CLAIMS

1. A method for processing substrates, the method comprising:

providing a semiconductor substrate to a reaction chamber;

performing n cycles of atomic layer deposition to deposit a silicon-containing film, each cycle comprising:

introducing a first reactant in vapor phase into the reaction chamber to adsorb the first reactant onto a surface of the semiconductor substrate,

introducing a dose of a second reactant in vapor phase into the reaction chamber for a dose time, and

generating a first plasma in the reaction chamber while the second reactant in vapor phase is in the reaction chamber;

after every n cycles of the atomic layer deposition, exposing the deposited silicon-containing film to a second plasma; and

introducing fluorine-containing reactive species to form a fluorine-terminated silicon surface.

2. The method of claim 1, wherein the second plasma is generated using a power between about 1000W and about 2000W at a chamber pressure between about 1 Torr and about 10 Torr to reduce stress of the film to less than about -290 MPa to 55 MPa.

3. The method of claim 1, wherein the second plasma is generated using a power between about 3000W and about 6500W at a chamber pressure between about 1 Torr and about 5 Torr to reduce electrical leakage to less than about 1E-9 A/cm^2 at 2 MV field.

4. The method of claim 1, wherein the second plasma is generated using a power between about 3000W and about 6500W at a chamber pressure between about 1 Torr and about 5 Torr to yield a treated film, wherein the treated film has a breakdown voltage greater than 10 MV/cm.

5. The method of claim 1, wherein during the nth cycle of atomic layer deposition, introducing the dose of the second reactant for an extended dose time of at least 1.5 times longer than the dose time used for the first through (n-1)th cycles of atomic layer deposition.

6. The method of any one of claims 1-5, wherein the film comprises silicon oxide.

7. The method of any one of claims 1-5, wherein the first reactant is a silicon-containing precursor.

8. The method of any one of claims 1-5, wherein the second reactant comprises one or more oxygen-containing gases.

9. The method of claim 8, wherein the oxygen-containing gas is selected from the group consisting of oxygen, nitrous oxide, water, carbon dioxide, and combinations thereof.

10. The method of any one of claims 1-5, wherein n is an integer between and including 5 and 10.

11. The method of any one of claims 1-5, wherein the second plasma is generated by igniting an inert gas.

12. The method of any one of claims 1-5, wherein the second plasma is generated using a plasma density between about 0.4421 W/cm^2 and about 1.7684 W/cm^2.

13. The method of any one of claims 1-5, wherein the exposing of the film to the second plasma and the performing of the cycles of the atomic layer deposition are performed without breaking vacuum.

14. The method of any one of claims 1-5, wherein the exposing of the film to the second plasma comprises pulsing the second plasma.

15. The method of any one of claims 1-5, wherein exposing the deposited film to the second plasma further comprises introducing a mixture of argon and oxygen gas having a flow rate ratio of argon to oxygen gas is 12:1.