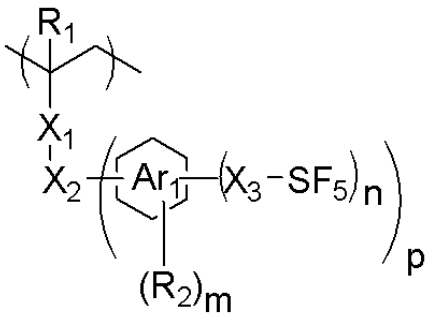
CLAIMS

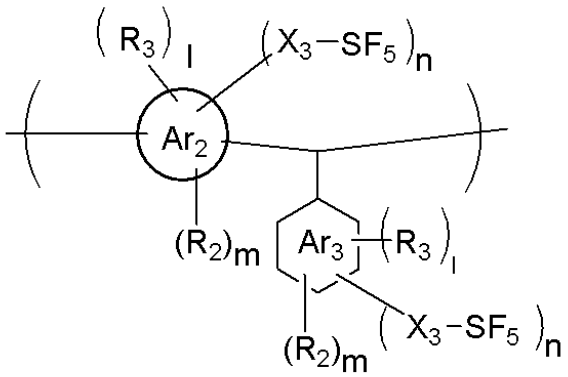
[Claim 1] A composition for forming a film comprising a surfactant that is a polymer (a) having a repeating unit “a” represented by any one of the following formulae (a1) to (a4),



(a1)

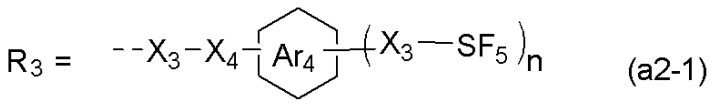
wherein, “p” represents an integer of 1 to 3; “n” represents an integer of 0 to 5; “m” represents an integer of 0 to 4; R_1 represents a hydrogen atom or a methyl group; R_2 represents a hydrocarbyl group having 1 to 6 carbon atoms, a hydrocarbyloxy group having 1 to 12 carbon atoms, a hydrocarbyloxycarbonyl group having 2 to 6 carbon atoms, a hydrocarbylcarbonyloxy group having 2 to 12 carbon atoms, a hydroxy group, a carboxy group, a halogen atom, a trifluoromethoxy group, a cyano group, or a nitro group; X_1 represents a single bond, an ester bond, an ether bond, a sulfonic acid ester group, a sulfonamide group, an amide bond, or a phenylene group; X_2 represents a single bond or a hydrocarbylene group having 1 to 20 carbon atoms when “p” represents 1, and X_2 represents a (p+1)-valent hydrocarbon group having 1 to 20 carbon atoms when “p” represents 2 or 3, and the hydrocarbylene group and the (p+1)-valent hydrocarbon group may contain at least one atom selected from the group consisting of an oxygen atom, a sulfur atom, a nitrogen atom, and a halogen atom; X_3 represents a single

bond or an ether bond; and Ar_1 each independently represents a (m+n+1)-valent group derived from benzene or naphthalene, provided that at least one of "n"s in the formula represents 1 or more,



(a2)

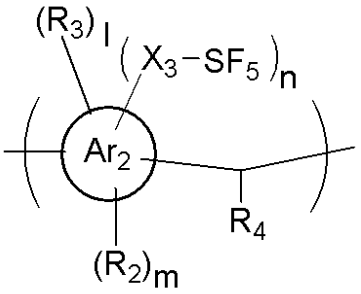
wherein, "n" and "m" represent the same as defined above, "l" represents an integer of 0 to 3, and at least one of the two "n"s and the two "1"s in the formula represents 1 or more; R_2 and X_3 represent the same as defined above; and R_3 represents the following general formula (a2-1); Ar_2 each independently represents a (n+m+l+2)-valent aromatic hydrocarbon group having 6 to 30 carbon atoms; and Ar_3 represents a (n+m+l+1)-valent group derived from benzene or naphthalene,



(a2-1)

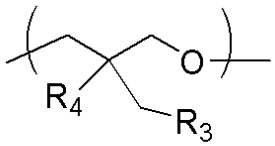
wherein, X_3 and "n" represent the same as above; X_4 represents a single bond or a hydrocarbylene group having 1 to 12 carbon atoms, and the hydrocarbylene group may have at least one selected from the group consisting of a hydroxy group, a saturated hydrocarbyloxy group having 1 to 6 carbon atoms, an ether bond, an ester bond, and an amide bond; and Ar_4 represents a (n+1)-valent group derived from benzene or

naphthalene,



(a3)

wherein “n”, “m”, “l”, Ar_2, R_2, R_3, and X_3 represent the same as defined above; R_4 represents a hydrogen atom or a hydrocarbyl group having 1 to 10 carbon atoms, and the hydrocarbyl group may have an oxygen atom but does not have a substituent having SF_5; and at least one of “n” and “l” in the formula represents 1 or more,



(a4)

wherein R_3 and R_4 represent the same as defined above.

[Claim 2] The composition for forming a film according to claim 1, wherein the repeating unit “a” is represented by the formula (a1).

[Claim 3] The composition for forming a film according to claim 1, wherein the polymer (a) further comprises a repeating unit “b1” having a hydrophilic group selected from the group consisting of an ether bond, an ester bond, a hydroxy group, a carboxy group, a sulfonamide bond, a sulfonimide bond, a sulfo group, a lactone ring, a sultone ring, a carbonate bond, a urethane bond, and an amide bond.

[Claim 4] The composition for forming a film according to claim 1, wherein the composition for forming a film is a composition for forming an organic film comprising (A) a resin or compound for forming an organic film; (B) the polymer (a); and (C) a solvent.

[Claim 5] The composition for forming a film according to claim 4, wherein the component (B) is contained in an amount of 0.01 to 5 parts by mass based on 100 parts by mass of the component (A).

[Claim 6] The composition for forming a film according to claim 4, further comprising (D) a photo-acid generator or (E) a thermal acid generator.

[Claim 7] A method for forming an organic film to be used in a manufacturing process of a semiconductor device, the method comprising:

spin-coating a substrate to be processed with the composition for forming a film according to any one of claims 4 to 6; and

forming a cured film by heating the substrate coated with the composition for forming a film at a temperature of 100°C or higher and 600°C or lower for 10 to 600 seconds.

[Claim 8] A patterning process comprising:

forming an organic film on a body to be processed by using the composition for forming a film according to claim 4;

forming a resist middle layer film on the organic film by using a silicon-containing resist middle

layer film material;

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

forming a circuit pattern in the resist upper layer film;

transferring the pattern to the resist middle layer film by etching while using the resist upper layer film having the formed circuit pattern as a mask;

transferring the pattern to the organic film by etching while using the resist middle layer film having the transferred pattern as a mask; and

further transferring the pattern in the body to be processed by etching while using the organic film having the transferred pattern as a mask.

[Claim 9] A patterning process comprising:

forming an organic film on a body to be processed by using the composition for forming a film according to claim 4;

forming a resist middle layer film on the organic film by using a silicon-containing resist middle layer film material;

forming an organic antireflective film or an adhesive film on the resist middle layer film;

forming a resist upper layer film on the organic antireflective film or the adhesive film by using a resist upper layer film material comprising a photoresist composition;

forming a circuit pattern in the resist upper layer film;

transferring the pattern to the organic

antireflective film or the adhesive film and to the resist middle layer film by etching while using the resist upper layer film having the formed circuit pattern as a mask;

transferring the pattern to the organic film by etching while using the resist middle layer film having the transferred pattern as a mask; and

further transferring the pattern to the body to be processed by etching while using the organic film having the transferred pattern as a mask.

[Claim 10] A patterning process comprising:

forming an organic film on a body to be processed by using the composition for forming a film according to claim 4;

forming an inorganic hard mask selected from the group consisting of a silicon oxide film, a silicon nitride film, and a silicon oxynitride film on the organic film;

forming a resist upper layer film on the inorganic hard mask by using a resist upper layer film material comprising a photoresist composition;

forming a circuit pattern in the resist upper layer film;

transferring the pattern to the inorganic hard mask by etching while using the resist upper layer film having the formed circuit pattern as a mask;

transferring the pattern to the organic film by etching while using the inorganic hard mask having the transferred pattern as a mask; and

further transferring the pattern to the body to be processed by etching while using the organic film having the transferred pattern as a mask.

[Claim 11] A patterning process comprising:

forming an organic film on a body to be processed by using the composition for forming a film according to claim 4;

forming an inorganic hard mask selected from the group consisting of a silicon oxide film, a silicon nitride film, and a silicon oxynitride film on the organic film;

forming an organic antireflective film or an adhesive film on the inorganic hard mask;

forming a resist upper layer film on the organic antireflective film or the adhesive film by using a resist upper layer film material comprising a photoresist composition;

forming a circuit pattern in the resist upper layer film;

transferring the pattern to the organic antireflective film or the adhesive film and to the inorganic hard mask by etching while using the resist upper layer film having the formed circuit pattern as a mask;

transferring the pattern to the organic film by etching while using the inorganic hard mask having the transferred pattern as a mask; and

further transferring the pattern to the body to be processed by etching while using the organic film having the transferred pattern as a mask.

[Claim 12] The patterning process according to claim 10 or 11, wherein the inorganic hard mask is formed by a CVD method or an ALD method.

[Claim 13] The patterning process according to any one of claims 8 to 11, wherein the circuit pattern is formed by a lithography using light having a wavelength of 10 nm or more and 300 nm or less, a direct writing with an electron beam, nanoimprinting, or a combination thereof.

[Claim 14] The patterning process according to any one of claims 8 to 11, wherein the circuit pattern is developed with an alkaline development or an organic solvent.

[Claim 15] The patterning process according to any one of claims 8 to 11, wherein the body to be processed is a semiconductor device substrate or the semiconductor device substrate coated with any of a metal film, a metal carbide film, a metal oxide film, a metal nitride film, a metal oxycarbide film, and a metal oxynitride film.

[Claim 16] The patterning process according to claim 15, wherein the metal constituting the body to be processed is silicon, titanium, tungsten, hafnium, zirconium, chromium, germanium, copper, silver, gold, aluminum, indium, gallium, arsenic, palladium, iron, tantalum, iridium, molybdenum, or an alloy thereof.

[Claim 17] A patterning process comprising:

forming a resist film on a substrate by using the composition for forming a film according to any one of claims 4 to 6;

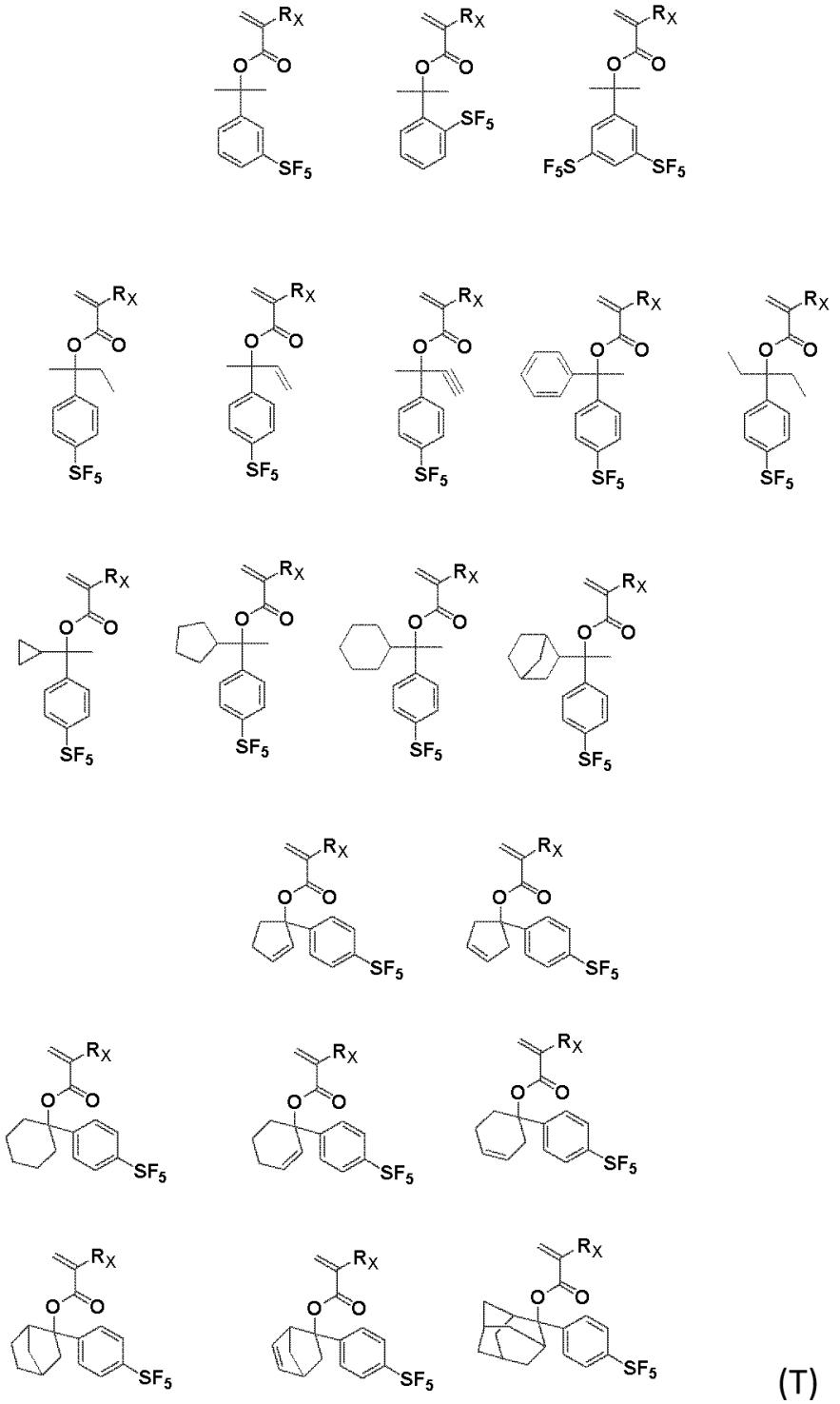
exposing the resist film to a high-energy beam; and

developing the exposed resist film by using

a developer.

[Claim 18] The patterning process according to claim 17, wherein the high-energy beam is a g-line, an i-line, a KrF excimer laser beam, an ArF excimer laser beam, an ultraviolet ray, an electron beam, or an extreme ultraviolet ray having a wavelength of 3 to 15 nm.

[Claim 19] A monomer represented by any of the following general formula (T),

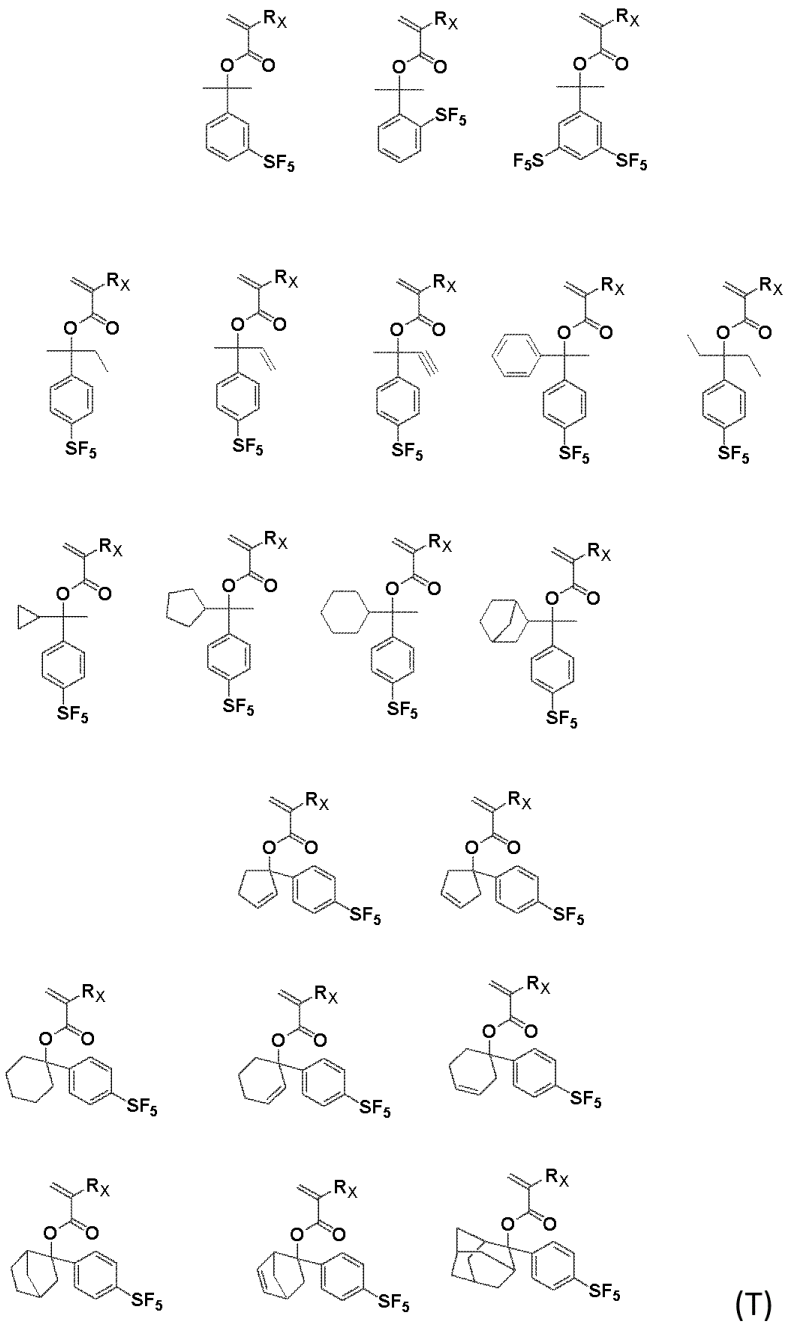


(T)

wherein R_X represents a hydrogen atom or a methyl group.

[Claim 20] A polymer having a repeating unit derived from a monomer represented by any of the following general formula (T) and having a polystyrene-equivalent

weight-average molecular weight in a range of 100 to 500,000 according to gel permeation chromatography (GPC) using THF as an eluent,



(T)

wherein R_X represents a hydrogen atom or a methyl group.