formation of defects on a substrate.

In view of the above circumstances, an object of the present invention is to provide a method for forming a film used in a lithography process in the manufacture of a semiconductor device. In particular, an object of the present invention is to provide a film with reduced formation of an edge reservoir at a periphery of a film in which the edge reservoir causes an unnecessary residue that cannot be removed by an etching process, and a method for forming the film.

Means for Solving the Problem

[0006] The present invention provides, as a first aspect, a film forming composition for use in a lithography process, the film forming composition characterized by comprising a surfactant containing a polymer and an oligomer having a C_{3-5} perfluoroalkyl partial structure,

as a second aspect, the film forming composition as described in the first aspect, in which the perfluoroalkyl partial structure has a carbon number of 4,

as a third aspect, the film forming composition as described in the first or second aspect, in which the perfluoroalkyl partial structure may further include an alkyl partial structure,

as a fourth aspect, the film forming composition as described in any one of the first to third aspects, in which the polymer and the oligomer are a (meth)acrylate polymer and a (meth)acrylate oligomer, respectively,

as a fifth aspect, the film forming composition as described in any one of the first to fourth aspects, in which the surfactant is contained in an amount of 0.0001% by mass to 1.5% by mass based on the total solid content of the film forming composition,

as a sixth aspect, the film forming composition as described in any one of the first to fifth aspects, further comprising a coating film resin.

as a seventh aspect, the film forming composition as described in the sixth aspect, in which the coating film resin is a novolac resin, a condensation epoxy resin, a (meth)acrylic resin, a polyether-based resin, or a silicon-containing resin,

resin, and a solvent. The composition may contain a cross-linking agent, an acid, an acid generator, and an absorptive compound, for example, as necessary. The coating film resin is a resin capable of being mainly used in film formation, and examples of the resin include a novolac resin, a condensation epoxy resin, a (meth)acrylic resin, a polyether-based resin, and a silicon-containing resin.

A solid content of the composition is 0.1% by mass to 70% by mass or 0.1% by mass to 60% by mass. The solid content is a content ratio of the component of the film forming composition from which the solvent is removed.

In the solid content, the coating film resin can be included in a ratio of 1% by mass to 99.9% by mass, 50% by mass to 99.9% by mass, 50% by mass to 95% by mass, or 50% by mass to 90% by mass.

The coating film resin has a weight average molecular weight of 600 to 1,000,000 or 600 to 200,000.

[0018] The novolac resin can be obtained by a reaction of an aromatic compound with aldehyde or ketone. Examples of the aromatic compound include phenolic hydroxy group-containing compounds, such as phenol, cresol, and naphthol, carbazole, phloroglucinol, phenylnaphthylamine, phenothiazine, phenylindole, polynuclear phenol, pyrrole, and derivatives thereof.

[0019] Examples of aldehydes include saturated aliphatic aldehydes, such as formaldehyde, paraformaldehyde, acetoaldehyde, propyl aldehyde, butylaldehyde, isobutyl aldehyde, valeraldehyde, capronaldehyde, 2-methylbutylaldehyde, hexylaldehyde, undecanealdehyde, 7-methoxy-3,7-dimethyloctylaldehyde, cyclohexanealdehyde, 3-methyl-2-butyraldehyde, glyoxal, malonaldehyde, succinaldehyde, glutaraldehyde, glutaraldehyde, and adipaldehyde, unsaturated aliphatic aldehydes such as acrolein and methacrolein, heterocyclic aldehydes such as furfural, pyridine aldehyde, and thiophene aldehyde, and aromatic aldehydes such as benzaldehyde, naphthaldehyde, anthracenecarboxaldehyde, phenylbenzaldehyde, anisaldehyde, terephthalaldehyde, pyrenecarboxaldehyde, phenanthrylaldehyde, salicylaldehyde, phenylacetaldehyde, 3-phenylpropionaldehyde, tolylaldehyde,

CLAIMS

1. A film forming composition for use in a lithography process, the film forming composition comprising a surfactant containing a polymer and an oligomer having a C_{3-5} perfluoroalkyl partial structure; and a coating film resin, wherein the coating film resin is a novolac resin, a condensation epoxy resin, a (meth)acrylic resin, a polyether-based resin, or a silicon-containing resin, wherein the surfactant is contained in an amount of 0.0001% by mass to 1.5% by mass based on the total solid content of the film forming composition, and wherein the film is a resist underlayer film or a resist overlayer film.

2. The film forming composition according to claim 1, wherein the perfluoroalkyl partial structure has a carbon number of 4.

3. The film forming composition according to claim 1 or 2, wherein the perfluoroalkyl partial structure may further include an alkyl partial structure.

4. The film forming composition according to any one of claims 1 to 3, wherein the polymer and the oligomer are a (meth)acrylate polymer and a (meth)acrylate oligomer, respectively.

5. A method for manufacturing a semiconductor device, the method comprising:

a process of forming an underlayer film on a semiconductor substrate by use of the film forming composition as claimed in any one of claims 1 to 4;

a process of forming a resist film on the underlayer film;

a process of forming a resist pattern by irradiation with light, EUV, or an electron beam and development;

a process of etching the underlayer film by use of the formed resist pattern; and

a process of processing the semiconductor substrate by use of the patterned

underlayer film.

6. A method for manufacturing a semiconductor device, the method comprising:

a process of forming an underlayer film on a semiconductor substrate by use of the film forming composition as claimed in any one of claims 1 to 4;

a process of forming a hard mask on the underlayer film;

a process of further forming a resist film on the hard mask;

a process of forming a resist pattern by irradiation with light, EUV, or an electron beam and development;

a process of etching the hard mask by use of the formed resist pattern;

a process of etching the underlayer film by use of the patterned hard mask; and

a process of processing the semiconductor substrate by use of the patterned underlayer film.

7. A method for manufacturing a semiconductor device, the method comprising:

a process of forming an organic underlayer film on a semiconductor substrate;

a process of applying the film forming composition as claimed in any one of claims 1 to 4 onto the organic underlayer film and baking the composition to form a resist underlayer film;

a process of applying a composition for a resist on the resist underlayer film to form a resist film;

a process of exposing the resist film with light, EUV, or an electron beam;

a process of developing the resist film after exposure to obtain a resist pattern;

a process of etching the resist underlayer film by use of the resist pattern;

a process of etching the organic underlayer film by use of the patterned resist underlayer film; and

a process of processing the semiconductor substrate by use of the patterned organic underlayer film.

8. A method for manufacturing a semiconductor device, the method comprising:

a process of forming a resist film on a semiconductor substrate;

a process of applying the film forming composition as claimed in any one of claims 1 to 4 onto the resist film and baking the composition to form a resist overlayer film;

a process of exposing the semiconductor substrate, covered with the resist overlayer film and the resist film, with light, EUV, or an electron beam; and

a process of performing development after exposure to remove the resist overlayer film and the resist film.