CLAIMS

1. A method of cyclic plasma-assisted semiconductor deposition processing in multiple stations in a process chamber of a substrate processing apparatus, the method comprising:

a) providing substrates at each of the multiple stations;

b) distributing RF power to multiple stations to thereby generate a plasma in the stations, wherein the RF power is distributed according to a RF power parameter that is adjusted to reduce station to station variations;

c) tuning a frequency of the RF power, wherein tuning the frequency includes:

i) measuring an impedance of the plasma,

ii) determining, according to the impedance measured in (i), a change to the frequency of the RF power, and

iii) adjusting the frequency of the RF power; and

d) depositing a thin film on the substrate at each station, wherein:

the thin film is produced during a single ALD cycle,

(b) through (d) are repeatedly performed, each time during a new ALD cycle of the semiconductor deposition processing,

each ALD cycle comprises igniting the plasma and temporarily delivering one or more process gases to the process chamber,

the station-to-station distribution of the RF power parameter is not changed over the multiple ALD cycles, and

the tuning in (c) produces a first RF power frequency in one ALD cycle and a second RF power frequency in another ALD cycle, and wherein the first and second RF power frequencies are different.

2. The method of claim 1, further comprising determining an adjustment for adjusting the RF power parameter delivered to each station during (b), wherein determining the adjustment includes:

measuring a RF power parameter at each station;

comparing the RF power parameter at each station with a set point for each station; and

determining a change to an RF adjuster to adjust the RF power parameter at each station such that the difference between the measurement and set point is reduced.

3. The method of claim 1, wherein i) comprises measuring impedance as seen by a source of the RF power and ii) comprises determining a change to the frequency of the RF power such that the change to the frequency would result in a phase of the impedance as seen by the source of the RF power having zero value.

4. The method of claim 1, wherein the RF power at each station during the depositing operation is substantially the same.

5. The method of claim 1, wherein the RF power distributed is at a fixed frequency.

6. The method of claim 5, wherein the fixed frequency is a preset frequency.

7. The method of claim 6, wherein i) comprises measuring impedance as seen by a source of the RF power and the preset frequency is a frequency calculated to result in a magnitude of the impedance as seen by the source of the RF power having a value of about 50 ohms.

8. The method of claim 5, wherein the fixed frequency is a frequency of about 13.56 MHz.

9. The method of claim 1, wherein tuning the frequency of the RF power is performed over a duration of 10 seconds or less.

10. A method of cyclic plasma-assisted semiconductor deposition processing in multiple stations, the method comprising:

providing a substrate at each of the multiple stations, wherein the multiple stations are within a chamber;

performing at least a first and a second deposition process to produce first and second layers having different materials with different values of intrinsic properties, wherein:

the first deposition process is performed according to a first recipe having a first station-to-station adjustment for an RF power parameter,

the second deposition process is performed according to a second recipe having a second station-to-station adjustment for the RF power parameter,

each deposition process includes:

a) distributing RF power to the multiple stations, wherein the RF power is distributed according to a RF power parameter that is adjusted to reduce station to station variations;

b) tuning a frequency of the RF power, wherein tuning the frequency includes:

i) measuring an impedance of a plasma,

ii) determining, according to the impedance measured in (i), a change to the frequency of the RF power, and

iii) adjusting the frequency of the RF power; and

c) depositing a thin film on the substrate at each station,

the first adjustment for the RF power parameter of the first recipe is different from the second adjustment for the RF power parameter of the second recipe, and

for the first layer:

the thin film is produced during a single ALD cycle,

(a) through (c) are repeatedly performed, each time during a new ALD cycle of the semiconductor deposition processing,

each ALD cycle comprises igniting the plasma and temporarily delivering one or more process gases to the process chamber,

the station-to-station distribution of the RF power parameter is not changed over the multiple ALD cycles, and

the tuning in (b) produces a first RF power frequency in one ALD cycle and a second RF power frequency in another ALD cycle, and wherein the first and second RF power frequencies are different.

11. The method of claim 10, further comprising determining an adjustment for adjusting the RF power parameter delivered to each station during (b), wherein determining the adjustment includes:

measuring a RF power parameter at each station;

comparing the RF power parameter at each station with a set point for each station; and

determining a change to an RF adjuster to adjust the RF power parameter at each station such that the difference between the measurement and set point is reduced.

12. The method of claim 10, wherein i) comprises measuring impedance as seen by a source of the RF power and ii) comprises determining a change to the frequency of the RF power such that the change to the frequency would result in a phase of the impedance as seen by the source of the RF power having zero value.