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LIQUID COMPOSITION FOR REMOVING A PHOTORESIST

BACKGROUND OF THE INVENTION

1. Field of the Invention

Photoresists which are used in the application of lithography have been utilized in a wide range of areas, which are, for example, integrated circuits such as IC and LSI, display apparatuses such as LCD and EL devices, printed circuit board substrates, micro-machines and DNA chips. The present invention relates to a liquid composition for removing a photoresist that is used for removing the photoresist from the surface of various types of substrates.

2. Description of the Related Arts

Many types of processes are recently employed for producing semiconductor devices and liquid crystal display apparatuses containing silicon such as polysilicon. Therefore, a liquid composition for removing a photoresist that does not corrode silicon has been desired for such processes. Substrates to which a photoresist is applied mostly comprise silicon and, in general, are not easily corroded since a layer of silicon oxide is present. However, removing the photoresist after the substrates are subjected to treatments for a long time or after the treatments reducing the thickness of the oxide layer exists in an increasing number of cases, and accordingly silicon is more easily corroded in these cases. For removing a photoresist, alkaline liquid compositions for removing a photoresist have heretofore been used. For example, TOK 106 [a trade name; manufactured by TOKYO OHKA KOGYO CO., LTD.] is a solution



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containing an alkanolamine and dimethyl sulfoxide and EKC 265 [a trade name; manufactured by EKC TECHNOLOGY Co., Ltd.] is a solution containing an alkanolamine, hydroxylamine, catechol and water. In general, the foregoing compositions for removing a photoresist containing alkaline compounds are used in the step of removing a photoresist. Liquid compositions for removing a photoresist that do not contain water have a drawback in that the components containing metals remaining after the dry etching cannot be removed completely. Amine solutions containing water which are proposed to improve the foregoing drawback has a drawback in that silicon, aluminum and aluminum alloys are corroded. When liquid compositions containing hydroxylamine is used, the corrosion of silicon or the like is suppressed even when water is contained. However, the liquid compositions containing hydroxylamine has drawbacks in that hydroxylamine is expensive, tends to be decomposed easily and does not prevent corrosion effectively unless hydroxylamine is used in a great amount.

SUMMARY OF THE INVENTION

The present invention has an object of overcoming the drawbacks of the foregoing liquid compositions for removing a photoresist and providing a liquid composition for removing a photoresist which can remove a photoresist layer on a substrate, portions of the photoresist layer remaining on the substrate after etching and residues of the photoresist remaining on the substrate after etching and ashing easily in a short time without corrosion of various types of materials and, in particular, silicon so that a high precision circuit wiring can be produced.

As the result of intensive studies by the present inventors to achieve the object, it was found that a liquid composition for removing a photoresist comprising an amine compound and an amine polymer could remove residues formed from the photoresist, does not corrode various types of materials and exhibits excellent properties. The present invention has been completed based on the knowledge.

The present invention provides a liquid composition for removing a photoresist that comprises an amine compound and an amine polymer; a liquid composition for removing a photoresist which comprises an amine compound, an amine polymer and water. At the same time, the present invention provides a process for producing a semiconductor device that comprises removing a resist from a substrate having silicon with the liquid composition described above.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 shows a perspective sectional view of a portion of a semiconductor device after the ashing treatment with oxygen plasma.

Figure 2 shows a cross sectional view of a portion where polysilicon is exposed on a test substrate.

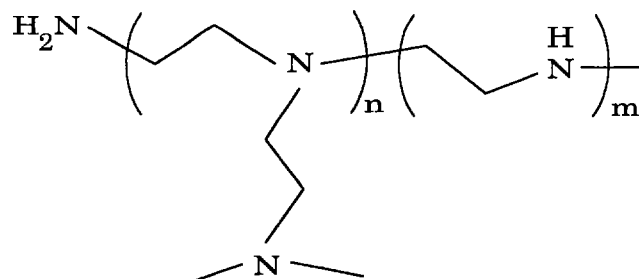
DESCRIPTION OF THE PREFERRED EMBODIMENTS

The present invention relates to a composition for removing a photoresist from a substrate, which is a liquid composition comprising an amine compound and an amine polymer. The removal of a photoresist can be more effectively achieved with a liquid composition comprising an amine compound, an amine polymer and water.

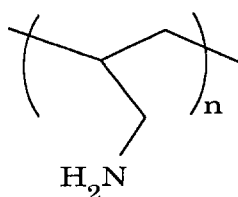
The amine polymer used in the present invention has a weight-average molecular weight of 250 or greater. Nitrogen atom may be present in any of side chains and the main chain. Although there is no specific upper limit to the molecular weight, an amine polymer having an excessively great molecular weight tends to have difficulty in mixing with the amine compound. The amine polymer may be any of the free amine type and the salt type and can be selected in accordance with the object. Amine polymers of the free amine type or of the organic acid salt type are preferable.

Specific examples of the amine polymer include polyethyleneimine, polyvinylamine, polyallylamine, polyornithine, polylysine, polyallylbiguranidoallylamine, polyallyl-N-carbamoylguanidinoallylamine, polyallylamine copolymers, polydiallylamine and polydiallylamine copolymers. In the present invention, the amine polymer is not particularly limited and not limited to the above compounds. The amine polymer may be used singly or in combination of two or more.

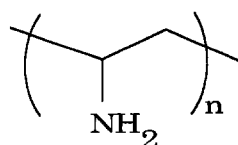
Polyethyleneimine, polyvinylamine and polyallylamine are preferable since these polymers are easily available and can be used easily. The structural formulae of the above polymers are schematically shown in the following.



Polyethyleneimine



Polyallylamine



Polyvinylamine

In the present invention, the amine polymer is not limited to the polymers described above and any polymer can be used as long as the polymer has the structure having amino group. Any type of amino group such as a primary amino group, a secondary amino group, a tertiary amino group and a quaternary ammonium group is effective. Different types of amino groups may be present in combination. For example, a commercial polyethyleneimine [manufactured by NIPPON SHOKUBAI Co., Ltd.] is a mixture of 35% of primary amines, 35% of secondary amines and 30% of tertiary amines and can be used effectively.

In general, silicon is corroded with an amine compound. The corrosion can be prevented with the amine polymer. The mechanism is estimated as follows. When silicon is corroded, silicon is considered to be eluted in the form of silicate ion or a coordination compound with an amine. When the amine polymer is present, the amine polymer coordinates at the surface or forms a passive state at the surface in the form of a counter cation and the elution of silicon is suppressed.

The amine polymer not only suppresses corrosion of silicon but also exhibits the effect of suppressing corrosion of other wiring materials. In particular, the amine polymer can work effectively on aluminum and

aluminum alloys.

Examples of the amine compound used in the present invention include alkylamines, alkanolamines, polyamines, hydroxylamines, cyclic amines and quaternary ammonium compounds.

Examples of the alkylamine include primary amines such as methylamine, ethylamine, n-propylamine, isopropylamine, n-butylamine, sec-butylamine, isobutylamine, t-butylamine, pentylamine, 2-aminopentane, 3-aminopentane, 1-amino-2-methylbutane, 2-amino-2-methylbutane, 3-amino-2-methylbutane, 4-amino-2-methylbutane, hexylamine, 5-amino-2-methylpentane, heptylamine, octylamine, nonylamine, decylamine, undecylamine, dodecylamine, tridecylamine, tetradecylamine, pentadecylamine, hexadecylamine, heptadecylamine and octadecylamine; secondary amines such as dimethylamine, diethylamine, dipropylamine, diisopropylamine, dibutylamine, diisobutylamine, di-sec-butylamine, di-t-butylamine, dipentylamine, dihexylamine, diheptylamine, dioctylamine, dinonylamine, didecylamine, methylethylamine, methylpropylamine, methylisopropylamine, methylbutylamine, methylisobutylamine, methyl-sec-butylamine, methyl-t-butylamine, methyl-t-butylamine, methylamylamine, methylisoamylamine, ethylpropylamine, ethylisopropylamine, ethylbutylamine, ethylisobutylamine, ethyl-sec-butylamine, ethylamine, ethylisoamylamine, propylbutylamine and propylisobutylamine; and tertiary amines such as trimethylamine, triethylamine, tripropylamine, tributylamine, tripentylamine, dimethylethylamine, methyldiethylamine, methyldipropylamine, N-ethylidenemethylamine, N-ethylideneethylamine, N-ethylidenepropylamine and N-ethylidenebutylamine.

Examples of the alkanolamine include ethanolamine, N-methylethanolamine, N-ethylethanolamine, N-propylethanolamine, N-butylethanolamine, diethanolamine, isopropanolamine, N-methylisopropanolamine, N-ethylisopropanolamine, N-propylisopropanolamine, 2-aminopropan-1-ol, N-methyl-2-aminopropan-1-ol, N-ethyl-2-aminopropan-1-ol, 1-aminopropan-3-ol, N-methyl-1-aminopropan-3-ol, N-ethyl-1-aminopropan-3-ol, 1-aminobutan-2-ol, N-methyl-1-aminobutan-2-ol, N-ethyl-1-aminobutan-2-ol, 2-aminobutan-1-ol, N-methyl-2-aminobutan-1-ol, N-ethyl-2-aminobutan-1-ol, 3-aminobutan-1-ol, N-methyl-3-aminobutan-1-ol, N-ethyl-3-aminobutan-1-ol, 1-amino-4-butan-4-ol, N-methyl-1-aminobutan-4-ol, N-ethyl-1-aminobutan-4-ol, 1-amino-2-methylpropan-2-ol, 2-amino-2-methylpropan-1-ol, 1-aminopentan-4-ol, 2-amino-4-methylpentan-1-ol, 2-aminohexan-1-ol, 3-aminoheptan-4-ol, 1-aminooctan-2-ol, 5-aminooctan-4-ol, 1-aminopropan-2,3-diol, 2-aminopropan-1,3-diol, tris(oxymethyl)aminomethane, 1,2-diaminopropan-3-ol, 1,3-diaminopropan-2-ol, 2-(2-aminoethoxy)ethanol, N-ethylideneethanolamine, N-ethylideneethoxyethanolamine, N-hydroxymethylethanolamine, N-hydroxymethylethylenediamine, N,N'-bis(hydroxymethyl)ethylenediamine and N-hydroxymethylpropanolamine.

Examples of the polyamine include ethylenediamine, propylenediamine, trimethylenediamine, tetramethylenediamine, 1,3-diaminobutane, 2,3-diaminobutane, pentamethylenediamine, 2,4-diaminopentane, hexamethylenediamine, heptamethylenediamine, octamethylenediamine, nonamethylenediamine, N-methylethylenediamine, N,N-dimethylethylenediamine, trimethylethylenediamine, N-ethylethylenediamine, N,N-diethylethylenediamine, triethylethylene-

diamine, 1,2,3-triaminopropane, hydrazine, tris(2-aminoethyl)amine, tetra(aminomethyl)methane, diethylenetriamine, triethylenetetramine, tetraethylenepentamine, heptaethyleneoctamine, nonaethylenedecamine, diazabicycloundecene, polyethyleneimine, polyvinylamine and polyallylamine.

Examples of the hydroxylamine include hydroxylamine, N-methylhydroxylamine, N-ethylhydroxylamine and N,N-diethylhydroxylamine.

Examples of the cyclic amine include pyrrol, 2-methylpyrrol, 3-methylpyrrol, 2-ethylpyrrol, 3-ethylpyrrol, 2,3-dimethylpyrrol, 2,4-dimethylpyrrol, 3,4-dimethylpyrrol, 2,3,4-trimethylpyrrol, 2,3,5-trimethylpyrrol, 2-pyrroline, 3-pyrroline, pyrrolidine, 2-methylpyrrolidine, 3-methylpyrrolidine, pyrazol, imidazole, 1,2,3-triazole, 1,2,3,4-tetrazole, piperidine, 2-pipecoline, 3-pipecoline, 4-pipecoline, 2,4-lupetidine, 2,6-lupetidine, 3,5-lupetidine, piperadine, 2-methylpiperadine, 2,5-dimethylpiperadine, 2,6-dimethylpiperadine and morpholine.

Examples of the quaternary ammonium compound include tetramethylammonium hydroxide, tetraethylammonium hydroxide, tetrapropylammonium hydroxide, tetrabutylammonium hydroxide, choline hydroxide and acetylcholine hydroxide.

The amine used in the present invention is not limited to the above compounds and any compounds can be used as long as the compounds are amine compounds.

Among the foregoing amines, methylamine, ethylamine, propylamine, butylamine, ethanolamine, N-methylethanolamine, N-ethylethanolamine, diethanolamine, isopropanolamine, 2-(2-

aminoethoxy)ethanol, ethylene-diamine, propylenediamine, butylenediamine, diethylenetriamine, piperadine and morpholine are preferable.

The amine polymer used in the present invention is also an amine compound. Therefore, the amine polymer can be used as the amine compound. In this case, the amine polymer can be used alone. The amine compound may be used singly or in combination of two or more.

The liquid composition for removing a photoresist of the present invention may further comprise an organic solvent. The organic solvent used in the present invention is not particularly limited as long as the organic solvent is compatible with the mixture of the amine polymer and the amine compound described above. Organic solvents soluble in water are preferable. Examples of the organic solvent include ether-based solvents such as ethylene glycol, ethylene glycol monthly ether, ethylene glycol monobutyl ether, diethylene glycol monomethyl ether, diethylene glycol monthly ether, diethylene glycol monobutyl ether, propylene glycol monomethyl ether, propylene glycol monthly ether, propylene glycol monobutyl ether, diethylene glycol monomethyl ether, dipropylene glycol monthly ether, dipropylene glycol monobutyl ether, diethylene glycol dimethyl ether and dipropylene glycol dimethyl ether; amide-based solvents such as formamide, monomethylformamide, dimethylformamide, monoethylformamide, diethylformamide, acetamide, monomethylacetamide, dimethylacetamide, monoethylacetamide, diethylacetamide, N-methylpyrrolidone and N-ethylpyrrolidone; alcohol-based solvents such as methyl alcohol, ethyl alcohol, isopropanol, ethylene glycol and propylene glycol; sulfoxide-based solvents such as dimethyl

sulfoxide; sulfone-based solvents such as dimethyl sulfone, diethyl sulfone and tetramethyl sulfone; imidazolidinone-based solvents such as 1,3-dimethyl-2-imidazolidinone, 1,3-diethyl-2-imidazolidinone and 1,3-diisopropyl-2-imidazolidinone; lactone-based solvents such as γ -butyrolactone and δ -valerolactone; and amine oxide solvents such as trimethylamine oxide and methyldimorpholine oxide.

Among these solvents, dimethyl sulfoxide, N,N-dimethylformamide, N,N-dimethylacetamide, N-methylpyrrolidone, diethylene glycol monomethyl ether, diethylene glycol monobutyl ether, dipropylene glycol monomethyl ether, dipropylene glycol monobutyl ether and propylene glycol are preferable since these solvents are easily available and have high boiling points.

In the liquid composition for removing a photoresist of the present invention, an anticorrosive may be optionally used. Examples of the anticorrosive include anticorrosives based on phosphoric acid, carboxylic acids, amines, oximes, acetylenes, aromatic hydroxyl compounds, triazole compounds and sugar alcohol compounds. Among these anticorrosives, anticorrosives based on aromatic hydroxyl compounds, sugar alcohol compounds and triazole compounds are widely used due to easiness in the use.

Examples of the anticorrosives based on phosphoric acid include 1,2-propanediaminetetramethylenephosphonic acid and hydroxyethanephosphonic acid. Examples of the anticorrosives based on carboxylic acids include ethylenediaminetetraacetic acid, dihydroxyethylglycine, nitriloacetic acid, oxalic acid, citric acid, malic acid and tartaric acid. Examples of the anticorrosives based on amines include bipyridine,

tetraphenylporphyrin, phenanthroline and 2,3-pyridinediol. Examples of the anticorrosives based on oximes include dimethylglyoxime and diphenylglyoxime. Examples of the anticorrosives based on acetylenes include phenylacetylene and 2,5-dimethyl-3-hexyn-2,5-diol.

Examples of the anticorrosives based on aromatic hydroxyl compounds include phenol, cresol, xlenol, pyrocatechol, t-butylcatechol, resorcinol, hydroquinone, pyrogallol, 1,2,4-benzenetriol, salicyl alcohol, p-hydroxybenzyl alcohol, o-hydroxybenzyl alcohol, p-hydroxyphenetyl alcohol, p-aminophenol, m-aminophenol, diaminophenol, aminoresorcinol, p-hydroxybenzoic acid, o-hydroxybenzoic acid, 2,4-dihydroxybenzoic acid, 2,5-dihydroxybenzoic acid, 3,4-dihydroxybenzoic acid, 3,5-dihydroxybenzoic acid and gallic acid. Examples of the anticorrosives based on sugar alcohol compounds include sorbitol, xylitol and paratinit. Examples of the anticorrosives based on triazole compounds include benzotriazole, aminotriazole and aminotetrazole. The above compounds may be used singly or in combination of two or more.

In the present invention, the amine compound is used in an amount in the range of 0.1 to 95% by weight; the amine polymer is used in a concentration in the range of 0.0001 to 95% by weight; and the organic solvent is used in an amount in the range of 0 to 99% by weight.

The amount of the organic solvent is not particularly limited and suitably decided in accordance with the viscosity and the specific gravity of the composition and the conditions of the etching and the ashing. In the composition of the present invention, the amount of the anticorrosive is not particularly limited. The amount of the anticorrosive is in the range of 0 to 30% by weight and preferably 15% by weight or less.

In the present invention, the amount of water is not particularly limited and suitably decided in accordance with the conditions of the etching and the ashing. In general, the amount of water is in the range of 0 to 50% by weight. When water is completely absent, etching of silicon is extremely small in many cases and the function of the amine polymer is not effectively exhibited. However, in many semiconductor processes, rinsing with water is conducted after the removal of a resist and a mixture of the amine polymer with water is formed in the rinsing. Therefore, the liquid composition for removing a photoresist containing the amine polymer has the advantage of suppressing corrosion when the liquid composition is mixed with water.

The temperature of the removal of a resist with the liquid composition for removing a photoresist of the present invention is, in general, in the range of the ordinary temperature to 150°C. In particular, the removal can be conducted at a low temperature of 70°C or lower. When the attack to the material is considered, a lower temperature is preferable.

As the material of the substrate used in the present invention, semiconductor wiring materials such as silicon, amorphous silicon, polysilicon, silicon oxide films, silicon nitride films, copper, copper alloys, aluminum, aluminum alloys, gold, platinum, silver, titanium, titanium-tungsten alloys, titanium nitride, tungsten, tantalum, tantalum compounds, chromium, chromium oxide, chromium alloys and ITO (indium-tin oxide); compound semiconductors such as gallium-arsenic mixtures, gallium-phosphorus mixtures and indium-phosphorus mixtures; dielectric materials such as strontium-bismuth-tantalum mixtures; and

glasses such as glasses used for substrates of LCD, can be used. In particular, substrates comprising bare silicon, amorphous silicon and polysilicon are effective.

The process for producing a semiconductor device comprises forming a specific pattern on a substrate with a film of a photoresist, removing unnecessary portions of the film on the substrate by etching and removing the resist with the foregoing liquid composition for removing a photoresist. When it is necessary, the ashing treatment may be conducted after the etching and residues formed by the ashing may be removed with the foregoing liquid composition.

In the ashing treatment described above, for example, a resist composed of an organic macromolecule is converted into CO and CO₂ by the burning reaction with oxygen plasma generated in a plasma and removed.

For the rinsing treatment after the application of the liquid composition for removing a photoresist of the present invention, an organic solvent such as an alcohol or water may be used. The rinsing solvent is not particularly limited.

EXAMPLES

The present invention will be described more specifically with reference to examples in the following. However, the present invention is not limited to the example.

Examples 1 to 7 and Comparative Examples 1 and 2

A glass substrate having a film of amorphous silicon (a-Si) formed

on an insulation film was coated with a resist and then the photoresist film was developed. After the dry etching step, a circuit was formed. The test of the property for removal of the resist was conducted using the obtained substrate. The etching rate of the amorphous silicon was measured.

The foregoing substrate was dipped into a liquid composition for removal of the resist having a composition shown in Table 1 at 40°C. After a prescribed time, the substrate was taken out, rinsed with water, dried by blowing with nitrogen gas and then observed by an optical microscope. The time required for the removal of the resist was obtained from the results. For the measurement of the etching rate of the amorphous silicon, the oxide layer was removed with a buffered fluoric acid and then the measurement was conducted. The etching rate of the amorphous silicon was obtained by using an optical thickness meter.

The results are shown in Table 1.

Table 1
Time for removal of a resist and etching rate of amorphous silicon*

	Composition (% by weight)	Amine polymer (% by weight)	Water (% by weight)	Time for removal of resist (second)	Etching rate of a-Si (Å/min)
Example 1	EA 36, HMEA 1, DMSO 20, sorbitol 5	PEI (Mw 10,000) 3	35	20	56
Example 2	EA 39.5, HMEA 0.1, DMAC 19.9, sorbitol 5	PEI (Mw 1,800) 0.5	35	30	61
Example 3	EA 37, DGME 20, sorbitol 5	PEI (Mw 1,800) 3	35	45	58
Example 4	EA 39.5, NMP 20, sorbitol 5	PEI (Mw 70,000) 0.5	35	45	40
Example 5	EA 40, PG 19, sorbitol 5	PEI (Mw 10,000) 1	35	60	54
Example 6	MEA 29.9, HMEA 0.1, NMP 28, sorbitol 5	PEI (Mw 10,000) 3	35	30	32
Example 7	EDA 20, DMAC 38, sorbitol 5	PAA (Mw 3,000) 2	35	45	30
Comparative Example 1	EA 39, HMEA 1, DMSO 20, sorbitol 5	-	35	20	142
Comparative Example 2	EA 40, PG 20, sorbitol 5	-	35	60	125

* Notes

EA: Ethanolamine

HMEA: N-Hydroxymethylethanolamine

DMSO: Dimethyl sulfoxide

DMAC: Dimethylacetamide

DGME: Diethylene glycol monomethyl ether

NMP: N-Methylpyrrolidone

MEA: Methylethanolamine

PG: Propylene glycol

EDA: Ethylenediamine

PEI (Mw 10,000): Polyethyleneimine (the average molecular weight: 10,000)

PEI (Mw 1,800): Polyethyleneimine (the average molecular weight: 1,800)

PEI (Mw 70,000): Polyethyleneimine (the average molecular weight: 70,000)

Examples 8 to 14 and Comparative Example 3 and 4

For the preparation of a semiconductor device, the dry etching was conducted using a resist film as the mask and a wiring of an aluminum alloy (Al-Cu) was formed. After the ashing treatment with oxygen plasma, a semiconductor device was obtained. A perspective sectional view of a portion of the obtained semiconductor device is shown in Figure 1. In the semiconductor device, an oxide film 2 was formed on a silicon substrate 1 and a wiring 5 of an aluminum alloy was formed on the oxide film 2. Residues of the resist 6 were left remaining on side walls thereof. Titanium 3 and titanium nitride 4 were present as the barrier metals.

The semiconductor device shown in Figure 1 was dipped into a liquid composition for removal of a resist having a composition shown in Table 2 at 70°C for 15 minutes. Then, the device was taken out of the liquid composition, rinsed with ultra pure water, dried and observed by an electron microscope (SEM). The results of the evaluation on the removal of the residues of the resist 6 and the corrosion of the aluminum wiring 5 are shown in Table 2. The result of the observation by using SEM was evaluated in accordance with the following criteria:

- A: Residues were completely removed.
- B: Residues remained.
- C: Corrosion was found.

The etching rate of the bare silicon with the composition used in the foregoing test was also measured at 70°C.

Table 2
Time for removal of a resist and etching rate of bare silicon*

	Composition (% by weight)	Amine polymer (% by weight)	Water (% by weight)	Removal of resist	Etching rate of bare Si (Å/min)
Example 8	EA 60, DGME 20, CA 2	PEI (Mw 10,000) 3	15	A	69
Example 9	EA 60, DGME 22.9, CA 2	PEI (Mw 10,000) 0.5	15	A	129
Example 10	EA 61, DMAC 20, BT 0.02, CA 1.98	PEI (Mw 600) 2	15	A	115
Example 11	EA 58, DGBE 20, BuCA 2	PAA (Mw 3,000) 2	18	A	30
Example 12	DGBE 50, CA 2	PEI (Mw 600) 28	20	A	25
Example 13	EA 36, DPME 40	PVA (Mw 1,000)- 50% formate 2	22	B	30
Example 14	AEE 79, CA 5	PAA (Mw 5,000) 1	15	A	32
Comparative Example 3	EA 60, DGME 23, CA 2	-	15	C	650
Comparative Example 4	AEE 75, CA 5, HA 5	-	15	B	600

* Notes

EA: Ethanolamine

DGME: Diethylene glycol monomethyl ether

CA: Catechol

DMAC: Dimethylacetamide
BT: Benzotriazole
BuCA: 4-t-Butylcatechol
DGBE: Diethylene glycol monobutyl ether
DPME: dipropylene glycol monomethyl ether
AEE: Aminoethoxyethanol
HA: Hydroxylamine
EDA: Ethylenediamine
PEI (Mw 10,000): Polyethyleneimine (the average molecular weight: 10,000)
PEI (Mw 600): Polyethyleneimine (the average molecular weight: 600)
PAA (Mw 3,000): Polyallylamine (the average molecular weight: 3,000)
PVA (Mw 1,000)-50% formate: 50% Formic acid salt of polyvinylamine (the average molecular weight: 1,000)
PAA (Mw 5,000): Polyallylamine (the average molecular weight: 5,000)

Examples 15 to 20 and Comparative Example 5 and 6

Using a glass substrate having a structure with a low temperature polysilicon (p-Si) formed on SiO_2 which was used for preparation of a thin layer transistor, the test of removal of a resist was conducted. Figure 2 shows a cross sectional view of a portion of where polysilicon was exposed on the test substrate. A layer of the low temperature polysilicon 9 was formed on a layer of SiO_2 10 which was formed on the glass substrate 11. An insulation layer 7 was formed on the layer of the low temperature polysilicon 9. Residues of the resist 8 were left remaining on the insulation layer 7. At some portions, the insulation layer was absent and the lower layer was directly in contact with the liquid composition for removing a resist. Using the foregoing substrate, the test of removal of the resist and the measurement of the etching rate of the polysilicon were conducted.

The foregoing substrate was dipped into a liquid composition for removing a resist having a composition shown in Table 3 at 40°C. After a prescribed time, the substrate was taken out, rinsed with water, dried by blowing with dry nitrogen gas and then observed by an optical microscope. The time required for the removal of the resist was obtained from the results. For the measurement of the etching rate of the amorphous silicon, the oxide layer was removed with a buffered fluoric acid and then the measurement was conducted. The etching rate of the amorphous silicon was obtained by using an optical thickness meter.

The results are shown in Table 3.

Table 3
Time for removal of a resist and etching rate of polysilicon*

	Composition (% by weight)	Amine polymer (% by weight)	Water (% by weight)	Time for removal of resist (second)	Etching rate of p-Si (Å/min)
Example 15	EA 5, NMP 74.9	PEI (Mw 10,000) 0.1	20	90	6
Example 16	EA 5, HMEA 0.1, MEA 10, DMAC 44.4, sorbitol 5	PEI (Mw 1,800) 0.5	35	45	7
Example 17	EA 18, DGBE 60.99, xylitol 1	PAA (Mw 3,000) 0.01	20	45	15
Example 18	EA 69.5, NMP 28	PEI (Mw 70,000) 0.5	2	20	2
Example 19	MEA 12, HMEA 1, DMAC 46.5, sorbitol 5	PEI (Mw 10,000) 0.5	35	60	5
Example 20	PA 12, DGME 70	PAA (Mw 10,000) 2	16	45	6
Example 21	MO 35, DEH 5, DMAC 19.95	PAA (Mw 3,000) 0.05	35	45	17
Comparative Example 4	EA 70, NMP 28	-	2	20	78
Comparative Example 5	EA 20, DGBE 39, xylitol 1	-	20	45	235

* Notes

EA: Ethanolamine

NMP: N-Methylpyrrolidone

HMEA: N-Hydroxymethylethanolamine

MEA: Methylethanolamine

DMAC: Dimethylacetamide

DGBE: Diethylene glycol monobutyl ether

PA: 1-Amino-2-propanol

DGME: Diethylene glycol monomethyl ether
MO: Morpholine
DEH: Diethylhydroxylamine
EDA: Ethylenediamine
PEI (Mw 10,000): Polyethyleneimine (the average molecular weight: 10,000)
PEI (Mw 1,800): Polyethyleneimine (the average molecular weight: 1,800)
PEI (Mw 3,000): Polyethyleneimine (the average molecular weight: 3,000)
PEI (Mw 70,000): Polyethyleneimine (the average molecular weight: 70,000)
PAA (Mw 10,000): Polyallylamine (the average molecular weight: 10,000)
PAA (Mw 3,000): Polyallylamine (the average molecular weight: 3,000)
NMP: N-Methylpyrrolidone
PG: Propylene glycol

EFFECTS OF THE INVENTION

To summarize the advantages of the present invention, a photoresist can be removed with the liquid composition for removing a photoresist of the present invention in a short time without corrosion of wiring materials and, in particular, silicon. More specifically, corrosion of silicon can be effectively prevented independently of the type of silicon such as bare silicon, amorphous silicon and polysilicon and a photoresist can be removed from a substrate comprising silicon without corrosion when the liquid composition for removing a photoresist of the present invention is used.

It is further understood by those skilled in the art that the foregoing description is a preferred embodiment of the invention and that various changes and modifications may be made in the invention without departing from the spirit and scope thereof.

WHAT IS CLAIMED IS:

1. A liquid composition for removing a photoresist that comprises an amine compound and an amine polymer.
2. A liquid composition for removing a photoresist that comprises an amine compound, an amine polymer and water.
3. The liquid composition according to Claim 1 or Claim 2, wherein the amine polymer is polyethyleneimine, polyvinylamine or polyallylamine.
4. The liquid composition according to any one of Claims 1 to 3, wherein the amine polymer has a weight-average molecular weight of 250 or greater.
5. The liquid composition according to any one of Claims 1 to 4, wherein the amine compound is an alkylamine, an alkanolamine, a polyamine, a hydroxylamine, a cyclic amine or a quaternary ammonium compound.
6. The liquid composition according to any one of Claims 1 to 5, that further comprises an organic solvent.
7. The liquid composition according to any one of Claims 1 to 6, that further comprises an anticorrosive.
8. The liquid composition according to Claim 7, wherein the anticorrosive

is an aromatic hydroxyl compound, a sugar alcohol compound or a triazole compound.

9. A process for producing a semiconductor device that comprises removing a resist from a substrate comprising silicon with the liquid composition according to Claim 1 or Claim 2.