

~~What is claimed is:~~

CLAIMS

1. ~~A faceplate for method of processing substrates~~ a substrate, comprising:
positioning a body formed from substrate on a heater ~~substrate support~~, the ~~substrate support~~ disposed in a processing volume of a processing chamber;
flowing a processing gas comprising a hydrocarbon gas and a diluent gas into the processing volume, the diluent gas comprising H₂, wherein a ratio of the H₂ to the hydrocarbon gas in the processing gas is between about 0.5:1 and about 1:10;
maintaining the processing volume at a processing pressure less than about 100 mTorr;
igniting and maintaining a deposition plasma of the processing gas by applying a first power to one of one or more power electrodes of the processing chamber;
maintaining the substrate support at a processing temperature less than about 350 °C;
exposing a surface of the substrate to the deposition plasma; and
depositing an amorphous carbon layer and an electrode on the surface of the substrate, the deposited amorphous carbon layer, wherein having a film stress with an outer diameter of the electrode layer defines a distribution portion of the body; absolute value less than about 500 MPa.
a plurality of apertures formed through the body within the distribution portion;
a heater disposed within the heater layer; and
a bridge surrounding the distribution portion, wherein the bridge couples the distribution portion to a coupling portion.
2. ~~The faceplate~~ method of claim 1, further comprising ~~an electrode disposed within the electrode layer~~ wherein the deposited amorphous carbon layer has a density of more than about 1.8 g/cm³.
3. ~~The faceplate of claim 1, further comprising a grounding electrode disposed within the heater layer.~~

4. The faceplate method of claim 1, wherein the body comprises a ceramic material. deposited amorphous carbon layer has a Young's modulus of more than about 50 GPa.

5. The faceplate of claim 4, wherein the ceramic material is aluminum nitride.

6. The faceplate of claim 1, further comprising a bonding layer disposed between the heater layer and the electrode layer.

4. The method of claim 1, wherein the deposited amorphous carbon layer has an absorption coefficient (optical K) of less than about 0.15 at a wavelength of about 633 nm.

5. The method of claim 1, wherein the deposited amorphous carbon layer has a density of more than about 1.8 g/cm³, a Young's modulus of more than about 50 GPa, and an absorption coefficient (optical K) of less than about 0.15 at a wavelength of about 633 nm.

6.

7. The faceplate method of claim 1, wherein the bridge is a thermal choke and has thickness less than a thickness of the coupling portion and a thickness of the distribution portion. hydrocarbon gas comprises one of CH₄, C₂H₂, C₃H₈, C₄H₁₀, C₂H₄, C₃H₆, C₄H₈, C₅H₁₀, or a combination thereof.

8.

7. The method of claim 6, wherein a ratio of hydrocarbon gas to diluent gas is between about 1:10 and about 10:1.

8. The method of claim 6, wherein the processing temperature is less than about 100 °C.

9. The method of claim 8, wherein the processing pressure is less than about 20 mTorr.

10. The method of claim 9, wherein each of the one or more power electrodes are part of the substrate support.

11. The method of claim 10, wherein the first power is an ac power between about 0.7 W and about 11.3 W per cm² of a substrate receiving surface of the substrate support, wherein the first power has a frequency between about 350 kHz and about 100 MHz.

12. The method of claim 11, further comprising applying a second power to one of the one or more power electrodes, wherein the second power is an ac power between about 0.14 W and about 11.3 W per cm² of the substrate receiving surface of the substrate support, wherein the second power has a frequency between about 350 kHz and about 100 MHz, and wherein the frequency of the first power is different than the frequency of the second power.

13. A faceplate for method of processing substrates a substrate, comprising:
positioning a body substrate on a substrate support, the substrate support disposed in a processing volume of a processing chamber;
flowing a processing gas comprising a hydrocarbon gas and a diluent gas into the processing volume, the diluent gas comprising H₂, wherein the body a ratio of the H₂ to the hydrocarbon gas in the processing gas is between about 0.5:1 and about 1:10;
maintaining the processing volume at a processing pressure less than about 20 mTorr;
igniting and maintaining a deposition plasma of the processing gas by applying a first ac power to one of one or more power electrodes of the substrate support, wherein the first ac power is between about 0.7 watts and about 15 watts per cm² of a substrate receiving surface of the substrate support;
maintaining the substrate support at a processing temperature less than about 100 °C;
exposing a surface of the substrate to the deposition plasma; and

depositing an amorphous carbon layer on the surface of the substrate, the deposited amorphous carbon layer having a film stress with an absolute value less than about 500 MPa.

14. The method of claim 13, wherein the hydrocarbon gas comprises: one of CH₄, C₂H₂, C₃H₈, C₄H₁₀, C₂H₄, C₃H₆, C₄H₈, C₅H₁₀, or a combination thereof.

an electrode layer;
a heater layer;
a grounding layer; and
a bonding layer disposed between the electrode layer and the heater layer and between the heater layer and the grounding layer;

15. The method of claim 13 further comprising applying a second ac power to one of the one or more power electrodes of the substrate support, wherein the second ac power is between about 0.14 W and about 7.1 W per cm² of the substrate receiving surface of the substrate support, wherein the first ac power and the second ac power each have a frequency between about 350 kHz and about 100 MHz, and wherein the frequency of the first ac power is different than the frequency of the second ac power.

16. A carbon hard mask, comprising:

an amorphous carbon layer disposed on a surface of a substrate, wherein the amorphous carbon layer has a density of more than about 1.8 g/cm³, a Young's modulus of more than about 50 GPa, a film stress with an absolute value less than about 500 MPa, and an absorption coefficient (optical K) of less than about 0.15 at a wavelength of about 633 nm.

17. The carbon hard mask of claim 16 wherein the amorphous carbon layer has a plurality of apertures/openings formed through the body having a first end and a second end, wherein the first end is located at an outer surface of the body and the second end of each aperture is fluidly coupled to one or more nozzles disposed in the electrode layer; and
a thermal choke.

~~9. The faceplate of claim 8, further comprising a distribution volume disposed between the apertures and the nozzles.~~

~~10. The faceplate of claim 8, wherein the thermal choke comprises one or more fluid channels disposed within the body and radially outward therethrough, and wherein each of the each of the plurality of apertures. openings have a height to width ratio of more than about 2:1.~~

~~41.~~

~~18. The faceplate carbon hard mask of claim 817, wherein each of the electrode layer, the height to width ratio of one or more of the heater layer, and the grounding layer are formed from a ceramic material plurality of openings is more than about 10:1.~~

~~4219. The faceplate method of claim 81, wherein a heater is disposed in the heater layer, and the processing temperature is less than 0 °C.~~

~~20. The method of claim 5, wherein the thermal choke limits the heat transfer from the heater to an area proximate a seal disposed radially outward of the heater. deposited amorphous carbon layer has a plurality of openings formed therethrough, and wherein each of the plurality of openings have a height to width ratio of more than about 2:1.~~

~~13. The faceplate of claim 8, wherein a cross-sectional area of the apertures is about twice the cross-sectional area of the nozzles.~~

~~14. A gas distribution apparatus for processing substrates, comprising:
—— a ceramic body, wherein the body is formed from a first layer, a second layer, and a third layer;
a plurality of apertures formed through the ceramic body;
—— a heater disposed in the first layer;
—— an electrode disposed in the second layer; and
—— a bridge portion extending perpendicularly from the third layer, wherein a coupling portion is disposed at an end of the bridge portion opposite the third layer, wherein the bridge portion is a thermal choke which limits heat transfer from the heater to the coupling portion.~~

~~15. The gas distribution apparatus of claim 14, wherein the apertures are arranged in a honeycomb array, wherein a center to center distance between adjacent apertures is between about 2mm and about 6mm.~~