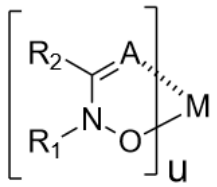
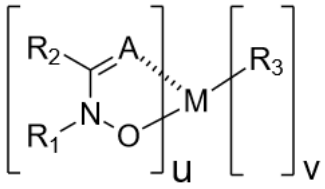
Claims:

1. An organometallic compound represented by Formula (I) or Formula (II),



(I)



(II)

wherein

M stands for a metal, in particular a transition metal, a non-metal or a metalloid of groups 1 to 15;

R_1 stands for hydrogen or an optionally substituted hydrocarbyl residue;

R_2 stands for hydrogen, a hydrocarbyl residue of a saturated or unsaturated, linear, branched or cyclic hydrocarbon, optionally substituted with one or more, reactive or non-reactive groups optionally containing hetero atoms, or R_2 is selected from amine, cyano, isocyanurate, nitrile, epoxy, glycidyl, mercapto, vinyl, allyl, acetyl, an alkenyl group with 2 to 10 carbon atoms, said alkenyl being optionally substituted with one or more alkyl groups having 1 to 10 carbon atoms; silyl, carboxy, carboxylate, acrylate, alkacrylate, wherein the alkyl residue has 1 to 10 carbon atoms, and halogen;

R_3 stands for an alkenyl group with 2 to 10 carbon atoms, said alkenyl being optionally substituted with one or more alkyl groups having 1 to 10 carbon atoms; an acrylate, methacrylate, carbamate, thiacarbamate, acetate, or an alkali metal salt of an acrylate, methacrylate, carbamate, thiacarbamate or acetate, or

R_3 represents a residue corresponding to the structure placed within the left-hand side brackets of Formula (I), whereby R_1 stands for hydrogen or an optionally substituted hydrocarbyl residue and R_2 stands for hydrogen, a hydrocarbyl residue of a saturated or unsaturated, linear, branched or cyclic hydrocarbon, optionally substituted with one or more, reactive or non-reactive groups optionally containing heteroatoms, or R_1 stands for hydrogen or an optionally substituted hydrocarbyl residue and R_2 is selected from amine, cyano, isocyanurate, nitrile, epoxy, glycidyl, mercapto, vinyl, allyl, acetyl, an alkenyl group with 2 to 10 carbon atoms, said alkenyl being optionally substituted with one or more alkyl

groups having 1 to 10 carbon atoms; silyl, carboxy, carboxylate, acrylate, alkacrylate, wherein the alkyl residue has 1 to 10 carbon atoms, and halogen, at least one of said substituents R_1 and R_2 in the meaning of R_3 being different from the corresponding substituents of the structure placed within the left-hand side brackets of Formula (I);
A stands for a heteroatom; and
u and v are independently selected from integers having a value in the range from 1 to 10.

2. A method of producing a metal-hydroxamate derivative according to any of the preceding claims, comprising the steps of

- reacting a carboxylic acid or esters of having Formula (IVa)

$$R_2COOR_4 \quad (IVa)$$

in which R_2 has the same meaning as in Formula (I), or an activated form thereof, with an amine having Formula (V), R_4 hydrogen or for a linear, branched or cyclic or heterocyclic alkyl group having 1 to 10 carbon atoms, optionally having 1 to 3 aryl substituents,

$$R_5ONR_6 \quad (V)$$

or a salt thereof,
wherein R_5 stands for hydrogen or for a linear, branched or cyclic or heterocyclic alkyl group having 1 to 10 carbon atoms, optionally having 1 to 3 aryl substituents, or R_5 stands for silyl group of formula $-SiR_7R_8R_9$, in which R_7, R_8 and R_9 are independently selected from linear or branched alkyl groups having 1 to 10 carbon atoms; and R_6 stands for hydrogen or a linear, branched or cyclic alkyl group having 1 to 10 carbon atoms or an aryl group having 6 to 18 carbon atoms,

to produce a hydroxyamic acid salt having Formula (VI),

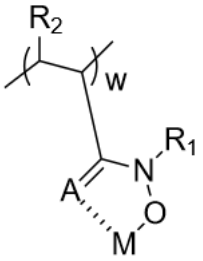
$$R_2CONHOX \quad (VI)$$

wherein R_2 has the same meaning as above,
and X is cation of alkali or alkaline earth metals or organic tetra-alkyl ammonium or phosphonium or sulfonium hydrocarbon.

- reacting the hydroxyamic acid salt of Formula (VI) with compound of group 1 to 15 of a metal or a metalloid or a non-metal to form a metal-hydroxamate derivative according to Formula (I).

3. A polymer comprising units of a compound according to claim 1.

4. The polymer according to claim 3, comprising a copolymer having Formula (III)



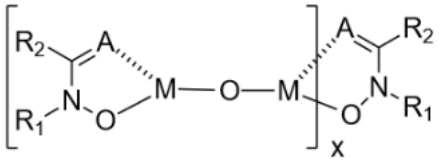
(III)

wherein

R_1, R_2, A and M have the same meaning as above in Formulas (I) and II; and

w is an integer having a value in the range from 100 to 100,000.

5. A polymer comprising units of a compound according to claim 1 afforded metal oxide metal polymer comprising two or more condensed units of a Formula (VII),



(VII)

wherein

R_1, R_2, A, and M have the same meaning as above in Formula (I), and

x stands for an integer having a value in the range from 1 to 100.

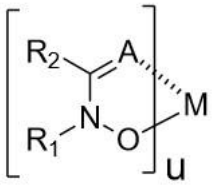
6. A composition comprising a compound according to claim 1 or a polymer according to claim 3, or both, in a liquid phase formed by at least one organic solvent for the polymer or the compound, optionally in mixture with water and in the presence of organic/inorganic acid or base.

7. A coating or film obtained by casting or coating of the composition according to claim 6 to a surface of a substrate, which composition is formulated for use in a method of a coating a substrate by casting.

8. A coating or film according to claim 7, comprising or consisting of a polymer of formula (III or IV) or an organo-metallic complex of formula (I or II) according to any of the preceding claims.

9. A resist underlayer film, obtained by applying a resist underlayer film composition according to claim 6 onto a semiconductor substrate, and baking the composition.

10. The resist underlayer film according to claim 9, wherein the composition contains a metal-hydroxamate derivative according to Formula (I)



(I)

wherein

M stands for zinc, tin, gallium, or antimony;

R_1 stands for hydrogen or a linear or branched alkyl having 1 to 6 carbon atoms;

R_2 stands for acrylate, methacrylate, amine, cyano, isocyanurate, nitrile, epoxy, glycidyl, mercapto, vinyl, allyl, acyl, an alkenyl group with 2 to 10 carbon atoms, said alkenyl being optionally substituted with one or more alkyl groups having 1 to 10 carbon atoms; acetyl, silyl, carboxy, carboxylate, acrylate, alkacrylate or halogen, said alkyl group having 1 to 6 carbon atoms;

A stands for oxygen; and

u is 2 or 3.

11. A method for producing a semiconductor device, the method comprising:

- applying a film forming composition as claimed in claim 6 onto a semiconductor substrate and baking the composition to form a resist underlayer film;
- applying a composition for a resist onto the resist underlayer film to form a resist film;
- exposing the resist film to light at a wavelength selected from the group of 13.5 nm, 193 nm, 248 nm and 365 nm or to electron beam radiation;
- developing the resist film after the exposing to obtain a patterned resist film;
- etching the resist underlayer film according to a pattern of the patterned resist film; and
- processing the semiconductor substrate according to a pattern of the resist film and the resist underlayer film.

12. A method for producing a semiconductor device, the method comprising:

- forming an organic underlayer film on a surface of a semiconductor substrate;
- applying the resist underlayer film forming composition according to claim 6 onto the organic underlayer film and baking the composition to form a resist underlayer film;
- applying a composition for a resist onto the resist underlayer film to form a resist film;
- exposing the resist film to light at a wavelength selected from 13.5 nm, 193 nm, 248 nm and 365 nm or to electron beam radiation;
- developing the resist film after the exposing to obtain a patterned resist film;
- etching the resist underlayer film according to a pattern of the patterned resist film;
- etching the organic underlayer film according to a pattern of the pattered resist underlayer film; and
- processing the semiconductor substrate according to a pattern of the patterned organic underlayer film.

13. A method for producing an optical or semiconductor device, the method comprising:

- applying a spin on carbon (SOC) with various thermal stabilities, e.g. High temperature (350–400 °C) SOC, or α-carbon layer obtained by CVD.on a surface of a substrate;
- applying a composition of high silicon content layer or silicon oxynitride or various metal oxide layer;
- applying a functional coating layer comprising a metal-organic complex according to claim 1 or a polymer or copolymer thereof poly-metal-hydroxamate according to any one of claims 3 to 6;
- applying a composition for a resist onto the resist underlayer functional layer to obtain a resist film;
- exposing the resist film to light at a wavelength selected from 13.5 nm, 193 nm, 248 nm and 365 nm, or to electron beam radiation;
- developing the resist film after the exposing to obtain a patterned resist film to achieve a 35–20 % decrease in dose compared to that achieved without functional layer;
- etching the resist underlayer film according to a pattern of the patterned resist film; and
- processing the substrate according to a pattern of the resist film and the resist underlayer film.

14. Use of a compound according to claim 1 or a polymer according to claim 3 as an additive, in particular to tune the polymer film thickness, index of refraction (n), molar absorptivity (k), etch properties, and contact angle (CA) of a desired composition.

15. A method for producing an optical element or an optically active device:

- applying the resist underlayer film forming composition according to claim 6 onto a surface of a substrate and baking the composition to form a resist underlayer film;
- exposing the resist film to light at a wavelength selected from 13.5 nm, 193 nm, 248 nm and 365 nm or to electron beam radiation;
- developing the resist film after the exposing to obtain a patterned resist film;
- etching the resist underlayer film according to a pattern of the patterned resist film; and
- processing the substrate according to a pattern of the resist film and the resist underlayer film.

16. A method according to claim 15, wherein the substrate is TiO_2, Si, GaAs or other substrate used in a diffractive or meta-optical element.

17. A method for patterning a semiconductor substrate, comprising:

- forming an organic underlayer film on a surface of a semiconductor substrate;
- forming an inorganic oxide containing middle layer on the organic underlayer;
- applying the resist underlayer film forming composition according to any of claims preceding claims onto the inorganic oxide containing middle layer film and baking the composition to form a resist underlayer film;
- applying a composition for a resist onto the resist underlayer film to form a resist film;
- exposing the resist film to light at a wavelength selected from 13.5 nm, 193 nm, 248 nm and 365 nm or to electron beam radiation:
- developing the resist film after the exposing to obtain a patterned resist film;
- etching the resist underlayer film according to a pattern of the patterned resist film;
- etching the inorganic oxide containing middle layer film according to a pattern of the patterned resist film;
- etching the organic underlayer film according to a pattern of the pattered resist underlayer film; and

- processing the semiconductor substrate according to a pattern of the patterned organic underlayer film.