number j of W³ is an integer of 1 to 5, preferably 2 to 4, and more preferably 2 or 3.

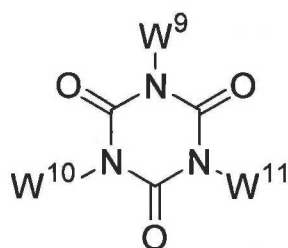
[0078] Preferred specific examples of the fluoroalkyl fluorophosphate anion can include [(CF₃CF₂)₂PF₄]⁻, [(CF₃CF₂)₃PF₃]⁻, [((CF₃)₂CF)₂PF₄]⁻, [((CF₃)₂CF)₃PF₃]⁻, [(CF₃CF₂CF₂)₂PF₄]⁻, [(CF₃CF₂CF₂)₃PF₃]⁻, [((CF₃)₂CFCF₂)₂PF₄]⁻, [((CF₃)₂CFCF₂)₃PF₃]⁻, [(CF₃CF₂CF₂CF₂)₂PF₄]⁻, or [(CF₃CF₂CF₂)₃PF₃]⁻. Among these, the following are preferred: [(CF₃CF₂)₃PF₃]⁻, [(CF₃CF₂CF₂)₃PF₃]⁻, [((CF₃)₂CF)₃PF₃]⁻, [((CF₃)₂CF)₂PF₄]⁻, [((CF₃)₂CFCF₂)₃PF₃]⁻, or [((CF₃)₂CFCF₂)₂PF₄]⁻.

[0079] Preferred specific examples of the borate anion represented by formula (C-1c) can include, for instance, [B(C₆F₅)₄]⁻, [B(C₆H₄CF₃)₄]⁻, [(C₆F₅)₂BF₂]⁻, [(C₆F₅)BF₃]⁻, or [B(C₆H₃F₂)₄]⁻. Among these, [B(C₆F₅)₄]⁻ is more preferred.

[0080] The second form of the acid generator (A) can include a triazine compound containing halogen such as 2,4-bis(trichloromethyl)-6-piperonyl-1,3,5-triazine,

15	2,4-bis(trichloromethyl)-6-[2-(2-furyl)ethenyl]symmetric	triazine,
	2,4-bis(trichloromethyl)-6-[2-(5-methyl-2-furyl)ethenyl]symmetric	triazine,
	2,4-bis(trichloromethyl)-6-[2-(5-ethyl-2-furyl)ethenyl]symmetric	triazine,
	2,4-bis(trichloromethyl)-6-[2-(5-propyl-2-furyl)ethenyl]symmetrical	triazine,
	2,4-bis(trichloromethyl)-6-[2-(3,5-dimethoxyphenyl)ethenyl]symmetric	triazine,
20	2,4-bis(trichloromethyl)-6-[2-(3,5-diethoxyphenyl)ethenyl]symmetric	triazine,
	2,4-bis(trichloromethyl)-6-[2-(3,5-dipropoxyphenyl)ethenyl]symmetric	triazine,
	2,4-bis(trichloromethyl)-6-[2-(3-methoxy-5-ethoxyphenyl)ethenyl],	
	2,4-bis(trichloromethyl)-6-[2-(3-methoxy-5-propoxyphenyl)ethenyl]symmetric	triazine,

- 2,4-bis(trichloromethyl)-6-[2-(3,4-methylenedioxyphenyl)ethenyl]symmetric triazine,
 2,4-bis(trichloromethyl)-6-(3,4-methylenedioxyphenyl)symmetric triazine,
 2,4-bis-trichloromethyl-6-(3-bromo-4-methoxy)phenyl symmetric triazine,
 2,4-bis-trichloromethyl-6-(2-bromo-4-methoxy)phenyl symmetric triazine,
 5 2,4-bis-trichloromethyl-6-(2-bromo-4-methoxy)styrylphenyl symmetric triazine,
 2,4-bis-trichloromethyl-6-(3-bromo-4-methoxy)styrylphenyl symmetric triazine,
 2-(4-methoxyphenyl)-4,6-bis(trichloromethyl)-1,3,5-triazine,
 2-(4-methoxynaphthyl)-4,6-bis(trichloromethyl)-1,3,5-triazine,
 2-[2-(2-furyl)ethenyl]-4,6-bis(trichloromethyl)-1,3,5-triazine,
 10 2-[2-(5-methyl-2-furyl)ethenyl]-4,6-bis(trichloromethyl)-1,3,5-triazine,
 2-[2-(3,5-dimethoxyphenyl)vinyl]-4,6-bis(trichloromethyl)-1,3,5-triazine,
 2-[2-(3,4-dimethoxyphenyl)vinyl]-4,6-bis(trichloromethyl)-1,3,5-triazine,
 2-(3,4-methylenedioxyphenyl)-4,6-bis(trichloromethyl)-1,3,5-triazine,
 tris(1,3-dibromopropyl)-1,3,5-triazine, or tris(2,3-dibromopropyl)-1,3,5-triazine, and a
 15 triazine compound containing halogen represented by formula (C-2) below such as
 tris(2,3-dibromopropyl)triisocyanate.



formula (C-2)

In formula (C-2), W^9 to W^{11} respectively independently represent a haloalkyl group.

- 20 **[0081]** Moreover, the third form of the photoacid generator (C) can include α -(p-toluenesulfonyloxyimino)-phenylacetonitrile,

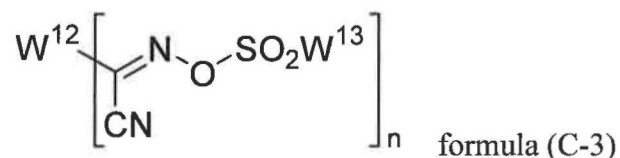
α -(benzenesulfonyloxyimino)-2,4-dichlorophenylacetonitrile,

α -(benzenesulfonyloxyimino)-2,6-dichlorophenylacetonitrile,

α -(2-chlorobenzenesulfonyloxyimino)-4-methoxyphenylacetonitrile,

α -(ethylsulfonyloxyimino)-1-chloropentenylacetonitrile, and a compound containing an

5 oxime sulfonate group represented by formula (C-3) below.



In formula (C-3), W^{12} represents a monovalent, a divalent, or a trivalent organic group, W^{13} represents a substituted or unsubstituted saturated hydrocarbon group, a unsaturated hydrocarbon group, or an aromatic compound group, and n

10 represents the number of repeating units of the structure in the parenthesis.

[0082] In formula (C-3), the aromatic compound group represents a group of a compound that allows an aromatic compound to display special physical properties and chemical properties, and can include, for instance, an aryl group such as phenyl group or naphthyl group or a heteroaryl group such as furanyl group or thienyl group. These can

15 also have 1 or more of a suitable substituent on a ring, such as halogen atom, alkyl group, alkoxy group, or nitro group. Moreover, W^{13} is more preferably a C_1 to C_6 alkyl group, and can include a methyl group, an ethyl group, a propyl group, or a butyl group. More preferably, W^{12} is an aromatic compound group, and W^{13} is a compound of a C_1 to C_4 alkyl group.

20 [0083] For the photoacid generator represented by formula (C-3), when $n=1$, W^{12} can be any of a phenyl group, methylphenyl group, or methoxyphenyl group, W^{13} is a compound of a methyl group, and can specifically include, for instance,

α -(methanesulfonyloxyimino)-1-phenylacetonitrile,

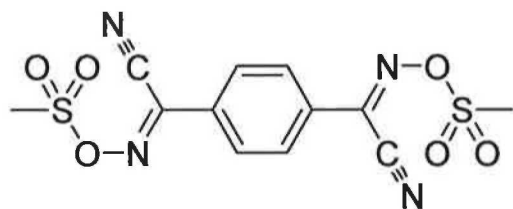
α -(methanesulfonyloxyimino)-1-(p-methylphenyl)acetonitrile,

α -(methanesulfonyloxyimino)-1-(p-methoxyphenyl)acetonitrile,

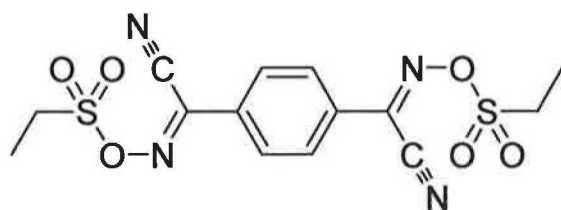
or

[2-(propanesulfoxyimino)-2,3-dihydroxythiophene-3-ylidene](o-tolyl)acetonitrile.

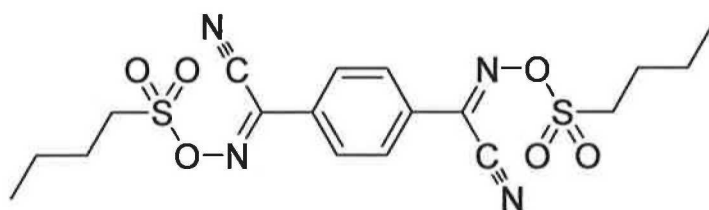
- 5 When $n=2$, the acid generator represented by formula (C-3) specifically can include the acid generators represented by formula (C-3-1) to formula (C-3-8) shown below:



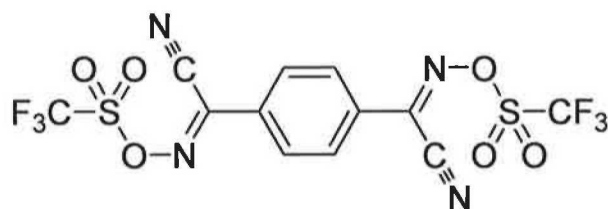
formula (C-3-1)



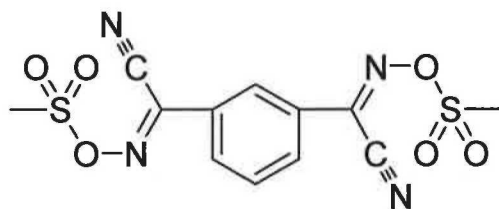
formula (C-3-2)



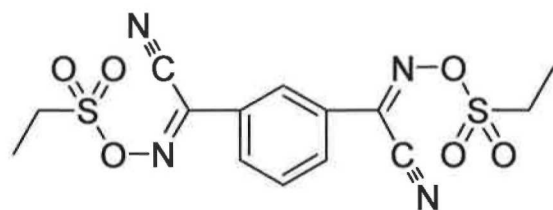
formula (C-3-3)



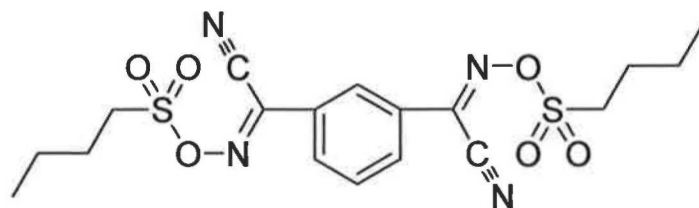
formula (C-3-4)



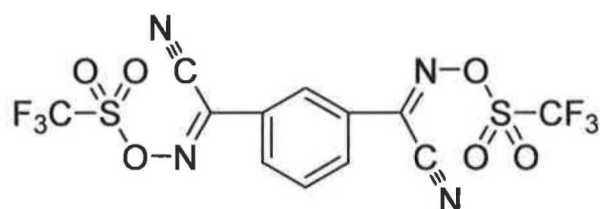
formula (C-3-5)



formula (C-3-6)



formula (C-3-7)



formula (C-3-8)

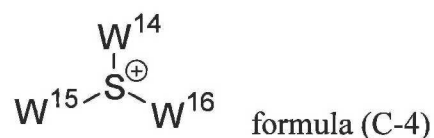
[0084] Moreover, the fourth form of the photoacid generator (C) can include onium

5 salt for which the cation portion has a naphthalene ring. "Having a naphthalene ring" refers to a structure derived from naphthalene, i.e., a structure of at least 2 rings, and the aromatic properties between the rings can be maintained. The naphthalene ring can also have a substituent such as a C₁ to C₆ straight or branched alkyl group, a hydroxyl group, or a C₁ to C₆ straight or branched alkoxy group. The structure derived from the

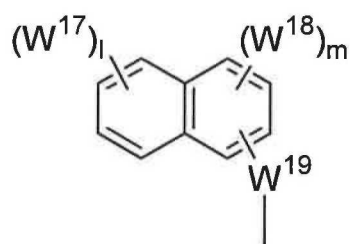
10 naphthalene ring can be monovalent (free valency of 1), and can also be bivalent (free valency of 2) or more, and monovalent is more preferred (however, at this point, the portion bonded to the substituent is removed to calculate the free valency). The number of the naphthalene ring is preferably 1 to 3.

[0085] The cation portion of onium salt having a naphthalene ring is preferably a

15 structure represented by formula (C-4) below:



In formula (C-4), at least one of W^{14} to W^{16} represents a group represented by formula (C-4a) below, and the rest represent a C_1 to C_6 straight or branched alkyl group, a phenyl group that can have a substituent, a hydroxyl group, or a C_1 to C_6 straight or branched alkoxy group. Or, one of W^{14} to W^{16} is a group represented by formula (C-4a) below, and the other two are respectively independently a C_1 to C_6 straight or branched alkylene group, and the ends of the alkylene group can be bonded to form a ring.



formula (C-4a)

In formula (C-4a), W^{17} and W^{18} respectively independently represent a hydroxyl group, a C_1 to C_6 straight or branched alkoxy group, or a C_1 to C_6 straight or branched alkyl group, and W^{19} represents a single bond or a C_1 to C_6 straight or branched alkylene group that can have a substituent. l and m respectively independently represent an integer of 0 to 2, and $l+m$ is 3 or less. When a plurality of W^{17} exists, they can be the same or different. When a plurality of W^{18} exists, they can be the same or different.

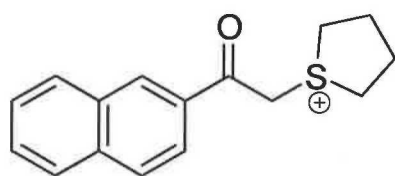
[0086] The number of the group represented by formula (C-4a) in W^{14} to W^{16} is preferably 1 from the stability viewpoint of the compound, the rest are C_1 to C_6 straight or branched alkylene groups, and the ends of the alkylene groups can be bonded to form

a ring. At this point, the 2 alkylene groups can contain a sulfur atom to form a 3- to 9-membered ring. The number of the atoms (containing sulfur atoms) forming the ring is preferably 5 to 6.

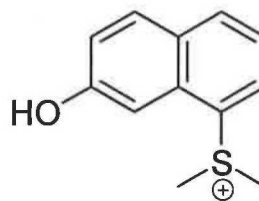
[0087] Moreover, the substituent that may be included in the alkylene group can be, for instance, an oxygen atom (here, a carbonyl group is formed by the oxygen atom with the carbon atom forming the alkylene group) or a hydroxyl group.

[0088] Moreover, the substituent for the phenyl group can include, for instance, a hydroxyl group, a C₁ to C₆ straight or branched alkoxy group, or a C₁ to C₆ straight or branched alkyl group.

[0089] Suitable cation portions can include formulas (C-4b) and (C-4c) below, in particular the structure represented by formula (C-4c) below.



formula (C-4b)



formula (C-4c)

[0090] The cation portion can be iodised salt or sulfonium salt; and sulfonium salt is preferred from the perspective of, for instance, acid generation efficiency.

[0091] Therefore, the anion portion having onium salt of a naphthalene ring is preferably an anion that can form sulfonium salt.

[0092] The anion portion used as such an acid generator is a fluoroalkylsulfonic acid ion or aryl sulfonic acid ion for which some or all of the hydrogen atoms are fluorinated.

[0093] The alkyl group in the fluoroalkylsulfonic acid ion can be C₁ to C₂₀ and straight, branched, or cyclic, and based on the volume of the resulting acid and the

diffusion distance thereof, C₁ to C₁₀ is preferred. In particular, branches or rings are preferred due to short diffusion distance. Moreover, in terms of affordable synthesis, a methyl group, an ethyl group, a propyl group, a butyl group, or an octyl group...etc. is preferred.

5 [0094] The aryl group in the aryl sulfonic acid ion is a C₆ to C₂₀ aryl group, and can include a phenyl group or a naphthyl group that can be substituted by an alkyl group or a halogen atom. In particular, in terms of affordable synthesis, a C₆ to C₁₀ aryl group is preferred. Preferred specific examples can include, for instance, a phenyl group, a toluenesulfonyl group, an ethylphenyl group, a naphthyl group, or a methyl naphthyl
10 group.

[0095] In the fluoroalkylsulfonic acid ion or aryl sulfonic acid ion, the fluorination rate when some or all of the hydrogen atoms are fluorinated is preferably 10% to 100%, more preferably 50% to 100%, and preferably, all of the hydrogen atoms are substituted by fluorine atoms due to increased acid strength. Among these,
15 trifluoromethanesulfonate, perfluorobutanesulfonate, perfluorooctanesulfonate, or perfluorobenzenesulfonate...etc. can specifically be used.

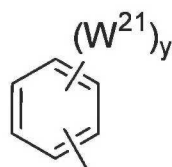
[0096] Among these, a preferred anion portion can include formula (C-4d) below:



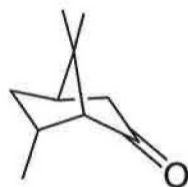
20

In formula (C-4d), W²⁰ is a group represented by formulas (C-4e), (C-4f), and (C-4g) below.

$-C_xF_{2x+1}$ formula (C-4e)



formula (C-4f)

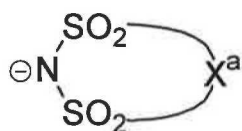


formula (C-4g)

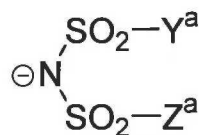
In formula (C-4e), x represents an integer of 1 to 4. In formula (C-4f), W^{21} represents a hydrogen atom, a hydroxyl group, a C_1 to C_6 straight or branched alkyl group, or a C_1 to C_6 straight or branched alkoxy group, and y represents an integer of 1 to 3. Among these, from the safety perspective, trifluoromethanesulfonate or perfluorobutanesulfonate is preferred.

[0097] Moreover, the anion portion can also include formula (C-4h) or formula (C-4i)

10 containing nitrogen below.



formula (C-4h)



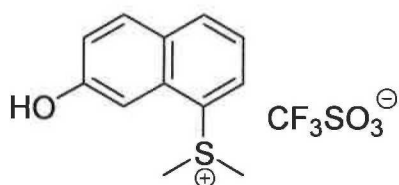
formula (C-4i)

In formula (C-4h) and formula (C-4i), X^a represents a straight or branched alkylene group for which at least 1 hydrogen atom is substituted by a fluorine atom, and the alkylene group is C_2 to C_6 , preferably C_3 to C_5 , and most preferably C_3 . Moreover, Y^a and Z^a respectively independently represent a straight or branched alkyl group for which at least 1 hydrogen atom is substituted by a fluorine atom, and the alkyl group is C_1 to C_{10} , preferably C_1 to C_7 , and more preferably C_1 to C_3 .

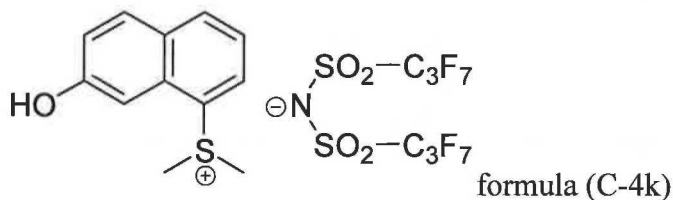
[0098] The less carbon atoms the alkylene group of X^a has or the less carbon atoms the alkyl group of Y^a and Z^a has, the better the solubility of the organic solvent, which is preferred.

[0099] Moreover, in the alkylene group of X^a or the alkyl group of Y^a and Z^a, a greater number of hydrogen atoms substituted by fluorine atoms results in greater acid strength, which is preferred. The ratio of fluorine atoms in the alkylene group or alkyl group, i.e., the fluorination rate, is preferably 70% to 100%, more preferably 90% to 100%, and a perfluoroalkyl group or a perfluoroalkyl group for which all of the hydrogen atoms are substituted by fluorine atoms is most preferred.

[0100] The onium salt having a naphthalene ring suitable for the cation portion can include compounds represented by formula (C-4j) and formula (C-4k) below:



10 formula (C-4j)



formula (C-4k)

[0101] Moreover, the fifth form of the photoacid generator (C) can include, for instance, dicarboxyl diazomethane such as bis(p-toluenesulfonyl)diazomethane, bis(1,1-dimethylethylsulfonyl)diazomethane, bis(cyclohexylsulfonyl)diazomethane, or bis(2,4-dimethylphenylsulfonyl)diazomethane; a methyl nitrobenzyl derivative such as methyl 2-nitrobenzyl p-toluenesulfonate, methyl 2,6-dinitrobenzyl p-toluenesulfonate, methyl nitrobenzene tosylate, methyl dinitrobenzene tosylate, methyl nitrobenzene sulfonate, methyl nitrobenzyl carbonate, or methyl dinitrobenzyl carbonate; sulfonate such as pyrogallol trifluoromethanesulfonate, pyrogallol trimethyl tosylate,

phenylmethyl toluenesulfonate, benzyl sulfonate, N-methanesulfonyl oxysuccinimide, N-trichloromethylsulfoxysuccinimide, N-phenylsulfonyloxy maleimide, or N-methanesulfonyloxyphthalimide; trifluoromethanesulfonate such as N-hydroxyphthalimide or N-hydroxynaphthyl imide; onium salt such as

- 5 diphenylphosphonium hexafluorophosphate, (4-methoxyphenyl)phenyl trifluoromethanesulfonate, bis(p-tert-butylphenyl)iodonium triflate, triphenylphosphonium hexafluorophosphate, (4-methoxyphenyl)diphenylphosphonium trifluoromethanesulfonate, or (p-tert-butylphenyl)diphenyl sulfonium trifluoromethanesulfonate; benzoin toluene sulfonate such as benzoin toluene sulfonate
10 or a-methyl benzoin toluene sulfonate; other diphenyliodonium salt, triphenyl sulfonium salt, phenyl diazonium salt, or methyl phenyl carbonate.

The photoacid generator (C) can be used alone, and can also be used in a combination of 2 or more.

- [0102]** Moreover, based on a total amount of 100 parts by weight of the resin (A), the
15 amount of the photoacid generator (C) is 0.5 parts by weight to 5 parts by weight, preferably 0.6 parts by weight to 4.5 parts by weight, and more preferably 0.7 parts by weight to 4 parts by weight.

Solvent (D)

- 20 **[0103]** The type of the solvent (D) is not particularly limited as long as the scope of the objects of the invention is not affected, and a suitable organic solvent commonly used in a positive photosensitive resin composition can be used.

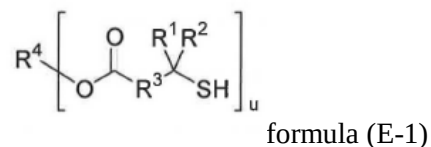
[0104] Specific examples of the solvent (D) can include, for instance, ketone such as

acetone, methyl ethyl ketone, cyclohexanone, methyl isopentyl ketone, or 2-heptanone; polyol and the derivative thereof such as monomethyl ether, monoethyl ether, monopropyl ether, monobutyl ether, or monophenyl ether of ethylene glycol, ethylene glycol monoacetate, diethylene glycol, diethylene glycol monoacetate, propylene glycol, propylene glycol monoacetate, dipropylene glycol, diethylene glycol dimethyl ether, and dipropylene glycol monoacetate; cyclic ether such as dioxane; ester such as ethyl formate, methyl lactate, ethyl lactate, methyl acetate, ethyl acetate, butyl acetate, methyl pyruvate, methyl acetoacetate, ethyl acetoacetate, ethyl pyruvate, ethyl ethoxyacetate, methyl methoxypropionate, ethyl ethoxypropionate, methyl 2-hydroxypropionate, ethyl 2-hydroxypropionate, ethyl 2-hydroxy-2-methylpropionate, methyl 2-hydroxy-3-methylbutanoate, 3-methoxybutyl acetate, or 3-methyl-3-methoxybutyl acetate; aromatic hydrocarbon such as toluene or xylene. These can be used alone and can also be used in a mixture of 2 or more.

[0105] Based on a total amount of 100 parts by weight of the resin (A), the amount of the solvent (D) is 30 parts by weight to 360 parts by weight, preferably 40 parts by weight to 300 parts by weight, and more preferably 50 parts by weight to 240 parts by weight.

Thiol compound (E)

[0106] The thiol compound (E) has a structure represented by formula (E-1) below:



In formula (E-1), R^1 and R^2 each independently represent a hydrogen atom or

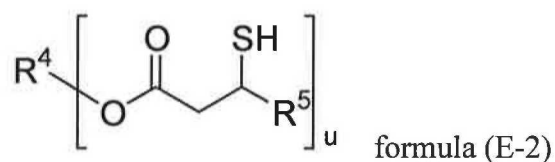
a C₁ to C₄ alkyl group, R³ represents a single bond or a C₁ to C₁₀ alkylene group, and R⁴ represents a u-valence organic group; and u represents an integer of 2 to 6.

[0107] When R¹ and R² are alkyl groups, the alkyl groups can be straight or branched, preferably straight. When R¹ and R² are alkyl groups, the alkyl groups are preferably C₁ to C₄, more preferably C₁ or C₂, and most preferably C₁. The combination of R¹ and R² is preferably a hydrogen atom and an alkyl group, more preferably a hydrogen atom and a methyl group.

[0108] When R³ is an alkylene group, the alkylene group can be straight or branched, preferably straight. When R³ is an alkylene group, the alkylene group is preferably C₁ to C₁₀, more preferably C₁ to C₅, still more preferably C₁ or C₂, and most preferably C₁.

[0109] The u-valence organic group defined by R⁴ is specifically a 2- to 6-valence aliphatic group that can contain an atom other than carbon. Atoms in R⁴ other than carbon can include, for instance, a nitrogen atom, an oxygen atom, a sulfur atom, a fluorine atom, a chlorine atom, a bromine atom, and an iodine atom. The structure of the aliphatic group of R⁴ can be straight, branched, or cyclic, and can also be a structure formed by the combination of such structures.

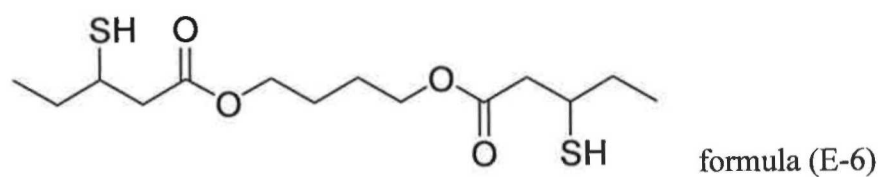
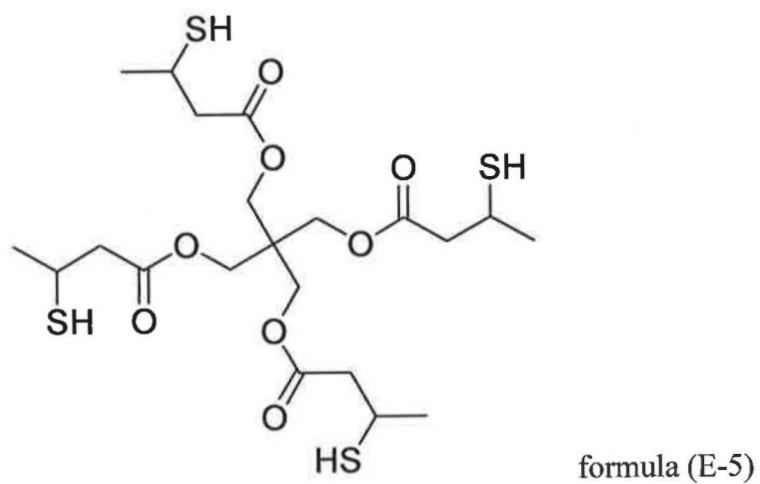
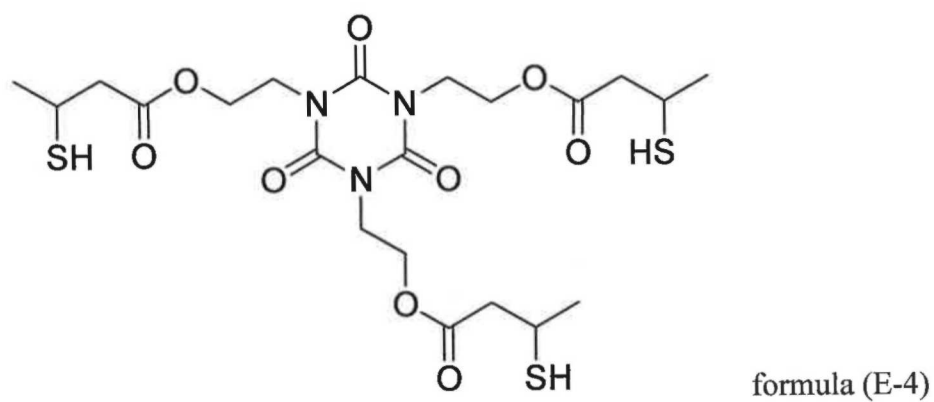
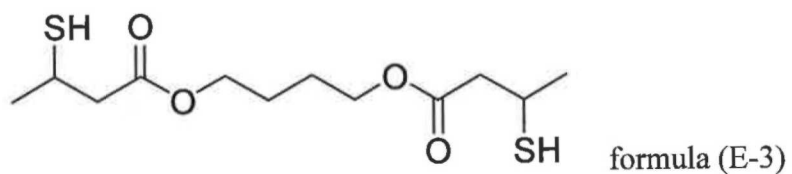
[0110] In the thiol compound (E) represented by formula (E-1), the compound represented by formula (E-2) below is more preferred:

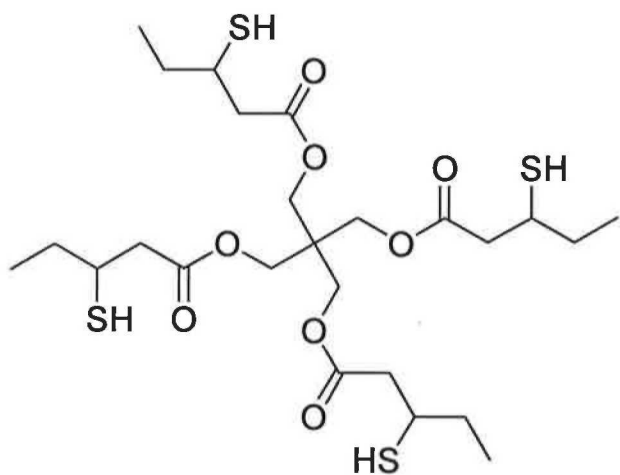


In formula (E-2), the definitions of R⁴ and u are the same as formula (E-1), and R⁵ is a hydrogen atom or a C₁ to C₄ alkyl group.

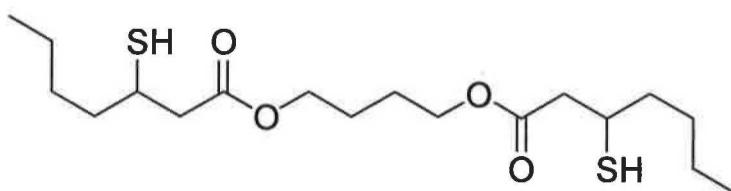
[0111] Specific examples of the thiol compound (E) can include formula (E-3) to

formula (E-16), but are not limited to these specific examples:

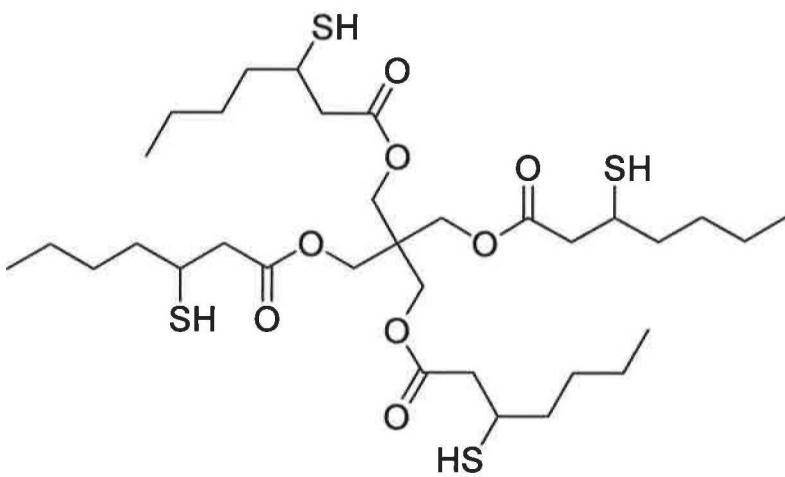




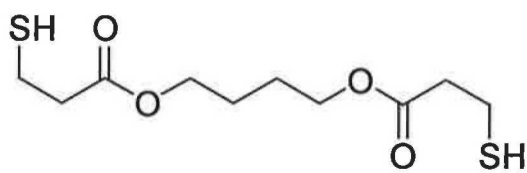
formula (E-7)



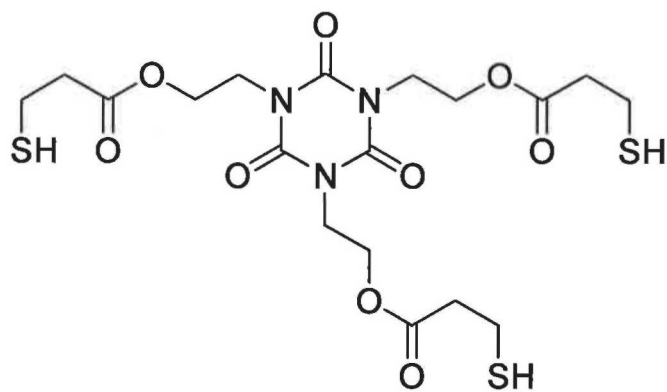
formula (E-8)



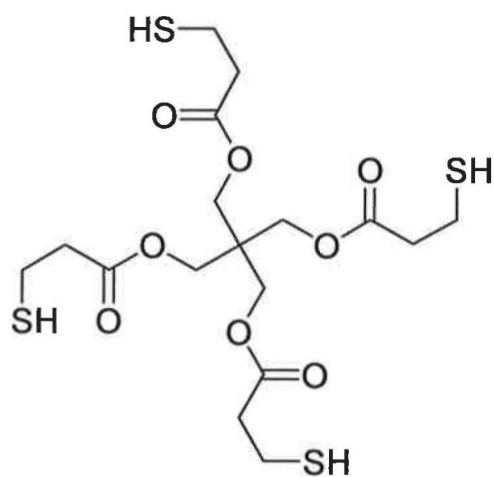
formula (E-9)



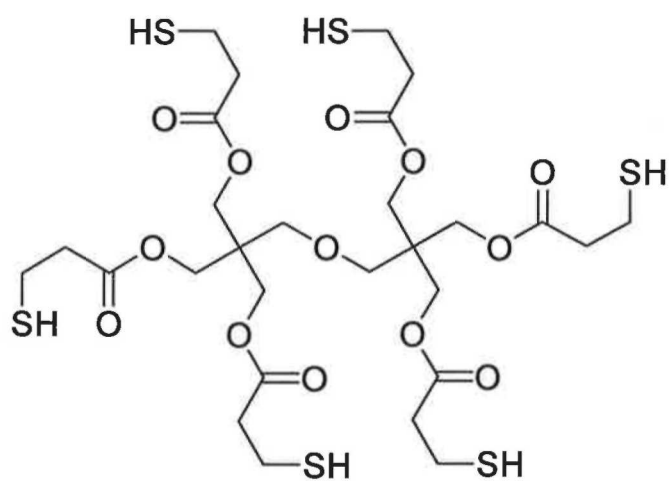
formula (E-10)



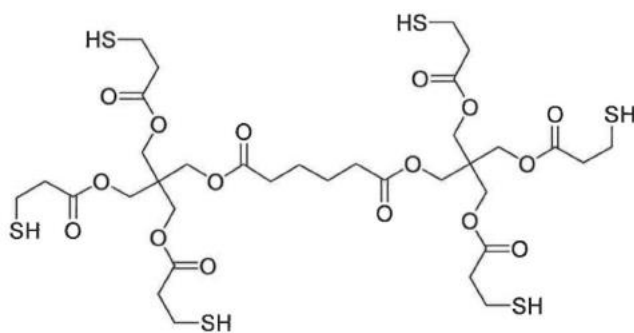
formula (E-11)



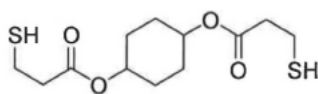
formula (E-12)



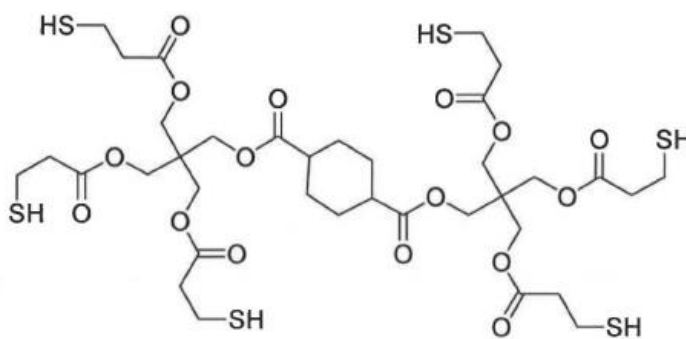
formula (E-13)



formula (E-14)



formula (E-15)



formula (E-16)

5

[0112] Based on a total amount of 100 parts by weight of the resin (A), the amount of the thiol compound (E) is 0.3 parts by weight to 3 parts by weight, preferably 0.4 parts by weight to 2.8 parts by weight, and more preferably 0.5 parts by weight to 2.5 parts by weight.

10

[0113] When the chemically-amplified positive photosensitive resin composition includes the thiol compound (E), the rectangularity of the chemically-amplified positive

photosensitive resin composition can be further improved.

Anthracene compound (F)

[0114] Specific examples of the anthracene compound (F) can include, but are not

- 5 limited to, the following compounds: anthracene, 9,10-dibutoxyanthracene,
9,10-dimethoxyanthracene, 2-ethyl-9,10-dimethoxyanthracene,
2-tert-butyl-9,10-dimethoxyanthracene, 2,3-dimethyl-9,10-dimethoxyanthracene,
9-methoxy-10-methylanthracene, 9,10-diethoxyanthracene,
2-ethyl-9,10-diethoxyanthracene, 2-tert-butyl-9,10-diethoxyanthracene,
10 2,3 -dimethyl-9,10-diethoxyanthracene, 9-ethoxy-10-methylanthracene,
9,10-dipropoxyanthracene, 9,10-diisopropoxyanthracene,
2-ethyl-9,10-dipropoxyanthracene, 2-tert-butyl-9,10-dipropoxyanthracene,
2,3 -dimethyl-9,10-dipropoxyanthracene, 9-isopropoxy-10-methylanthracene,
9,10-dimethylphenoxyanthracene, 2-ethyl-9,10-dimethylphenoxyanthracene,
15 2-tert-butyl-9,10-dimethylphenoxyanthracene,
2,3-dimethyl-9,10-dimethylphenoxyanthracene, 9-tolyloxy-10-methylanthracene,
9,10-di- α -methyltoluoyloxyanthracene, 2-ethyl-9,10-di- α -methyltoluoyloxyanthracene,
2-tert-butyl-9,10-di- α -methyltoluoyloxyanthracene,
2,3-dimethyl-9,10-di- α -methyltoluoyloxyanthracene,
20 9-(α -methyltoluoxoxy)-10-methylanthracene, 9,10-diphenylanthracene,
9-methoxyanthracene, 9-ethoxyanthracene, 9-methylanthracene, 9-bromoanthracene,
9-methylthioanthracene, or 9-ethylthioanthracene.

[0115] Based on a total amount of 100 parts by weight of the resin (A), the amount of

the anthracene compound (F) is 0.2 parts by weight to 1.5 parts by weight, preferably 0.25 parts by weight to 1.3 parts by weight, and more preferably 0.3 parts by weight to 1.1 parts by weight. When the chemically-amplified positive photosensitive resin composition includes the anthracene compound (F), the sensitivity of the chemically-amplified positive photosensitive resin composition can be further improved.

Additive (G)

[0116] In the chemically-amplified positive photosensitive resin composition, an additive (G) can be further included as long as the effects of the invention are not affected, and the additive (G) can be used alone or in multiple combinations as decided based on actual need. The specific amount of the additive (G) is described below.

[0117] In the chemically-amplified positive photosensitive resin composition, to improve plasticity, a polyethylene resin can also be further included as the additive (G).

Specific examples of the polyethylene resin can include, for instance, polyvinyl chloride, polystyrene, polyhydroxystyrene, polyvinyl acetate, polyvinyl benzoic acid, polyvinyl ether, polyethylene ether, polyvinyl alcohol, polyvinylpyrrolidone, polyphenol, and copolymers thereof. The polyethylene resin is preferably polyvinyl ether due to lower glass transition temperature.

[0118] Moreover, in the chemically-amplified positive photosensitive resin composition, to improve the bonding of the template formed by the photosensitive resin composition and the metal substrate, a bonding auxiliary can also be included as the additive (G). Specific examples of the bonding auxiliary can include products made by

CYTEC with the model number Cymel-300 or Cymel-303; melamine compound products with the model number MW-30MH, MW-30, MS-11, MS-001, MX-750, or MX-706 made by Sanwa Chemical; a silane compound such as vinyl trimethoxysilane, vinyl triethoxysilane, 3-methacryloyloxypropyltrimethoxysilane, 3-propenyloxypropyltrimethoxysilane, vinyl tris(2-methoxyethoxy)silane, N-(2-aminoethyl)-3-aminopropylmethyldimethoxysilane, N-(2-aminoethyl)-3-aminopropyltrimethoxysilane, 3-aminopropyltriethoxysilane, 3-glycidoxypropyltrimethoxysilane, 3-glycidoxypropyl dimethyl methoxysilane, 2-(3,4-epoxycyclohexyl)ethyltrimethoxysilane, 3-chloropropylmethyldimethoxysilane, 3-chloropropyltrimethoxysilane, 3-mercaptopropyltrimethoxysilane, or bis-1,2-(trimethoxysilyl)ethane.

[0119] Moreover, in the chemically-amplified positive photosensitive resin composition, to improve, for instance, coatability, defoaming properties, and uniformity, a surfactant can also be included as the additive (G). Specific examples of the surfactant can include, for instance, commercial fluoride surfactants such as BM-1000 and BM-1100 (both made by BM Chmie), MEGAFACE F142D, MEGAFACE F172, MEGAFACE F173, MEGAFACE F183 (all made by DIC), FLUORAD FC-135, FLUORAD FC-170C, FLUORAD FC-430, FLUORAD FC-431 (all made by Sumitomo 3M), SURFLON S-112, SURFLON S-113, SURFLON S-131, SURFLON S-141, SURFLON S-145 (all made by Asahi Glass), and SH-28PA, SH-190, SH-193, SZ-6032, SF-8428 (all made by Toray Silicone), but are not limited thereto.

[0120] Moreover, in the chemically-amplified positive photosensitive resin composition, to perform microadjustments on the solubility of the developing solution, a

solvent containing acid, anhydride, or a high-boiling point solvent can be further added as the additive (G).

[0121] Specific examples of the acid and anhydride can include, for instance, monocarboxylic acid such as acetic acid, propionic acid, n-butyric acid, isobutyric acid, 5 n-valeric acid, isovaleric acid, benzoic acid, or cinnamic acid; hydroxyl monocarboxylic acid such as lactic acid, 2-hydroxybutyric acid, 3-hydroxybutyric acid, salicylic acid, m-hydroxybenzoic acid, p-hydroxybenzoic acid, 2-hydroxyl cinnamic acid, 3-hydroxyl cinnamic acid, 4-hydroxyl cinnamic acid, 5-hydroxyisophthalic acid, or syringic acid; polycarboxylic acid such as oxalic acid, succinic acid, glutaric acid, adipic acid, maleic 10 acid, itaconic acid, hexahydrophthalic acid, phthalic acid, isophthalic acid, terephthalic acid, 1,2-cyclohexanedicarboxylic acid, 1,2,4-cyclohexane tricarboxylic acid, butane tetracarboxylic acid, trimellitic acid, benzenetetracarboxylic acid, cyclopentane tetracarboxylic acid, butane tetracarboxylic acid, or 1,2,5,8-naphthalene tetracarboxylic acid; anhydride such as itaconic anhydride, succinic anhydride, citraconic anhydride, 15 dodecene succinic anhydride, propane tricarboxylic anhydride, maleic anhydride, hexahydrophthalic anhydride, methyl tetrahydrophthalic anhydride, humic anhydride, 1,2,3,4-butanetetracarboxylic anhydride, cyclopentane tetracarboxylic dianhydride, phthalic anhydride, pyromellitic anhydride, trimellitic anhydride, benzophenone tetracarboxylic anhydride, ethylene glycol bis-trimellitic anhydride, or glycerol 20 tris-trimellitic anhydride.

[0122] Moreover, specific examples of the high-boiling point solvent can include, for instance, N-methylformamide, N,N-dimethylformamide, N-methyl toluidine, N-methylacetamide, N,N-dimethylacetamide, N-methylpyrrolidone, dimethyl sulfoxide,

benzyl ether, dihexyl ether, acetylacetone, isophorone, hexanoic acid, caprylic acid, 1-octanol, 1-nonanol, benzyl alcohol, benzyl acetate, ethyl benzoate, diethyl oxalate, diethyl maleate, γ -butyrolactone, vinyl carbonate, propylene carbonate, phenyl sorsulfide.

[0123] Moreover, in the chemically-amplified positive photosensitive resin composition, to improve sensitivity, a sensitizer can further be included as the additive (G).

<Manufacturing method of chemically-amplified positive photosensitive resin composition>

10 [0124] The manufacturing method of the chemically-amplified positive photosensitive resin composition is not particularly limited, and the chemically-amplified positive photosensitive resin composition can be obtained by mixing and stirring each component above via a regular method. The device mixing and stirring each of the components can include, for instance, a dissolving machine, a homogenizer, or a
15 three-roller mill. After each component was evenly mixed, the resulting mixture can also be further filtered using, for instance, a screen or a membrane filter.

<Manufacturing method of substrate with casting mold>

[0125] The method of forming the photoresist pattern for forming the casting mold of
20 the electroplated molded article on the metal surface of the substrate using the chemically-amplified positive photosensitive resin composition is not particularly limited.

[0126] A preferred method can contain, for instance: a lamination step laminating a

photosensitive resin layer formed by the chemically-amplified positive photosensitive resin composition on the metal surface of a substrate, an exposure step irradiating actinic ray or radiation on the photosensitive resin layer, and an developing step developing the photosensitive resin layer after exposure to form a casting mold forming
5 an electroplated molded article.

[0127] The substrate for laminating a photosensitive resin layer is not particularly limited, and a known substrate for electronic components or a substrate having a wiring pattern...etc. can be used. The substrate has a metal surface; and the metal forming the metal surface is preferably copper, gold, or aluminum, more preferably copper.

10 [0128] The photosensitive resin layer is laminated on the substrate by, for instance, the following method. A liquid chemically-amplified positive photosensitive resin composition is coated on the substrate, and then the solvent is removed to form a photosensitive resin layer having the desired thickness. The thickness of the photosensitive resin layer is not particularly limited as long as the photoresist pattern
15 used as the template can be formed at the desired film thickness. The film thickness of the photosensitive resin layer is not particularly limited, and is preferably 10 μm or more, more preferably 10 μm to 150 μm , still more preferably 20 μm to 120 μm , and most preferably 20 μm to 100 μm .

[0129] The coating method for the photosensitive resin composition on the substrate
20 can include, for instance, a spin coating method, slit coating method, roll coating method, screen printing method, or spreading method. Preferably, the photosensitive resin layer is pre-baked. The pre-bake conditions differ based on, for instance, the type of each component in the photosensitive resin composition, the mixing ratio, and the

coating film thickness, and are generally 70 °C to 150 °C, preferably 80 °C to 140 °C, and about 2 minutes to 60 minutes.

[0130] An actinic ray or radiation is selectively irradiated (exposure) on the resulting photosensitive resin layer with a mask having a predetermined pattern in between, such as UV or visible light having a wavelength of, for instance, 300 nm to 500 nm.

[0131] The ray source of the radiation can include, for instance, a low-pressure mercury lamp, a high-pressure mercury lamp, an ultra high-pressure mercury lamp, a metal halide lamp, or an argon laser. Moreover, the radiation contains, for instance, microwave, infrared, visible light, UV, X-ray, γ -ray, electron beam, proton beam, neutron beam, or ion beam. The amount of radiation differs based on, for instance, the composition of the photosensitive resin composition or the film thickness of the photosensitive resin layer. For instance, when an ultra-high pressure mercury lamp is used, the amount of radiation is 100 mJ/cm² to 10000 mJ/cm². Moreover, the radiation contains light activating the photoacid generator (C) to generate acid.

[0132] After exposure, the photosensitive resin layer is heated using a known method to promote acid diffusion, and the exposed portion in the photosensitive resin film results in change in the alkali solubility of the photosensitive resin layer.

[0133] Next, the exposed photosensitive resin layer is developed by a known method, and the soluble portion is dissolved and removed to form a predetermined photoresist pattern. At this point, the developing solution is an alkaline aqueous solution.

[0134] The developing solution can include, for instance, an alkali aqueous solution such as sodium hydroxide, potassium hydroxide, sodium carbonate, sodium silicate, ammonia water, ethylamine, n-propylamine, diethylamine, di-n-propylamine,

triethylamine, methyldiamine, dimethylethanolamine, triethanolamine, tetramethylammonium hydroxide, tetraethylammonium hydroxide, pyrrole, piperidine, 1,8-diazabicyclo[5.4.0]-7-undecene, or 1,5-diazabicyclo[4.3.0]-5-nonane. Moreover, an aqueous solution formed by adding a water-soluble organic solvent such as methanol or ethanol or a surfactant in the alkali aqueous solution in a suitable amount can also be used as a developing solution.

[0135] The developing time differs from the composition of the photosensitive resin composition or the film thickness of the photosensitive resin layer, and is generally 1 minute to 30 minutes. The developing method can be any of a puddle method, dipping method, paddle method, or injection developing method.

[0136] After developing, washing is performed with running water for 30 seconds to 90 seconds, and drying is performed using, for instance, an air gun or an oven. As a result, the metal surface of a substrate with a casting mold used as a photoresist pattern can be formed.

<Manufacturing method of electroplated molded article>

[0137] A conductor such as metal is embedded in the non-photoresist portion (the portion removed by the developing solution) in the casting mold of the substrate formed by the above method via electroplating to form an electroplated molded article such as a connection terminal such as a bump or a metal column. Moreover, the electroplating treatment method is not particularly limited, and various known methods can be used. The electroplating solution preferably includes solder paste, copper electroplating, gold electroplating, or nickel electroplating solution. The remaining casting mold is lastly

removed by a common method using, for instance, a stripping solution.

[0138] According to the above method, a photoresist pattern that can inhibit undercutting and be used as the casting mold at the same time can be formed. By using the resulting substrate with a casting mold that can inhibit undercutting, an
5 electroplated molded article having good adhesion with the substrate can be formed.

[0139] Examples are provided below to describe the invention in detail, but the invention is not limited to the contents disclosed in the examples.

<Examples>

10 **Synthesis examples of rein (A)**

[0140] Synthesis examples A-1 to A-10 of the resin (A) are described below:

[0141] Synthesis example A-1

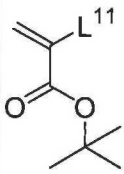
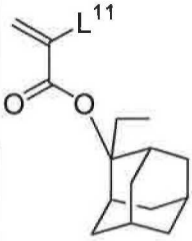
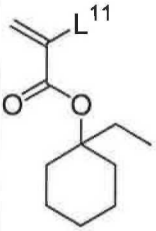
A nitrogen inlet, stirrer, heater, condenser, and thermometer were provided to a 1000-mL four-necked flask. Next, 50 parts by weight of diethylene glycol
15 dimethyl ether was added, and the temperature of the oil bath was increased to 70 °C. Next, 15 parts by weight of the compound represented by formula (A-1-26) (a11), 10 parts by weight of methacrylic acid (a41), 10 parts by weight of 2-hydroxyethyl methacrylate (a43), 35 parts by weight of isobonyl methacrylate (a44), 30 parts by weight of benzyl methacrylate (a46), and 3.5 parts by weight of 2,2'-azobis-2-methyl
20 butyronitrile (AMBN) were added in a four-necked flask, and the mixture was slowly stirred. The reaction temperature of the entire polymerization process was kept at 70 °C, and the polymerization was maintained for 6 hours. After the polymerization was complete, the polymerization product was removed from the four-necked flask, and the

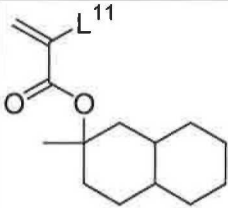
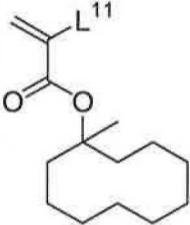
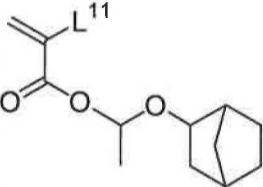
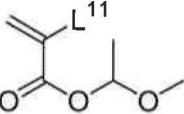
solvent was removed to obtain the resin (A-1).

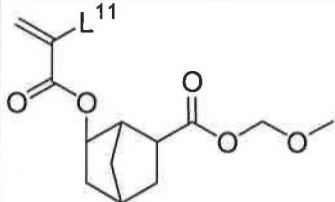
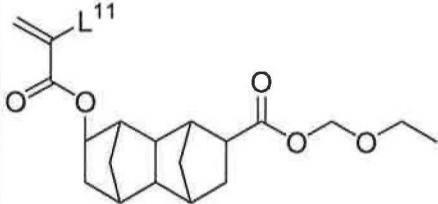
[0142] Synthesis examples A-2 to A-10

In synthesis examples A-2 to A-10, resins (A-2) to (A-10) were prepared with the same steps as synthesis example A-1, and the difference is: the reaction
 5 temperature, reaction time, and component types and amounts were changed, as shown in detail in Table 1.

[0143] Moreover, the compounds corresponding to the abbreviations in the following synthesis examples A-1 to A-10 are as shown below.

Abbreviation	Name/structure
a11	Compound represented by formula (A-1-26), L ¹¹ is a methyl group 
a12	Compound represented by formula (A-1-5), L ¹¹ is a methyl group 
a13	Compound represented by formula (A-1-1), L ¹¹ is a methyl group 
a14	Compound represented by formula (A-1-10), L ¹¹ is a hydrogen atom

	
a15	Compound represented by formula (A-1-21), L¹¹ is a hydrogen atom 
a21	3-methacryloyloxy methyl oxetane
a22	3-acryloyloxy-2-trifluoromethyl oxetane
a23	2-methacryloyloxymethyl-3-phenyl oxetane
a24	Tetrahydrofurfuryl acrylate
a25	(Tetrahydropyran-2-yl)methyl methacrylate
a31	Compound represented by formula (A-1-2), L¹¹ is a methyl group 
a32	Compound represented by formula (A-2-21), L¹¹ is a hydrogen atom 
a33	Compound represented by formula (A-3-1), L ¹¹ is a methyl group

	
a34	Compound represented by formula (A-3-8), L¹¹ is a hydrogen atom 
a41	Methacrylic acid
a42	Cyclohexyl acrylate
a43	2-hydroxyethyl methacrylate
a44	Isobonyl methacrylate
a45	Methyl methacrylate
a46	Benzyl methacrylate
ADV N	2,2'-azobis(2,4-dimethylvaleronitrile)
AMBN	2,2'-azobis(2-methylbutyronitrile)
Diglyme	Diethylene glycol dimethyl ether
PGMEA	Propylene glycol monomethyl ether acetate

[0144] [Table 1]

Preparation examples			A-1	A-2	A-3	A-4	A-5	A-6	A-7	A-8	A-9	A-10
Monomer (parts by weight)	(a1)	a11	15	-	-	-	-	20	-	-	-	-
		a12	-	10	-	-	-	20	-	-	-	-
		a13	-	-	20	-	-	-	60	-	-	-
		a14	-	-	-	30	-	-	-	-	-	-
		a15	-	-	-	-	50	-	-	-	-	-
	(a2)	a21	-	30	-	-	-	-	10	-	-	-
		a22	-	-	25	-	-	-	-	15	-	-
		a23	-	-	-	15	-	-	-	-	-	-
		a24	-	-	-	-	10	-	-	-	-	-
		a25	-	-	-	-	-	5	10	-	-	-
	(a3)	a31	-	10	-	-	-	5	-	-	15	-
		a32	-	-	10	-	-	-	-	35	-	40
		a33	-	-	5	-	-	-	-	-	10	-
		a34	-	-	-	-	20	-	-	-	-	-
	(a4)	a41	10	-	15	15	-	5	10	-	20	-
		a42	-	10	-	-	-	10	-	-	-	-
		a43	10	15	-	-	10	-	-	20	-	25
		a44	35	-	25	-	-	35	-	-	20	-
		a45	-	25	-	20	-	-	10	30	35	20
		a46	30	-	-	20	10	-	-	-	-	15
Solvent (parts by weight)	Diglyme	50	-	60	-	-	-	-	-	60	20	-
	PGMEA	-	55	-	55	60	55	60	-	-	35	55
Catalyst (parts by weight)	AMBN	3.5	-	-	3.0	4.0	4.0	4.0	4.0	4.0	-	4.5
	ADVN	-	4.0	3.0	0.5	-	-	-	-	-	4.0	-
Reaction temperature (°C)			70	65	70	75	70	70	70	70	65	75
Polycondensation time (hours)			6	7	6	6	6	6	6	6	7	5

Synthesis examples of novolac resin (B)

[0145] The novolac resin (B) was synthesized according to the components shown in Table 2 and Table 3.

5 [0146] [Table 2]

Preparation examples			B-1	B-2	B-3
Composition (number of moles)	Aromatic hydroxyl compound	o-cresol	-	0.05	-
		m-cresol	0.7	0.3	0.35
		p-cresol	0.3	0.65	0.6
		2,5-xyleneol	-	-	0.05
	Aldehyde	Formaldehyde	0.65	0.8	0.7
	Catalyst	Oxalic acid	0.02	0.015	0.02
Reaction temperature (°C)			100	95	100
Polycondensation time (hours)			6	6	6
Cresol binuclear area (%)			10.4	8.1	9.5

[0147] [Table 3]

Preparation examples		B-4	B-5	B-6	B-7
Novolac resin	B-1	100	100	-	-
	B-2	-	-	100	-
	B-3	-	-	-	100
Good solvent	PGMEA	300	300	300	300
Poor solvent	Ethylbenzene	2000	-	-	2000
	Cumene	-	3000	2000	1000
Number of times washed		1	1	2	2
Cresol binuclear area (%)		6	4.8	3.3	0.5

[0148] Synthesis of novolac resin (B-1)

10 A nitrogen inlet, stirrer, heater, condenser tube, and thermometer were provided to a four-necked flask having a volume of 1,000 mL. Nitrogen was

introduced, and feed compositions were added according to the amounts shown in Table 1. The feed compositions include 0.7 moles of m-cresol, 0.3 moles of p-cresol, 0.65 moles of formaldehyde, and 0.02 moles of oxalic acid. The contents of the four-necked flask were stirred and the temperature of the oil bath was increased to 100 °C. The reaction temperature of the polycondensation process was kept at 100 °C, and the polycondensation time was 6 hours. After the polycondensation was complete, the solvent was evaporated to obtain a novolac resin (B-1).

[0149] Synthesis of novolac resins (B-2) and (B-3)

The synthesis is similar to the operation method of the novolac resin (B-1), but the type and amount of the aromatic hydroxyl compound, the amount of the aldehyde, the amount of the acid catalyst, and the reaction temperature were changed, and the formula and reaction conditions thereof are shown in Table 2.

[0150] Synthesis of novolac resin (B-4)

100 parts by weight of the novolac resin (B-1) obtained above was dissolved in 300 parts by weight of a propylene glycol monomethyl ether acetate solvent, and the mixture was continuously stirred at room temperature until the novolac resin (B-1) was completely dissolved. Next, the mixture was injected into 2,000 parts by weight of ethylbenzene, and after stirring continuously for 30 minutes, the precipitate was removed and then the solvent was evaporated to obtain a novolac resin (B-4).

[0151] Synthesis of novolac resin (B-5)

100 parts by weight of the novolac resin (B-1) obtained above was dissolved in 300 parts by weight of a propylene glycol monomethyl ether acetate solvent, and the mixture was continuously stirred at room temperature until the novolac resin (B-1) was

completely dissolved. Next, the mixture was injected into 3,000 parts by weight of cumene, and after stirring continuously for 30 minutes, the precipitate was removed and then the solvent was evaporated to obtain a novolac resin (B-5).

[0152] Synthesis of novolac resin (B-6)

100 parts by weight of the novolac resin (B-2) obtained above was dissolved in 300 parts by weight of a propylene glycol monomethyl ether acetate solvent, and the mixture was continuously stirred at room temperature until the novolac resin (B-2) was completely dissolved. Next, the mixture was injected into 2,000 parts by weight of cumene, and after stirring continuously for 30 minutes, the precipitate was removed and then the solvent was evaporated. The steps of dissolution, precipitation, and evaporation were repeated to obtain a novolac resin (B-6).

[0153] Synthesis of novolac resin (B-7)

100 parts by weight of the novolac resin (B-3) was dissolved in 300 parts by weight of a propylene glycol monomethyl ether acetate solvent, and the mixture was continuously stirred at room temperature until the novolac resin (B-3) was completely dissolved. Next, the mixture was injected into 2,000 parts by weight of ethylbenzene and 1,000 parts by weight of cumene, and after stirring continuously for 30 minutes, the precipitate was removed and then the solvent was evaporated. The steps of dissolution, precipitation, and evaporation were repeated to obtain a novolac resin (B-7).

[0154] Cresol binuclear area in novolac resin (B)

In the operation method of gel permeation chromatography, the signal of a molecular weight between 200 and 150,000 of the novolac resin (B) is integrated, and an integral molecular weight distribution curve is obtained by molecular weight and

cumulative weight percentage. The gel permeation chromatography includes a 717 plus sampling instrument made by Waters®, a 79911GP-501, 79911GP-502, 79911GP-503, or 79911GP-504 column made by Agilent Technologies® and a 2414 RI detector made by Waters®, tetrahydrofuran for the mobile phase, a flow of 1.0 mL/min, 5 an injection volume of 100 µL, a measurement temperature of 40 °C, a measurement time of 60 minutes, and polystyrene as the molecular weight standard.

Based on an integral area of 100% of the molecular weight of the novolac resin (B) measured by gel permeation chromatography, the percentage of the cresol binuclear area in the novolac resin (B) was measured.

10 The results are shown in Table 2 and Table 3.

Examples of chemically-amplified positive photosensitive resin composition

[0155] Example 1 to example 14 and comparative example 1 to comparative example 4 of the chemically-amplified positive photosensitive resin composition are described 15 below:

[0156] Example 1

100 parts by weight of the resin (A-1) obtained in synthesis example A-1, 20 parts by weight of the novolac resin (B-4), 0.2 parts by weight of the photoacid generator C-1 (hereinafter C-1), and 0.3 parts by weight of 2,4-bis(trichloromethyl)-6-piperonyl-1,3,5-triazine (hereinafter C-2) were added to 30 parts by weight of propylene glycol monomethyl ether acetate (hereinafter D-1), and then the components were dissolved and mixed by a shaking stirrer to obtain a chemically-amplified positive photosensitive resin composition. The

chemically-amplified positive photosensitive resin composition was evaluated by each measurement method below, and the results are shown in Table 4.

[0157] Example 2 to example 14

5 In example 2 to example 14, the same operating method as the manufacturing method of the chemically-amplified positive photosensitive resin composition of example 1 was used, and the difference is that in example 2 to example 14, the type and amount of the raw materials of the chemically-amplified positive photosensitive resin composition were changed, and the formula and the following evaluation results are as shown in Table 4 and Table 5.

10 **[0158]** Comparative example 1 to comparative example 4

[0159] In comparative example 1 to comparative example 4, the same operating method as the manufacturing method of the chemically-amplified positive photosensitive resin composition of example 1 was used, and the difference is that in comparative example 1 to comparative example 4, the type and amount of the raw materials of the chemically-amplified positive photosensitive resin composition were changed, and the formula and the following evaluation results are as shown in Table 5.

15

[0160] [Table 4]

Component (parts by weight)		Examples								
		1	2	3	4	5	6	7	8	9
Resin (A)	A-1	100	-	-	-	-	-	-	-	-
	A-2	-	100	-	-	-	-	-	-	-
	A-3	-	-	100	-	-	-	-	-	-
	A-4	-	-	-	100	-	-	-	-	-
	A-5	-	-	-	-	50	-	-	50	-
	A-6	-	-	-	-	50	-	80	-	-
	A-7	-	-	-	-	-	100	-	-	-
	A-8	-	-	-	-	-	-	-	-	100
	A-9	-	-	-	-	-	-	20	-	-
	A-10	-	-	-	-	-	-	-	50	-
Novolac resin (B)	B-1	-	-	-	-	-	-	-	-	-
	B-2	-	-	-	-	-	-	-	-	-
	B-3	-	-	-	-	-	-	-	-	-
	B-4	20	-	-	-	100	-	-	-	50
	B-5	-	60	-	-	-	110	-	-	40
	B-6	-	-	45	-	-	-	120	-	-
	B-7	-	-	-	80	-	-	-	30	-
Photoacid generator (C)	C-1	0.2	-	-	-	-	2.0	-	-	-
	C-2	0.3	0.8	-	-	-	-	3.0	-	-
	C-3	-	-	1.0	-	-	-	-	4.0	-
	C-4	-	-	-	1.3	-	-	-	-	5.0
	C-5	-	-	-	-	1.5	-	-	-	-
Solvent (D)	D-1	30	-	-	55	-	-	120	-	60
	D-2	-	40	-	-	70	-	-	140	-
	D-3	-	-	45	-	-	100	-	-	100
Thiol compound (E)	E-1	-	0.3	-	0.2	-	2.0	-	-	-
	E-2	-	-	1.0	-	-	-	-	-	-
	E-3	-	-	-	0.5	-	-	-	-	-
	E-4	-	-	-	-	-	-	-	3.0	-
Anthracene compound	F-1	-	0.5	-	-	-	-	0.3	-	-
	F-2	-	-	0.2	-	-	-	-	-	-
	F-3	-	-	-	-	-	0.8	-	-	-

(F)	F-4	-	-	-	-	-	-	-	1.0	-
Additive (G)	G-1	-	-	0.3	-	-	-	-	-	-
	G-2	-	-	-	-	-	-	-	-	-
Sensitivity evaluation		○	◎	◎	◎	◎	◎	◎	◎	◎
Rectangularity evaluation		◎	◎	◎	◎	◎	◎	◎	◎	○

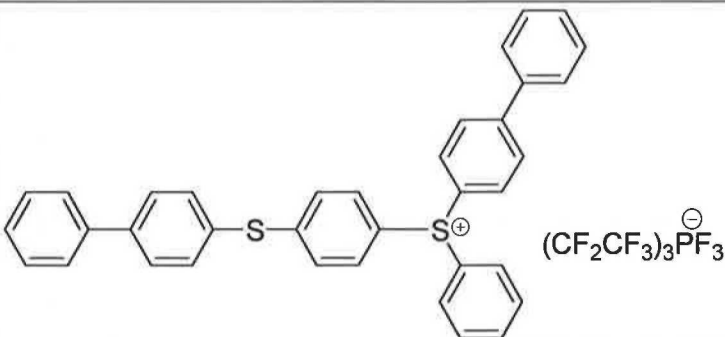
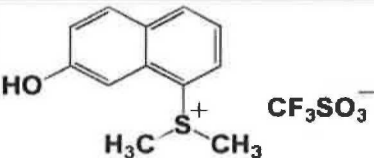
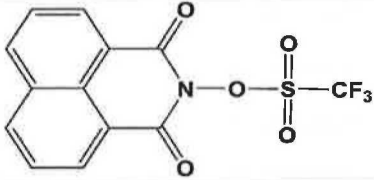
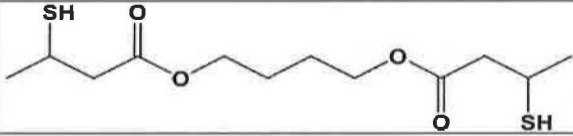
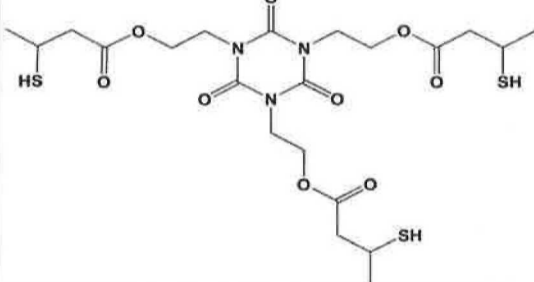
[0161] [Table 5]

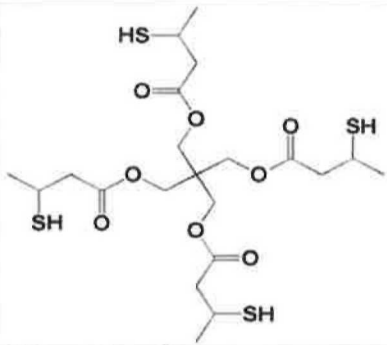
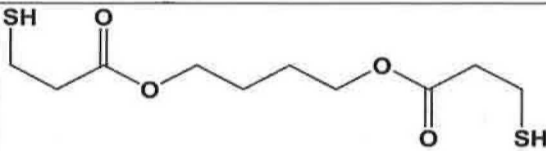
Component (parts by weight)		Examples					comparative example			
		10	11	12	13	14	1	2	3	4
Resin (A)	A-1	-	-	-	-	-	-	-	100	-
	A-2	-	-	-	-	-	-	-	-	-
	A-3	-	-	-	-	-	-	-	-	-
	A-4	-	-	-	-	-	-	-	-	-
	A-5	-	-	-	-	-	-	-	-	-
	A-6	-	-	-	-	-	-	-	-	-
	A-7	-	-	-	-	-	-	-	-	-
	A-8	-	-	-	-	-	-	-	-	-
	A-9	100	-	100	-	100	-	-	-	-
	A-10	-	100	-	100	-	-	-	-	-
Novolac resin (B)	B-1	80	-	-	-	-	100	-	-	-
	B-2	-	-	-	65	-	-	-	50	-
	B-3	-	-	-	-	-	-	-	-	50
	B-4	-	-	95	-	-	-	100	-	-
	B-5	-	-	-	35	-	-	-	-	50
	B-6	70	-	-	-	105	-	-	-	-
	B-7	-	50	-	-	-	-	-	-	-
Photoacid generator (C)	C-1	-	1.8	-	-	-	2.0	-	-	-
	C-2	-	-	1.2	-	-	-	3.0	-	-
	C-3	-	-	-	0.7	-	-	-	4.0	-
	C-4	-	-	-	-	2.8	-	-	-	2.5
	C-5	2.3	-	-	-	-	-	-	-	-
Solvent (D)	D-1	360	-	-	160	-	50	-	-	80
	D-2	-	300	-	160	-	-	60	-	-
	D-3	-	-	240	-	280	-	-	70	-
Thiol compound (E)	E-1	-	-	-	-	-	-	-	-	-
	E-2	-	-	0.5	-	-	-	-	-	-
	E-3	-	-	-	1.5	-	-	-	-	-
	E-4	-	-	-	-	-	-	-	-	-
Anthracene compound	F-1	-	-	-	1.3	1.0	-	-	-	-
	F-2	-	-	-	-	-	-	-	-	-
	F-3	-	-	-	-	-	-	-	-	-

(F)	F-4	-	-	-	-	0.5	-	-	-	-
Additive (G)	G-1	-	-	-	-	-	-	-	-	-
	G-2	1	-	-	-	-	-	-	-	-
Sensitivity evaluation		○	○	○	◎	◎	X	X	○	X
Rectangularity evaluation		○	○	◎	◎	○	X	X	X	X

[0162] The compounds corresponding to the labels in Table 4 and Table 5 are as shown below.

Abbreviation	Compound
A-1	Resin (A-1) of synthesis example A-1
A-2	Resin (A-2) of synthesis example A-2
A-3	Resin (A-3) of synthesis example A-3
A-4	Resin (A-4) of synthesis example A-4
A-5	Resin (A-5) of synthesis example A-5
A-6	Resin (A-6) of synthesis example A-6
A-7	Resin (A-7) of synthesis example A-7
A-8	Resin (A-8) of synthesis example A-8
A-9	Resin (A-9) of synthesis example A-9
A-10	Resin (A-10) of synthesis example A-10
B-1	Novolac resin (B-1)
B-2	Novolac resin (B-2)
B-3	Novolac resin (B-3)
B-4	Novolac resin (B-4)
B-5	Novolac resin (B-5)
B-6	Novolac resin (B-6)
B-7	Novolac resin (B-7)
C-1	Photoacid generator represented by the following formula

	
C-2	2,4-bis(trichloromethyl)-6-piperonyl-1,3,5-triazine
C-3	
C-4	
C-5	
D-1	Propylene glycol methyl ether acetate
D-2	Diethylene glycol dimethyl ether
D-3	Ethyl 3-ethoxypropionate
E-1	
E-2	

E-3	
E-4	
F-1	9,10-dibutoxyanthracene
F-2	2-tert-butyl-9,10-dimethoxyanthracene
F-3	2,3-dimethyl-9,10-diethoxyanthracene
F-4	9-isopropoxy-10-methylantracene
G-1	SH-28PA (made by Toray Silicone)
G-2	3-glycidoxypropyltrimethoxysilane

Evaluation method

[0163] a. Sensitivity

The chemically-amplified positive photosensitive resin compositions of the

5 examples and comparative examples were coated on a 6-in. copper substrate using a spin coating machine to form a 50- μm photosensitive resin layer. Next, the photosensitive resin layer was pre-baked at 110 $^{\circ}\text{C}$ for 6 minutes. After pre-bake, pattern exposure was performed using a mask having a hole pattern and a diameter of 60 μm and the exposure device Titan 2 (made by Ultratech) with g ray, h ray, and i ray, and

10 the amount of exposure was changed stepwise. Next, the substrate was placed on a heating plate, and exposure was performed at 100 $^{\circ}\text{C}$ for 3 minutes, and then heating was performed (PEB). Next, 2.38% tetramethylammonium hydroxide (TMAH)

aqueous solution was added dropwise to the photosensitive resin layer, then the photosensitive resin layer was left at 23 °C for 60 seconds to repeat the developing process 4 times. Next, washing was performed with running water, then nitrogen was blown to obtain a thick-film photoresist pattern having a via hole pattern and a diameter of 50 μm.

Next, the amount of exposure for which pattern residue was not observed was obtained as the minimum amount of exposure needed to form the thick-film photoresist pattern as an indicator for sensitivity. The evaluation criteria are as follows:

- 10 ⊙: amount of exposure < 100 mJ/cm²
- : 100 mJ/cm² ≤ amount of exposure < 150 mJ/cm²
- △: 150 mJ/cm² ≤ amount of exposure < 200 mJ/cm²
- ×: amount of exposure ≥ 200 mJ/cm²

15 **[0164]** b. Rectangularity

Referring to FIG. 1, FIG. 1 is a schematic of the measurement of the rectangularity of a photoresist pattern. After the photosensitive resin layer coated on a substrate 100 was exposed and developed, a photoresist pattern 120 having a photoresist portion 122 and a non-photoresist portion 124 was formed. The section shape of the photoresist pattern having the optimal amount of exposure was observed, the values of a bottom width L_b and a top width L_t were measured, and L_t/L_b was calculated as an indicator for rectangularity. The evaluation criteria are as follows:

20 ⊙: $0.9 < L_t/L_b < 1.1$

○: $0.85 < L_t/L_b \leq 0.9$; $1.1 \leq L_t/L_b < 1.15$

△: $0.75 < L_t/L_b \leq 0.85$; $1.15 \leq L_t/L_b < 1.25$

×: $L_t/L_b < 0.75$; $L_t/L_b > 1.25$

5 Evaluation results

[0165] It can be known from Table 4 and Table 5 that, in comparison to the chemically-amplified positive photosensitive resin composition of the invention containing the novolac resin (B) in which the cresol binuclear area is between 0.5% and 6% (B-4 to B-7) (examples 1 to 14), the rectangularity of the chemically-amplified positive photosensitive resin composition containing the novolac resin (B) in which the cresol binuclear area is greater than 6% (B-1 to B-3) (comparative examples 1 and 3) is poor.

[0166] At the same time, when the copolymerized monomer mixture used in the resin (A) contains the monomer (a1) having the structure represented by formula (A-1) (examples 1 to 8), the rectangularity performance thereof is better. Moreover, when the monomer mixture further includes the monomer (a2) containing a cyclic ether group (examples 2 to 9), the sensitivity performance thereof is better.

[0167] Moreover, when the chemically-amplified positive photosensitive resin composition contains the thiol compound (E) (examples 2 to 4, 6, 8, 12, and 13), the rectangularity performance thereof is also better.

[0168] Moreover, when the chemically-amplified positive photosensitive resin composition contains the anthracene compound (F) (examples 2, 3, 6 to 8, 13, and 14), the sensitivity performance thereof is also better.

[0169] Based on the above, the rectangularity of the chemically-amplified positive photosensitive resin composition of the invention can be improved due to a cresol binuclear area between 0.5% and 6% in the novolac resin (B) thereof.

[0170] Although the invention has been described with reference to the above
5 embodiments, it will be apparent to one of ordinary skill in the art that modifications to the described embodiments may be made without departing from the spirit of the invention. Accordingly, the scope of the invention is defined by the attached claims not by the above detailed descriptions.

CLAIMS

WHAT IS CLAIMED IS:

1. A chemically-amplified positive photosensitive resin composition,
5 comprising:

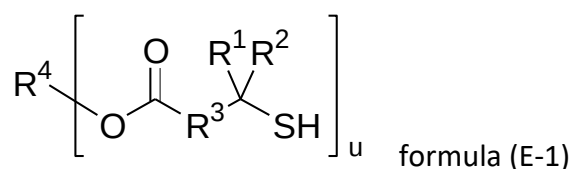
a resin (A), wherein the resin (A) is obtained by a copolymerization of a monomer mixture and contains an acid-dissociated protecting group;

a novolac resin (B) obtained by a polycondensation of a cresol aromatic hydroxyl compound and an aldehyde compound, and based on an integral area of
10 100% of a molecular weight of the novolac resin (B) measured by gel permeation chromatography, a cresol binuclear area of the novolac resin (B) is between 0.5% and 6%;

a photoacid generator (C); and

a solvent (D); and

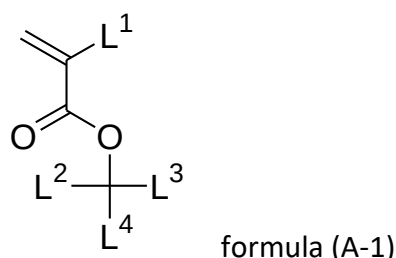
15 a thiol compound (E), wherein the thiol compound (E) has a structure represented by formula (E-1) below:



in formula (E-1), R^1 and R^2 each independently represent a hydrogen atom or a C_1 to C_4 alkyl group, R^3 represents a single bond or a C_1 to C_{10} alkylene group, and R^4 represents a u-valence organic group; and u represents an integer of 2
20 to 6,

wherein based on a total amount of 100 parts by weight of the resin (A), an amount of the thiol compound (E) is 0.3 parts by weight to 3 parts by weight.

2. The chemically-amplified positive photosensitive resin composition of
25 claim 1, wherein the monomer mixture comprises a monomer (a1), and the monomer (a1) has a structure represented by formula (A-1) below:



in formula (A-1), L^1 represents a hydrogen atom, a C_1 to C_6 straight or branched alkyl group, a fluorine atom, or a C_1 to C_6 straight or branched fluorinated
30 alkyl group; L^2 , L^3 , and L^4 respectively independently represent a C_1 to C_6 straight or branched alkyl group or a C_1 to C_6 straight or branched fluoroalkyl group, or L^3 and L^4

are bonded to each other to form a C₅ to C₂₀ hydrocarbon ring.

3. The chemically-amplified positive photosensitive resin composition of claim 1, wherein the monomer mixture comprises a monomer (a2), and the monomer (a2) contains a cyclic ether group.

5 4. The chemically-amplified positive photosensitive resin composition of claim 1, further comprising an anthracene compound (F).

10 5. The chemically-amplified positive photosensitive resin composition of claim 1, wherein based on a total amount of 100 parts by weight of the resin (A), an amount of the novolac resin (B) is 20 parts by weight to 150 parts by weight, an amount of the photoacid generator (C) is 0.5 parts by weight to 5 parts by weight, and an amount of the solvent (D) is 30 parts by weight to 360 parts by weight.

15 6. The chemically-amplified positive photosensitive resin composition of claim 2, wherein based on a total amount of 100 parts by weight of the monomer mixture, an amount of the monomer (a1) is 10 parts by weight to 60 parts by weight.

15 7. The chemically-amplified positive photosensitive resin composition of claim 3, wherein based on a total amount of 100 parts by weight of the monomer mixture, an amount of the monomer (a2) is 5 parts by weight to 35 parts by weight.

20 8. The chemically-amplified positive photosensitive resin composition of claim 4, wherein based on a total amount of 100 parts by weight of the resin (A), an amount of the anthracene compound (F) is 0.2 parts by weight to 1.5 parts by weight.

9. A manufacturing method of a substrate with a casting mold, comprising:

25 a laminate step, laminating a photosensitive resin layer formed by the chemically-amplified positive photosensitive resin composition of any of claims 1 to 8 on a metal surface of a substrate;

an exposure step, irradiating the photosensitive resin layer with an actinic ray or a radiation; and

30 a developing step, developing the photosensitive resin layer after exposure to form a casting mold for forming an electroplated molded article.

10. A manufacturing method of an electroplated molded article, comprising:

35 a step of electroplating the substrate with the casting mold made by the manufacturing method of the substrate with the casting mold of claim 9 to form an electroplated molded article in the casting mold.