

DESCRIPTION

PHOTOSENSITIVE RESIN COMPOSITION AND CURED PRODUCT OF SAME

TECHNICAL FIELD

[0001]

The present invention relates to a negative photosensitive resin composition that is excellent in resolution and is useful for the production of MEMS (microelectromechanical system) components, micromachine components, microfluidic components, μ -TAS (micro-total analysis system) components, inkjet printer components, microreactor components, conductive layers, LIGA components, molds and stamps for microinjection molding and thermal embossing, screens or stencils for microprinting applications, MEMS package components, semiconductor package components, BioMEMS and biophotonic devices, and printed wiring boards, as well as to a cured product of the negative photosensitive resin composition that has high adhesion to a substrate, provides a pattern having high strength, has low thermal expansion coefficient, and has excellent durability against thermal deformation.

BACKGROUND ART

[0002]

Resists capable of being processed by photolithography are widely used in semiconductors and MEMS/micromachine applications. In such applications, photolithography is achieved by subjecting the resist to pattern exposure on a substrate and then developing the resist with a developer to selectively remove an exposed region or an unexposed region. Resists (photoresists) capable of being processed by photolithography include positive resists and negative resists. In the positive resist, the exposed portion is dissolved in the developer. Conversely, in the negative resist, the exposed portion is insoluble in the developer. In the electronic package application and the MEMS application as the advanced technology, not only a capability of forming a uniform spin coating film but also a high aspect ratio, a straight side wall shape of a thick resist film, high adhesion to a substrate, and the like are required. Here, the aspect ratio is calculated by the resist film thickness/pattern line width, and is an important characteristic indicating the performance of photolithography.

[0003]

As such a photoresist, a negative chemically amplified photoresist composition containing a polyfunctional bisphenol A novolac epoxy resin (for example, EPON SU-8 resin (trade name) manufactured by Resolution Performance Products, Inc.) and a photo-cationic polymerization initiator such as CYRACURE UVI-6974 (trade name) manufactured by The

Dow Chemical Company (i.e., a propylene carbonate solution of aromatic sulfonium hexafluoroantimonate) is known. Since the photoresist composition has very low light absorption in a wavelength region from 350 to 450 nm, it is known as a photoresist composition that is capable of being processed by thick film photolithography. The photoresist composition is applied to various substrates by a technique such as spin coating or curtain coating, and then the solvent is volatilized by baking, whereby a solid photoresist layer having a thickness of 100 μm or more can be formed. Further, the photoresist layer can be irradiated with near ultraviolet light through a photomask by various exposure methods such as contact exposure, proximity exposure, or projection exposure, whereby the photoresist layer can be processed by photolithography. Subsequently, the photoresist layer is immersed in a developer to dissolve the unexposed region, whereby a negative image of a high-resolution photomask can be formed on the substrate.

[0004]

In recent years, not only a silicon wafer that has been conventionally generally used as a substrate in MEMS components, MEMS packages, semiconductor packages, and the like, but also various types of substrates, such as a bonded wafer containing lithium tantalate and silicon in combination may be used depending on the application. In these substrates, a piezoelectric material and a support substrate are bonded together, so that the substrates are significantly reduced in expansion and contraction due to heat, which has been a defect of the piezoelectric material.

[0005]

Patent Literature 1 discloses a photosensitive resin composition containing a photocationic polymerization initiator having a specific structure and a polyfunctional epoxy resin. In the section of Examples of the literature, it is described that a cured product of the photosensitive resin composition has excellent adhesion to various substrates.

CITATION LIST

PATENT LITERATURE

[0006]

PATENT LITERATURE 1: WO 2019/156154 A

SUMMARY OF INVENTION

TECHNICAL PROBLEM

[0007]

In the case of forming a photoresist resin layer on a bonded substrate that is significantly reduced in expansion and contraction due to heat as described above, the resin layer is also required to have durability against thermal deformation.

[0008]

The present invention has been made in view of the above-mentioned circumstances, and an object of the present invention is to provide a negative photosensitive resin composition that is excellent in resolution and that provides a cured product having high mechanical strength and excellent adhesion to a substrate, and further having small displacement due to temperature and excellent durability against thermal deformation.

SOLUTIONS TO PROBLEM

[0009]

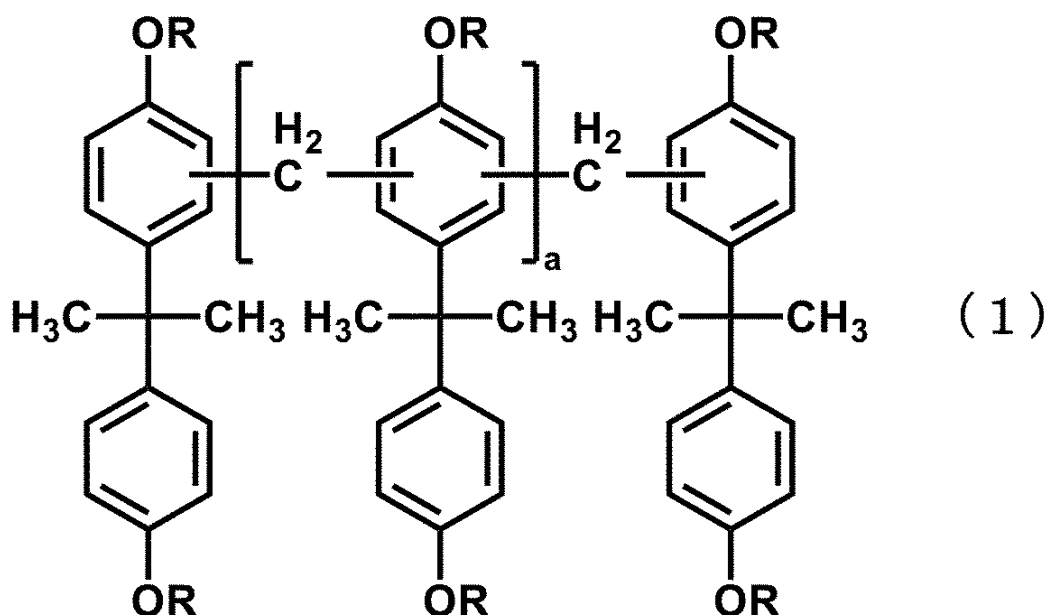
As a result of intensive studies, the present inventors have found that a photosensitive resin composition containing an epoxy resin having a specific structure, a phenolic hydroxyl group-containing compound having a specific structure, and a photo-cationic polymerization initiator having a specific structure can solve the above-mentioned problem.

That is, aspects of the present invention for solving the above-mentioned problem are as follows.

[1].

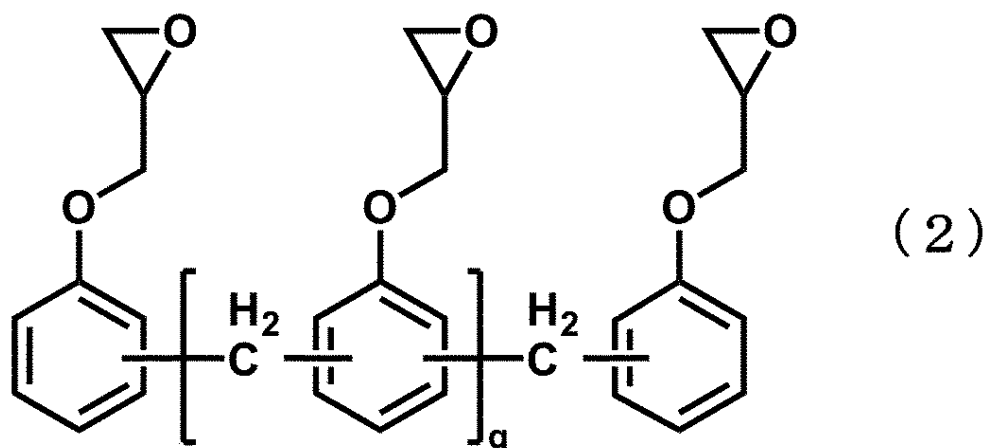
A negative photosensitive resin composition comprising: (A) an epoxy resin, (B) a phenolic hydroxyl group-containing compound, and (C) a photo-cationic polymerization initiator, wherein

30 mass% or more of the epoxy resin (A) is an epoxy resin (A-1) represented by formula (1):

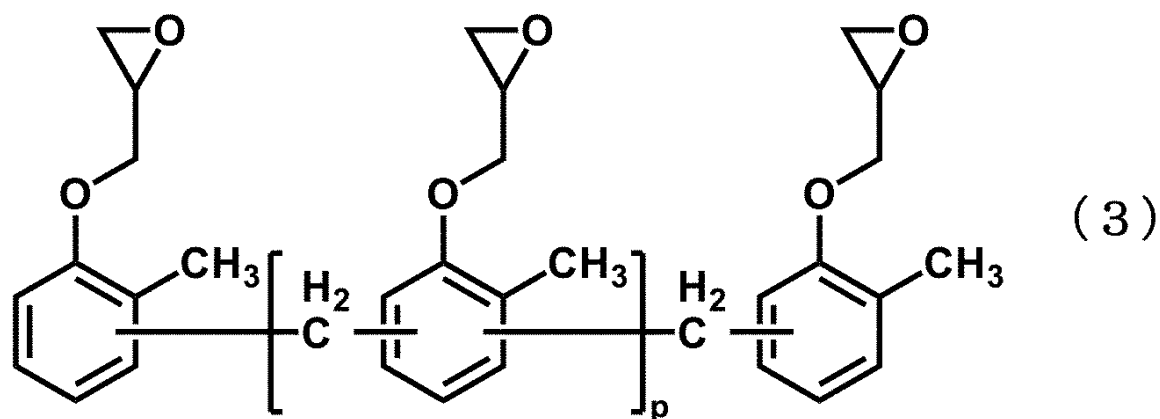


wherein R's each independently represent a glycidyl group or a hydrogen atom, and at least two of a plurality of R's are glycidyl groups, and a represents an average value of number of repeating units and is a real number in a range of 0 to 30,

the epoxy resin further contains one or more epoxy resins selected from the group consisting of an epoxy resin (A-2) represented by formula (2):

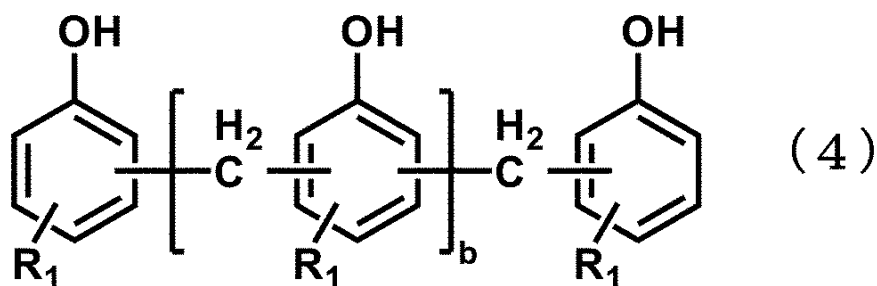


wherein q represents an average value and is a real number in a range of 0 to 10, and an epoxy resin (A-3) represented by formula (3):



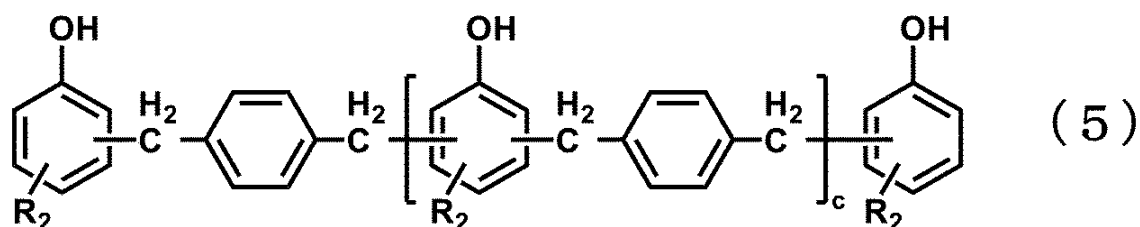
wherein p represents an average value and is a real number in a range of 0 to 30,

the phenolic hydroxyl group-containing compound (B) contains one or more phenol compounds selected from the group consisting of a phenolic hydroxyl group-containing compound (B-1) represented by formula (4):



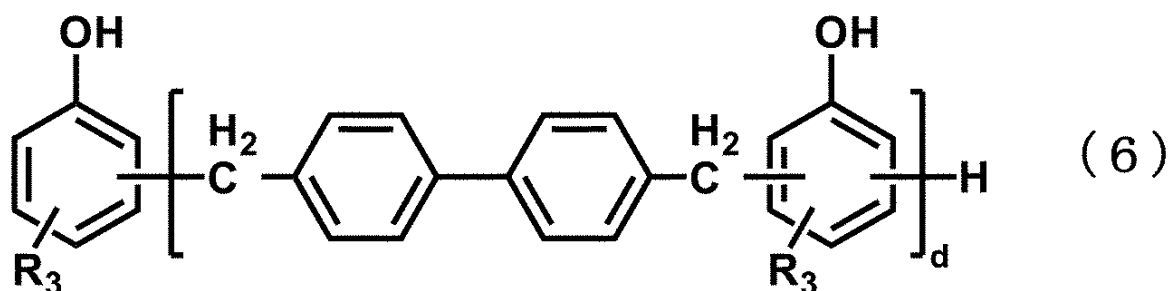
wherein b is an average value and represents a real number in a range of 1 to 10, and R₁'s each independently represent a hydrogen atom or an alkyl group having 1 to 4 carbon atoms,

a phenolic hydroxyl group-containing compound (B-2) represented by formula (5):



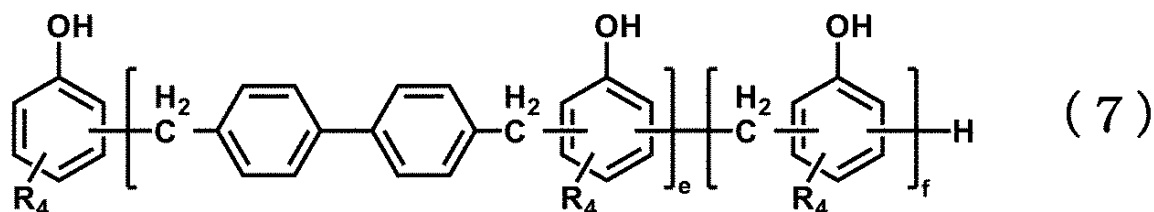
wherein c is an average value and represents a real number in a range of 1 to 10, and R₂'s each independently represent a hydrogen atom or an alkyl group having 1 to 4 carbon atoms,

a phenolic hydroxyl group-containing compound (B-3) represented by formula (6):



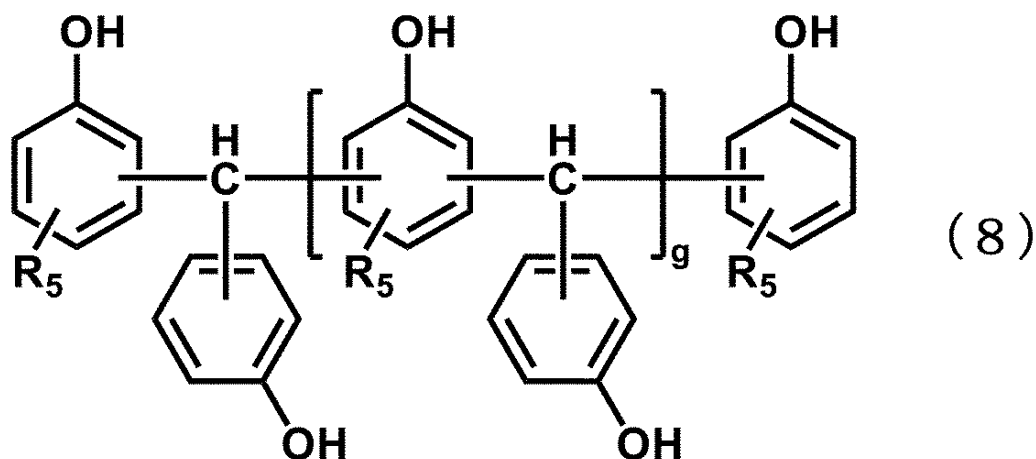
wherein d is an average value and represents a real number in a range of 1 to 10, and R₃'s each independently represent a hydrogen atom or an alkyl group having 1 to 4 carbon atoms,

a phenolic hydroxyl group-containing compound (B-4) represented by formula (7):



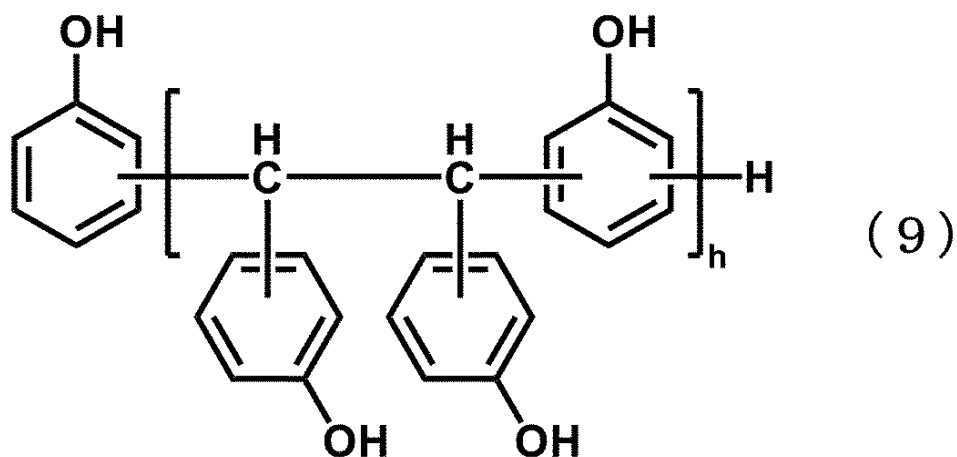
wherein e and f are each an average value and each independently represent a real number in a range of 1 to 10, and R₄'s each independently represent a hydrogen atom or an alkyl group having 1 to 4 carbon atoms,

a phenolic hydroxyl group-containing compound (B-5) represented by formula (8):

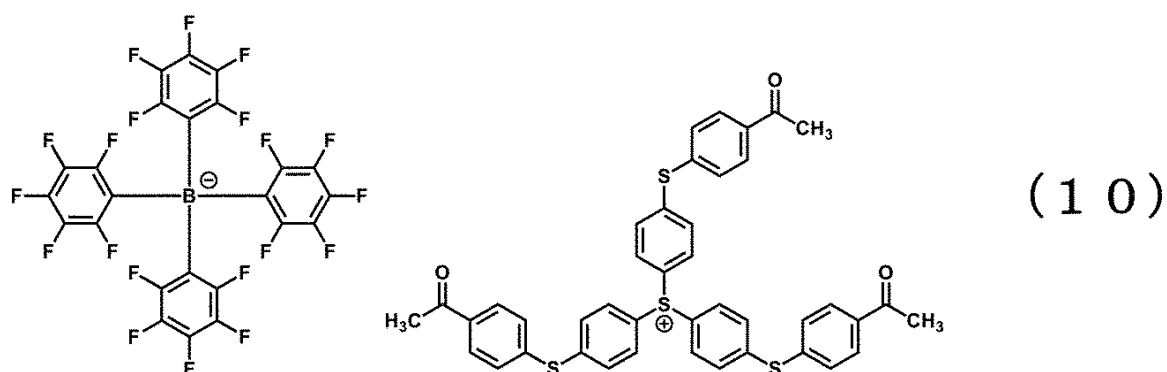


wherein g is an average value and represents a real number in a range of 1 to 10, and R₅'s each independently represent a hydrogen atom or an alkyl group having 1 to 4 carbon atoms, and

a phenolic hydroxyl group-containing compound (B-6) represented by formula (9):



wherein h is an average value and represents a real number in a range of 1 to 10, and the photo-cationic polymerization initiator (C) contains a compound represented by formula (10):



[2].

A dry film resist comprising the negative photosensitive resin composition according to item [1].

[3].

A cured product of the negative photosensitive resin composition according to item [1].

[4].

A cured product of the dry film resist according to item [2].

[5].

A wafer level package comprising the cured product according to item [3] or [4].

[6].

An adhesive layer between a substrate and an adherend, the adhesive layer comprising the cured product according to item [3] or [4].

ADVANTAGEOUS EFFECTS OF INVENTION

[0010]

The negative photosensitive resin composition of the present invention is excellent in resolution, and a cured product thereof has excellent adhesion to a substrate and high mechanical strength, and further has small displacement due to temperature and excellent durability against thermal deformation. Therefore, the cured product can be suitably used in MEMS components, micromachine components, semiconductor package components, and the like.

DESCRIPTION OF EMBODIMENTS

[0011]

Hereinafter, the present invention will be described.

The negative photosensitive resin composition of the present invention contains (A) an epoxy resin (hereinafter also simply referred to as “component (A)”), (B) a phenolic hydroxyl group-containing compound (hereinafter also simply referred to as “component (B)”), and (C) a photo-cationic polymerization initiator (hereinafter also simply referred to as “component (C)”).

[0012]

The epoxy resin (A) contained in the negative photosensitive resin composition is characterized in that 30 mass% or more of the epoxy resin (A) is the epoxy resin (A-1) represented by formula (1).

In formula (1), R's each independently represent a glycidyl group or a hydrogen atom, and at least two of a plurality of R's are glycidyl groups. The reference sign “a” represents an average value of number of repeating units and is a real number in a range of 0 to 30.

Specific examples of the epoxy resin (A-1) represented by formula (1) include KM-N-LCL (trade name, bisphenol A novolac epoxy resin, manufactured by Nippon Kayaku Co., Ltd., epoxy equivalent: 195 to 210 g/eq., softening point: 78 to 86°C), Epikote 157 (trade name, bisphenol A novolac epoxy resin, manufactured by Mitsubishi Chemical Corporation, epoxy equivalent: 180 to 250 g/eq., softening point: 80 to 90°C), and EPON SU-8 (trade name, bisphenol A novolac epoxy resin, manufactured by Resolution Performance Products, LLC, epoxy equivalent: 195 to 230 g/eq., softening point: 80 to 90°C).

In the present description, for example, the epoxy resin represented by formula (1) means an epoxy resin containing the epoxy resin represented by formula (1) as a major component (for example, the percentage of the epoxy resin represented by formula (1) is 90 mass% or more, preferably 95 mass% or more, more preferably 98 mass% or more, and 100 mass% or less), and the term encompasses a case where the epoxy resin represented by formula (1) contains a minor component(s) produced during the production of the epoxy resin, a high-molecular-weight product(s) of the epoxy resin, or the like. The same applies to epoxy resins

described below, which are each represented by a formula other than formula (1).

[0013]

The epoxy equivalent (g/eq.) of the component (A) contained in the negative photosensitive resin composition is preferably from 150 to 500, and more preferably from 150 to 450. The “epoxy equivalent of the component (A)” as used herein means the epoxy equivalent of a mixture of all the epoxy resins that are contained in the negative photosensitive resin composition of the present invention as the component (A).

The molecular weight of the component (A) contained in the negative photosensitive resin composition is preferably from 500 to 15000, and more preferably from 500 to 9000. The “molecular weight of the component (A)” as used herein means the average molecular weight of a mixture of all the epoxy resins that are contained in the negative photosensitive resin composition of the present invention as the component (A).

The softening point of the component (A) contained in the negative photosensitive resin composition is preferably from 40 to 120°C, and more preferably from 55°C to 110°C. The “softening point of the component (A)” as used herein means the softening point of a mixture of all the epoxy resins that are contained in the negative photosensitive resin composition of the present invention.

The epoxy equivalent in the present description is a value measured by a method in accordance with JIS K 7236. The molecular weight in the present description is a value of weight average molecular weight calculated in terms of polystyrene on the basis of the measurement result of gel permeation chromatography. The softening point in the present description is a value measured by a method in accordance with JIS K 7234.

[0014]

In the epoxy resin (A) contained in the negative photosensitive resin composition, 30 mass% or more thereof is the epoxy resin (A-1) represented by formula (1). The content of the epoxy resin (A-1) in the component (A) is more preferably 40 mass% or more, still more preferably 50 mass% or more, particularly preferably 60 mass% or more, and most preferably 70 mass% or more for reasons such as high chemical resistance and high plasma resistance of the cured product, and further, low moisture absorption of the cured product.

[0015]

The epoxy resin (A) contained in the negative photosensitive resin composition is characterized in that it further contains one or more epoxy resins selected from the group consisting of the epoxy resin (A-2) represented by formula (2) and the epoxy resin (A-3) represented by formula (3), in addition to that 30 mass% or more of the epoxy resin (A) is the epoxy resin (A-1) represented by formula (1).

[0016]

In formula (2), q represents an average value and is a real number in a range of 0 to 10.

Specific examples of the epoxy resin (A-2) represented by formula (2) include EPPN-201-L (trade name, manufactured by Nippon Kayaku Co., Ltd., epoxy equivalent: 180 to 200 g/eq., softening point: 65 to 78°C) and RE-305S (trade name, manufactured by Nippon Kayaku Co., Ltd., epoxy equivalent: 170 to 180 g/eq., a resin that is liquid at room temperature).

[0017]

In formula (3), p represents an average value and is a real number in a range of 0 to 30.

Specific examples of the epoxy resin (A-3) represented by formula (3) include EOCN-1020 (trade name, manufactured by Nippon Kayaku Co., Ltd., epoxy equivalent: 190 to 210 g/eq., softening point: 55 to 85°C).

[0018]

In the epoxy resin (A) contained in the negative photosensitive resin composition, the content of one or more epoxy resins selected from the group consisting of the epoxy resin (A-2) represented by formula (2) and the epoxy resin (A-3) represented by formula (3) is preferably in a range of 5 to 70 mass%. The content is more preferably 7 to 60 mass%, and still more preferably 10 to 50 mass%, for the reasons such as that a resist layer having a stable shape can be obtained at the time of dry film formation, that the negative photosensitive resin composition can have high adhesion to a substrate at the time of bonding with the substrate, and that the negative photosensitive resin composition can have high shape stability at the time of being used as a roof portion of a hollow structure.

[0019]

The phenolic hydroxyl group-containing compound (B) contained in the negative photosensitive resin composition is characterized in that it contains one or more phenol compounds selected from the group consisting of the phenolic hydroxyl group-containing compounds (B-1) to (B-6) represented by formulae (4) to (9), respectively. When the component (B) has a hydroxyl equivalent equal to or more than a predetermined preferable lower limit, good durability can be imparted to the cured product. Meanwhile, when the component (B) has a hydroxyl equivalent equal to or less than a predetermined preferable upper limit, contribution to improvement of the strength of the cured film can be maintained. The hydroxyl equivalent of the component (B) is preferably from 90 to 300, and more preferably from 90 to 250 or from 90 to 220. The hydroxyl equivalent as used herein means a value measured by a method in accordance with JIS K 0070. The component (B) may be used alone or in combination of two or more thereof.

[0020]

In formula (4), b is an average value and represents a real number in a range of 1 to 10. R₁'s each independently represent a hydrogen atom or an alkyl group having 1 to 4 carbon atoms.

Specific examples of the phenolic hydroxyl group-containing compound (B-1) represented by formula (4) include PN-152 (trade name, manufactured by UBE Corporation, softening point: 50°C, hydroxyl equivalent: 105 g/eq.), H-1 (trade name, manufactured by UBE Corporation, softening point: 80°C, hydroxyl equivalent: 103 g/eq.), H-4 (trade name, manufactured by UBE Corporation, softening point: 70°C, hydroxyl equivalent: 105 g/eq.), TD-2131 (trade name, manufactured by DIC Corporation, softening point: 80°C, hydroxyl equivalent: 105 g/eq.), and KA-1160 (trade name, manufactured by DIC Corporation, softening point: 81°C, hydroxyl equivalent: 117 g/eq.).

In formula (5), c is an average value and represents a real number in a range of 1 to 10. R₂'s each independently represent a hydrogen atom or an alkyl group having 1 to 4 carbon atoms.

Specific examples of the phenolic hydroxyl group-containing compound (B-2) represented by formula (5) include MEHC-7800H (trade name, manufactured by UBE Corporation, softening point: 85°C, hydroxyl equivalent: 179 g/eq.).

[0021]

In formula (6), d is an average value and represents a real number in a range of 1 to 10. R₃'s each independently represent a hydrogen atom or an alkyl group having 1 to 4 carbon atoms.

Specific examples of the phenolic hydroxyl group-containing compound (B-3) represented by formula (6) include MEHC-7851H (trade name, manufactured by UBE Corporation, softening point: 84°C, hydroxyl equivalent: 217 g/eq.) and GPH-65 (trade name, manufactured by Nippon Kayaku Co., Ltd., softening point: 65°C, hydroxyl equivalent: 200 g/eq.).

In formula (7), e and f are each an average value and represent a real number in a range of 1 to 10. R₄'s each independently represent a hydrogen atom or an alkyl group having 1 to 4 carbon atoms.

Specific examples of the phenolic hydroxyl group-containing compound (B-4) represented by formula (7) include MEHC-7841-4S (trade name, manufactured by UBE Corporation, softening point: 65°C, hydroxyl equivalent: 166 g/eq.).

[0022]

In formula (8), g is an average value and represents a real number in a range of 1 to 10. R₅'s each independently represent a hydrogen atom or an alkyl group having 1 to 4 carbon

atoms.

Specific examples of the phenolic hydroxyl group-containing compound (B-5) represented by formula (8) include KTG-105 (trade name, manufactured by Nippon Kayaku Co., Ltd., softening point: 103°C, hydroxyl equivalent: 105 g/eq.) and MEH-7500 (trade name, manufactured by UBE Corporation, softening point: 109°C, hydroxyl equivalent: 98 g/eq.).

In formula (9), h is an average value and represents a real number in a range of 1 to 10.

Specific examples of the phenolic hydroxyl group-containing compound (B-6) represented by formula (9) include MEH-7600-4H (trade name, manufactured by UBE Corporation, softening point: 154°C, hydroxyl equivalent: 101 g/eq.).

[0023]

As the component (B) contained in the negative photosensitive resin composition, a phenolic hydroxyl group-containing compound other than the phenolic hydroxyl group-containing compounds (B-1) to (B-6) respectively represented by formulae (4) to (9) may be used in combination, and the compound that can be used in combination is not particularly limited. The content of the phenolic hydroxyl group-containing compounds (B-1) to (B-6) respectively represented by formulae (4) to (9) in the component (B) may be usually 50 mass%, and preferably 60 mass% or more, 70 mass% or more, 80 mass% or more, 90 mass% or more, or substantially 100 mass%.

It is not necessary to add a large amount of the component (B), and the percentage of the component (B) blended in the negative photosensitive resin composition is preferably from 1 to 35 mass%, and more preferably from 5 to 25 mass% with respect to the total of the component (A), the component (B), and the component (C).

[0024]

The photo-cationic polymerization initiator (C) contained in the negative photosensitive resin composition contains the compound represented by formula (10).

The photo-cationic polymerization initiator (C) is a compound that generates a cation when being irradiated with ultraviolet rays, far ultraviolet rays, excimer lasers such as KrF or ArF lasers, or radiation such as X-rays or electron beams, and the cation can trigger the initiation of polymerization. Such a photo-cationic polymerization initiator is usually also called an energy ray sensitive acid generator or a photoacid generator.

Specific examples of a commercially available product of the compound represented by formula (10) include Irgacure 290 (trade name, BASF).

As the component (C) contained in the negative photosensitive resin composition, a photo-cationic polymerization initiator other than the compound represented by formula (10) may be used in combination, and the photo-cationic polymerization initiator that can be used in

combination is not particularly limited. The content of the compound represented by formula (10) in the component (C) may be usually 50 mass%, and preferably 60 mass% or more, 70 mass% or more, 80 mass% or more, 90 mass% or more, or substantially 100 mass%.

The content of the component (C) in the negative photosensitive resin composition may be usually from 0.2 to 5 mass%, and is preferably from 0.5 to 3 mass% with respect to the total mass of the component (A) and the component (B).

[0025]

To the negative photosensitive resin composition, a miscible reactive epoxy monomer may be added to improve pattern performance. In the present description, the reactive epoxy monomer means a compound that has an epoxy group and is liquid or semi-solid at room temperature, which is a compound having a weight average molecular weight of about 500 or less and deviates from the definition of the epoxy resin (A). As a specific example thereof, a glycidyl ether compound that is liquid at room temperature can be used. Examples of the glycidyl ether compound include diethylene glycol diglycidyl ether, hexanediol diglycidyl ether, dimethylolpropane diglycidyl ether, polypropylene glycol diglycidyl ether (ED506 manufactured by ADEKA Corporation), trimethylolpropane triglycidyl ether (ED505 manufactured by ADEKA Corporation), trimethylolpropane triglycidyl ether (low chlorine type, EX321L manufactured by Nagase ChemteX Corporation), pentaerythritol tetraglycidyl ether, and dicyclopentadiene dimethanol diglycidyl ether (EP4088L manufactured by ADEKA Corporation). Since these epoxy monomers generally have a high chlorine content, it is preferable to use a low chlorine type epoxy monomer produced by a low chlorine method or subjected to a purification process. These epoxy monomers can be used alone or as a mixture of two or more thereof.

[0026]

The reactive epoxy monomer component is used for the purpose of improving the reactivity of the resist and the physical properties of the cured film. The reactive epoxy monomer component often may be liquid at room temperature. The percentage of the reactive epoxy monomer component blended is not particularly limited. However, in the case of a reactive epoxy monomer component that is liquid at room temperature, it is desirable that the component is blended in an amount of 20 mass% or less with respect to the total amount of the negative photosensitive resin composition, thereby avoiding the inconvenience that the film obtained after the solvent removal becomes sticky to easily cause mask sticking. From this point of view, in the case of blending the reactive epoxy monomer component in the negative photosensitive resin composition, the percentage thereof is preferably 10 mass% or less, and particularly suitably 7 mass% or less with respect to the total mass of the component (A) and the component (B).

[0027]

To the negative photosensitive resin composition, a solvent may be added in order to lower the viscosity of the composition and improve the film coating properties. The solvent is not particularly limited as long as it is an organic solvent that is commonly used in inks, paints, and the like and that can dissolve components of the photosensitive resin composition. Specific examples of the solvent include ketones such as acetone, ethyl methyl ketone, cyclohexanone, and cyclopentanone, aromatic hydrocarbons such as toluene, xylene, and tetramethylbenzene, glycol ethers such as ethylene glycol dimethyl ether, dipropylene glycol dimethyl ether, and dipropylene glycol diethyl ether, esters such as ethyl acetate, butyl acetate, butyl cellosolve acetate, carbitol acetate, propylene glycol monomethyl ether acetate, and γ -butyrolactone, alcohols such as methanol, ethanol, cellosolve, and methyl cellosolve, aliphatic hydrocarbons such as octane and decane, and petroleum solvents such as petroleum ether, petroleum naphtha, hydrogenated petroleum naphtha, and solvent naphtha.

[0028]

These solvents can be used alone or as a mixture of two or more thereof. The solvent component is added for the purpose of appropriately changing the film thickness and coatability at the time of applying the negative photosensitive resin composition to a substrate. The amount of the solvent for appropriately maintaining the solubility of main components, the volatility of components, the liquid viscosity of the composition, and the like is preferably 95 mass% or less, and more preferably 10 to 90 mass% in the negative photosensitive resin composition.

[0029]

In the negative photosensitive resin composition, a miscible adhesion imparting agent may be used for the purpose of improving the adhesion of the composition to a substrate. As the adhesion imparting agent, a coupling agent such as a silane coupling agent or a titanium coupling agent can be used. A silane coupling agent is preferable.

[0030]

Examples of the silane coupling agent include 3-chloropropyltrimethoxysilane, vinyltrichlorosilane, vinyltriethoxysilane, vinyltrimethoxysilane, vinyltris(2-methoxyethoxy)silane, 3-methacryloxypropyltrimethoxysilane, 2-(3,4-epoxycyclohexyl)ethyltrimethoxysilane, 3-glycidoxypropyltrimethoxysilane, 3-mercaptopropyltrimethoxysilane, 3-aminopropyltriethoxysilane, N-2-(aminoethyl)-3-aminopropyltrimethoxysilane, and 3-ureidopropyltriethoxysilane. These adhesion imparting agents can be used alone or in combination of two or more thereof.

The adhesion imparting agent is not reactive with main components, and thus the

component except for a portion that acts at the interface with the base material is present as a residual component after curing. Since the adhesion imparting agent exhibits an effect even in a small amount depending on the base material, it is appropriate to use the adhesion imparting agent within a range in which it does not exhibit an effect such as deteriorating the physical properties. The percentage of the adhesion imparting agent is preferably 15 mass% or less, and more preferably 5 mass% or less in the negative photosensitive resin composition.

[0031]

In the negative photosensitive resin composition, a sensitizer may be further used in order to absorb ultraviolet rays and donate the absorbed light energy to the photo-cationic polymerization initiator. As the sensitizer, for example, thioxanthenes and anthracene compounds having alkoxy groups at positions 9 and 10 (9,10-dialkoxyanthracene derivatives) are preferable. Examples of the alkoxy group in the anthracene compound having alkoxy groups at positions 9 and 10 include alkoxy groups having 1 to 4 carbon atoms, such as a methoxy group, an ethoxy group, a propoxy group, and a butoxy group. The 9,10-dialkoxyanthracene derivative may further have a substituent. Examples of the substituent include halogen atoms such as a fluorine atom, a chlorine atom, a bromine atom, and an iodine atom, alkyl groups having 1 to 4 carbon atoms, such as a methyl group, an ethyl group, and a propyl group, sulfonic acid alkyl ester groups, and carboxylic acid alkyl ester groups. Examples of the alkyl group in the sulfonic acid alkyl ester group and the carboxylic acid alkyl ester group include alkyl groups having 1 to 4 carbon atoms, such as methyl, ethyl, and propyl. The substitution position of the substituent in the anthracene compound having alkoxy groups at positions 9 and 10 is preferably the position 2.

[0032]

Specific examples of the thioxanthenes include 2,4-dimethylthioxanthone, 2,4-diethylthioxanthone, 2-chlorothioxanthone, 2,4-diisopropylthioxanthone, and 2-isopropylthioxanthone. Preference is given to 2,4-diethylthioxanthone (for example, KAYACURE DETX-S (trade name) manufactured by Nippon Kayaku Co., Ltd.) and 2-isopropylthioxanthone.

[0033]

Examples of the 9,10-dialkoxyanthracene derivative include 9,10-dimethoxyanthracene, 9,10-diethoxyanthracene, 9,10-dipropoxyanthracene, 9,10-dibutoxyanthracene, 9,10-dimethoxy-2-ethylanthracene, 9,10-diethoxy-2-ethylanthracene, 9,10-dipropoxy-2-ethylanthracene, 9,10-dimethoxy-2-chloroanthracene, methyl 9,10-dimethoxyanthracene-2-sulfonate, methyl 9,10-diethoxyanthracene-2-sulfonate, and methyl 9,10-dimethoxyanthracene-2-carboxylate.

[0034]

These sensitizers can be used alone or as a mixture of two or more thereof. The use of 2,4-diethylthioxanthone and 9,10-dimethoxy-2-ethylanthracene is most preferable. Since the sensitizer component exhibits an effect in a small amount, the percentage thereof is preferably 30 mass% or less, and more preferably 20 mass% or less with respect to the component (C).

[0035]

In the case where it is necessary to reduce an adverse effect due to ions derived from the component (C), an ion catcher may be added to the negative photosensitive resin composition. Examples of the ion catcher include alkoxyaluminums such as trimethoxyaluminum, trisethoxyaluminum, trisisopropoxyaluminum, isopropoxydiethoxyaluminum, and trisbutoxyaluminum, phenoxyaluminums such as trisphenoxyaluminum and trisparamethylphenoxyaluminum, and organoaluminum compounds such as trisacetoxaluminum, trisstearatoaluminum, trisbutyratoaluminum, trispropionatoaluminum, trisacetylacetonatoaluminum, tris(trifluoroacetylacetonato)aluminum, trisethylacetoacetatoaluminum, diacetylacetonatodipivaloylmethanatoaluminum, and diisopropoxy(ethylacetoacetato)aluminum. These ion catchers can be used alone or in combination of two or more thereof. The amount thereof blended may be 10 mass% or less with respect to the total solid content (all components except the solvent) of the negative photosensitive resin composition.

[0036]

To the negative photosensitive resin composition, various additives such as a thermoplastic resin, a colorant, a thickener, an antifoaming agent, and a leveling agent can be further added as necessary. Examples of the thermoplastic resin include polyethersulfone, polystyrene, and polycarbonate. Examples of the colorant include phthalocyanine blue, phthalocyanine green, iodine green, crystal violet, titanium oxide, carbon black, and naphthalene black. Examples of the thickener include orben, benton, and montmorillonite. Examples of the antifoaming agent include silicone-based, fluorine-based, and polymer-based antifoaming agents. In the case where these additives and the like are used, the amount thereof is, for example, 30 mass% or less in the photosensitive resin composition as a rough standard, but the amount may be appropriately increased or decreased according to the purpose of use.

[0037]

An inorganic filler such as barium sulfate, barium titanate, silicon oxide, amorphous silica, talc, clay, magnesium carbonate, calcium carbonate, aluminum oxide, aluminum hydroxide, or mica powder can be added to the negative photosensitive resin composition. The amount of the inorganic filler added may be 60 mass% or less in the negative photosensitive resin composition.

[0038]

The negative photosensitive resin composition can be prepared only by blending the component (A), the component (B), and the component (C) as essential components, and a solvent, various additives, and the like as necessary, and then mixing and stirring them by a common method. If necessary, the components may be dispersed and mixed using a disperser such as a dissolver, a homogenizer, or a three-roll mill. In addition, after mixing, the resulting mixture may be further subjected to filtration using a mesh, a membrane filter, or the like.

[0039]

The negative photosensitive resin composition is preferably used in the form of a solution containing a solvent. When the negative photosensitive resin composition dissolved in a solvent is used, for example, the negative photosensitive resin composition can be applied in a thickness of 0.1 to 1000 μm to a substrate such as a metal substrate of silicon, aluminum, copper, gold, platinum or the like, a ceramic substrate of lithium tantalate, glass, silicon oxide, silicon nitride or the like, or a resin substrate of polyimide, polyethylene terephthalate or the like using a spin coater. Subsequently, the solvent can be removed under heating conditions at 60 to 130°C for about 5 to 60 minutes to form a negative photosensitive resin composition layer. Then, a mask having a predetermined pattern can be placed on the negative photosensitive resin composition layer, and the negative photosensitive resin composition layer can be irradiated with ultraviolet rays. Subsequently, heat treatment is performed under conditions of 50 to 130°C for about 1 to 50 minutes, and then an unexposed portion can be developed using a developer at a temperature ranging from room temperature (for example, 15°C or higher) to 50°C for about 1 to 180 minutes to form a pattern. Finally, heat treatment is performed under conditions of 130 to 200°C to give a cured product satisfying various properties. As the developer, for example, an organic solvent such as γ -butyrolactone, triethylene glycol dimethyl ether, or propylene glycol monomethyl ether acetate, or a mixed liquid of the organic solvent and water can be used. For the development, a developing device such as a paddle type, spray type, or shower type developing device may be used, and ultrasonic irradiation may be performed as necessary. Examples of a preferable metal substrate for use with the negative photosensitive resin composition include an aluminum substrate.

[0040]

The negative photosensitive resin composition can be applied to a base film using a roll coater, a die coater, a knife coater, a bar coater, a gravure coater or the like, and then dried in a drying oven set at 45 to 100°C to remove a predetermined amount of the solvent, and a cover film or the like can be stacked thereon as necessary, whereby the negative photosensitive resin composition can be formed into a dry film resist. At this time, the thickness of the resist on the

base film may be controlled within the range of from 2 to 100 μm . As the base film and the cover film, for example, films of polyester, polypropylene, polyethylene, TAC, polyimide or the like are used. A film release-treated with a silicone-based release treatment agent, a non-silicone-based release treatment agent, or the like as necessary may be used as these films. When the dry film resist is used, for example, the cover film is peeled off, the dry film resist is transferred to a substrate at a temperature of 40 to 100°C and a pressure of 0.05 to 2 MPa using a hand roll or a laminator, and the resist is subjected to exposure, post-exposure baking, development, and heat treatment similarly to the case of the negative photosensitive resin composition dissolved in the solvent.

[0041]

If the negative photosensitive resin composition is supplied as a dry film as described above, the steps of application to a support and drying can be omitted. This makes it possible to more easily form a cured product pattern using the negative photosensitive resin composition.

[0042]

In the case of the use for a MEMS package or a semiconductor package, the substrate can be used by being covered with the negative photosensitive resin composition or with a hollow structure produced from the negative photosensitive resin composition. A substrate used in the MEMS and semiconductor packages may be a substrate obtained by forming a thin film of a metal such as aluminum, gold, copper, chromium, or titanium having a film thickness of 10 to 5000 Å with sputtering or vapor deposition on a silicon wafer having various shapes, and finely processing the metal by an etching method or the like. In some cases, as an inorganic protective film, silicon oxide or silicon nitride may be further deposited in a film thickness of 10 to 10,000 Å. Then, a MEMS or semiconductor device is made or placed on the substrate. It is required to cover the device or make a hollow structure in order to shield the device from the outside air. In the case of covering the device with the negative photosensitive resin composition, the device can be covered by the above-mentioned method. In the case of producing a hollow structure, a barrier rib is formed on the substrate by the above-mentioned method, and patterning is further performed on the barrier rib by the above-mentioned method so that a dry film is laminated thereon to serve as a lid on the barrier rib, whereby a hollow package structure can be produced. Further, after the production, heat treatment can be performed at 130 to 200°C for 10 to 120 minutes as necessary, so that a MEMS package component and a semiconductor package component satisfying various properties can be obtained.

[0043]

It is noted that the “packaging” is a sealing method used to block entry or infiltration of gas and liquid from the outside in order to maintain stability of a substrate, wiring, an element,

and the like. The “packaging” mentioned in the present description refers to hollow packaging for surrounding a component having a drive unit, such as a MEMS or for surrounding a vibrator of a SAW device or the like, and surface protection, resin sealing, or the like that is performed to prevent deterioration of a semiconductor substrate, a printed wiring board, wiring, or the like. Further, the “wafer level packaging” refers to a packaging method in which a wafer is subjected to formation of a protective film and a terminal, wiring, and packaging, and then the wafer is cut into chips.

[0044]

The negative photosensitive resin composition of the present invention is excellent in resolution, and a cured product thereof exhibits excellent effects that it has excellent adhesion to a substrate and high mechanical strength, and further has small displacement due to temperature and excellent durability against thermal deformation. Therefore, the cured product of the photosensitive resin composition can be used for, for example, production of MEMS (microelectromechanical system) components, micromachine components, microfluidic components, μ -TAS (micro-total analysis system) components, inkjet printer components, microreactor components, conductive layers, LIGA components, molds and stamps for microinjection molding and thermal embossing, screens or stencils for microprinting applications, MEMS package components, semiconductor package components, BioMEMS and biophotonic devices, and printed wiring boards. The cured product of the photosensitive resin composition is particularly useful for MEMS package components and semiconductor package components.

EXAMPLES

[0045]

Hereinafter, the present invention will be described with reference to examples. These examples are merely intended for suitably illustrating the present invention, and the scope of the present invention is not limited to the following examples.

[0046]

Examples 1 to 9 and Comparative Examples 1 to 3 (Preparation of negative photosensitive resin composition)

According to each composition shown in Tables 1 and 2 (unit: parts by mass), the epoxy resin (A), the phenolic hydroxyl group-containing compound (B), the photo-cationic polymerization initiator (C), and other components were stirred and mixed in a flask with a stirrer at 60°C for 2 hours to give negative photosensitive resin compositions of the present invention and for comparison.

[0047]

(Application, drying, exposure, and development of photosensitive resin composition layer)

Each of the negative photosensitive resin compositions of Examples 1 to 9 and Comparative Examples 1 to 3 was applied to a silicon (Si) wafer substrate using a spin coater so as to have a film thickness (film thickness after drying) of 20 μm . Then, the negative photosensitive resin composition was dried under conditions of 120°C for 2 minutes using a hot plate to give each negative photosensitive resin composition layer. The substrate provided with the negative photosensitive resin composition layer was prebaked under conditions of 65°C for 5 minutes and then 95°C for 15 minutes using a hot plate, and further subjected to pattern exposure (soft contact, i-line) using an i-line exposure apparatus (mask aligner: manufactured by Ushio Inc.). The exposed substrate was subjected to post-exposure baking (PEB) at 95°C for 6 minutes using a hot plate, and then subjected to development treatment at 23°C for 6 minutes by an immersion method using propylene glycol monomethyl ether acetate. The substrate was hard-baked for 60 minutes in an oven at 200°C (under a nitrogen atmosphere) to give a pattern of a cured negative photosensitive resin composition on the Si wafer substrate.

[0048]

(Sensitivity evaluation of negative photosensitive resin composition)

In the pattern exposure described above, the exposure amount at which the best transfer accuracy of the mask was achieved according to the appearance of the obtained pattern was defined as the optimum exposure amount, and the sensitivity of each negative photosensitive resin composition was evaluated. The evaluation results mean that a composition having a smaller value of the optimum exposure amount has higher sensitivity. The evaluation results on the Si wafer substrate are shown in the following Tables 1 and 2.

Evaluation criteria

- (good): The optimum exposure amount was 300 mJ or less.
- × (poor): The optimum exposure amount exceeded 300 mJ.

[0049]

(Resolution evaluation of negative photosensitive resin composition)

In the pattern exposure at the optimum exposure amount that was obtained in the aforementioned paragraph “Sensitivity evaluation of negative photosensitive resin composition”, the resolution of the negative photosensitive resin composition was evaluated by measuring the width of the thinnest pattern adhered to the substrate in the resist pattern resolved without residue with a line-and-space ratio of 1 : 1. The evaluation results on the Si wafer substrate are shown in the following Tables 1 and 2.

Evaluation criteria

○ (good): The thinnest pattern had a width of 10 μm or less.

× (poor): The thinnest pattern had a width exceeding 10 μm .

[0050]

(Evaluation of adhesion force of cured product of negative photosensitive resin composition to Si)

The adhesion force herein is a shear strength measured at the time when the pattern is peeled off from the substrate by applying a force from the side surface of the pattern using a shear tool. A larger value is preferable because it means a higher adhesion force between the substrate and the resin composition. Specifically, a 100 μm $\times$ 100 μm (film thickness: 20 μm) block-shaped resist pattern was formed on the substrate at the optimum exposure amount that was obtained as described above. A load was laterally applied to the pattern at a position of 3 μm in height from the substrate at a speed of 50 $\mu\text{m}/\text{sec}$ using a shear tool of 100 μm , and the failure load was measured by a bonding tester (manufactured by RHESCA CO., LTD.). The results are shown in the following Tables 1 and 2.

Evaluation criteria

○ (good): The shear strength was 30 MPa or more.

× (poor): The shear strength was less than 30 MPa.

[0051]

(Crack evaluation of cured product of negative photosensitive resin composition)

In the Si substrate with a resin pattern of the cured negative photosensitive resin composition, minute cracks generated in the pattern after hard baking treatment were observed, and the crack resistance of each negative photosensitive resin composition was evaluated. The evaluation results on the Si wafer substrate are shown in the following Tables 1 and 2.

Evaluation criteria

○ (good): No crack was generated in the pattern.

× (poor): Cracks were generated in the pattern.

[0052]

(Evaluation of strength at high temperatures of cured product of negative photosensitive resin composition)

The cured product of the negative photosensitive resin composition having a size of 20 μm in thickness $\times$ 4 mm in width $\times$ 50 mm in length was subjected to measurement with a dynamic viscoelasticity measuring device (RSA-G2: manufactured by TA Instruments), and the strength of the cured product of each negative photosensitive resin composition at high temperatures was evaluated. The evaluation results of the glass transition temperature (T_g) and

the elastic modulus at 175°C are shown in the following Tables 1 and 2.

Evaluation criteria (T_g)

- (good): The T_g was 200°C or higher.
- × (poor): The T_g was lower than 200°C.

Evaluation criteria (elastic modulus)

- (good): The elastic modulus was 1.5 GPa or more.
- × (poor): The elastic modulus was less than 1.5 GPa.

[0053]

(Thermal deformation evaluation of cured product of negative photosensitive resin composition)

The cured product of the negative photosensitive resin composition having a size of 20 μm in thickness × 4 mm in width × 50 mm in length was subjected to measurement with a dynamic viscoelasticity measuring device (TMA-Q400: manufactured by TA Instruments), and the amount of thermal deformation of the cured product of each negative photosensitive resin composition was evaluated. The evaluation results of the thermal expansion rate calculated from the amount of displacement in the range of -50°C to 180°C are shown in the following Tables 1 and 2.

Evaluation criteria

- (good): The thermal expansion rate was 75 ppm/°C or less.
- × (poor): The thermal expansion rate exceeded 75 ppm/°C.

[0054]

Table 1 Evaluated compositions and evaluation results

			Examples			Comparative Examples		
			1	2	3	1	2	3
(A) Epoxy resin	KM-N	A-1	70	70	70	70	70	40
	RE-305S	A-2	15	15	15			
	NC-3000	A-4				15		15
	NER-7604	A-5					15	20
(B) Phenolic hydroxyl group-containing compound	PN-152	B-1	15			15		
	H-1	B-1'		15				20
	H-4	B-1''			15		15	
(C) Photoacid generator	IRG290	C	2	2	2	2	2	1
Reactive epoxy monomer	EX-321L	D						5
Coupling agent	S-510	E	5	5	5	5	5	5
Solvent	MMM	F	30	30	30	30	30	30
Optimum exposure amount (Si)			○	○	○	○	○	○
Resolution			○	○	○	○	○	○
Adhesion force (Si)			○	○	○	○	○	○
Cracks			○	○	○	○	○	○
Elastic modulus (175°C)			○	○	○	×	×	×
T _g			○	○	○	○	○	×
Thermal expansion rate			○	○	○	×	×	○

[0055]

Table 2 Evaluated compositions and evaluation results

			Examples					
			4	5	6	7	8	9
(A) Epoxy resin	KM-N	A-1	70	70	70	70	70	70
	RE-305S	A-2		15	15	15	15	15
	EOCN-1020	A-3	15					
	NC-3000	A-4						
	NER-7604	A-5						
(B) Phenolic hydroxyl group-containing compound	PN-152	B-1	15					
	MEHC-7800H	B-2		15				
	MEHC-7851H	B-3			15			
	MEHC-7841-4S	B-4				15		
	MEH-7500	B-5					15	
	MEH-7600-4H	B-6						15
(C) Photoacid generator	IRG290	C	2	2	2	2	2	2
Coupling agent	S-510	E	5	5	5	5	5	5
Solvent	MMM	F	30	30	30	30	30	30
Optimum exposure amount (Si)			○	○	○	○	○	○
Resolution			○	○	○	○	○	○
Adhesion force (Si)			○	○	○	○	○	○
Cracks			○	○	○	○	○	○
Elastic modulus (175°C)			○	○	○	○	○	○
Tg			○	○	○	○	○	○
Thermal expansion rate			○	○	○	○	○	○

[0056]

It is noted that each of (A-1) to (F) in Tables 1 and 2 is as follows.

(A-1): KM-N-LCL (trade name, manufactured by Nippon Kayaku Co., Ltd., epoxy equivalent: 210 g/eq., softening point: 85°C, a compound represented by formula (1) (average number of repetitions a = 4)) In the tables, the compound is described as “KM-N”.

(A-2): RE-305S (trade name, manufactured by Nippon Kayaku Co., Ltd., epoxy equivalent: 173 g/eq., a liquid resin, a compound represented by formula (2))

(A-3): EOCN-1020 (trade name, manufactured by Nippon Kayaku Co., Ltd., epoxy equivalent: 190 to 210 g/eq., softening point: 55 to 85°C, a compound represented by formula (3))

(A-4): NC-3000 (trade name, manufactured by Nippon Kayaku Co., Ltd., epoxy equivalent: 347 g/eq., softening point: 71°C)

(A-5): NER-7604 (trade name, manufactured by Nippon Kayaku Co., Ltd., epoxy equivalent: 347 g/eq., softening point: 71°C)

(B-1): a compound represented by formula (4), PN-152 (trade name, manufactured by UBE Corporation, hydroxyl equivalent: 103 g/eq.)

(B-1’): a compound represented by formula (4), H-1 (trade name, manufactured by UBE Corporation, hydroxyl equivalent: 103 g/eq., softening point: 80°C)

(B-1’): a compound represented by formula (4), H-4 (trade name, manufactured by UBE Corporation, hydroxyl equivalent: 105 g/eq., softening point: 70°C)

(B-2): a compound represented by formula (5), MEHC-7800H (trade name, manufactured by UBE Corporation, softening point: 85°C, hydroxyl equivalent: 179 g/eq.)

(B-3): a compound represented by formula (6), MEHC-7851H (trade name, manufactured by UBE Corporation, softening point: 84°C, hydroxyl equivalent: 217 g/eq.)

(B-4): a compound represented by formula (7), MEHC-7841-4S (trade name, manufactured by UBE Corporation, softening point: 65°C, hydroxyl equivalent: 166 g/eq.)

(B-5): a compound represented by formula (8), MEH-7500 (trade name, manufactured by UBE Corporation, softening point: 109°C, hydroxyl equivalent: 98 g/eq.)

(B-6): a compound represented by formula (9), MEH-7600-4H (trade name, manufactured by UBE Corporation, softening point: 154°C, hydroxyl equivalent: 101 g/eq.)

(C): a compound represented by formula (10), Irgacure 290 (trade name, manufactured by BASF)

In the tables, the component (C) is described as “photoacid generator”, and the product is described as “IRG 290”.

(D): trade name EX-321L, manufactured by Nagase ChemteX Corporation, epoxy equivalent: 140 g/eq.

(E): a silane coupling agent (3-glycidoxypopyltrimethoxysilane, trade name S-510, manufactured by CHISSO CORPORATION)

(F): a solvent (ethylene glycol dimethyl ether, trade name: HISOLVE MMM, manufactured by TOHO Chemical Industry Co., Ltd.)

In the tables, the solvent is described as “MMM”.

[0057]

The results in Tables 1 and 2 revealed that the negative photosensitive resin compositions of the present invention (Examples 1 to 9) had a higher elastic modulus at high temperatures than the negative photosensitive resin compositions of Comparative Examples 1 to 3, had a higher glass transition temperature than the negative photosensitive resin composition of Comparative Example 3, and had smaller thermal deformation than the negative photosensitive resin compositions of Comparative Examples 1 and 2.

INDUSTRIAL APPLICABILITY

[0058]

The negative photosensitive resin composition according to the present invention can provide a pattern having high adhesion to a substrate and can be suitable for fields such as MEMS package components and semiconductor packages. In particular, in polymer capping for SAW/BAW filters, the photosensitive resin composition of the present invention can provide a pattern having high strength, have low thermal expansion coefficient, and have excellent

durability against thermal deformation. Thus, the photosensitive resin composition can be advantageous for shape retention under an environment in wide temperature ranges from high temperatures to low temperatures such as during cavity formation and molding.

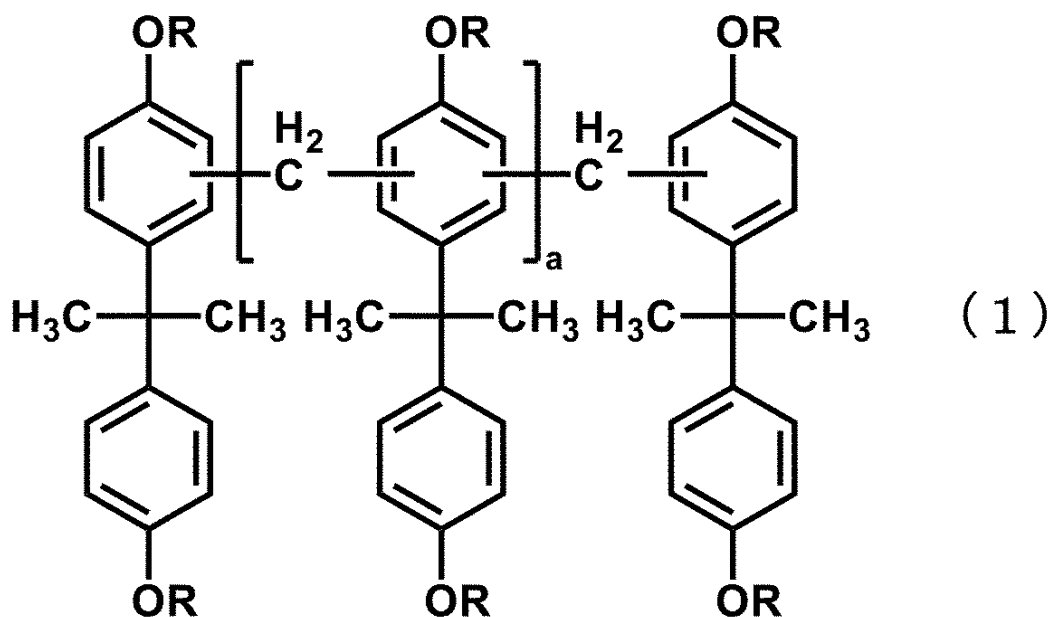
Specifically, the cured product of the photosensitive resin composition can be particularly suitably used for, for example, production of MEMS (microelectromechanical system) components, micromachine components, microfluidic components, μ -TAS (micro-total analysis system) components, inkjet printer components, microreactor components, conductive layers, LIGA components, molds and stamps for microinjection molding and thermal embossing, screens or stencils for microprinting applications, MEMS package components, semiconductor package components, BioMEMS and biophotonic devices, and printed wiring boards.

CLAIMS

CLAIM 1

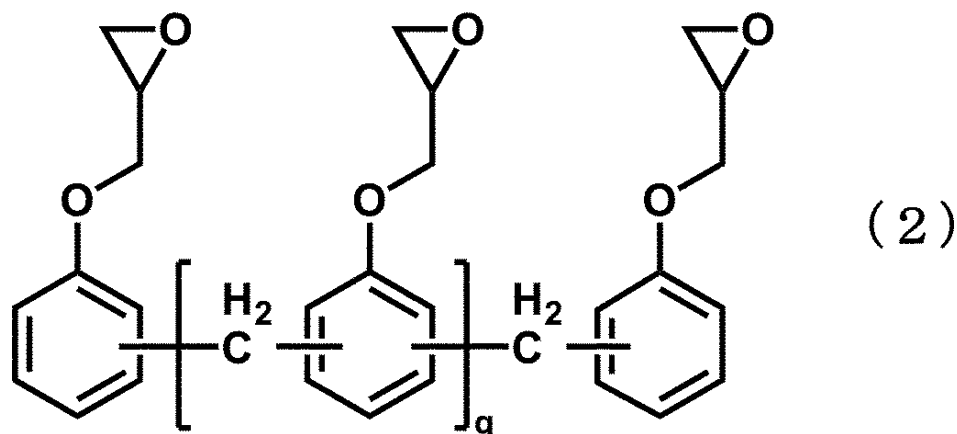
A negative photosensitive resin composition comprising: (A) an epoxy resin, (B) a phenolic hydroxyl group-containing compound, and (C) a photo-cationic polymerization initiator, wherein

30 mass% or more of the epoxy resin (A) is an epoxy resin (A-1) represented by formula (1):

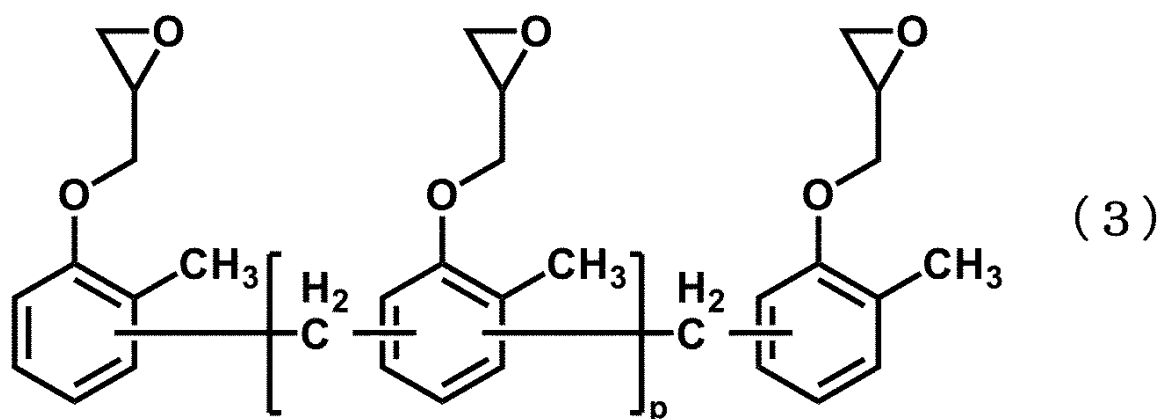


wherein R's each independently represent a glycidyl group or a hydrogen atom, and at least two of a plurality of R's are glycidyl groups, and $\bar{n}$ represents an average value of number of repeating units and is a real number in a range of 0 to 30,

the epoxy resin (A) further contains one or more epoxy resins selected from the group consisting of an epoxy resin (A-2) represented by formula (2):

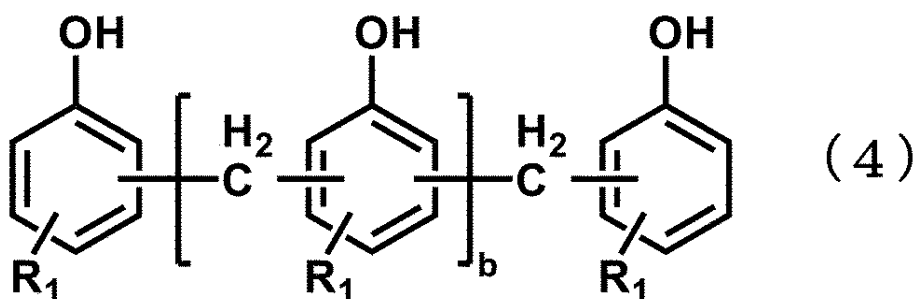


wherein q represents an average value and is a real number in a range of 0 to 10, and an epoxy resin (A-3) represented by formula (3):



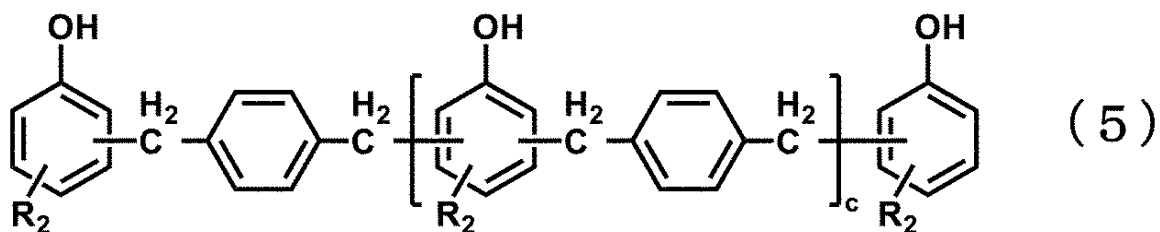
wherein p represents an average value and is a real number in a range of 0 to 30,

the phenolic hydroxyl group-containing compound (B) contains one or more phenol compounds selected from the group consisting of a phenolic hydroxyl group-containing compound (B-1) represented by formula (4):



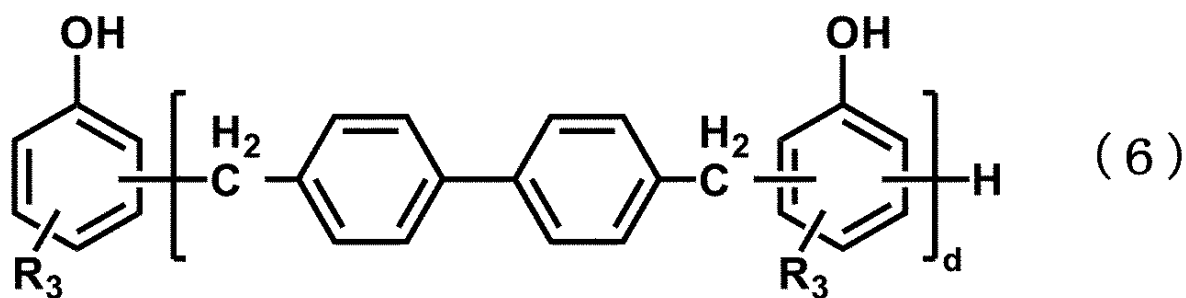
wherein b is an average value and represents a real number in a range of 1 to 10, and R₁'s each independently represent a hydrogen atom or an alkyl group having 1 to 4 carbon atoms,

a phenolic hydroxyl group-containing compound (B-2) represented by formula (5):



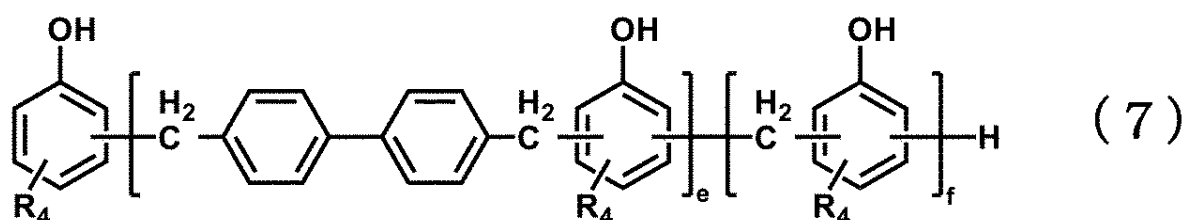
wherein c is an average value and represents a real number in a range of 1 to 10, and R₂'s each independently represent a hydrogen atom or an alkyl group having 1 to 4 carbon atoms,

a phenolic hydroxyl group-containing compound (B-3) represented by formula (6):



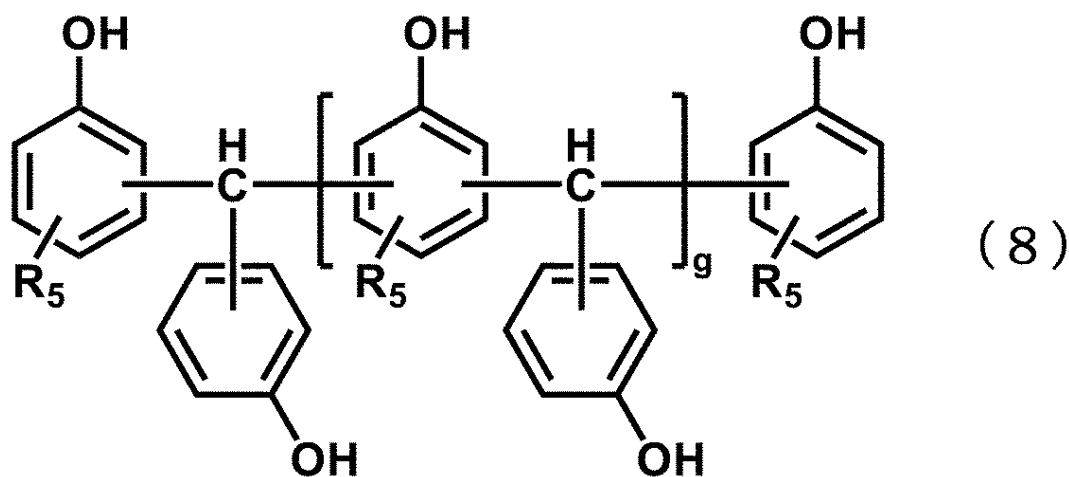
wherein d is an average value and represents a real number in a range of 1 to 10, and R₃'s each independently represent a hydrogen atom or an alkyl group having 1 to 4 carbon atoms,

a phenolic hydroxyl group-containing compound (B-4) represented by formula (7):



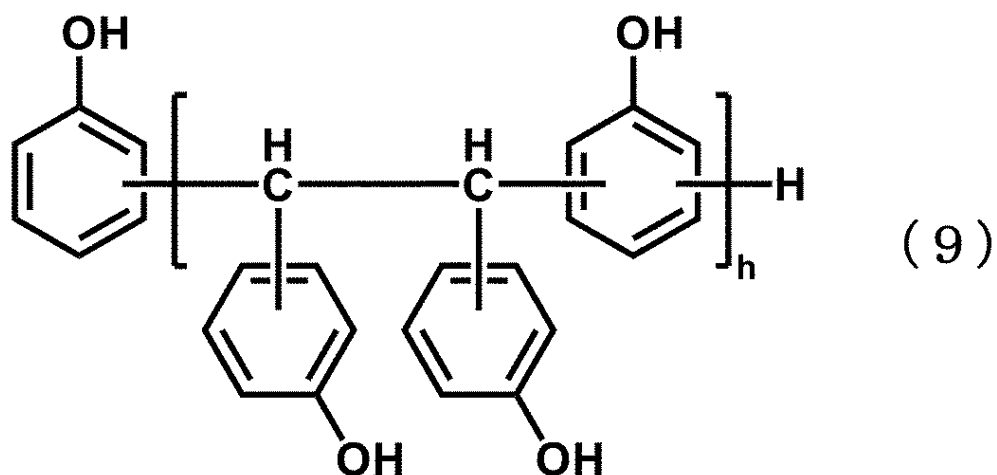
wherein e and f are each an average value and each independently represent a real number in a range of 1 to 10, and R₄'s each independently represent a hydrogen atom or an alkyl group having 1 to 4 carbon atoms,

a phenolic hydroxyl group-containing compound (B-5) represented by formula (8):

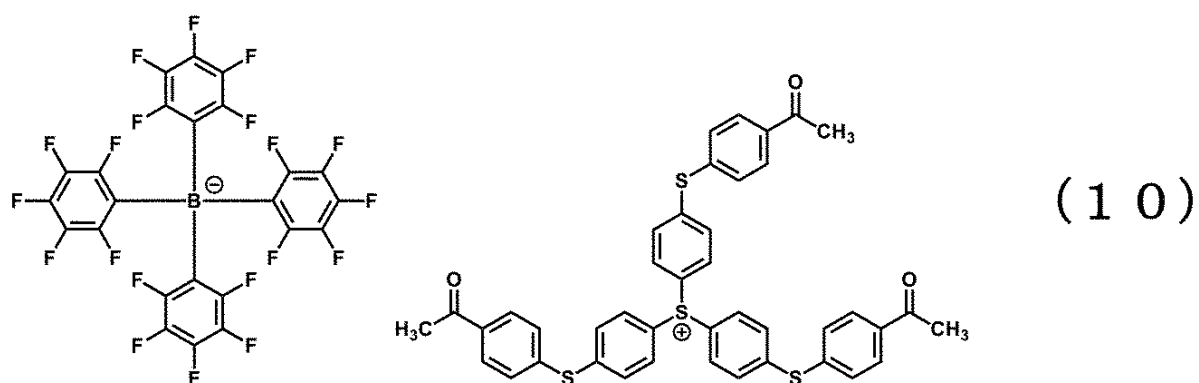


wherein g is an average value and represents a real number in a range of 1 to 10, and R₅'s each independently represent a hydrogen atom or an alkyl group having 1 to 4 carbon atoms, and

a phenolic hydroxyl group-containing compound (B-6) represented by formula (9):



wherein h is an average value and represents a real number in a range of 1 to 10, and the photo-cationic polymerization initiator (C) contains a compound represented by formula (10):



CLAIM 2

A dry film resist comprising the negative photosensitive resin composition according to claim 1.

CLAIM 3

A cured product of the negative photosensitive resin composition according to claim 1.

CLAIM 4

A cured product of the dry film resist according to claim 2.

CLAIM 5

A wafer level package comprising the cured product according to claim 3 or 4.

CLAIM 6

An adhesive layer between a substrate and an adherend, the adhesive layer comprising the cured product according to claim 3 or 4.