CLAIMS

1. An apparatus for etching a feature on a substrate, the apparatus comprising:

a chamber defining an interior where a plasma can be provided;

a substrate holder for holding the substrate in the chamber during etching;

a plasma generator for producing plasma within the chamber;

a grid assembly dividing the interior of the chamber into an upper sub-chamber proximate the plasma generator and a lower sub-chamber proximate the substrate holder; and

a controller configured to produce the plasma in the chamber under conditions that use the grid assembly to produce an upper zone plasma in the upper sub-chamber and a lower zone plasma in the lower sub-chamber, the lower zone plasma being an ion-ion plasma,

wherein the upper sub-chamber has a height that is at least about 1/6 that of the lower sub-chamber,

wherein the grid assembly comprises at least a first grid and a second grid, each grid comprising a plurality of slots that substantially prevent formation of induced current in the grid when the plasma is produced within the chamber, wherein at least one of the plurality of slots in at least one of the first and second grids in the grid assembly has a height to width aspect ratio between about 0.5-2.

2. The apparatus of claim 1, wherein the controller is configured to produce the upper zone plasma and the lower zone plasma such that

(i) the effective electron temperature in the lower zone plasma is about 1 eV or less, and is less than the effective electron temperature in the upper zone plasma, and

(ii) the electron density in the lower zone plasma is about $5x10^{9}$ cm^{-3} or less, and is less than the electron density in the upper zone plasma.

3. The apparatus of claim 2, wherein the controller is configured to produce the upper zone plasma and the lower zone plasma such that (iii) the effective electron temperature in the upper zone plasma is at least about 2 times the effective electron temperature in the lower zone plasma, and (iv) the electron density in the upper zone plasma is at least about 10 times the electron density of the lower zone plasma.

4. The apparatus of claim 1, wherein at least one grid of the grid assembly has an average thickness of between about 1 and 50 mm.

5. The apparatus of claim 1, wherein the slots are separated from azimuthally adjacent slots by no more than about 60 degrees.

6. The apparatus of claim 1, wherein the first and second grids have substantially identical slot patterns.

7. The apparatus of claim 1, wherein the first and second grids have slot patterns that are different from one another.

8. The apparatus of claim 1, wherein at least one of the first and second grids is rotatable about an axis normal to an upper surface of the substrate holder.

9. The apparatus of claim 8, wherein the first grid and second grid have slot patterns allowing plasma conditions in the lower sub-chamber to be radially tuned.

10. The apparatus of claim 1, wherein at least one of the first and second grid is movable such that the distance between the first grid and second grid is variable.

11. The apparatus of claim 1, wherein at least one grid of the grid assembly comprises one or more inlets for gas delivery.

12. The apparatus of claim 1,

wherein at least one of the first and second grids comprises a central region, a middle region surrounding the central region, an outer region surrounding the middle region, and a peripheral region surrounding the outer region,

wherein the slots in the at least one of the first and second grids comprise a first slot shape, a second slot shape, and a third slot shape,

wherein the first slot shape extends radially outward from the central region to the peripheral region of the grid,

wherein the second slot shape extends radially outward from the middle region to the peripheral region of the grid, and

wherein the third slot shape extends radially outward from the outer region to the peripheral region of the grid.

13. The apparatus of claim 12, wherein the aspect ratio of each slot is constant throughout the slot.

14. The apparatus of claim 1, wherein the aspect ratio of each slot is constant throughout the slot.

15. The apparatus of claim 1, wherein the controller is configured to produce the lower zone plasma such that a ratio of negative ions to positive ions in the lower zone plasma is between about 0.5-1.

16. The apparatus of claim 1, wherein the controller is configured to produce the lower zone plasma such that a ratio of positive ions to electrons in the lower zone plasma is about 2 or greater.

17. The apparatus of claim 16, wherein the controller is configured to produce the lower zone plasma and the upper zone plasma such that the ratio of positive ions to electrons in the lower zone plasma is at least about 2 times as great as a ratio of positive ions to electrons in the upper zone plasma.

18. The apparatus of claim 1, wherein the controller is configured to produce the lower zone plasma and the upper zone plasma such that (i) a plasma potential in the upper zone plasma is between about 8-35V, (ii) a plasma potential in the lower zone plasma is between about 0.4-10V, and (iii) the plasma potential in the upper zone plasma is greater than the plasma potential in the lower zone plasma.

19. The apparatus of claim 1, wherein the slots in the first and second grids extend roughly radially outwards.