Claims

1. A method for plasma processing of a wafer, comprising:

positioning a wafer on a wafer support apparatus, the wafer support apparatus positioned beneath an electrode such that a plasma generation region exists between the wafer and the electrode;

supplying radiofrequency signals of a first signal frequency to the plasma generation region to generate a plasma within the plasma generation region during multiple sequential plasma processing cycles of a plasma processing operation;

detecting formation of a plasma instability within the plasma based on supplying the radiofrequency signals of the first signal frequency to the plasma generation region; and

after detecting formation of the plasma instability, supplying radiofrequency signals of a second signal frequency to the plasma generation region to generate the plasma within the plasma generation region, the radiofrequency signals of the second signal frequency supplied in lieu of the radiofrequency signals of the first signal frequency, the second signal frequency being greater than the first signal frequency, the second signal frequency causing a reduction in ion energy within the plasma while maintaining an existing flux of ions incident upon the wafer with a corresponding reduction in secondary electron emission from the wafer caused by ion interaction with the wafer.

2. The method for plasma processing of the wafer as recited in claim 1, wherein the plasma instability is a plasmoid characterized by an area of higher density plasma surrounded by larger volumes of normal density plasma.

3. The method for plasma processing of the wafer as recited in claim 1,

wherein the plasma instability causes a non-uniformity in a deposited film thickness on the wafer.

4. The method for plasma processing of the wafer as recited in claim 1, wherein the plasma processing operation is an atomic layer deposition process.

5. The method for plasma processing of the wafer as recited in claim 1, wherein the plasma processing operation is a plasma enhanced chemical vapor deposition process.

6. The method for plasma processing of the wafer as recited in claim 1, wherein the first signal frequency is 13.56 megaHertz.

7. The method for plasma processing of the wafer as recited in claim 6, wherein the second signal frequency is within a range extending from the first signal frequency up to about 60 megaHertz.

8. The method for plasma processing of the wafer as recited in claim 6, wherein the second signal frequency is 27.12 megaHertz.

9. The method for plasma processing of the wafer as recited in claim 1, wherein detecting formation of the plasma instability within the plasma occurs during the plasma processing operation.

10. The method for plasma processing of the wafer as recited in claim 9, wherein supplying radiofrequency signals of the first signal frequency to the plasma

generation region includes supplying radiofrequency signals of the first signal frequency to the electrode, and wherein formation of the plasma instability is detected through measurement of a radiofrequency parameter on the electrode.

11. The method for plasma processing of the wafer as recited in claim 10, wherein the radiofrequency parameter is one or more of a radiofrequency voltage, a radiofrequency current, a radiofrequency impedance, a radiofrequency signal phase angle, and a radiofrequency power.

12. The method for plasma processing of the wafer as recited in claim 9, wherein formation of the plasma instability is detected through measurement of optical emissions from the plasma.

13. The method for plasma processing of the wafer as recited in claim 9, wherein supplying radiofrequency signals of the second signal frequency to the plasma generation region occurs during a same plasma processing operation in which formation of the plasma instability was detected.

14. The method for plasma processing of the wafer as recited in claim 1, wherein detecting formation of the plasma instability within the plasma occurs after the plasma processing operation.

15. The method for plasma processing of the wafer as recited in claim 14, wherein detecting formation of the plasma instability within the plasma is done by measuring a non-uniformity in deposited film thickness on the wafer.

16. The method for plasma processing of the wafer as recited in claim 14, wherein supplying radiofrequency signals of the second signal frequency to the plasma generation region occurs during a different plasma processing operation than that in which formation of the plasma instability was detected.

17. A method for performing a plasma process on a wafer, comprising:

positioning a wafer on a wafer support apparatus, the wafer support apparatus positioned beneath an electrode such that a plasma generation region exists between the wafer and the electrode; and

supplying radiofrequency signals having a signal frequency greater than 13.56 megaHertz to the electrode to generate a plasma within the plasma generation region;

adjusting the signal frequency to keep an ion energy within the plasma sufficiently low to maintain an acceptable amount of secondary electron emission from the wafer caused by ion interaction with the wafer, wherein the acceptable amount of secondary electron emission from the wafer is low enough to prevent formation of a secondary electron-induced instability within the plasma, and wherein adjusting the signal frequency is performed to keep an ion flux incident upon the wafer at a level high enough to maintain a required deposited film quality on the wafer.

18. The method for performing the plasma process on the wafer as recited in claim 17, wherein the plasma process is either an atomic layer deposition process or a plasma enhanced chemical vapor deposition process.

19. The method for performing the plasma process on the wafer as recited in claim 17, wherein the plasma instability is a plasmoid characterized by an area of higher density plasma surrounded by larger volumes of normal density plasma.

20. The method for performing the plasma process on the wafer as recited in claim 17, wherein the signal frequency is within a range extending from 13.56 megaHertz up to about 60 megaHertz.