

CLAIMS

1. A method comprising:
 - (a) introducing a first reactant in vapor phase into a reaction chamber having a substrate therein, and allowing the first reactant to adsorb onto a surface of the substrate;
 - (b) purging the reaction chamber after a flow of the first reactant has ceased;
 - (c) introducing a second reactant in vapor phase into the reaction chamber while the first reactant is adsorbed onto the substrate surface;
 - (d) exposing the substrate surface to plasma to drive a surface reaction between the first and second reactants on the substrate surface to form a film layer that lines the gap, wherein the plasma is a pulsed plasma;
 - (e) extinguishing the plasma; and
 - (f) purging the reaction chamber,wherein a ratio between a wet etch rate of the film layer at a middle portion of a sidewall of the gap (WE_m) and a wet etch rate of the film layer at a top (WE_t) and/or bottom (WE_b) of the gap is between about 0.25-3.
2. The method of claim 1, wherein a frequency of the plasma pulses during the exposing the substrate surface to plasma operation is between about 25-5000 Hz.
3. The method of claim 2, wherein the frequency of the plasma pulses is between about 100-500 Hz.
4. The method of claim 1, wherein the film deposited is a silicon nitride or silicon carbonitride film.
5. The method of claim 1, wherein the film deposited is an oxide.
6. The method of claim 1, wherein operations (c) and (d) occur, at least partially, at the same time.
7. The method of claim 1, wherein the plasma is a capacitively coupled plasma or an inductively coupled plasma.

8. The method of claim 1, wherein the plasma is generated using an RF plasma generator.
9. The method of claim 8, wherein a plasma power is between about 50-2500 W/station.
10. The method of claim 1, wherein the film formed in the gap at a middle portion of the gap, as measured vertically, exhibits a wet etch rate between about 1-25 Å/min.
11. The method of claim 4, wherein an average ratio of carbon:silicon at a sidewall of the gap is at least about 0.4.
12. The method of claim 1, wherein a composition of the film is substantially uniform throughout the film.
13. The method of claim 1, further comprising repeating operations (a) through (f), wherein a first iteration of operation (d) is performed at a different pulse frequency than a second iteration of operation (d).
14. The method of claim 1, further comprising repeating operations (a) through (f), wherein a first iteration of operation (d) is performed at a different duty cycle than a second iteration of operation (d).
15. The method of claim 1, further comprising repeating operations (a) through (f), wherein a first iteration of operation (d) is performed at a different RF power than a second iteration of operation (d).
16. The method of claim 1, wherein the pulsed plasma pulses between an on state and an off state.
17. The method of claim 1, wherein the pulsed plasma pulses between at least a first non-zero power state and a second non-zero power state, and wherein power delivered during the first non-zero power state is different from power delivered during the second non-zero power state.

18. An apparatus for depositing films on a substrate, the apparatus comprising:
- a reaction chamber;
 - an inlet port for delivering gas phase reactants to the reaction chamber;
 - a plasma generator for providing pulsed plasma to the reaction chamber; and
 - a controller comprising instructions for
 - (a) introducing a first reactant in vapor phase into the reaction chamber and allowing the first reactant to adsorb onto the substrate surface;
 - (b) purging the reaction chamber after a flow of the first reactant has ceased;
 - (c) introducing a second reactant in vapor phase into the reaction chamber while the first reactant is adsorbed onto the substrate surface;
 - (d) periodically striking a pulsed plasma to expose the substrate surface to pulsed plasma when the vapor phase flow of the first reactant has ceased in order to drive a surface reaction between the first and second reactants on the substrate surface to form film layer that lines a gap on the substrate, the film layer having a wet etch rate at a middle portion of a sidewall of the gap (WE_m) and a wet etch rate at a top (WE_t) and/or bottom (WE_b) of the gap, and wherein a ratio between the wet etch rate at the middle portion of the gap (WE_m) and the wet etch rate at the top (WE_t) and/or bottom (WE_b) of the gap is between about 0.25-3.
19. The method of claim 1, wherein the wet etch rates correspond to etch rates that would be achieved in a solution comprising water and HF, wherein the ratio of water:HF in the solution is about 100:1.