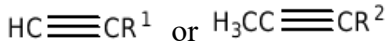
CLAIMS

We claim:

1. A method for forming an aluminum-containing dielectric film selectively on at least one surface of a substrate comprising:

(a) providing the substrate in a reactor, the substrate having a first surface comprising a metal and a second surface comprising a dielectric material, wherein the first surface and the second surface are coplanar;

(b) forming at least one passivated layer on the first surface by exposing the first surface and the second surface to a passivating composition comprising an alkyne having one of the following formulae:



IA IB;

wherein R^1 and R^2 are each selected from the group consisting of a linear or branched C_6 to C_{14} alkyl or a linear or branched C_6 to C_{14} arylalkyl;

(c) purging the reactor with inert gas;

(d) introducing an aluminum precursor into the reactor to react with the dielectric material to form an aluminum-containing layer;

(e) purging the reactor with inert gas;

(f) introducing a vapor comprising water into the reactor to react with the aluminum-containing layer to form an aluminum oxide layer;

(g) purging the reactor with inert gas; and

(h) repeating steps (d) through (g) to deposit a desired thickness of the aluminum-containing dielectric film on top of the dielectric material; and wherein step (b) is conducted at temperatures of between about 150 and about 350 degrees Celsius without plasma.

2. The method of claim 1, wherein the thickness of the aluminum-containing dielectric film can range from about 1 Å to about 100 Å.

3. The method of claim 1, wherein the aluminum precursor is selected from the group consisting of triethylaluminum, dimethylaluminum iso-propoxide, and diethylaluminum iso-propoxide.

4. The method of claim 1, wherein the alkyne of Formula IA is selected from the group consisting of 1-octyne, 1-nonyne, 1-decyne, 1-undecyne, 1-dodecyne, 1-tridecyne, 1-tetradecyne, ethynylbenzene, 3-phenyl-1-propyne, 4-phenyl-1-butyne, 5-phenyl-1-pentyne, and 6-phenyl-1-hexyne.

5. The method of claim 1, wherein the alkyne of Formula IB is selected from the group consisting of 2-octyne, 2-nonyne, 2-decyne, 2-undecyne, 2-dodecyne, 2-tridecyne, and 2-tetradecyne.

6. The method of claim 1, wherein the passivating composition comprises or consists essentially of 1-decyne, 1-dodecyne, or 5-phenyl-1-pentyne.

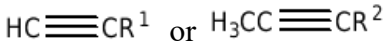
7. The method of claim 1, wherein a deposition selectivity of the second surface to the first surface is greater than about 0.3.

8. The method of claim 1, wherein a deposition selectivity of the second surface to the first surface is greater than about 0.6 and the thickness of the aluminum-containing dielectric film is about 50 Å or less.

9. A method for forming an aluminum doped silicon oxide dielectric film selectively on at least one surface of a substrate comprising:

(a) loading the substrate into a reactor, the substrate comprising a first surface comprising a metal and a second surface comprising a dielectric material, wherein the first surface and the second surface are coplanar;

(b) introducing an alkyne into the reactor to selectively form an organic layer on the metal surface, the alkyne having the following formula:



IA IB;

wherein R^1 and R^2 are each selected from the group consisting of a linear or branched C_6 to C_{14} alkyl or a linear or branched C_6 to C_{14} arylalkyl;

(c) purging the reactor with inert gas;

(d) introducing an aluminum precursor into the reactor to react with the dielectric material to form an aluminum-containing layer;

(e) purging the reactor with inert gas;

(f) introducing a vapor comprising an alkoxysilanol into the reactor to react with the aluminum-containing layer to form an aluminum silicon oxide layer and;

(g) purging the reactor with inert gas; and

(h) optionally repeating steps (d) to (g) to deposit a desired thickness of the aluminum doped silicon oxide dielectric film on top of the dielectric material; and wherein step (b) is conducted at temperatures of between about 150 and about 350 degrees Celsius without plasma.

10. The method of claim 9, wherein the aluminum doped silicon oxide dielectric film has a thickness ranging from about 1 Å to about 100 Å.

11. The method of claim 9, wherein the aluminum precursor is selected from the group consisting of triethylaluminum, dimethylaluminum iso-propoxide, and diethylaluminum iso-propoxide.

12. The method of claim 9, wherein the alkyne with Formula IA is selected from the group consisting of 1-octyne, 1-nonyne, 1-decyne, 1-undecyne, 1-dodecyne, 1-tridecyne, 1-tetradecyne, ethynylbenzene, 3-phenyl-1-propyne, 4-phenyl-1-butyne, 5-phenyl-1-pentyne, and 6-phenyl-1-hexyne.

13. The method of claim 9, wherein the alkyne with Formula IB can be selected from the group consisting of 2-octyne, 2-nonyne, 2-decyne, 2-undecyne, 2-dodecyne, 2-tridecyne, and 2-tetradecyne.

14. The method of claim 9, wherein the alkoxysilanol is selected from the group consisting of tris(tert-butoxy)silanol, tris(tert-pentoxy)silanol, bis(tert-butoxy)(tert-pentoxy)silanol, and bis(tert-pentoxy)(tert-butoxy)silanol.

15. The method of claim 9, wherein the dielectric material of the second surface is selected from the group consisting of silicon oxide, carbon doped silicon oxide, silicon oxynitride, carbon doped oxynitride, silicon nitride, zirconium oxide, hafnium oxide, silicon doped zirconium oxide, silicon doped hafnium oxide, and a combination thereof.

16. The method of claim 9, wherein the metal of the metal of the first surface is selected from selected from the group consisting of cobalt, aluminum, copper, tantalum, ruthenium, molybdenum, tungsten, platinum, iridium, nickel, titanium, silver, gold, or a combination thereof.

17. The method of claim 9, wherein a deposition selectivity of the second surface to the first surface is greater than about 0.6, and the thickness of the aluminum doped silicon oxide dielectric film is about 100 Å or less.

18. The method of claim 1 or claim 9, wherein steps (d) to (g) are conducted at a temperature of between about 150 and about 350 degrees Celsius.

19. The method of claim 1 or claim 9, wherein a preclean step is conducted prior to step (a), the preclean step comprising exposing the first surface to an acid, a reducing environment, heating, or a combination thereof.

20. The method of claim 19, wherein the preclean step comprises exposing the substrate to citric acid, followed by exposing the substrate to H_2 at a temperature ranging from about 250 to about 500 degrees Celsius.

21. The method of claim 19, wherein the substrate is subjected to a chemical mechanical planarization step, wherein the chemical mechanical planarization step is conducted prior to the preclean step in order to provide

coplanarity of the first surface and the second surface.

22. A method for passivating a metal-containing surface of a substrate comprising:

(a) providing the substrate in a reactor at temperatures ranging from 20°C to 400°C, the substrate having a first surface comprising a metal and a second surface comprising a dielectric material;

(b) forming at least one passivation layer on the first surface by exposing both the first surface and the second surfaces to a passivating composition comprising an alkyne having the following formula:



wherein R^1 a linear or branched C_6 to C_{14} arylalkyl; and

(c) purging the reactor with inert gas; and wherein step (b) is conducted at temperatures of between about 150 and about 350 degrees Celsius without plasma.

23. The method of claim 22, wherein steps (a) to (c) are repeated to provide a fully covered passivation layer on the second surface.

24. The method of claim 22, wherein the first surface comprises a metal or metalloid chosen from the group consisting of ruthenium (Ru), cobalt (Co), copper (Cu), titanium, (Ti), tantalum (Ta), nickel (Ni), tungsten (W), molybdenum (Mo), and combinations thereof, or wherein the first surface comprises a metal nitride chosen from the group consisting of tantalum nitride (TaN), titanium nitride (TiN), tungsten nitride (WN), tungsten carbonitride (WCN), molybdenum nitride (MoN), copper silicon nitride (CuSiN), silicon, germanium, and combinations thereof.

25. The method of claim 22, wherein the second surface is selected from the group consisting of silicon oxide and carbon doped silicon oxide, or

wherein the second surface is selected from the group consisting of silicon nitride.

26. The method of claim 22, wherein the alkyne is selected from the group consisting of ethynylbenzene, 3-phenyl-1-propyne, 4-phenyl-1-butyne, 5-phenyl-1-pentyne, and 6-phenyl-1-hexyne.