

ELECTRONIC DEVICE MANUFACTURING SOLUTION, METHOD FOR
MANUFACTURING RESIST PATTERN, AND METHOD FOR
MANUFACTURING DEVICE

5

BACKGROUND OF THE INVENTION

TECHNICAL FIELD

[0001] The present invention relates to an electronic device manufacturing
solution, a method for manufacturing a resist pattern, and a method for
10 manufacturing a device.

BACKGROUND ART

[0002] In recent years, needs for high integration of LSI has been
increasing, and refining of patterns is required. In order to respond such
15 needs, lithography processes using KrF excimer laser (248 nm), ArF
excimer laser (193 nm), extreme ultraviolet (EUV; 13 nm), X-ray of short
wavelength, electron beam or the like have been put to practical use. In
order to respond to such refining of resist patterns, also for photosensitive
resin compositions to be used as a resist during refining processing, those
20 having high resolution are required. Finer patterns can be formed by
exposing with light of short wavelength, but since an extremely fine
structure is formed, a yield becomes a problem due to fine pattern collapse
or the like.

[0003] Under such circumstances, in Patent Document 1, a rinse liquid for
25 lithography, which has good performance such as pattern collapse margin,
defect, and LWR as in the conventional system containing a surfactant,
and also has good characteristics in melting, has been studied.

[0004] Further, as another attempt there are studies to use a fluorine-
containing surfactant (Patent Document 2 and Patent Document 3).

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PRIOR ART DOCUMENTS

PATENT DOCUMENTS

[0005] [Patent document 1] JP 2014-219577 A

[Patent document 2] WO 2018/095885

[Patent document 3] WO 2017/220479

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SUMMARY OF THE INVENTION

PROBLEMS TO BE SOLVED BY THE INVENTION

[0006] The present inventors considered that there are one or more
10 problems still need improvements. Examples of these include the
followings: reducing defects in fine resist patterns; suppressing bridge
formation in resist patterns; preventing resist pattern collapse in fine resist
patterns; suppressing resist pattern width non-uniformity; reducing the
residue after removing an electronic device manufacturing solution;
15 reducing the surface tension of an electronic device manufacturing
solution; providing an electronic device manufacturing solution with less
environmental impact; providing an electronic device manufacturing
solution with low handling risk; providing an electronic device
manufacturing solution having good storage stability (for example, long-
20 term storage); and providing an electronic device manufacturing solution
with less impact given to resist patterns.

The present invention has been made based on the technical
background as described above, and provides an electronic device
manufacturing solution.

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MEANS FOR SOLVING THE PROBLEMS

[0007] An electronic device manufacturing solution according to the
present invention comprises at least:

- an anionic surfactant (A);
- 30 a solvent (B); and
- a quaternary ammonium compound (C).

[0008] A method for manufacturing a resist pattern according to the present invention uses the above-mentioned electronic device manufacturing solution.

5 [0009] A method for manufacturing a resist pattern according to the present invention comprises steps below:

(1) applying a photosensitive resin composition on a substrate with or without one or more intervening layers, to form a photosensitive resin layer;

(2) exposing the photosensitive resin layer to radiation;

10 (3) developing the exposed photosensitive resin layer; and

(4) cleaning the developed layer with the above-mentioned electronic device manufacturing solution.

[0010] A method for manufacturing a device according to the present invention comprises the above-mentioned method for manufacturing a resist pattern.

EFFECTS OF THE INVENTION

[0011] Using the electronic device manufacturing solution according to the present invention, it is possible to expect one or more of the following effects.

20 It is possible to reduce defects in fine resist patterns. It is possible to suppress the formation of bridges in the resist patterns. It is possible to prevent the resist pattern collapse in fine resist patterns. It is possible to suppress the resist pattern width non-uniformity. It is possible to reduce the residue after removing an electronic device manufacturing solution. It is possible to reduce the surface tension of an electronic device manufacturing solution. It is possible to reduce the environmental impact of an electronic device manufacturing solution. It is possible to reduce the handling risk of an electronic device manufacturing solution. It is possible to make good storage stability of an electronic device manufacturing solution. It is possible to reduce the impact that an electronic device manufacturing solution gives to resist patterns.

BRIEF DESCRIPTION OF THE DRAWING

[0012] Figure 1 is a schematic illustration showing the condition of resist walls rinsing.

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DETAILED DESCRIPTION OF THE INVENTION

MODE FOR CARRYING OUT THE INVENTION

[0013] Embodiments of the present invention are described below in detail.

10

[0014] Definitions

Unless otherwise specified in the present specification, the definitions and examples described in this paragraph are followed.

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The singular form includes the plural form and "one" or "that" means "at least one". An element of a concept can be expressed by a plurality of species, and when the amount (for example, mass% or mol%) is described, it means sum of the plurality of species.

"And/or" includes a combination of all elements and also includes single use of the element.

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When a numerical range is indicated using "to" or "-", it includes both endpoints and units thereof are common. For example, 5 to 25 mol% means 5 mol% or more and 25 mol% or less.

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The descriptions such as "C_{x-y}", "C_x-C_y" and "C_x" mean the number of carbons in a molecule or substituent. For example, C₁₋₆ alkyl means an alkyl chain having 1 or more and 6 or less carbons (methyl, ethyl, propyl, butyl, pentyl, hexyl etc.).

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When polymer has plural types of repeating units, these repeating units copolymerize. These copolymerization may be any of alternating copolymerization, random copolymerization, block copolymerization, graft copolymerization, or a mixture thereof. When polymer or resin is represented by a structural formula, n, m or the like that is attached next to parentheses indicate the number of repetitions.

Celsius is used as the temperature unit. For example, 20 degrees means 20 degrees Celsius.

The additive refers to a compound itself having a function thereof (for example, in the case of a base generator, a compound itself that generates a base). An embodiment in which a compound is dissolved or dispersed in a solvent and added to a composition is also possible. As one embodiment of the present invention, it is preferable that such a solvent is contained in the composition according to the present invention as the solvent (B) or another component.

[0015] <Electronic device manufacturing solution>

An electronic device manufacturing solution according to the present invention comprises at least an anionic surfactant (A), a solvent (B), and a quaternary ammonium compound (C).

The electronic device manufacturing solution is one used in the process of manufacturing an electronic device. It can be one used in the manufacturing process of an electronic device and can be one being removed or lost in the course of the process. Examples of the electronic device include display devices, LED and semiconductor devices.

The electronic device manufacturing solution is preferably an electronic device manufacturing aqueous solution, more preferably a semiconductor substrate manufacturing aqueous solution, more preferably a semiconductor substrate manufacturing process cleaning liquid, further preferably a lithography cleaning liquid, and further more preferably a resist pattern cleaning liquid. In an embodiment of the present invention, the electronic device manufacturing solution is a rinse composition used for rinsing an exposed and developed resist pattern.

[0016] Anionic surfactant (A)

The electronic device manufacturing solution according to the present invention comprises the anionic surfactant (A) (hereinafter, referred to as the component (A); the same applies to other components). The component (A) is not particularly limited as long as it is a compound

having a lipophilic group and a hydrophilic group and the hydrophilic moiety is dissociated into an anion.

One of effects obtained by the component (A) is to contribute to prevention of pattern collapse after development of a resist pattern. This is considered to be because the surfactant action of the component (A) increases the contact angle between the resist pattern and the electronic device manufacturing solution.

Examples of the hydrophilic group of the component (A) include a carboxylate, a sulfonate, a sulfuric acid ester salt, and a phosphoric acid ester salt, and a carboxylate is preferable.

The component (A) is preferably a carboxy-containing compound and more preferably an alkylcarboxylic acid compound, and further preferably a compound represented by Formula (a).

[0017] Formula (a) is as follows.

$$\text{R}^{\text{a1}}\text{-COOH (a)}$$

where

R^{a1} is C_{3-12} alkyl, preferably linear or branched C_{3-10} alkyl, further preferably linear or branched C_{3-9} alkyl, and further more preferably linear or branched C_{3-8} alkyl.

It is considered that the alkyl in Formula (a) can reduce the surface tension of the electronic device manufacturing solution, and the carboxy can improve the solubility of the electronic device manufacturing solution, thereby being capable of making the balance between the solubility and the low surface tension improved.

[0018] Exemplified embodiments of the component (A) include 2-methylpropanoic acid, n-butanoic acid, 2-methylbutanoic acid, n-pentanoic acid, n-hexanoic acid, n-heptanoic acid, n-octanoic acid, 2-methylpentanoic acid, 2-methylhexanoic acid, 5-methylhexanoic acid, 2-methylheptanoic acid, 4-methyl-n-octanoic acid, 2-ethylhexanoic acid, 2-propylpentanoic acid, 2,2-dimethylpentanoic acid, and 3,5,5-trimethylhexanoic acid.

[0019] The content of the component (A) is preferably 0.01 to 10 mass%, more preferably 0.02 to 5 mass%, and further preferably 0.02 to 1 mass%, based on the total content of the electronic device manufacturing solution.

[0020] Solvent (B)

5 The electronic device manufacturing solution of the present invention comprises the solvent (B). The solvent (B) preferably comprises water. The water is preferably deionized water.

 Considering that it is used in the electronic device manufacturing process, the solvent (B) is preferably one having few impurities. The
10 impurity concentration of the solvent (B) is preferably 1 ppm or less, more preferably 100 ppb or less, and further preferably 10 ppb or less.

 The content of the water based on the total content of the solvent (B) is preferably 90 to 100 mass%, more preferably 98 to 100 mass%, further preferably 99 to 100 mass%, and further more preferably 99.9 to 100
15 mass%. In a preferred embodiment of the present invention, the solvent (B) consists substantially only of water. However, an embodiment in which an additive is dissolved and/or dispersed in a solvent other than water and contained in the electronic device manufacturing solution of the present invention is accepted as a preferred embodiment of the present invention.
20 In a further preferred embodiment of the present invention, the content of the water contained in the solvent (B) is 100 mass%.

[0021] As exemplified embodiments of the solvent (B) excluding water, for example, cyclohexanone, cyclopentanone, propylene glycol monomethyl ether (PGME), propylene glycol monoethyl ether, propylene glycol
25 monopropyl ether, propylene glycol monobutyl ether, propylene glycol dimethyl ether, propylene glycol diethyl ether, propylene glycol 1-monomethyl ether 2-acetate (PGMEA), propylene glycol monoethyl ether acetate, propylene glycol monopropyl ether acetate, γ -butyrolactone, ethyl lactate, or any mixture of any of these is preferable. These are preferable
30 in terms of storage stability of the solution. These solvents can be also used as any mixture of any two or more.

[0022] The content of the component (B) is preferably 80 to 99.99 mass%, more preferably 90 to 99.99 mass%, further preferably 95 to 99.99 mass%, and further more preferably 98 to 99.99 mass%, based on the total content of the electronic device manufacturing solution.

5 The content of the water contained in the solvent (B) is preferably 80 to 99.99 mass%, more preferably 90 to 99.99 mass%, further preferably 95 to 99.99 mass%, and further more preferably 98 to 99.99 mass%, based on the total content of the electronic device manufacturing solution.

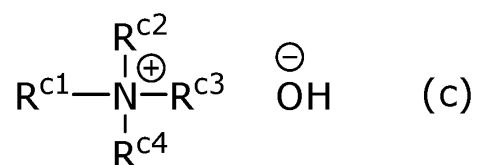
[0023] Quaternary ammonium compound (C)

10 The electronic device manufacturing solution of the present invention comprises the quaternary ammonium compound (C).

Examples of the component (C) include quaternary ammonium hydroxide.

15 It is considered that the electronic device manufacturing solution can remarkably improve the defect prevention effect and the collapse prevention effect by containing the component (C). Although not wishing to be bound by any theory, it is considered that the component (C) has strong basicity, and thus has a large action of ionizing the component (A).

20 [0024] The component (C) is preferably quaternary ammonium hydroxide, and more preferably is represented by Formula (c) below.



25 where

$\text{R}^{\text{c}1}$, $\text{R}^{\text{c}2}$, $\text{R}^{\text{c}3}$, and $\text{R}^{\text{c}4}$ are each independently halogen;

linear or branched C_{1-25} alkyl unsubstituted or substituted with halogen, C_{3-25} cycloalkyl, C_{4-25} aryl or hydroxy;

30 linear or branched C_{2-25} alkenylene unsubstituted or substituted with halogen, linear or branched C_{1-25} alkyl, C_{3-25} cycloalkyl, C_{4-25} aryl or hydroxy;

C₃₋₂₅ cycloalkyl unsubstituted or substituted with halogen, linear or branched C₁₋₂₅ alkyl, C₄₋₂₅ aryl or hydroxy; or

C₄₋₂₅ aryl unsubstituted or substituted with halogen, linear or branched C₁₋₂₅ alkyl, C₃₋₂₅ cycloalkyl or hydroxy. In the present invention, alkenylene means a divalent hydrocarbon having one or more double bonds.

Preferably, R^{c1}, R^{c2}, R^{c3}, and R^{c4} are each independently linear or branched C₁₋₁₈ alkyl unsubstituted or substituted with phenyl or hydroxy;

C₅₋₁₅ cycloalkyl unsubstituted or substituted with linear or branched C₁₋₅ alkyl or hydroxy; or

C₆₋₁₂ aryl unsubstituted or substituted with linear or branched C₁₋₅ alkyl or hydroxy.

More preferably, R^{c1}, R^{c2}, R^{c3}, and R^{c4} are each independently methyl, ethyl, propyl, butyl, hexadecyl, hydroxyethyl, benzyl, adamantyl or phenyl.

The total number of carbon atoms contained in R^{c1}, R^{c2}, R^{c3}, and R^{c4} is preferably 4 to 25 and more preferably 4 to 20.

R^{c1}, R^{c2}, R^{c3}, and R^{c4} may all be different, but preferably three or four are the same and the rest is different.

[0025] Exemplified embodiments of the component (C) include

tetramethylammonium hydroxide, tetraethylammonium hydroxide, tetrapropylammonium hydroxide, tetrabutylammonium hydroxide, tetrahexylammonium hydroxide, hexadecyltrimethylammonium hydroxide, 2-hydroxyethyltrimethylammonium hydroxide, trimethylphenylammonium hydroxide, benzyltrimethylammonium hydroxide, benzyltriethylammonium hydroxide, and N,N,N-trimethyl-1-adamantylammonium hydroxide.

[0026] The content of the component (C) is preferably 0.00001 to 1 mass%, more preferably 0.0001 to 0.1 mass%, and further preferably 0.0002 to 0.01 mass%, based on the total content of the electronic device manufacturing solution.

[0027] The electronic device manufacturing solution according to the present invention essentially contains the above-mentioned components (A), (B), and (C), but can contain further components, if necessary.

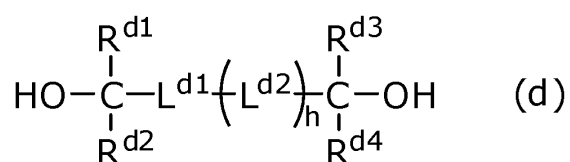
Details thereof are described below. The components other than (A), (B), and (C) (in the case of a plurality, the sum thereof) in the entire composition are preferably 0 to 10 mass%, more preferably 0 to 5 mass%, further preferably 0 to 3 mass%, and further more preferably 0 to 1 mass%, based on the total content of the electronic device manufacturing solution. An embodiment in which the electronic device manufacturing solution according to the present invention contains no component other than (A), (B), and (C) (0 mass%) is also an embodiment of the present invention.

[0028] Hydroxy-containing compound (D)

The electronic device manufacturing solution according to the present invention can further contain a hydroxy-containing compound (D). The hydroxy-containing compound (D) is a compound different from the component (A) and the component (B), may have 1 or more hydroxy in the compound, and is preferably a C₃₋₃₀ compound, which has 1 to 3 hydroxy and may be fluorine-substituted. The fluorine substitution in this case substitutes the H of the compound with F, but this substitution does not substitute the H in the hydroxy.

It is considered that further including the component (D) makes it possible to further reduce the limit size that does not collapse.

[0029] The component (D) is preferably represented by Formula (d) below.



where

R^{d1}, R^{d2}, R^{d3} and R^{d4} are each independently hydrogen, fluorine or C₁₋₅ alkyl, preferably, each independently hydrogen, fluorine, methyl, ethyl, t-butyl, isopropyl or isopentyl; and more preferably, each independently hydrogen, methyl or ethyl.

L^{d1} and L^{d2} are each independently C₁₋₂₀ alkylene, C₁₋₂₀ cycloalkylene, C₂₋₄ alkenylene, C₂₋₄ alkynylene or C₆₋₂₀ allylene. These groups can be

substituted with fluorine, C₁₋₅ alkyl or hydroxy. Alkenylene means a divalent hydrocarbon having one or more double bonds, and alkynylene means a divalent hydrocarbon group having one or more triple bonds.

Preferably, L^{d1} and L^{d2} are each independently optionally fluorine-substituted C₁₋₅ alkylene, C₂₋₄ alkynylene or phenylene (C₆ allylene). L^{d1} and L^{d2} are more preferably, each independently fluorine-substituted C₂₋₄ alkylene, acetylene (C₂ alkynylene) or phenylene; and further more preferably, fluorine-substituted C₂₋₄ alkylene or acetylene.

In another embodiment of the present invention, L^{d1} and L^{d2} are also preferably not fluorine-substituted, each independently C₁₋₅ alkylene, C₂₋₄ alkynylene or phenylene, more preferably, each independently C₂₋₄ alkylene, acetylene or phenylene, and further preferably, each independently C₂₋₄ alkylene or acetylene.

h is 0, 1 or 2, preferably 0 or 1, and more preferably 0.

[0030] Exemplified embodiments of the component (D) include 3-hexyne-2,5-diol, 2,5-dimethyl-3-hexyne-2,5-diol, 3,6-dimethyl-4-octyne-3,6-diol, 1,4-butyne-2,3-diol, 2,4-hexadiyne-1,6-diol, 1,4-butanediol, 2,4,7,9-tetramethyl-5-decyne-4,7-diol, 2,2,3,3-tetrafluoro-1,4-butanediol, 2,2,3,3,4,4,5,5-octafluoro-1,6-hexanediol, cis-1,4-dihydroxy-2-butene and 1,4-benzenedimethanol.

[0031] The content of the component (D) is preferably 0.001 to 10 mass%, more preferably 0.002 to 5 mass%, and further preferably 0.005 to 1 mass%, based on the total content of the electronic device manufacturing solution.

It is also a preferred embodiment of the present invention to contain no component (D).

[0032] Additive (E)

The electronic device manufacturing solution according to the present invention can further contain an additive (E) different from the components (A) to (D). In the present invention, the additive (E) comprises one or two or more selected from the group consisting of a second surfactant, an

acid, a base, a germicide, an antibacterial agent, a preservative, and a fungicide.

[0033] The second surfactant is a surfactant other than the anionic surfactant, and examples thereof include a nonionic surfactant. The
5 second surfactant can be contained in the electronic device manufacturing solution in order to improve coatability and solubility. It is also a preferred embodiment of the present invention to contain no second surfactant.

The acid or base can be used to adjust the pH value of the treating liquid and improve the solubility of each component.

10 The germicide, the antibacterial agent, the preservative, and the fungicide are used to prevent bacteria and fungi from growing over time, and examples thereof include alcohols such as phenoxyethanol, and isothiazolone.

[0034] The content of the component (E) is preferably 0.0001 to 10
15 mass%, more preferably 0.0003 to 0.1 mass%, and further preferably 0.0005 to 0.01 mass%, based on the total content of the electronic device manufacturing solution. It is also a preferred embodiment of the present invention to contain no component (E).

[0035] The electronic device manufacturing solution according to the
20 present invention can be produced by dissolving each component in a solvent, and then performing filtration with a filter to remove impurities and/or insolubles.

[0036]<Method for manufacturing resist pattern>

The present invention also provides a method for producing a resist
25 pattern using the above-mentioned electronic device manufacturing solution. The photosensitive resin composition (resist composition) used in the method may be either a positive type or a negative type, and is preferably a positive type. A typical method for manufacturing a resist pattern to which the electronic device manufacturing solution according to
30 the present invention is applied comprises steps below:

(1) applying a photosensitive resin composition on a substrate with or without one or more intervening layers, to form a photosensitive resin layer;

(2) exposing the photosensitive resin layer to radiation;

5 (3) developing the exposed photosensitive resin layer; and

(4) cleaning the developed layer with the above-mentioned electronic device manufacturing solution.

[0037] Hereinafter, details are explained.

10 First, a photosensitive resin composition is applied (for example, laminated) above a substrate such as a silicon substrate or a glass substrate, which has been pretreated as necessary, thereby forming a photosensitive resin layer. Any publicly known method can be used for laminating, but a coating method such as spin coating is suitable. The photosensitive resin composition can be laminated directly on the
15 substrate or can be laminated with one or more intervening layers (for example, BARC). Further, an anti-reflective coating (for example, TARC) may be laminated above the photosensitive resin layer (opposite to the substrate). Layers other than the photosensitive resin layer are described later. Forming an anti-reflective coating above or under the photosensitive
20 resin layer makes it possible to improve the cross-sectional shape and the exposure margin.

[0038] Typical examples of the positive type or negative type photosensitive resin composition used in the method for manufacturing a resist pattern of the present invention include one comprising a
25 quinonediazide-based photosensitizer and an alkali-soluble resin, and a chemically amplified type photosensitive resin composition. From the viewpoint of forming a fine resist pattern having high resolution, a chemically amplified type photosensitive resin composition is preferable, and examples thereof include a chemically amplified type PHS-acrylate
30 hybrid-based EUV resist composition. It is more preferable that these are positive type photosensitive resin compositions.

[0039] Examples of the quinonediazide-based photosensitizer used in the positive type photosensitive resin composition comprising the quinonediazide-based photosensitizer and the alkali-soluble resin include 1,2-benzoquinonediazide-4-sulfonic acid, 1,2-naphthoquinonediazide-4-sulfonic acid, 1,2-naphthoquinone diazido-5-sulfonic acid, esters or amides of these sulfonic acids or the like, and examples of the alkali-soluble resin include novolak resin, polyvinyl phenol, polyvinyl alcohol, copolymer of acrylic acid or methacrylic acid or the like. Preferable examples of novolac resin include those produced from one or two or more phenols such as phenol, o-cresol, m-cresol, p-cresol and xlenol, and one or more aldehydes such as formaldehyde and paraformaldehyde.

[0040] As the chemically amplified type photosensitive resin composition, a positive type chemically amplified photosensitive resin composition comprising a compound (photoacid generator) that generates an acid by irradiation with radiation and resin whose polarity is increased by the action of an acid generated from the photoacid generator and whose solubility in a developer changes between the exposed portion and the unexposed portion, or a negative type chemically amplified type photosensitive resin composition comprising an alkali-soluble resin, a photoacid generator and a crosslinking agent, in which crosslinking of the resin occurs by the action of the acid and the solubility in a developer changes between the exposed portion and the unexposed portion can be mentioned.

[0041] As the resin whose polarity is increased by the action of the acid and whose solubility in a developer changes between the exposed portion and the unexposed portion, resin having a group at the main chain or side chain of the resin, or both the main chain and the side chain of the resin, which decomposes by the action of the acid to generate an alkali-soluble group can be mentioned. Typical examples thereof include polymer in which an acetal group or a ketal group is introduced as a protective group into a hydroxystyrene-based polymer (PHS), and a similar polymer in

which a t-butoxy carbonyloxy group or a p-tetrahydropyranyloxy group is introduced as an acid-decomposable group, and the like.

[0042] The photoacid generator may be any compound that generates an acid by irradiating radiation, and examples thereof include onium salts
5 such as diazonium salts, ammonium salts, phosphonium salts, iodonium salts, sulfonium salts, selenonium salts and arsonium salts, organic halogen compounds, organometallic compounds/organic halides, photoacid generators having an o-nitrobenzyl type protective group, compounds capable of photolysis to generate a sulfonic acid represented
10 by iminosulfonate or the like, disulfon compounds, diazoketosulfone compounds, diazodisulfone compounds, and the like. Compounds in which these groups or compounds capable of generating an acid by light are introduced into the main chain or the side chain of polymer can also be used.

[0043] The above-mentioned chemically amplified type photosensitive resin composition can further comprise, if necessary, an acid-decomposable and dissolution inhibiting compound, a dye, a plasticizer, a surfactant, a photosensitizer, an organic basic compound, a compound
15 that promotes solubility in a developer, and the like.

[0044] For example, the photosensitive resin composition is applied on a substrate by a suitable coating apparatus such as a spinner or coater by means of a suitable coating method, and is heated on a hot plate to remove the solvent in the photosensitive resin composition, thereby forming a photosensitive resin layer. The heating temperature varies
20 depending on the solvent or resist composition used, but is generally performed at 70 to 150°C, preferably 90 to 150°C, and the heating can be performed for 10 to 180 seconds, preferably 30 to 120 seconds in the case of hot plate, or for 1 to 30 minutes in the case of clean oven.

[0045] In the method for manufacturing a resist pattern of the present
30 invention, the presence of film(s) or layer(s) other than the photosensitive resin layer is also accepted. Without direct contact of the substrate with the photosensitive resin layer, intervening layer(s) may be interposed. The

intervening layer is a layer to be formed between a substrate and a photosensitive resin layer and is referred also to as underlayer film. As the underlayer film, a substrate modifying film, a planarization film, a bottom anti-reflective coating (BARC), an inorganic hard mask intervening layer (silicon oxide film, silicon nitride film and silicon oxynitride film), and an adhesion film can be referred. As to the formation of the inorganic hard mask intervening layer, JP 5336306 B2 can be referenced. The intervening layer may be composed of one layer or a plurality of layers. A top anti-reflective coating (TARC) may be formed on the photosensitive resin layer.

[0046] For the layer constitution in the process for manufacturing a resist pattern of the present invention, any publicly known technique can be used in accordance with process conditions. For example, the following layer constitution can be referred.

substrate / underlayer film / photosensitive resin layer
substrate / planarization film / BARC / photosensitive resin layer
substrate / planarization film / BARC / photosensitive resin layer / TARC
substrate / planarization film / inorganic hard mask intervening layer / photosensitive resin layer / TARC

substrate / planarization film / inorganic hard mask intervening layer / BARC / photosensitive resin layer / TARC
substrate / planarization film / adhesion film / BARC / photosensitive resin layer / TARC

substrate / substrate modifying layer / planarization film / BARC / photosensitive resin layer / TARC
substrate / substrate modifying layer / planarization film / adhesion film / BARC / photosensitive resin layer / TARC

These layers can be formed by coating and thereafter heating and/or exposing to cure, or by employing any publicly known method such as CVD method. These layers can be removed by any publicly known method (etching or the like) and can be patterned using the upper layer as a mask.

[0047] The photosensitive resin layer is exposed through a predetermined mask. When other layers (TARC or the like) are also included, they may be exposed together. The wavelength of the radiation (light) used for exposure is not particularly limited, but it is preferable to perform exposure with light having a wavelength of 13.5 to 248 nm. In particular, KrF excimer laser (wavelength: 248 nm), ArF excimer laser (wavelength: 193 nm), extreme ultraviolet ray (wavelength: 13.5 nm) and the like can be used, and extreme ultraviolet ray is more preferable. These wavelengths allow a range of $\pm 5\%$, and preferably a range of $\pm 1\%$. After the exposure, post exposure bake (PEB) may be performed, if needed. The temperature for post exposure baking is appropriately selected from 70 to 150°C, preferably 80 to 120°C, and the heating time is appropriately selected from 0.3 to 5 minutes, preferably 0.5 to 2 minutes.

[0048] Thereafter, development is performed with a developer. For the development in the method for manufacturing a resist pattern of the present invention, a 2.38 mass% ($\pm 1\%$ is accepted) tetramethylammonium hydroxide (TMAH) aqueous solution is preferably used. A surfactant or the like may also be added to the developer. The temperature of the developer is appropriately selected from generally 5 to 50°C, preferably 25 to 40°C, and the developing time is appropriately selected generally from 10 to 300 seconds, preferably 20 to 60 seconds. As the developing method, any publicly known method such as paddle development can be used.

As described above, the resist pattern of the present invention includes not only one obtained by exposing / developing a resist film but also one having a wall thickened by further covering a resist film with other layer(s) or film(s).

[0049] The resist pattern (the developed photosensitive resin layer) formed up to the above steps is in a non-cleaned state. This resist pattern can be cleaned with the electronic device manufacturing solution of the present invention. The time for bringing the electronic device manufacturing solution into contact with the resist pattern, that is, the processing time is

preferably 1 second or more. The processing temperature may be also freely determined. The method for bringing the electronic device manufacturing solution into contact with the resist is also freely selected, and it can be performed, for example, by immersing a resist substrate in the electronic device manufacturing solution or dropping the electronic device manufacturing solution on a rotating resist substrate surface.

5 [0050] In the method for manufacturing a resist pattern according to the present invention, the resist pattern after being developed can be cleaned with other cleaning liquid before and/or after the cleaning processing with the electronic device manufacturing solution. The other cleaning liquid is preferably water, and more preferably pure water (DW, deionized water or the like). The cleaning before the present processing is useful for cleaning the developer that has adhered to the resist pattern. The cleaning after the present processing is useful for cleaning the electronic device manufacturing solution. One preferred embodiment of the manufacturing method according to the present invention is a method comprising cleaning the pattern after being developed while substituting the developer by pouring pure water on the resist pattern, and further cleaning the pattern while substituting pure water by pouring the electronic device manufacturing solution while keeping the pattern immersed in pure water.

10 15 20

The cleaning with the electronic device manufacturing aqueous solution may be carried out by any publicly known method.

It can be performed, for example, by immersing a resist substrate in the electronic device manufacturing solution, or by dropping the electronic device manufacturing solution on a rotating resist substrate surface.

25 These methods may be also carried out in appropriate combination thereof.

[0051] As one of the conditions under which pattern collapse is likely to occur, there is a place where the distance between a wall and a wall of a resist pattern is the narrowest. At a place where a wall and a wall of a resist pattern are aligned in parallel, this becomes a severe condition. In the present specification, the distance of the interval at the place where

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the interval is the smallest on one circuit unit is defined as the minimum space size. It is preferable that one circuit unit becomes one semiconductor in a later process. It is also a preferred embodiment that one semiconductor includes one circuit unit in the horizontal direction and a plurality of circuit units in the vertical direction. Of course, unlike the test sample, if the occurrence frequency of the place where the interval between a wall and a wall is narrow is low, the occurrence frequency of defects decreases, so that the occurrence frequency of defective products decreases.

In the present invention, the minimum space size of the resist pattern in one circuit unit is preferably 10 to 30 nm, more preferably 10 to 20 nm, and further preferably 10 to 17 nm.

[0052] <Method for manufacturing device>

The method for manufacturing a device of the present invention comprises the method for manufacturing a resist pattern using the electronic device manufacturing solution. Preferably, the method for manufacturing a device according to the present invention further comprising etching using a resist pattern manufactured by the above-mentioned method as a mask and processing a substrate. After processing, the resist film is peeled off, if necessary.

In the manufacturing method of the present invention, the intervening layer and/or the substrate can be processed by etching using the resist pattern as a mask. For etching, any publicly known method such as dry etching and wet etching can be used, and dry etching is more suitable. For example, the intervening layer can be etched using the resist pattern as an etching mask, and the substrate can be etched using the obtained intervening layer pattern as an etching mask to process the substrate. While etching the layer(s) under the resist layer (for example, an intervening layer) using the resist pattern as an etching mask, the substrate can also be uninterruptedly etched. The processed substrate becomes, for example, a patterned substrate. A wiring can be formed on the substrate by utilizing the formed pattern.

These layers can be removed preferably by performing dry etching with O₂, CF₄, CHF₃, Cl₂ or BCl₃, and preferably, O₂ or CF₄ can be used. As a preferred embodiment, the method for manufacturing a device according to the present invention further comprises forming a wiring on a processed substrate.

[0053] <Stress applied to resist wall>

As described in Namatsu et al., Appl. Phys. Lett. 1995 (66), p 2655-2657 and schematically illustrated in FIG. 1, the stress applied to a resist pattern wall 1 during drying rinse can be indicated by the following formula:

$$\sigma_{\max} = (6\gamma\cos\theta/D) \times (H/W)^2$$

where

$\sigma_{\max}$: maximum stress applied to a resist,

γ : surface tension of rinse

θ : contact angle,

D: distance between walls

H: height of wall, and

W: width of wall.

These lengths can be measured by a known method (for example, SEM photograph).

[0054] As can be seen from the above formula, the shorter D or W is, the more stress is caused. In the present specification, a pitch size 3 means, as described in FIG. 1, one unit of a resist pattern unit sequence having W and D.

This means that the finer (narrower pitch size) the required resist pattern is, the greater the stress applied to the resist pattern becomes. As the pattern becomes finer in this way, the conditions become stricter, and more improvements are required for an electronic device manufacturing solution 2 (for example, a rinse composition).

[0055] Preferred embodiments are listed below.

[Embodiment 1]

An electronic device manufacturing solution comprising at least:
an anionic surfactant (A);

a solvent (B); and

a quaternary ammonium compound (C).

The surfactant (A) is preferably a carboxy-containing compound and more preferably an alkylcarboxylic acid compound, and is further preferably represented by Formula (a).

R^{a1} -COOH Formula (a)

where R^{a1} is C_{3-12} alkyl, and R^{a1} is preferably linear or branched C_{3-10} alkyl, further preferably linear or branched C_{3-9} alkyl, and further more preferably linear or branched C_{3-8} alkyl.

The surfactant (A) is preferably selected from the group consisting of 2-methylpropanoic acid, n-butanoic acid, 2-methylbutanoic acid, n-pentanoic acid, n-hexanoic acid, n-heptanoic acid, n-octanoic acid, 2-methylpentanoic acid, 2-methylhexanoic acid, 5-methylhexanoic acid, 2-methylheptanoic acid, 4-methyl-n-octanoic acid, 2-ethylhexanoic acid, 2-propylpentanoic acid, 2,2-dimethylpentanoic acid, and 3,5,5-trimethylhexanoic acid.

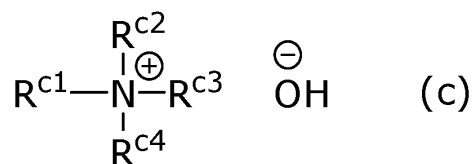
The solvent (B) preferably contains water, more preferably consists substantially only of water, and further preferably has a content of water of 100 mass%.

The electronic device manufacturing solution is preferably an electronic device manufacturing aqueous solution.

[0056] [Embodiment 2]

The electronic device manufacturing solution described in Embodiment 1, in which the quaternary ammonium compound (C) is quaternary ammonium hydroxide.

The quaternary ammonium compound (C) is preferably represented by Formula (c).



where

R^{c1} , R^{c2} , R^{c3} , and R^{c4} are each independently halogen; linear or branched C₁₋₂₅ alkyl unsubstituted or substituted with halogen, C₃₋₂₅ cycloalkyl, C₄₋₂₅ aryl or hydroxy; linear or branched C₂₋₂₅ alkenylene unsubstituted or substituted with halogen; linear or branched C₁₋₂₅ alkyl, C₃₋₂₅ cycloalkyl, C₄₋₂₅ aryl or hydroxy, C₃₋₂₅ cycloalkyl unsubstituted or substituted with halogen; linear or branched C₁₋₂₅ alkyl, C₄₋₂₅ aryl or hydroxy or C₄₋₂₅ aryl unsubstituted or substituted with halogen; linear or branched C₁₋₂₅ alkyl, C₃₋₂₅ cycloalkyl or hydroxy, preferably, linear or branched C₁₋₁₈ alkyl unsubstituted or substituted with phenyl or hydroxy, C₅₋₁₅ cycloalkyl unsubstituted or substituted with linear or branched C₁₋₅ alkyl or hydroxy or C₆₋₁₂ aryl unsubstituted or substituted with linear or branched C₁₋₅ alkyl or hydroxy, and more preferably selected from the group consisting of methyl, ethyl, propyl, butyl, hexadecyl, hydroxyethyl, benzyl, adamantyl, and phenyl.

The quaternary ammonium compound (C) is preferably selected from the group consisting of tetramethylammonium hydroxide, tetraethylammonium hydroxide, tetrapropylammonium hydroxide, tetrabutylammonium hydroxide, tetrahexylammonium hydroxide, hexadecyltrimethylammonium hydroxide, 2-hydroxyethyltrimethylammonium hydroxide, trimethylphenylammonium hydroxide, benzyltrimethylammonium hydroxide, benzyltriethylammonium hydroxide, and N,N,N-trimethyl-1-adamantylammonium hydroxide.

[0057] [Embodiment 3]

The electronic device manufacturing solution described in Embodiment 1 or 2, in which a content of the anionic surfactant (A) is 0.01 to 10 mass%, preferably 0.02 to 5 mass%, and more preferably 0.02 to 1 mass%, based on the total content of the electronic device manufacturing solution.

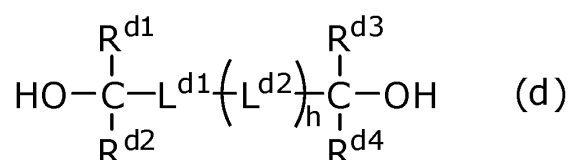
Preferably, a content of the solvent (B) is 80 to 99.99 mass%, based on the total content of the electronic device manufacturing solution, and preferably, a content of water contained in the solvent (B) is 80 to 99.99 mass%, based on the total content of the electronic device manufacturing solution.

Preferably, a content of the quaternary ammonium compound (C) is preferably 0.00001 to 1 mass%, more preferably 0.0001 to 0.1 mass%, and further preferably 0.0002 to 0.01 mass%, based on the total content of the electronic device manufacturing solution.

5 [0058] [Embodiment 4]

The electronic device manufacturing solution described in any one of Embodiments 1 to 3, further comprising a hydroxy-containing compound (D).

10 The hydroxy-containing compound (D) is preferably represented by Formula (d) below.



15 where

R^{d1} , R^{d2} , R^{d3} and R^{d4} are each independently hydrogen, fluorine or C_{1-5} alkyl, preferably, each independently hydrogen, fluorine, methyl, ethyl, t-butyl, isopropyl or isopentyl; and more preferably, each independently hydrogen, methyl or ethyl.

20 L^{d1} and L^{d2} are each independently C_{1-20} alkylene, C_{1-20} cycloalkylene, C_{2-4} alkenylene, C_{2-4} alkynylene or C_{6-20} allylene. These groups can be substituted with fluorine, C_{1-5} alkyl or hydroxy. Alkenylene means a divalent hydrocarbon having one or more double bonds, and alkynylene means a divalent hydrocarbon group having one or more triple bonds.

25 Preferably, L^{d1} and L^{d2} are each independently optionally fluorine-substituted C_{1-5} alkylene, C_{2-4} alkynylene or phenylene (C_6 allylene). L^{d1} and L^{d2} are more preferably, each independently fluorine-substituted C_{2-4} alkylene, acetylene (C_2 alkynylene) or phenylene; and further more preferably, fluorine-substituted C_{2-4} alkylene or acetylene.

30 In another embodiment of the present invention, L^{d1} and L^{d2} are also preferably not fluorine-substituted, each independently C_{1-5} alkylene, C_{2-4} alkynylene or phenylene, more preferably, each independently C_{2-4}

alkylene, acetylene or phenylene, and further preferably, each independently C₂₋₄ alkylene or acetylene.

h is 0, 1, or 2, preferably 0 or 1, and more preferably 0.

[0059] [Embodiment 5]

5 The electronic device manufacturing solution described in any one of Embodiments 1 to 4, further comprising an additive (E).

In Embodiment 5, the additive (E) comprises one or two or more selected from the group consisting of a second surfactant, an acid, a base, a germicide, an antibacterial agent, a preservative, and a fungicide.

10 A content of the additive (E) is preferably 0.0001 to 10 mass%, more preferably 0.0003 to 0.1 mass%, and further preferably 0.005 to 0.01 mass%, based on the total content of the electronic device manufacturing solution.

[0060] [Embodiment 6]

15 The electronic device manufacturing solution described in any one of Embodiments 1 to 5, which is a semiconductor manufacturing aqueous solution:

preferably, the electronic device manufacturing solution is a semiconductor substrate manufacturing aqueous solution;

20 preferably, the electronic device manufacturing solution is a semiconductor substrate manufacturing process cleaning liquid;

preferably, the electronic device manufacturing solution is a lithography cleaning liquid;

25 preferably, the electronic device manufacturing solution is a resist pattern cleaning liquid; or

preferably, the electronic device manufacturing solution is a rinse composition.

[0061] [Embodiment 7]

30 A method for manufacturing a resist pattern using the electronic device manufacturing solution described in any one of Embodiments 1 to 6.

[0062] [Embodiment 8]

A method for manufacturing a resist pattern comprising steps below:

(1) applying a photosensitive resin composition on a substrate with or without one or more intervening layers, to form a photosensitive resin layer;

(2) exposing the photosensitive resin layer to radiation;

5 (3) developing the exposed photosensitive resin layer; and

(4) cleaning the developed layer with the electronic device manufacturing solution described in any of Embodiments 1 to 6.

[0063] [Embodiment 9]

10 The method for manufacturing a resist pattern described in Embodiment 8, in which the photosensitive resin composition is a chemically amplified type photosensitive resin composition, and preferably, exposure is performed using extreme ultraviolet ray.

[0064] [Embodiment 10]

15 The method for manufacturing a resist pattern described in any one of Embodiments 7 to 9, in which a minimum space size of a resist pattern in one circuit unit is 10 to 30 nm.

[0065] [Embodiment 11]

20 A method for manufacturing a device, comprising the method for manufacturing a resist pattern described in any one of Embodiments 7 to 10.

[0066] [Embodiment 12]

25 The method for manufacturing a device described in Embodiment 11, further comprising etching using a resist pattern manufactured by the method described in any one of Embodiments 7 to 10 as a mask, and processing a substrate.

[0067] [Embodiment 13]

The method for manufacturing a device described in Embodiment 11 or 12, further comprising forming a wiring on a processed substrate.

30 [0068] The present invention is described below with reference to various examples. Further, the embodiments of the present invention are not limited to these examples.

[0069] <Preparation of electronic device manufacturing solution of Example 101>

Into deionized water, 2-methylbutanoic acid as the component (A) and hexadecyltrimethylammonium hydroxide as the component (C) are added so that their concentration become respectively 0.7 mass% and 0.005 mass%, and the mixture is stirred. Visually, its complete dissolvment is confirmed. This is filtered (pore size = 10 nm) to obtain an electronic device manufacturing solution of Example 101.

[0070] <Preparation of electronic device manufacturing solutions of Examples 102 to 109 and Comparative Examples 101 and 102>

In the same manner as in the preparation of Example 101 above, using the component (A) and the component (C) as shown in Table 1, electronic device manufacturing solutions of Examples 102 to 109 and Comparative Examples 101 and 102 are prepared so as to have the concentrations as shown in Table 1.

Comparative Example 101 is one, in which deionized water to which nothing is added, is filtered, and Comparative Example 102 is one that does not contain the component (A).

[Table 1]

Table 1

		Component (A) (mass%)	Component (C) (mass%)	Collapse prevention
5 10 15	Example	101 2-methylbutanoic acid (0.7)	hexadecyltrimethylammonium hydroxide (0.005)	A
		102 2-methylpentanoic acid (0.2)	benzyltrimethylammonium hydroxide (0.003)	A
		103 n-heptanoic acid (0.06)	N,N,N-trimethyl-1-adamantylammonium hydroxide (0.001)	A
		104 2-methylhexanoic acid (0.1)	tetramethylammonium hydroxide (0.005)	A
		105 3,5,5-trimethylhexanoic acid (0.04)	2-hydroxyethyltrimethylammonium hydroxide (0.002)	A
		106 2-methylheptanoic acid (0.05)	tetrabutylammonium hydroxide (0.0005)	A
		107 2-propylpentanoic acid (0.05)	tetramethylammonium hydroxide (0.001)	A
		108 3,5,5-trimethylhexanoic acid (0.03)	N,N,N-trimethyl-1-adamantylammonium hydroxide (0.001)	A
		109 2-methylheptanoic acid (0.06)	tetrabutylammonium hydroxide(0.001)	A
	Comparative Example	101 -	-	B
		102 -	2-hydroxyethyltrimethylammonium hydroxide (0.005)	B

[0071] <Evaluation Substrate Production 1>

20 A BARC composition (AZ Kr-F17B, Merck Electronics K.K. (hereinafter referred to as ME)) is applied on a silicon substrate by spin coating, and heating is performed on a hot plate at 180°C for 60 seconds to obtain a BARC having a film thickness of 80 nm. A PHS-acrylate-based chemically amplified type resist (DX6270P, ME) is applied on this and heating is

25 performed on a hot plate at 120°C for 90 seconds to obtain a resist film having a film thickness of 620 nm. This substrate is exposed using a KrF stepper (FPA3000 EX5, Canon) through a mask (250 nm, line/space = 1 : 1). At this time, the exposure amount is changed from 25 mJ/cm² to 40 mJ/cm² so that the line width to be obtained is changed.

30 After that, PEB is performed on a hot plate at 100°C for 60 seconds, a developer that is a 2.38 mass% TMAH aqueous solution is poured in, and thereafter this state is held for 60 seconds (paddle). In the state that the

developer is paddled, water pouring is started. While rotating the substrate, the developer is replaced with water, this treatment is stopped in the state of being paddled with water, and this state is left standing for 60 seconds. After that, the aqueous solution of Example 101 prepared above is poured into the state of being paddled with water, the water is replaced while rotating the substrate with the electronic device manufacturing solution of Example 101, the pouring of the electronic device manufacturing solution of Example 101 is stopped for 10 seconds in the state of being paddled with the aqueous solution of Example 101. The substrate is dried by spin drying for 30 seconds.

For Examples 102 to 109 and Comparative Example 102, the evaluation substrate production is performed in the same manner as the above using the respective electronic device manufacturing solutions.

Comparative Example 101 is different from the above Example 101 in that the substrate is immediately spin-dried after the state of being paddled with water, but is the same as Example 101 excluding that.

[0072] <Evaluation of collapse prevention>

Using the evaluation substrates of Production 1, evaluation of the pattern collapse prevention performance is carried out. The resist pattern is observed using SEM equipment S-9220 (Hitachi High-Technologies), and the presence or absence of pattern collapse is observed. The evaluation criteria are shown below. In Comparative Example 101, pattern collapse of a resist pattern is confirmed when the line width becomes thinner than 190 nm. The results are as shown in Table 1.

A: No pattern collapse is confirmed in the resist pattern having a line width of 150 nm or more and 177 nm or less.

B: Pattern collapse is confirmed in the resist pattern having a line width of 150 nm or more and 197 nm or less.

C: Pattern collapse is confirmed in the resist pattern having a line width larger than 200 nm.

[0073] <Preparation of electronic device manufacturing solutions of Examples 201 to 206 and Comparative Examples 201 to 204>

In the same manner as in the preparation of the electronic device manufacturing solution of Example 101 above, using the component (A), the component (C), and the component (D) as shown in Table 2, electronic device manufacturing solutions of Examples 201 to 206 and Comparative Examples 201 to 204 are prepared so as to have the concentrations as shown in Table 2.

Further, Comparative Example 203 is one, in which deionized water to which nothing is added, is filtered.

[Table 2]

Table 2

		Component (A) (mass%)	Component (C) (mass%)	Component (D) (mass%)	Limit pattern size (nm)	LWR (nm)
Example	201	2-methylhexanoic acid (0.08)	tetramethylammonium hydroxide (0.01)	-	14.5	4.1
	202	2-methylbutanoic acid (0.7)	2-hydroxyethyltrimethylammonium hydroxide (0.003)	-	14.3	4.1
	203	3,5,5-trimethylhexanoic acid (0.04)	tetrabutylammonium hydroxide (0.0005)	-	13.9	4.0
	204	n-heptanoic acid (0.06)	N,N,N-trimethyl-1-adamantylammonium hydroxide (0.001)	-	14.2	4.2
	205	2-methylhexanoic acid (0.07)	tetrabutylammonium hydroxide (0.0005)	2,2,3,3-tetrafluoro-1,4-butanediol (0.05)	13.5	4.1
	206	2-methylhexanoic acid (0.06)	2-hydroxyethyltrimethylammonium hydroxide (0.01)	2,4,7,9-tetramethyl-5-decyne-4,7-diol (0.01)	13.3	4.0
Comparative Example	201	2-methylhexanoic acid (0.08)	-	-	16.4	4.3
	202	2-methylpentanoic acid (0.2)	-	-	16.3	4.5
	203	-	-	-	17.3	4.2
	204	-	tetrabutylammonium hydroxide (0.002)	-	17.0	4.0

[0074] <Evaluation Substrate Production 2>

A silicon substrate is treated with hexamethyldisilazane (HMDS) at 90°C for 30 seconds. A PHS-acrylate-based chemically amplified type resist for EUV is applied thereon by spin coating and heating is performed on a hot plate at 110°C for 60 seconds to obtain a resist film having a film thickness of 50 nm. This substrate is exposed using an EUV stepper (NXE: 3400, ASML) through a mask (16 nm, line/space = 1 : 1). At this time, the exposure amount is changed so that the line width to be obtained is changed. After that, PEB is performed on a hot plate at 100°C for 60 seconds, a developer that is a 2.38 mass% TMAH aqueous solution is poured in, and thereafter this state is held for 30 seconds (paddle). In the state that the developer is paddled, water pouring is started. While rotating the substrate, the developer is replaced with water, this treatment is stopped in the state of being paddled with water, and this state is left standing for 60 seconds. After that, the electronic device manufacturing solution of Example 201 is poured into the state of being paddled with water, the water is replaced while rotating the substrate with the electronic device manufacturing solution of Example 201, the pouring of the electronic device manufacturing solution of Example 201 is stopped for 10 seconds in the state of being paddled with the electronic device manufacturing solution of Example 201. This substrate is dried by spin drying.

For the electronic device manufacturing solutions of Examples 202 to 206 and Comparative Examples 201, 202, and 204, the evaluation substrate production is performed in the same manner as the above using the respective electronic device manufacturing solutions.

Comparative Example 201 is different from the above Example 201 in that the substrate is immediately spin-dried after the state of replacing the developer with water and being paddled with water, but is the same as Example 201 excluding that.

[0075] <Evaluation of limit pattern size (16 nm, line/space)>

Using a length measuring SEM CG5000 (Hitachi High-Technologies), line width and existence or absence of pattern collapse of the resist

pattern formed on the evaluation substrates of Production 2 are observed. As the amount of exposure increases, the line width decreases. The minimum line width size at which no pattern collapse occurs is defined as "limit pattern size". The results are as shown in Table 2.

5 [0076] <Evaluation of LWR (16 nm, line/space)>

The LWR of the resist pattern formed on the evaluation substrates of Production 2 is evaluated. Using a length measuring SEM CG5000, the LWR (Line Width Roughness) of the resist pattern having a line width of 16 nm is measured. The results are as shown in Table 2.

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EXPLANATION OF SYMBOLS

[0077] 1 Resist pattern wall

2 Electronic device manufacturing solution

3 Pitch size

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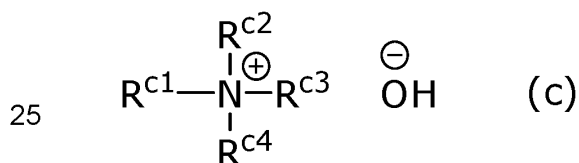
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Patent Claims

1. An electronic device manufacturing solution comprising at least:
 5 an anionic surfactant (A);
 a solvent (B); and
 a quaternary ammonium compound (C),
 wherein
 the surfactant (A) is preferably a carboxy-containing compound and more
 10 preferably an alkylcarboxylic acid compound, and is further preferably
 represented by Formula (a):
 $R^{a1}-COOH$ Formula (a)
 where R^{a1} is C₃₋₁₂ alkyl, preferably R^{a1} is linear or branched C₃₋₁₀ alkyl, and
 the solvent (B) preferably comprises water, or
 15 the electronic device manufacturing solution is preferably an electronic
 device manufacturing aqueous solution.

2. The electronic device manufacturing solution according to claim 1,
 wherein the quaternary ammonium compound (C) is quaternary ammonium
 20 hydroxide:
 preferably, the quaternary ammonium compound (C) is represented by
 Formula (c),



- where
 R^{c1} , R^{c2} , R^{c3} , and R^{c4} are each independently halogen, linear or branched
 C₁₋₂₅ alkyl unsubstituted or substituted with halogen, C₃₋₂₅ cycloalkyl, C₄₋₂₅
 30 aryl or hydroxy; linear or branched C₂₋₂₅ alkenylene unsubstituted or
 substituted with halogen; linear or branched C₁₋₂₅ alkyl, C₃₋₂₅ cycloalkyl, C₄₋₂₅
 aryl or hydroxy; C₃₋₂₅ cycloalkyl unsubstituted or substituted with halogen,

linear or branched C₁₋₂₅ alkyl, C₄₋₂₅ aryl or hydroxy; or C₄₋₂₅ aryl unsubstituted or substituted with halogen, linear or branched C₁₋₂₅ alkyl, C₃₋₂₅ cycloalkyl or hydroxy.

- 5 3. The electronic device manufacturing solution according to claim 1 or 2, wherein a content of the anionic surfactant (A) is 0.01 to 10 mass%, based on the total content of the electronic device manufacturing solution:
 preferably, a content of the solvent (B) is 80 to 99.99 mass%, based on the total content of the electronic device manufacturing solution;
10 preferably, a content of water contained in the solvent (B) is 80 to 99.99 mass%, based on the total content of the electronic device manufacturing solution; or
 preferably, a content of the quaternary ammonium compound (C) is 0.00001 to 1 mass% and more preferably 0.0001 to 0.1 mass%, based on
15 the total content of the electronic device manufacturing solution.
4. The electronic device manufacturing solution according to any one of claims 1 to 3, further comprising a hydroxy-containing compound (D).
- 20 5. The electronic device manufacturing solution according to any one of claims 1 to 4, further comprising an additive (E),
 wherein
 the additive (E) comprises one or two or more selected from the group consisting of a second surfactant, an acid, a base, a germicide, an
25 antibacterial agent, a preservative, and a fungicide; and
 preferably, a content of the additive (E) is 0.0001 to 10 mass%, based on the total content of the electronic device manufacturing solution.
- 30 6. The electronic device manufacturing solution according to any one of claims 1 to 5, which is a semiconductor manufacturing aqueous solution:
 preferably, the electronic device manufacturing solution is a semiconductor substrate manufacturing aqueous solution;

preferably, the electronic device manufacturing solution is a semiconductor substrate manufacturing process cleaning liquid;

preferably, the electronic device manufacturing solution is a lithography cleaning liquid; or

5 preferably, the electronic device manufacturing solution is a resist pattern cleaning liquid.

7. A method for manufacturing a resist pattern using the electronic device manufacturing solution according to any one of claims 1 to 6.

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8. A method for manufacturing a resist pattern, comprising steps below:

(1) applying a photosensitive resin composition on a substrate with or without one or more intervening layers, to form a photosensitive resin layer;

(2) exposing the photosensitive resin layer to radiation;

15 (3) developing the exposed photosensitive resin layer; and

(4) cleaning the developed layer with the electronic device manufacturing solution according to any one of claims 1 to 6.

9. The method for manufacturing a resist pattern according to claim 8, wherein the photosensitive resin composition is a chemically amplified type photosensitive resin composition, and preferably, exposure is performed using extreme ultraviolet ray.

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10. The method for manufacturing a resist pattern according to any one of claims 7 to 9, wherein a minimum space size of a resist pattern in one circuit unit is 10 to 30 nm.

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11. A method for manufacturing a device, comprising the method for manufacturing a resist pattern according to any one of claims 7 to 10.

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12. The method for manufacturing a device according to claim 11, further comprising etching using a resist pattern manufactured by the method

according to any one of claims 7 to 10 as a mask, and processing a substrate.

13. The method for manufacturing a device according to claim 11 or 12,
5 further comprising forming a wiring on a processed substrate.

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