Claims

What is claimed is:

1. A method for controlling the spatial temperature across a semiconductor wafer during a multistep plasma etching process wherein wafer temperature is changed for the particular layer being etched comprising:

maintaining a base at a constant temperature, said constant temperature being below the temperature of the wafer, said base having a layer of thermal insulation material mounted on top of said base;

electrostatically clamping the wafer against a top face of a flat support having a plurality of spatial regions, said flat support mounted on top of said layer of thermal insulation material;

plasma etching a layer on the wafer under conditions such that local concentration of reactants varies across the wafer;

independently heating each spatial region of said flat support with a plurality of heaters mounted to an underside of said flat support so as to induce a radial temperature gradient which compensates for the variation in the local concentration of the reactants; and

changing the temperature of at least one spatial region of said flat support during the multistep plasma etching process at a rate of at least 1 ℃ per second.

2. The method of claim 1 further comprising monitoring the temperature of said plurality of spatial regions with a sensor placed in each region.

3. The method of claim 2 further comprising adjusting the temperature of each spatial region based on said monitoring.

4. The method of claim 1 wherein said plurality of heaters includes a plurality of electrically resistive heaters.

5. The method of claim 1 wherein said multistep plasma etching process is carried out for a time period of 20 seconds to 2 minutes.

6. The method of claim 1 wherein said multistep plasma etching process comprises etching multiple layers and altering the radial temperature profile on a step-by-step basis and within each step of the multistep plasma etching process.

7. The method of claim 1 wherein the temperature of one or more of the spatial regions of said flat support during the multistep etching process is changed less than 10℃.

8. A method for controlling the spatial temperature across a semiconductor wafer during a multistep plasma etching process wherein wafer temperature is changed for the particular layer being etched comprising:

maintaining a base at a constant temperature, said constant temperature being below the temperature of the wafer, said base having a layer of thermal insulation material mounted on top of said base;

electrostatically clamping the wafer against a top face of a flat support having a plurality of spatial regions, said flat support mounted on top of said layer of thermal insulation material;

plasma etching a layer on the wafer under conditions such that local concentration of reactants varies across the wafer;

independently heating each spatial region of said flat support with a plurality of heaters embedded within said flat support so as to induce a radial temperature gradient which compensates for the variation in the local concentration of the reactants; and

changing the temperature of at least one spatial region of said flat support during the multistep plasma etching process at a rate of at least 1℃ per second.

9. The method of claim 8 further comprising monitoring the temperature of said plurality of spatial regions with a sensor placed in each region.

10. The method of claim 9 further comprising adjusting the temperature of each spatial region based on said monitoring.

11. The method of claim 8 wherein said plurality of heaters includes a plurality of electrically resistive heaters.

12. The method of claim 8 wherein said multistep plasma etching process is carried out for a time period of 20 seconds to 2 minutes.

13. The method of claim 8 wherein said multistep plasma etching process comprises etching multiple layers and altering the radial temperature profile on a step-by-step basis and within each step of the multistep plasma etching process.

14. The method of claim 8 wherein the temperature of one or more of the spatial regions of said flat support during the multistep etching process is changed less than 10℃.

15. The method of claim 1, wherein heat flux impinging on the wafer from the plasma is less than $2W/cm^2$.

16. The method of claim 8, wherein heat flux impinging on the wafer from the plasma is less than $2W/cm^2$.

17. The method of claim 1, wherein an outer edge of the wafer extends radially outward from an outer edge of the flat support and heat flux impinging on the outer edge of the wafer flows radially inward.

18. The method of claim 8, wherein an outer edge of the wafer extends radially outward from an outer edge of the flat support and heat flux impinging on the outer edge of the wafer flows radially inward.

19. The method of claim 1, wherein the layer of thermal insulation provides a thermal impedance break between the base and the flat support, the layer of thermal insulation having a thermal conductivity of 0.05 to 0.20 W/mK.

20. The method of claim 8, wherein the layer of thermal insulation provides a thermal impedance break between the base and the flat support, the layer of thermal insulation having a thermal conductivity of 0.05 to 0.20 W/mK.

Claims

1. A method for controlling the spatial temperature across a semiconductor wafer during a multistep plasma etching process wherein wafer temperature is changed for the particular layer being etched comprising:

maintaining a base at a constant temperature, said constant temperature being below the temperature of the wafer, said base having a layer of thermal insulation material mounted on top of said base;

electrostatically clamping the wafer against a top face of a flat support having a plurality of spatial regions, said flat support mounted on top of said layer of thermal insulation material;

plasma etching a layer on the wafer under conditions such that local concentration of reactants varies across the wafer;

independently heating each spatial region of said flat support with a plurality of heaters mounted to an underside of said flat support so as to induce a radial temperature gradient which compensates for the variation in the local concentration of the reactants; and

wherein during the multistep plasma etching process the spatial regions are independently heated to different initial temperatures at a rate of at least 1°C per second with a total change in temperature of less than 10°C to account for differing temperature sensitivity of different etching conditions so as to maintain feature dimensions across the wafer and/or produce tapering within different layers on the wafer.

2. The method of claim 1 further comprising monitoring the temperature of said plurality of spatial regions with a sensor placed in each region.

3. The method of claim 2 further comprising adjusting the temperature of each spatial region based on said monitoring.

4. The method of claim 1 wherein said plurality of heaters includes a plurality of electrically resistive heaters.

5. The method of claim 1 wherein said multistep plasma etching process is carried out for a time period of 20 seconds to 2 minutes.

6. The method of claim 1 wherein said multistep plasma etching process comprises etching multiple layers and altering the radial temperature profile on a step-

by-step basis and within each step of the multistep plasma etching process.

7. The method of claim 1, wherein heat flux impinging on the wafer from the plasma is less than $2W/cm^2$.

8. The method of claim 1, wherein an outer edge of the wafer extends radially outward from an outer edge of the flat support and heat flux impinging on the outer edge of the wafer flows radially inward.

9. The method of claim 1, wherein the layer of thermal insulation provides a thermal impedance break between the base and the flat support, the layer of thermal insulation having a thermal conductivity of 0.05 to 0.20 W/mK.