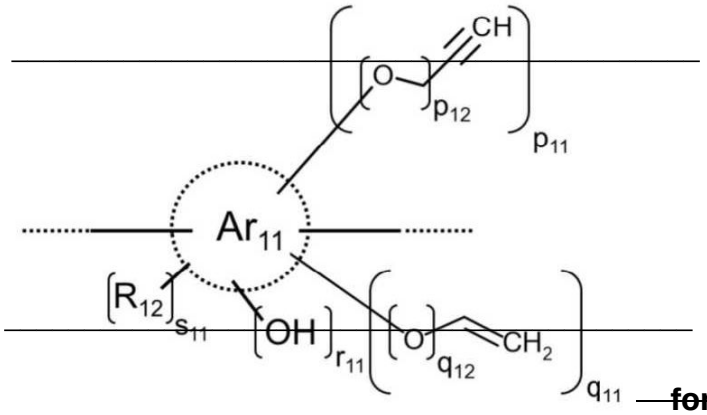
Patent Claims Claims

1. A method for manufacturing a cured film comprising the following processes:
(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) represented by the following formula (A1):

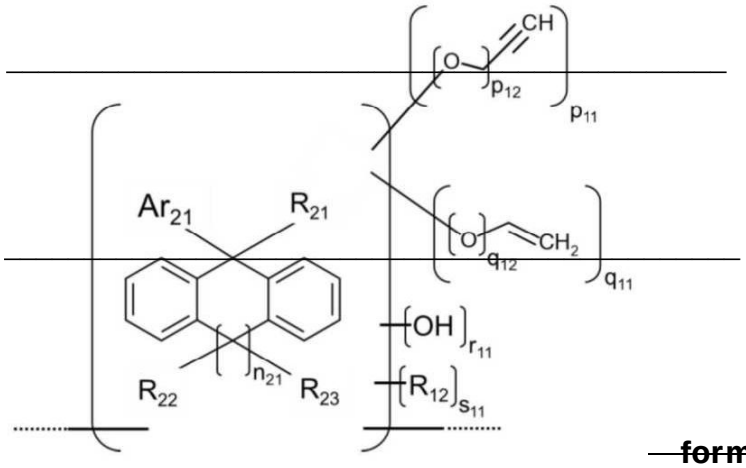


formula (A1)

wherein,
Ar_{11} is a C_{6-60} hydrocarbon group substituted with R_{11} or unsubstituted (provided that Ar_{11} contains no fused aromatic ring);
R_{11} is a linear, branched or cyclic C_{1-20} alkyl, amino or alkylamino;
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 a number of 0 to 5, q_{12} is a number of 0 to 1, 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.

2. The method for manufacturing a cured film according to

~~claim 1, wherein the formula (A1) is the following formulae (A1-1), (A1-2), and/or (A1-3):~~



~~formula (A1-1)~~

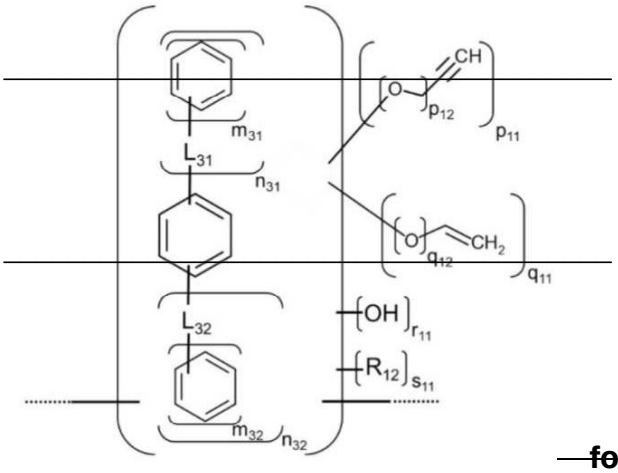
~~wherein,~~

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

~~R_{21}, R_{22} and R_{23} are each independently a C_{6-50} aromatic hydrocarbon group, hydrogen, or a single bond bonded to another structural unit;~~

~~n_{21} is an integer of 0 or 1;~~

~~where, Ar_{21}, R_{21}, R_{22} and R_{23} contain no fused aromatic ring; and the definitions of R_{12}, p_{11}, p_{12}, q_{11}, q_{12}, r_{11} and s_{11} are each independently the same as the above,~~



~~formula (A1-2)~~

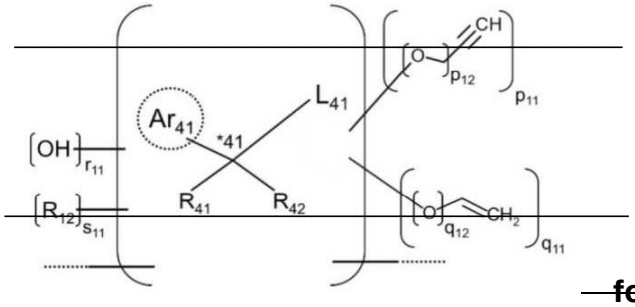
~~wherein,~~

~~L_{31} and L_{32} are each independently a single bond or phenylene;~~

~~n_{31}, n_{32}, m_{31} and m_{32} are each independently a number of 0 to 6;~~

~~and~~

~~where, the definitions of R_{12}, p_{11}, p_{12}, q_{11}, q_{12}, r_{11} and s_{11} are each independently the same as the above,~~



~~formula (A1-3)~~

~~wherein,~~

~~Ar_{41} is a C_{6-50} aromatic hydrocarbon group;~~

~~R_{41} and R_{42} are each independently a C_{1-10} alkyl, and R_{41} and R_{42} can form a hydrocarbon ring;~~

~~the carbon atom at the position of *41 is a quaternary carbon atom;~~

~~L_{41} is a C_{6-50} arylene or a single bond bonded to another structural unit;~~

~~where, the definitions of R_{12}, p_{11}, p_{12}, q_{11}, q_{12}, r_{11} and s_{11} are each independently the same as the above; and~~

~~preferably, the molecular weight of the hydrocarbon-containing compound (A) is 500 to 6,000.~~

~~3. The method for manufacturing a cured film according to claim 1 or 2, wherein the composition (i) further comprises a surfactant (C);~~

~~preferably, the composition (i) further comprises an additive (D); and/or~~

~~preferably, 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 cured film according to one or more of claims 1 to 3, wherein the solvent (B) comprises an~~

organic solvent; and
preferably, 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 cured film according to one or more of claims 1 to 4, 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);
preferably, the content of the surfactant (C) is 0.01 to 10 mass% based on the hydrocarbon-containing compound (A); and/or
preferably, 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 cured film according to one or more of claims 1 to 5, wherein
the hydrocarbon-containing compound (A) is polymer, and an aldehyde derivative used when the polymer is synthesized is 0 to 30 mol% based on the sum of all elements used in the synthesis; and
preferably, the polymer essentially does not contain secondary or tertiary carbon atoms in its main chain.

7. The method for manufacturing a cured film according to one or more of claims 1 to 6, 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.~~

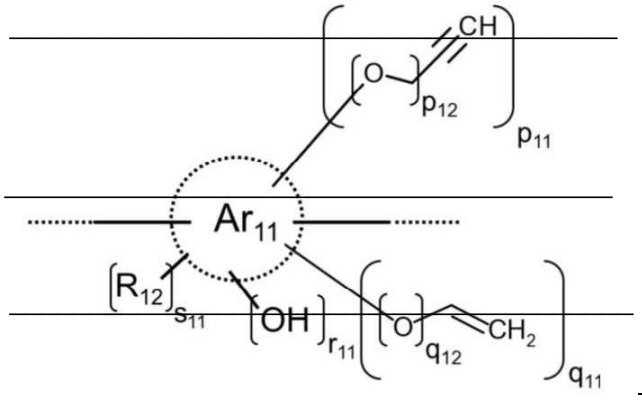
~~8. The method for manufacturing a cured film according to one or more of claims 1 to 7, wherein~~
~~in the cured film formed in the process (3), the film density is increased by 5 to 75% and/or the film hardness is increased by 50 to 500%, as compared with the hydrocarbon-containing film formed in the process (2);~~
~~preferably, 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;~~
~~preferably, 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); and/or~~
~~preferably, the surface resistivity of the cured film formed in the process (3) is 10^9 to 10^{16} Ω□ (more preferably 10^{12} to 10^{16} Ω□, and further preferably 10^{13} to 10^{16} Ω□).~~

~~9. The method for manufacturing a cured film according to one or more of claims 1 to 8, wherein the process (2) for forming a hydrocarbon-containing film from the composition (i) comprises at least either of the following conditions:~~
~~heating at 80 to 800°C for 30 to 180 seconds; and~~
~~irradiating ultraviolet light of 10 to 380 nm.~~

~~10. A carbon-containing cured film, wherein~~
~~the film density is 1.3 to 3.2 g/cm^3;~~
~~the film hardness is 1.5 to 20 GPa; and/or~~
~~intensity ratio of G band and D band $R = I_D/I_G$ in Raman spectroscopy (measured with laser wavelength of 514.5 nm) is 0.35 to 0.90.~~

~~11. The carbon-containing cured film according to claim 10,~~

~~wherein the carbon-containing cured film is formed by irradiating plasma, electron beam and/or ion;~~
~~preferably, the surface resistivity of the carbon-containing cured film is 10^9 to 10^{16} Ω□;~~
~~preferably, the carbon-containing cured film is formed by irradiating the hydrocarbon-containing film with plasma; and/or~~
~~preferably, the hydrocarbon-containing film is formed from the composition (i) comprising a hydrocarbon-containing compound (A) and a solvent (B);~~
~~the hydrocarbon-containing compound (A) comprises a structural unit (A1) represented by the following formula (A1):~~



~~formula (A1)~~

~~wherein,~~
~~Ar_{11} is a C_{6-60} hydrocarbon group substituted with R_{11} or unsubstituted (provided that Ar_{11} contains no fused aromatic ring);~~
~~R_{11} is a linear, branched or cyclic C_{1-20} alkyl, amino or alkylamino;~~
~~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 a number of 0 to 5, q_{12} is a number of 0 to 1, 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.~~

~~12. A method for manufacturing a resist layer above the cured film according to one or more of claims 1 to 11.~~

~~**13. A method for manufacturing a resist pattern by exposing and developing the resist layer according to claim 12.**~~

~~**14. A method for manufacturing a device comprising the method according to one or more of claims 1 to 9, 12 and 13.**~~

1. An invention not claimed in any divisional application.