CLAIMS

~~What is claimed is:~~

1. A method of processing a semiconductor substrate having features in a reaction chamber, the method comprising:
   (a) exposing the substrate to an aluminum-containing precursor for a duration sufficient to substantially adsorb to a surface of the substrate;
   (b) purging the aluminum-containing precursor from the reaction chamber for a duration insufficient to remove substantially all of the aluminum-containing precursor from the gas phase;
   (c) exposing the substrate to a nitrogen-containing precursor for a duration sufficient to drive a thermally mediated reaction to form a layer of aluminum nitride on the surface of the substrate, wherein the layer of aluminum nitride is substantially conformal to the substrate and has a thickness of about 1.5Å or greater;
   (d) purging the nitrogen-containing precursor in gas phase from the reaction chamber; and
   (e) repeating (a) through (d).

2. The method of claim 1, wherein the layer of aluminum nitride has step coverage of at least about 80%.

3. The method of claim 1, wherein the substrate is processed at a process temperature between about 250°C and about 450°C.

4. The method of claim 1, wherein the substrate is processed at a pressure between about 0.01 Torr and about 10 Torr.

5. The method of ~~any of~~ claim~~s~~ 1~~-4~~, wherein the aluminum-containing precursor is trimethylaluminum (TMA).

6. The method of ~~any of~~ claim~~s~~ 1~~-4~~, wherein the nitrogen-containing precursor is ammonia (NH_3).

7. The method of ~~any of~~ claims ~~1-4~~, wherein purging the aluminum-containing precursor further comprises flowing nitrogen (N_2) and purging the nitrogen-containing precursor further comprises flowing nitrogen (N_2).

8. The method of ~~any of~~ claims ~~1-4~~, wherein the aluminum-containing precursor is purged for about 2 seconds.

9. The method of ~~any of~~ claims ~~1-4~~, wherein the substrate is exposed to the aluminum-containing precursor for about 7.5 seconds to about 30 seconds.

10. The method of ~~any of~~ claims ~~1-4~~, wherein the ratio of the time the substrate is exposed to the aluminum-containing precursor to the time the aluminum-containing precursor is purged is between about 3.75:1 and about 15:1.

11. The method of ~~any of~~ claims ~~1-4~~, wherein processing exhibits substantially no pattern loading.

12. The method of ~~any of~~ claims ~~1-4~~, wherein the amount of aluminum nitride deposited during a cycle of (a) through (d) is at least about 2Å.

13. The method of ~~any of~~ claims ~~1-4~~, wherein the amount of aluminum nitride deposited during a cycle of (a) through (d) is at least about 5Å.

14. The method of ~~any of~~ claims ~~1-4~~, wherein the features of the substrate have aspect ratios of at least about 2:1.

15. The method of ~~any of~~ claims ~~1-4~~, wherein the features of the substrate have openings of less than about 100 nm.

16. An apparatus for depositing a film on a substrate surface, the apparatus comprising:
a reaction chamber comprising a pedestal for holding the substrate;
at least one outlet for coupling to a vacuum;
one or more process gas inlets coupled to two or more precursor sources; and
a controller for controlling operations in the apparatus, comprising machine-readable instructions for:
(a) introducing a first precursor into the reaction chamber for a duration sufficient to substantially adsorb the first precursor to the surface of the substrate;
(b) purging the chamber for a duration insufficient to remove substantially all of the first precursor from gas phase;
(c) introducing a second precursor to the reaction chamber for a duration sufficient to form a layer on the substrate surface, wherein the layer is substantially conformal to the substrate and has a thickness of about 1.5Å or greater;
(d) purging the chamber for a duration sufficient to remove the second precursor from gas phase; and
(e) repeating (a) through (d).

17. The apparatus of claim 16, wherein the controller further comprises instructions for performing (a) for a time about 3.75 to about 15 times greater than the time for performing (b).

18. The apparatus of any of claims 16 and 17, wherein introducing the first precursor comprises drawing the first precursor from the headspace of a reservoir of the first precursor to the chamber.

19. The apparatus of claim 18, wherein introducing the first precursor further comprises flowing a carrier gas with the first precursor downstream from the drawing of the first precursor from the headspace and upstream from the reaction chamber.