What is claimed is:

1. A patterned liquid crystal monolayer structure (100) on a patterned substrate (900), comprising:

the patterned substrate (900) comprising a first surface area (500) having a liquid crystal compound (300) adsorbed thereon as a self-assembled monolayer (SAM) (200) and a second surface area (400) free of the liquid crystal compound (300);

wherein said liquid crystal compound (300) consists of a cylindrical linear organic liquid crystal core structure comprising a 1,4-phenylene moiety (700) to which is attached at one end a linear alkyl group comprising at least two carbons, preferably a linear C2 to C5 alkyl group (600) and at the other end a polar anchor group (800) selected from the group consisting of a phosphonate ester comprising moiety, a phosphonic acid comprising moiety, a thiol comprising moiety, an amino comprising moiety, an alkylenehydroxy comprising moiety, and an alkyl-polyol comprising moiety;

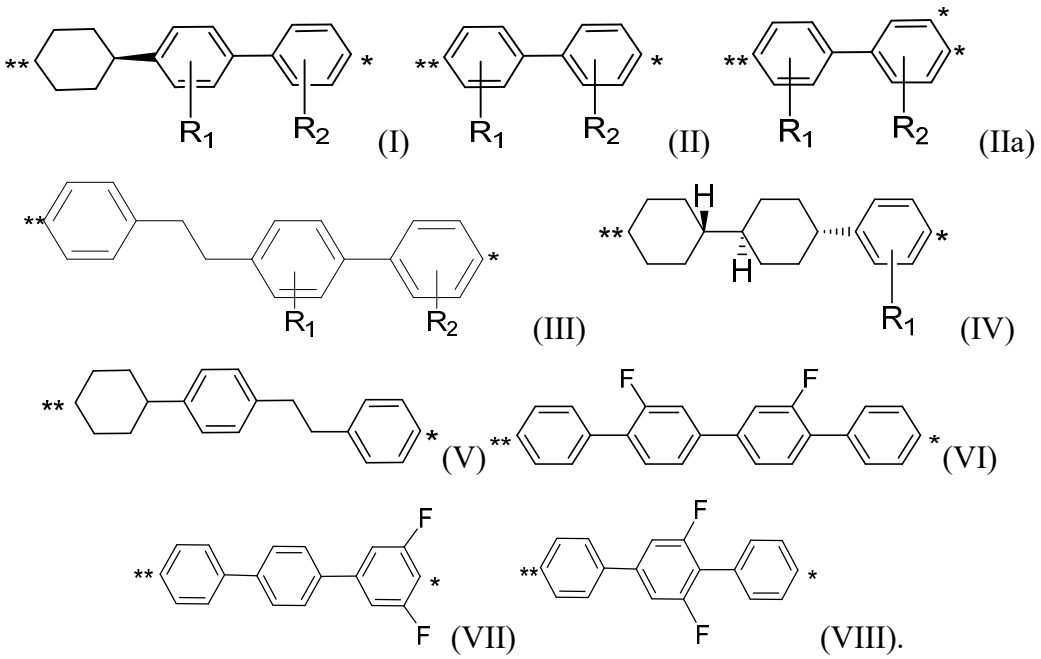
wherein in said self-assembled monolayer (200), said liquid crystal compound (300) is arranged in the self-assembled monolayer (200) so that the liquid crystal compounds in said self-assembled monolayer (200) are parallel to each other and pointing in the same direction, perpendicular to said patterned substrate (900) and attached to surface area (500) only through said polar anchor group (800); and

wherein either,

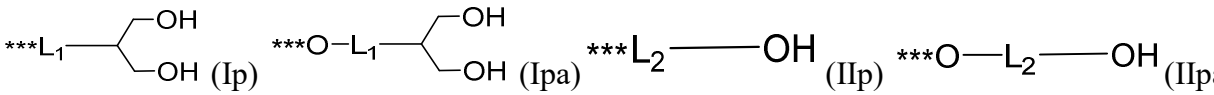
when said polar anchor group (800) is an alkyl-polyol coordination moiety or an alkylenehydroxy comprising moiety, said surface area (500) to which said self-assembled monolayer (200) is attached, is a non-metallic inorganic silicon compound-based surface area and said surface area (400) free of the liquid crystal compound (300) is a metallic surface area or,

when said polar anchor group is selected from the group consisting of a phosphonate ester comprising moiety, a phosphonic acid comprising moiety, a thiol comprising moiety, and an amino comprising moiety, said surface area (500) to which said self-assembled monolayer (200) is attached, is a metallic surface area and said surface area (400) free of the liquid crystal compound (300) is a non-metallic inorganic silicon compound-based surface area.

2. The patterned monolayer structure on a substrate of claim 1, wherein said cylindrical linear organic liquid crystal core structure comprising at least two 1,4-phenylene moieties (700) is selected from the group consisting of structures (I), (II), (IIa), (III), (IV), (V), (VI), (VII), and (VIII), wherein ** is the attachment point of said linear alkyl group (600) and * is the attachment point of said polar anchor group (800), R_1, and R_2 are individually selected from H, a C-1 to C-2 alkyl and F,

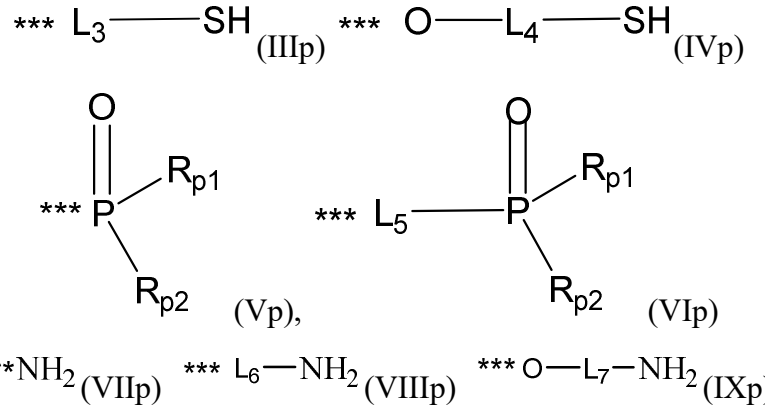


3. The patterned monolayer structure on a substrate of claims 1 or 2, wherein said polar anchor group (800) is selected from the group consisting of structure (Ip), structure (Ipa), structure (IIp), and structure (IIpa), wherein L_1, and L_2 are individually selected from a C-2 to C-4 linear alkylene spacer, and *** is the attachment point of said polar anchor group to said liquid crystal compound,



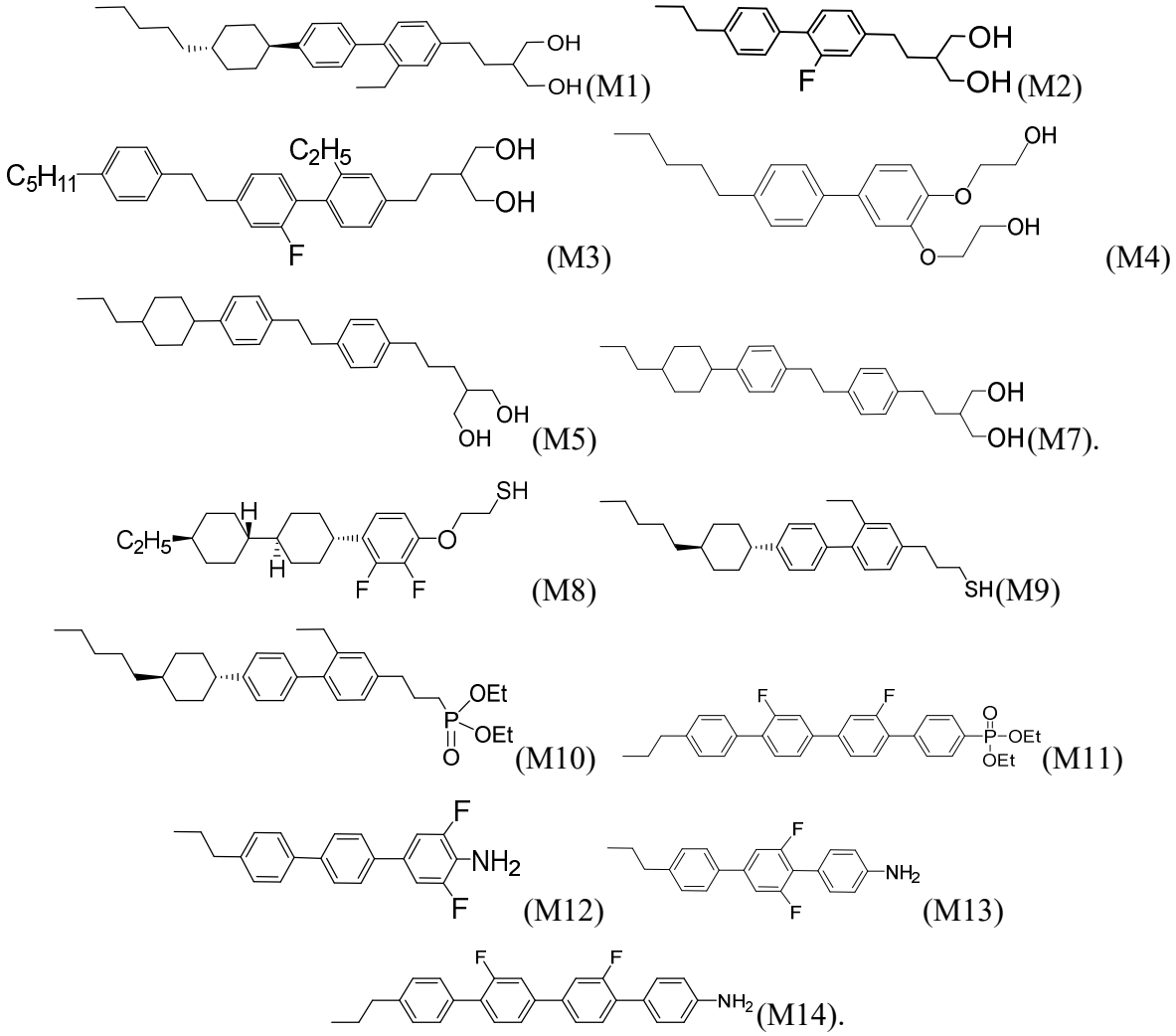
or

wherein said polar anchor group (800) is selected from the group consisting of structure (IIIp), structure (IVp), structure (Vp), structure (VIp), structure (VIIp), structure (VIIIp) and structure (IXp) wherein L_3, L_4, L_5, L_6, and L_7 are individually selected from a C-2 to C-4 linear alkylene spacer, *** is the attachment point of said polar anchor group (800) to said liquid crystal compound (300), R_{p1} is a C-1 to C-4 alkoxy, and R_{p2} is a C-1 to C-4 alkyl or a C-1 to C-4 alkoxy,



(IIIp) (IVp) (Vp), (VIp) (VIIp) (VIIIp) (IXp).

4. The patterned monolayer structure on a substrate according to any one or more of claims 1 to 3, wherein said liquid crystal compound (300) is one selected from group consisting of one having structures (M1), (M2), (M3), (M4), (M5), (M7), (M8), (M9), (M10), (M11), (M12), (M13) and (M14)



(M1) (M2) (M3) (M4) (M5) (M7). (M8) (M9) (M10) (M11) (M12) (M13) (M14).

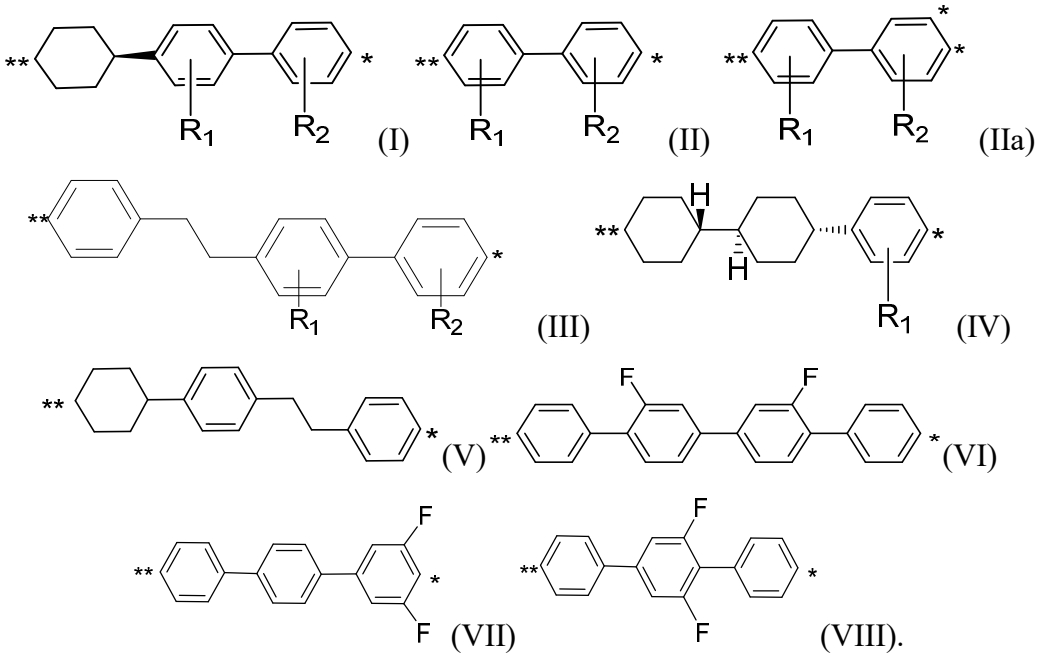
5. The patterned monolayer structure on a substrate according to any one or more of claims 1 to 4, wherein said surface area (500) overlaid with a SAM is a non-metallic inorganic silicon

compound-based surface area selected from the group consisting of silicon oxide (SiO_2), silicon with a native oxide, silicon nitride (SiN) and silicon oxynitride (SiON) and said surface area (400) which is bare, is a metal which is selected from the group consisting of tungsten, gold, silver, copper, cobalt, ruthenium, zirconium, titanium, and hafnium, or

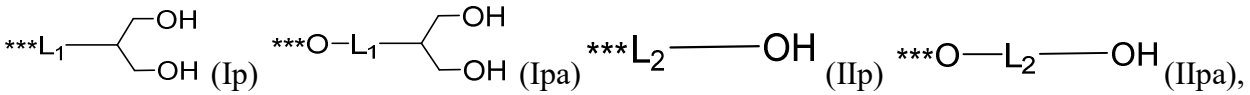
wherein said surface area (500) overlaid with a SAM is a metal selected from the group consisting of tungsten, gold, silver, copper, cobalt, ruthenium, zirconium, titanium, and hafnium and said surface area (400) which is bare, is a non-metallic inorganic silicon compound-based surface area which is selected from the group the group consisting of silicon oxide (SiO_2), silicon with a native oxide, silicon nitride (SiN) and silicon oxynitride (SiON).

6. A composition comprising a liquid crystal compound (300) and an organic spin casting solvent, wherein said liquid crystal compound consists of a cylindrical linear organic liquid crystal core structure comprising a 1,4-phenylene moiety (700) to which is attached at one end a linear alkyl group with at least two carbons, preferably a linear C2 to C5 alkyl group (600) and at the other end a polar anchor group (800).

7. The composition of claim 6, wherein said cylindrical linear organic liquid crystal core structure comprising at least two 1,4-phenylene moieties (700) is selected from the group consisting of structures (I), (II), (IIa), (III), (IV), (V), (VI), (VII), and (VIII), wherein ** is the attachment point of said linear alkyl group (600) and * is the attachment point of said polar anchor group (800), R_1, and R_2 are individually selected from H, a C-1 to C-2 alkyl and F,



8. The composition of any one of claims 6 to 10, wherein said polar anchor group (800) is selected from the group consisting of structure (Ip), structure (Ipa), structure (IIp), and structure (IIpa), wherein L_1 and L_2 are individually selected from a C-2 to C-4 linear alkylene spacer, *** is the attachment point of said polar anchor group (800) to said liquid crystal compound (300),



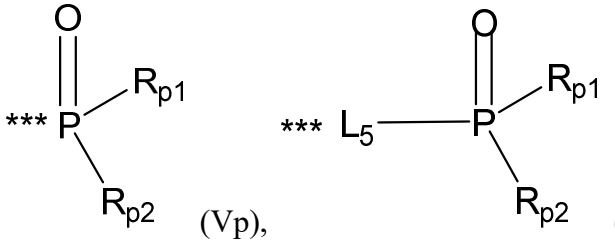
(Ip) (Ipa) (IIp) (IIpa),

or

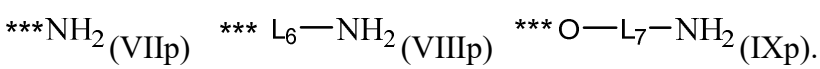
wherein said polar anchor group (800) is selected from the group consisting of structure (IIIp), structure (IVp), structure (Vp), structure (VIp), structure (VIIp), structure (VIIIp) and structure (IXp) wherein L_3, L_4, L_5, L_6, and L_7 are individually selected from a C-2 to C-4 linear alkylene spacer, *** is the attachment point of said polar anchor group (800) to said liquid crystal compound (300), R_{p1} is a C-1 to C-4 alkoxy, and R_{p2} is a C-1 to C-4 alkyl or a C-1 to C-4 alkoxy,



(IIIp) (IVp)

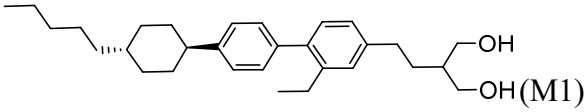


(Vp), (VIp)

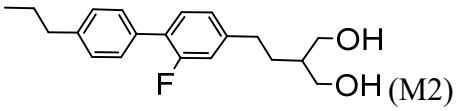


(VIIp) (VIIIp) (IXp).

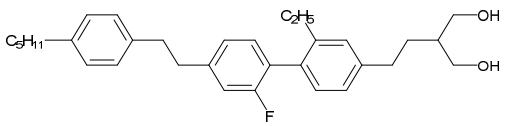
9. The composition of any one of claims 6 to 8, wherein said liquid crystal compound (300) is selected from the group consisting of one having structures (M1), (M2), (M3), (M4), (M5), (M7), (M8), (M96), (M10),0), (M11), (M12), (M13) and (M14),



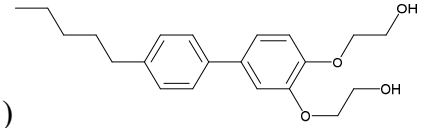
(M1)



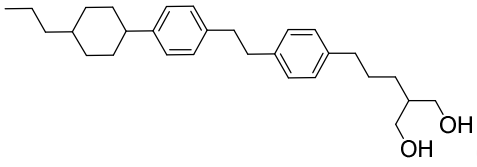
(M2)



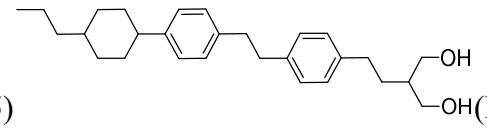
(M3)



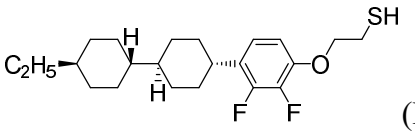
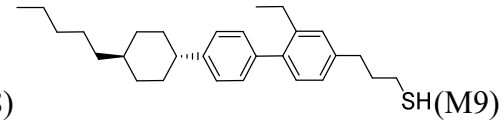
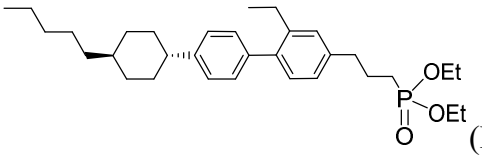
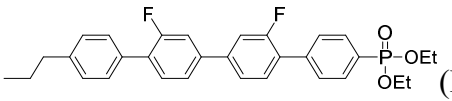
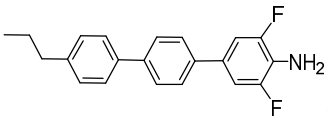
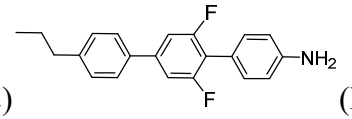
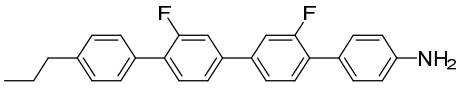
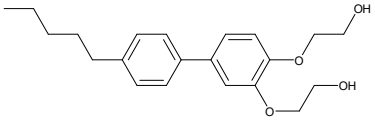
(M4)



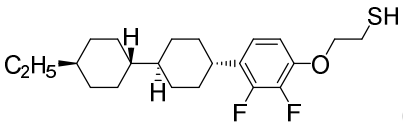
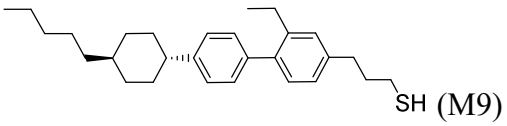
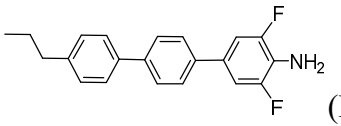
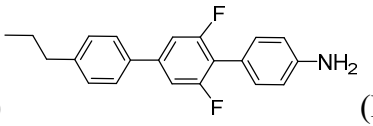
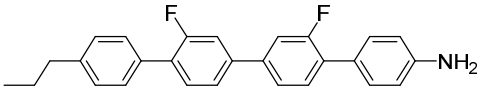
(M5)



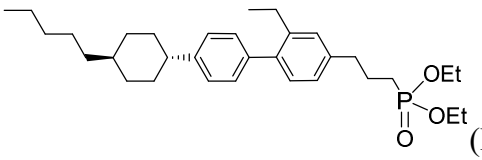
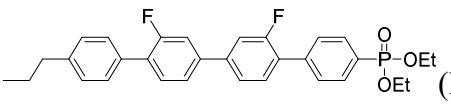
(M7).


(M8)

(M9)

(M10)

(M11)

(M12)

(M13)

(M14), where structure (M4) is preferred

(M4).

10. The composition of any one of claims 6 to 9, wherein said liquid crystal compound (300) is one selected from the group consisting of one having structures (M8), (M9), (M12), (M13) and (M14),


(M8)

(M9)

(M12)

(M13)

(M14).

or wherein said liquid crystal compound (300) is one selected from the group consisting of one having structures (M10), and (M11),


(M10)

(M11).

11. The composition of any one of claims 6 to 10, wherein said organic spin coating solvent is a single organic solvent or a mixture of at least two organic solvents selected from the group consisting of a glycol ether derivative selected from ethyl cellosolve, methyl cellosolve, propylene

glycol monomethyl ether (PGME), diethylene glycol monomethyl ether, diethylene glycol monoethyl ether, dipropylene glycol dimethyl ether, propylene glycol n-propyl ether, or diethylene glycol dimethyl ether; a glycol ether ester derivative such as ethyl cellosolve acetate, methyl cellosolve acetate, or propylene glycol monomethyl ether acetate (PGMEA),
a carboxylate of a mono-basic acid selected from ethyl acetate, n-butyl acetate and amyl acetate,
a carboxylate of di-basic acids selected from diethyloxylate and diethylmalonate,
a dicarboxylates of a glycol selected from ethylene glycol diacetate and propylene glycol diacetate,
a hydroxy carboxylate selected from methyl lactate, ethyl lactate (EL), ethyl glycolate, and ethyl-3-hydroxy propionate,
a ketone ester selected from methyl pyruvate and ethyl pyruvate,
an alkyloxycarboxylic acid ester selected from methyl 3-methoxypropionate, ethyl 3-ethoxypropionate, ethyl 2-hydroxy-2-methylpropionate, and methylethoxypropionate,
a ketone derivative selected from methyl ethyl ketone, acetyl acetone, cyclopentanone, cyclohexanone and 2-heptanone, diacetone alcohol methyl ether,
a ketone alcohol derivative selected from acetol and diacetone alcohol,
a ketal or acetal selected from 1,3 dioxalane and diethoxypropane, butyrolactone,
an amide selected from dimethylacetamide and dimethylformamide, and
anisole, where preferably, said organic spin coating solvent is a mixture of PGME and PGMEA, and where more preferably, said organic spin coating solvent is a mixture of 70 wt. % PGME and 30 wt. % PGMEA.

12. The composition of any one of claims 6 to 11, wherein said liquid crystal compound is present at a loading of about 0.5 wt. % to about 2.0 wt. %.

13. A process for forming a self-assembled monolayer (SAM) of a liquid crystal (LC) selectively on nonmetallic areas in a mixed substrate which comprises both metallic and nonmetallic areas, the process comprising the steps:
i) spin coating on a mixed substrate the composition of any one of claims 6 to 9, 11 and 12, where said polar anchor group (800) is an alkyl-polyol coordination moiety or an alkylenehydroxy comprising moiety, and where said nonmetallic areas are selected from silicon dioxide, silicon with native oxide, silicon nitride, and silicon oxynitride, and said metallic areas are selected from the group consisting of tungsten, gold, silver, copper, cobalt, ruthenium, zirconium, titanium, and hafnium,

ii) baking at a temperature ranging from about 150°C to about 180°C for about 2 min to about 10 min under an inert gas,

iii) rinsing with an organic spin coating solvent,

iv) air drying substrate,

v) repeat steps i) to iv) two times, to obtain self-assembled monolayer of liquid crystal on both the metallic and non-metallic areas,

vi) rinsing the substrate with a dilute aqueous solution of an acid to selectively remove the self-assembled monolayer of liquid crystal on the metallic areas,

vii) rinsing the substrate with water and air drying to obtain a substrate in where the non-metallic areas only have a SAM of a LC.

14. A process for selective atomic layer deposition on metallic areas of a mixed substrate comprising both metallic and non-metallic areas, the process comprising the steps:

ia) producing, in accordance with the process of claim 13, a mixed substrate in which non-metallic areas have a self-assembled monolayer of liquid crystal,

iia) using an atomic layer deposition technique, deposit a metal oxide more selectively on the metallic areas which do not have a self-assembled monolayer of liquid crystal, where preferably the,

atomic layer deposition technique is one employing deposition of about 10 to about 50 cycles of deposition, wherein each cycle employs a vapor treatment with $(MeCp)_2Hf(OMe)Me$ for about 1 to about 5 s followed by a treatment with N_2 for about 5 s to about 15 s, a treatment with H_2O for about 1 s to about 5 s, and a treatment with N_2 for about 5 s to about 15 s at a temperature of about 250°C to about 350°C.

15. A process for forming a self-assembled monolayer (SAM) of a liquid crystal (LC) selectively on metallic areas in a mixed substrate which comprises both metallic and nonmetallic areas, the process comprising the steps:

ib) spin coating on a mixed substrate the composition of any one of claims 6 to 12, where a polar anchor group (800) is selected from the group consisting of a phosphonate ester comprising moiety, a phosphonic acid comprising moiety, a thiol comprising moiety, and an amino comprising moiety, and wherein said nonmetallic areas are selected from silicon dioxide, silicon with native oxide, silicon nitride, and silicon oxynitride, and said metallic areas are selected from the group consisting of tungsten, gold, silver, copper, cobalt, ruthenium, zirconium, titanium, and hafnium,

iib) baking at a temperature ranging from about 150°C to about 180°C for about 2 min to about 10 min under an inert gas,

iiib) rinsing with an organic spin coating solvent,

ivb) air drying substrate,

vb) repeat steps ib) to ivb) two times,

vib) air drying substrate, to obtain a self-assembled monolayer of liquid crystal only on the metallic areas of said substrate.

16. A process for selective atomic layer deposition on non-metallic areas of a mixed substrate comprising both metallic and non-metallic areas, the process comprising the steps:

ic) producing, in accordance with the process of claim 15, a mixed substrate in which metallic areas have a self-assembled monolayer of liquid crystal,

iic) using an atomic layer deposition technique, deposit a metal oxide more selectively on the non-metallic areas which do not have a self-assembled monolayer of liquid crystal, where preferably the,

atomic layer technique is one employing deposition of about 10 to about 50 cycles of deposition, wherein each cycle employs a vapor treatment with $(MeCp)_2Hf(OMe)Me$ for about 1 to about 5 s followed by a treatment with N_2 for about 5 s to about 15 s, a treatment with H_2O for about 1 s to about 5 s, and a treatment with N_2 for about 5 s to about 15 s at a temperature of about 250°C to about 350°C.

17. The use of the composition according to any one of claims 6 to 12 or the liquid crystal compound (300) as defined in any one of claims 1 to 9 for selectively forming a self-assembled monolayer on either metallic or non-metallic areas of a mixed substrate which comprises both metallic and nonmetallic areas.