Patent Claims

1. A method for manufacturing a resist layer above a cured film comprising:

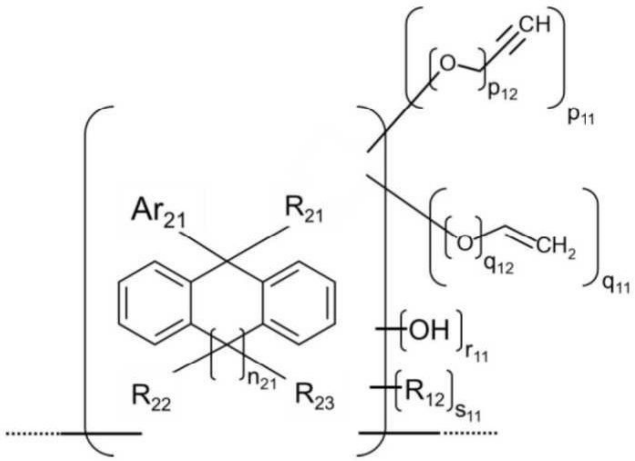
(1) applying a composition (i) above a substrate;

(2) forming a hydrocarbon-containing film from the composition (i); and

(3) irradiating the hydrocarbon-containing film with plasma, electron beam and/or ion to form a cured film,

provided that the composition (i) comprises a hydrocarbon-containing compound (A) and a solvent (B); and

the hydrocarbon-containing compound (A) comprises a structural unit (A1-1) represented by the following formula (A1-1):



formula (A1-1)

wherein,

Ar_{21} is a C_{6-50} aromatic hydrocarbon group;

R_{21} is a C_{6-50} aromatic hydrocarbon group, hydrogen, or a single bond bonded to another structural unit;

n_{21} is 0;

wherein R_{22} and R_{23} are not present;

wherein a single bond connects the two phenyl rings;

R_{12} is I, Br or CN; p_{11} is a number of 0 to 5, p_{12} is a number of 0 to 1, q_{11} is 0, r_{11} is a number of 0 to 5, s_{11} is a number of 0 to 5; and

p_{11}, q_{11} and r_{11} do not become 0 simultaneously in one structural unit;

where, the intensity ratio of G band and D band $R = I_D/I_G$ in Raman spectroscopy (measured with laser wavelength of 514.5 nm) of the cured film formed in the process (3) is 0.35 to 0.90;

wherein the hydrocarbon-containing compound (A) is polymer comprising an aldehyde derivative when the polymer is synthesized from 0 to 30 mol% based on the sum of all components used in the synthesis;

wherein the process (3) comprises the following conditions:

in the case of plasma irradiation:

the atmosphere is N_2, NF_3, H_2, fluorocarbon, rare gas, or a mixture of any of these; and/or

the RF discharge power is 1,000 to 10,000 W,

in the case of electron beam irradiation:

the acceleration voltage is 2 to 200 kV, and/or

the irradiation amount is 100 to 5,000 kGy,

in the case of ion irradiation:

the elemental species of the ion to be irradiated is hydrogen, boron, carbon, nitrogen, rare gas, or a mixture of any of these;

the acceleration voltage is 3 to 1000 kV; and/or

the irradiation amount is 10^{13} to 10^{18} ion/cm^2.

2. The method for manufacturing a resist layer according to claim 1, wherein the molecular weight of the hydrocarbon-containing compound (A) is 500 to 6,000.

3. The method for manufacturing a resist layer according to claim 1, wherein the composition (i) further comprises a surfactant (C) or an additive (D); where, the additive (D) comprises a crosslinking agent, a high carbon material, an acid generator, a radical generator, a photopolymerization initiator, a substrate adhesion enhancer, or a mixture of any of these.

4. The method for manufacturing a resist layer according to claim 1, wherein the solvent (B) comprises an organic solvent;

where, the organic solvent comprises a hydrocarbon solvent, an ether solvent, an ester solvent, an alcohol solvent, a ketone solvent, or a mixture of any of these.

5. The method for manufacturing a resist layer according to claim 1,
wherein, the content of the hydrocarbon-containing compound (A) is 2 to 30 mass% based on the composition (i);
the content of the solvent (B) is 60 to 98 mass% based on the composition (i);
the content of the surfactant (C) is 0.01 to 10 mass% based on the hydrocarbon-containing compound (A); or
the content of the additive (D) is 0.05 to 100 mass% based on the hydrocarbon-containing compound (A).

6. The method for manufacturing a resist layer according to claim 1, wherein the polymer essentially does not contain secondary or tertiary carbon atoms in its main chain.

7. The method for manufacturing a resist layer according to claim 1, wherein in the cured film formed in the process (3), the film density is increased by 5 to 75% or the film hardness is increased by 50 to 500%, as compared with the hydrocarbon-containing film formed in the process (2).

8. The method for manufacturing a resist layer according to claim 1, wherein
the hydrocarbon-containing film formed in the process (2) is more easily etched by 5 to 200% than the cured film formed in the process (3); or
the surface resistivity of the cured film formed in the process (3) is 10^{9} to 10^{16} Ω.

9. The method for manufacturing a resist layer according to claim 1, wherein the heating conditions in process (2) are 80 to 800°C and for 30 to 180 seconds.

10. The method for manufacturing a resist layer according to claim 1,
wherein
the cured film has the film density of 1.3 to 3.2 g/cm^{3}; or
the cured film has the film hardness of 1.5 to 20 GPa.

11. A method for manufacturing a resist pattern by exposing and developing the resist layer according to claim 1.

12. A method for manufacturing a device comprising the method according to claim 1.

13. A method for manufacturing a resist layer according to claim 1,
wherein a cured film has a diamond-like carbon structure.