CLAIMS

1. A method for producing a semiconductor device comprising the steps of:

(1) forming an organic underlayer film onto a semiconductor substrate;

(2) applying a silicon hard mask-forming composition on the organic underlayer film and baking the applied silicon hard mask-forming composition to form a silicon hard mask;

(3) applying a resist composition onto the silicon hard mask to form a resist film;

(4) exposing the resist film to light and developing the resist film after exposure to give a resist pattern;

(5) etching the silicon hard mask using the resist pattern;

(6) etching the organic underlayer film using the patterned silicon hard mask to form a patterned organic underlayer film;

(7) applying a polysiloxane composition comprising a hydrolysis condensate of a hydrolyzable silane comprising the hydrolyzable silane having two to three hydrolyzable groups in a proportion of 30 mol% to 100 mol% in total silanes, for coating onto the patterned organic underlayer film to embed the polysiloxane composition between traces of the pattern of the organic underlayer film and exposing an upper surface of the organic underlayer film by etch back; and

(8) etching the organic underlayer film to reverse the pattern.

2. The method according to claim 1, wherein the hydrolyzable silane is a hydrolyzable silane of Formula (1):

$$R^1{}_aSi(R^2)_{4-a}$$ Formula (1)

in Formula (1), R^1 is an alkyl group, an aryl group, a halogenated alkyl group, a halogenated aryl group, an alkoxy aryl group, an alkenyl group, or an organic group having an epoxy group, an acryloyl group, a methacryloyl group, a mercapto group, or a

cyano group and bonding to a silicon atom through a Si-C bond; R^2 is an alkoxy group, an acyloxy group, or a halogen group; and a is an integer of 0 to 2, and comprises a hydrolyzable silane, in which a in Formula (1) is 1 or 2, in a proportion of 30 mol% to 100 mol% and a hydrolyzable silane, in which a in Formula (1) is 0, in a proportion of 0 mol% to 70 mol% in the total silanes.

3. The method according to claim 2, wherein the polysiloxane composition comprises the hydrolysis condensate of the hydrolyzable silane comprising the hydrolyzable silane of Formula (1), where a is 1 or 2, in a proportion of 100 mol% in the total silanes and a crosslinkable compound having two to six methoxymethyl groups.

4. The method according to claim 2 or 3, wherein R^1 in Formula (1) is a methyl group or a phenyl group optionally substituted with a halogen group or an alkoxy group.

5. The method according to any one of claims 1 to 4, wherein hydrolysis of the hydrolyzable silane is carried out using an acid or a base as a hydrolysis catalyst.

6. The method according to any one of claims 1 to 5, further comprising one or more substances selected from the group consisting of water, an acid, and a curing catalyst.