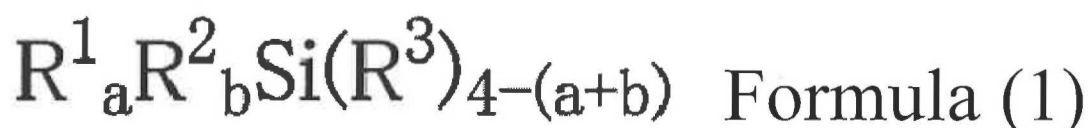
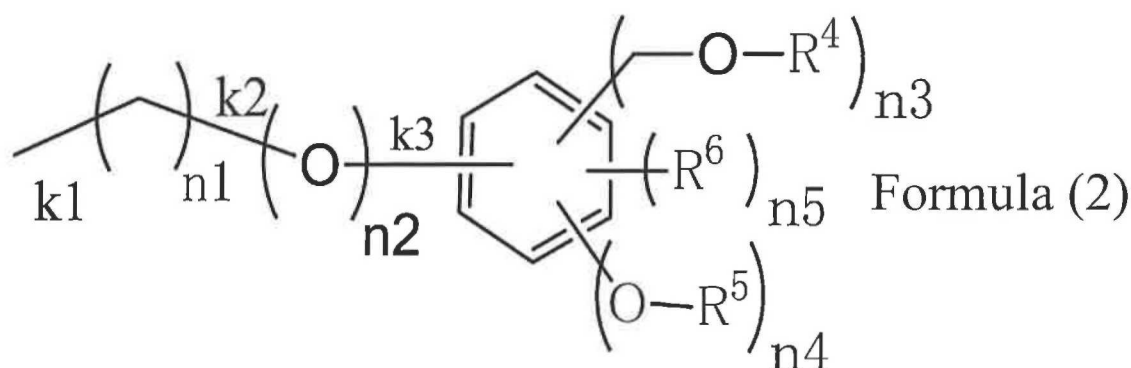


## CLAIMS

1. A film-forming composition, the composition comprising:  
 as a silane, a hydrolyzable silane, a hydrolysis product thereof, or a  
 5 hydrolysis-condensation product thereof, wherein  
 the hydrolyzable silane includes a hydrolyzable silane of Formula (1):



- in Formula (1),  $R^1$  is an organic group of Formula (2) and is bonded to a silicon  
 10 atom through a Si-C bond or a Si-O bond:



- in Formula (2),  $R^4$  is a hydrogen atom, a  $C_{1-10}$  alkyl group, or an acyl group,  $R^5$  is a  
 hydrogen atom, a  $C_{1-10}$  alkyl group, or a  $C_{1-10}$  alkyl group having a  $C_{1-10}$  alkoxy group,  $R^6$   
 15 is a  $C_{1-10}$  alkyl group,  $n1$  is an integer of 0 to 10,  $n2$  is an integer of 0 or 1,  $n3$ ,  $n4$  and  $n5$   
 are integers, where  $n3$  satisfies  $1 \leq n3 \leq 5$ ,  $n4$  satisfies  $0 \leq n4 \leq 4$ , and  $n5$  satisfies  $0 \leq n5$   
 $\leq 4$ ,  $k1$  is a bond end with a silicon atom when  $n1$  is an integer of 1 to 10,  $k2$  is a bond  
 end with a silicon atom when  $n1$  is 0 and  $n2$  is 1, and  $k3$  is a bond end with a silicon atom  
 when  $n1$  and  $n2$  are 0;  
 20  $R^2$  is an alkyl group, an aryl group, a halogenated alkyl group, a halogenated aryl  
 group, an alkoxyaryl group, an alkenyl group, or an organic group having an epoxy group,

an acryloyl group, a methacryloyl group, a mercapto group, an amino group, or a cyano group, or a combination thereof, and is bonded to a silicon atom through a Si-C bond;

$R^3$  is an alkoxy group, an acyloxy group, or a halogen group;

a is an integer of 1;

5 b is an integer of 0 to 2; and

a + b is an integer of 1 to 3, and wherein

the hydrolyzable silane is a combination of the hydrolyzable silane of Formula (1) with another hydrolyzable silane, in which the other hydrolyzable silane is at least one hydrolyzable silane selected from the group consisting of:

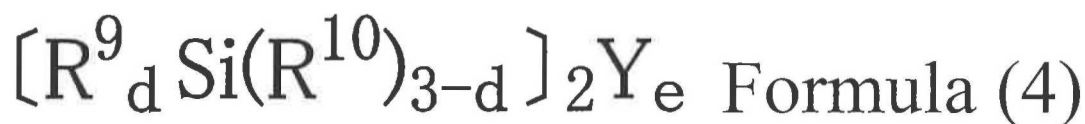
10 a hydrolyzable silane of Formula (3):



in Formula (3),  $R^7$  is an alkyl group, an aryl group, a halogenated alkyl group, a halogenated aryl group, an alkoxyalkyl group, an alkoxyaryl group, an alkoxyalkoxyaryl group, an alkenyl group, or an organic group having an epoxy group, an acryloyl group, a methacryloyl group, a mercapto group, a sulfonamide group, or a cyano group, or a combination thereof, and is bonded to a silicon atom through a Si-C bond,  $R^8$  is an alkoxy group, an acyloxy group, or a halogen group, and c is an integer of 0 to 3, and

a hydrolyzable silane of Formula (4):

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in Formula (4),  $R^9$  is an alkyl group and is bonded to a silicon atom through a Si-C bond,  $R^{10}$  is an alkoxy group, an acyloxy group, or a halogen group, Y is an alkylene group or an arylene group, d is an integer of 0 or 1, and e is an integer of 0 or 1.

25

2. A film-forming composition, the composition comprising:  
as a polymer, a hydrolysis-condensation product of a hydrolyzable silane composed  
of a combination of:

the hydrolyzable silane of Formula (1) in claim 1; and

5 the hydrolyzable silane of Formula (3) in claim 1.

3. The film-forming composition according to any one of claims 1 to 2, further  
comprising a curing catalyst selected from ammonium salts, phosphines, phosphonium  
salts, or sulfonium salts.

10

4. The film-forming composition according to any one of claims 1 to 3, wherein the  
film-forming composition is a resist underlayer film-forming composition for use in a  
lithography process.

15 5. A resist underlayer film formed on a semiconductor substrate, comprising a cured  
product of the resist underlayer film-forming composition as claimed in claim 4.

6. A method of producing a semiconductor device comprising:

a step of applying the resist underlayer film-forming composition as claimed in

20 claim 4 on a semiconductor substrate and baking the resist underlayer film-forming  
composition to form a resist underlayer film;

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

a step of exposing the resist film;

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

a step of etching the resist underlayer film using the resist pattern; and

a step of processing the semiconductor substrate using the patterned resist and the

resist underlayer film.

7. A method of producing a semiconductor device comprising:

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

5 a step of applying the resist underlayer film-forming composition as claimed in claim 4 on the organic underlayer film and baking the resist underlayer film-forming composition to form a resist underlayer film;

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

10 a step of exposing the resist film;

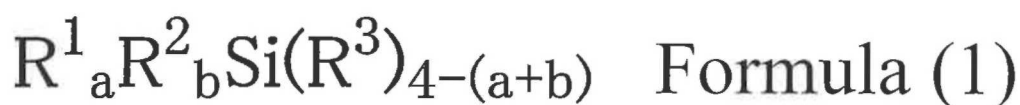
a step of developing the resist film after exposure to obtain a resist pattern;

a step of etching the resist underlayer film using the resist pattern;

a step of etching the organic underlayer film using the patterned resist underlayer film; and

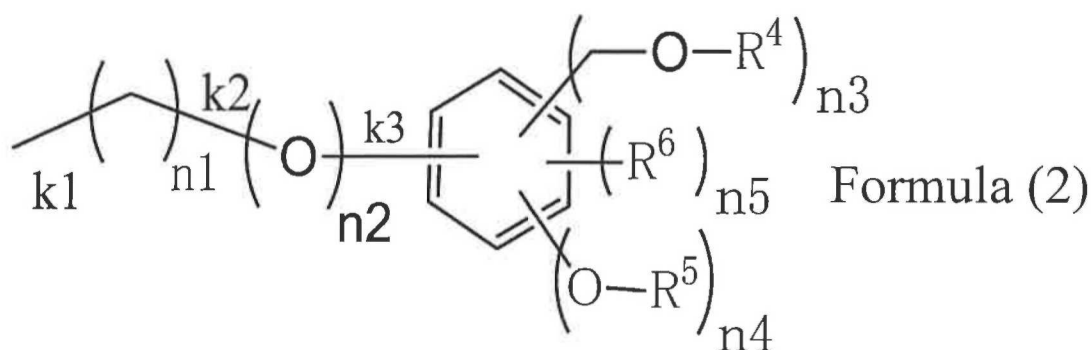
15 a step of processing the semiconductor substrate using the patterned organic underlayer film.

8. A hydrolyzable silane of Formula (1):



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in Formula (1),  $R^1$  is an organic group of Formula (2) and is bonded to a silicon atom through a Si-C bond or a Si-O bond:



in Formula (2),  $R^4$  is a hydrogen atom, a  $C_{1-10}$  alkyl group, or an acyl group,  $R^5$  is a hydrogen atom, a  $C_{1-10}$  alkyl group, or a  $C_{1-10}$  alkyl group having a  $C_{1-10}$  alkoxy group,  $R^6$  is a  $C_{1-10}$  alkyl group,  $n_1$  is an integer of 0 to 10,  $n_2$  is an integer of 0 or 1,  $n_3$ ,  $n_4$ , and  $n_5$  are integers, where  $n_3$  satisfies  $1 \leq n_3 \leq 5$ ,  $n_4$  satisfies  $0 \leq n_4 \leq 4$ , and  $n_5$  satisfies  $0 \leq n_5 \leq 4$ ,  $k_1$  is a bond end with a silicon atom when  $n_1$  is 1 to 10,  $k_2$  is a bond end with a silicon atom when  $n_1$  is 0 and  $n_2$  is 1, and  $k_3$  is a bond end with a silicon atom when  $n_1$  and  $n_2$  are 0;

$R^2$  is an alkyl group, an aryl group, a halogenated alkyl group, a halogenated aryl group, an alkoxyaryl group, an alkenyl group, or an organic group having an epoxy group, an acryloyl group, a methacryloyl group, a mercapto group, an amino group, or a cyano group, or a combination thereof, and is bonded to a silicon atom through a Si-C bond;

$R^3$  is an alkoxy group, an acyloxy group, or a halogen group;

$a$  is an integer of 1;

$b$  is an integer of 0 to 2; and

$a + b$  is an integer of 1 to 3, in combination

with another hydrolyzable silane, in which the other hydrolyzable silane is at least one hydrolyzable silane selected from the group consisting of:

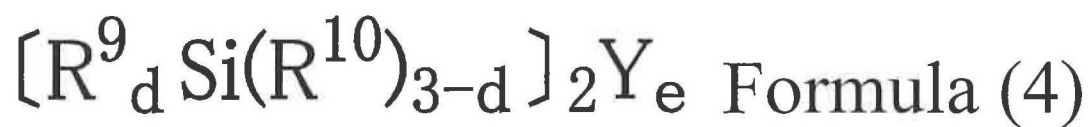
a hydrolyzable silane of Formula (3):



20

in Formula (3),  $R^7$  is an alkyl group, an aryl group, a halogenated alkyl group, a halogenated aryl group, an alkoxyalkyl group, an alkoxyaryl group, an alkoxyalkoxyaryl group, an alkenyl group, or an organic group having an epoxy group, an acryloyl group, a methacryloyl group, a mercapto group, a sulfonamide group, or a cyano group, or a combination thereof, and is bonded to a silicon atom through a Si-C bond,  $R^8$  is an alkoxy group, an acyloxy group, or a halogen group, and  $c$  is an integer of 0 to 3, and

a hydrolyzable silane of Formula (4):



- 5        in Formula (4),  $R^9$  is an alkyl group and is bonded to a silicon atom through a Si-C bond,  $R^{10}$  is an alkoxy group, an acyloxy group, or a halogen group, Y is an alkylene group or an arylene group, d is an integer of 0 or 1, and e is an integer of 0 or 1.