Claims

What is claimed is

1. A thermal ALE process performed in a reactor for selectively etching a metal substrate comprising the steps of:

(i) forming a chlorinated metal-containing layer on a surface of a metal by exposing the surface to a chlorinating agent,

(ii) conducting a first purge to remove any excess chlorinating agent and/or reaction products,

(iii) forming a volatile etch product on the surface of the metal by exposing the chlorinated metal-containing layer to at least one volatilizing agent; and

(iv) conducting a second purge to remove the volatile etch product.

2. The process of claim 1, wherein the chlorinating agent is formed by mixing thionyl chloride ($SOCl_2$) with pyridine.

3. The process of claim 1, wherein the chlorinating agent comprises thionyl chloride ($SOCl_2$).

4. The process of claim 1, wherein the metal comprises one or more of cobalt, nickel, copper, molybdenum, ruthenium, tungsten and alloys including the same.

5. The process of claim 1, wherein the chlorinated metal comprises one or more of cobalt, nickel, copper, molybdenum, ruthenium, tungsten and alloys including the same.

6. The process of claim 1, wherein step (i) is performed at temperature between 100 °C and 350 °C.

7. The process of claim 1, wherein step (iii) is performed at temperature between 100 °C and 350 °C.

8. The process of claim 1, wherein step (i) and step (iii) are performed at the same temperature.

9. The process of claim 1, wherein step (i) and step (iii) are each performed at a different temperature.

10. A metal-containing film etched by the process of claim 1, wherein the film comprises one or more of cobalt, nickel, copper, molybdenum, ruthenium, tungsten and alloys including the same.