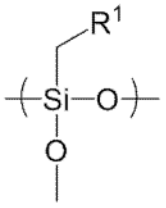
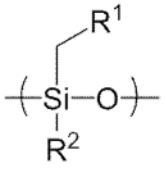
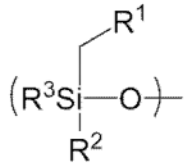
CLAIMS

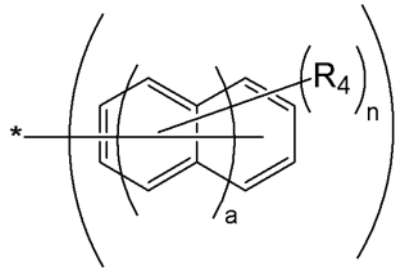
1. A composition for forming a silicon-containing resist film comprising a polysiloxane comprising at least one of any of a repeating unit represented by formula (A-1), a repeating unit represented by formula (A-2), or a substructure represented by formula (A-3):


(A − 1)


(A − 2)


(A − 3)

wherein R^1 is a monovalent group represented by formula (B-1), fluorine, bromine, iodine, a hydroxy group, a sulfo group, a nitro group, or a carboxyl group, functioning as a group eliminated by heat, acid, or base, and R^2 and R^3 each independently represent a monovalent organic group having 1 to 30 carbon atoms and optionally having a substituent.


(B − 1)

wherein R4 are each a substituent attached to an aromatic ring and each independently represent a hydrogen atom or ethyl

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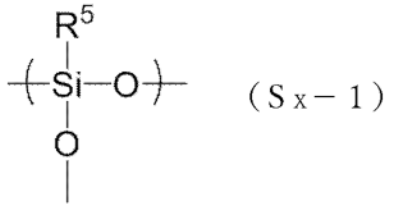
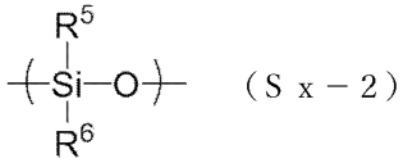
group, an n-propyl group, an i-propyl group, an n-butyl group, an i-butyl group, a sec-butyl group, a t-butyl group, an n-pentyl group, an n-hexyl group, an aryl group having 6 to 20 carbon atoms and optionally having a substituent, a halogenated alkyl group having 1 to 20 carbon atoms and optionally having a substituent, a halogenated aryl group having 6 to 20 carbon atoms and optionally having a substituent, an alkoxyalkyl group having 1 to 20 carbon atoms and optionally having a substituent, an alkoxyaryl group having 6 to 20 carbon atoms and optionally having a substituent, an acyl group having 6 to 20 carbon atoms and optionally having a substituent, a halogen atom, a hydroxy group, a sulfo group, a nitro group, or a carboxyl group; a = 0 or 1; n = 2a + 5; and * denotes a bond to another atom. Provided that all R4 atoms are not hydrogen atoms at the same time.

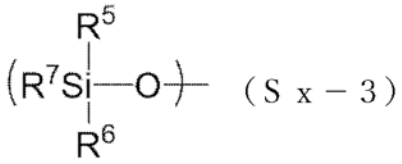
2. The composition for forming a silicon-containing resist film according to claim 1, wherein the polysiloxane comprises a thermally crosslinkable polysiloxane comprising at least one of any of a repeating unit represented by formula (Sx-1), a repeating unit represented by formula (Sx-2), or a substructure represented by formula (Sx-3):



(Sx-1)



(Sx-2)



(Sx-3)

wherein R^5, R^6, and R^7 are each independently a monovalent organic group having 1 to 30 carbon atoms and optionally having a substituent.

3. The composition for forming a silicon-containing resist film according to claim 1, further comprising a crosslinking catalyst.

4. The composition for forming a silicon-containing resist film according to claim 3, wherein the crosslinking catalyst is an ammonium salt or a sulfonium salt.

5. The composition for forming a silicon-containing resist film according to claim 1, further comprising an acid generator.

6. The composition for forming a silicon-containing resist film according to claim 5, wherein the acid generator is a sulfonium salt.

7. A patterning process comprising the steps of:

forming, on a body to be processed, an organic film using a coating-type organic film material;

forming, on the organic film, a silicon-containing resist middle layer film using the composition for forming a silicon-containing resist film according to any one of claims 1 to 6;

forming, on the silicon-containing resist middle layer film, a resist upper layer film by using a resist upper layer film material comprising a photoresist composition;

forming a circuit pattern on the resist upper layer film;

using, as a mask, the resist upper layer film having the formed circuit pattern to transfer the pattern onto the silicon-containing resist middle layer film by etching;

using, as a mask, the silicon-containing resist middle layer film having the transferred pattern to transfer the pattern onto the organic film by etching; and

using, as a mask, the organic film having the transferred pattern to transfer the pattern onto the body to be processed by etching.

8. A patterning process comprising the steps of:

forming, on a body to be processed by CVD method, a hard mask primarily composed of carbon;

forming, on the hard mask, a silicon-containing resist middle layer film using the composition for forming a silicon-containing resist film according to any one of claims 1 to 6;

forming, on the silicon-containing resist middle

layer film, a resist upper layer film by using a resist upper layer film material comprising a photoresist composition;

forming a circuit pattern on the resist upper layer film;

using, as a mask, the resist upper layer film having the formed circuit pattern to transfer the pattern onto the silicon-containing resist middle layer film by etching;

using, as a mask, the silicon-containing resist middle layer film having the transferred pattern to transfer the pattern onto the hard mask by dry etching; and

using, as a mask, the hard mask having the transferred pattern to transfer the pattern onto the body to be processed by dry etching.

9. The patterning process according to claim 7, wherein the pattern formation in the step of forming a circuit pattern on the resist upper layer film is pattern formation performed by optical lithography with a wavelength of 10 nm or more and 300 nm or less, direct electron beam lithography, nanoimprinting, or a combination thereof.

10. The patterning process according to claim 7, wherein the body to be processed is any of a semiconductor device substrate, a metal film, a metal carbide film, a metal oxide film, a metal nitride film, a metal oxide carbide film, or a metal oxide nitride film.

11. The patterning process according to claim 10,

wherein a metal constituting the body to be processed is silicon, gallium, titanium, tungsten, hafnium, zirconium, chromium, germanium, copper, silver, gold, indium, arsenic, palladium, tantalum, iridium, aluminum, iron, molybdenum, cobalt, or an alloy thereof.