Claims

1. A method of processing a substrate, comprising:

flowing an argon containing gas into a process chamber;

flowing a nitrogen containing gas into the process chamber, wherein a nitrogen containing gas to argon containing gas ratio is 1:3 to 1:10;

igniting a plasma in the process chamber;

flowing a precursor gas into the process chamber after igniting the plasma, wherein a ratio of a flow rate of the precursor gas to a flow rate of the combined argon containing and nitrogen containing gases is 1:3 to 1:15;

performing a deposition process at a temperature of 560 degrees C to 700 degrees C; and

forming a nitrogen doped carbon hardmask, wherein the nitrogen doped carbon hardmask has an atomic nitrogen composition of 1% nitrogen to 16% nitrogen and an edge drop of 55 nm to 25 nm, and wherein the nitrogen doped carbon hardmask has a relative thickness loss between 0.075% and 0.25% and a bow of the nitrogen doped carbon hardmask is 30 um to 40 um.

2. The method of claim 1, wherein the argon containing gas is atomic argon.

3. The method of claim 1, wherein the nitrogen containing gas is diatomic nitrogen.

4. The method of claim 1, wherein the argon containing gas and the nitrogen containing gas are introduced simultaneously.

5. The method of claim 1, wherein the nitrogen containing gas has a flow rate of 250 sccm to 1000 sccm.

6. The method of claim 1, wherein the argon containing gas has a flow rate of 2000 sccm to 4000 sccm.

7. The method of claim 1, wherein a pressure during the flowing the argon containing gas and the flowing the nitrogen containing gas is 6 Torr to 12 Torr.

8. The method of claim 1, wherein the deposition process is performed at a temperature of 600 degrees C to 650 degrees C.

9. The method of claim 8, wherein a radio frequency power applied during ignition of the plasma is 3250 Watts to 5000 Watts.

10. A method of processing a substrate comprising:

flowing an argon containing gas into a process chamber;

flowing a nitrogen containing gas into the process chamber, wherein a nitrogen containing gas to argon containing gas ratio is 1:3 to 1:10;

applying a radio frequency power to the argon containing gas and the nitrogen containing gas to ignite a plasma, wherein the radio frequency power is 3250 Watts to 5000 Watts;

flowing a precursor gas into the process chamber after igniting the plasma, a ratio of a flow rate of the precursor gas to a flow rate of the combined argon containing and nitrogen containing gases is 1:3 to 1:15;

performing a deposition process at a temperature of 560 degrees C to 700 degrees C; and

forming a nitrogen doped carbon hardmask, wherein the nitrogen doped carbon hardmask has a thickness of 0.5 um to 6 um and a thickness profile uniformity of less than 3%, an atomic nitrogen composition of 1% nitrogen to 16% nitrogen, and a change in a thickness of the nitrogen doped carbon hardmask for an outer 20 mm of a radius of the nitrogen doped carbon hardmask is 55 nm to 25 nm.

11. The method of claim 10, wherein the precursor gas is a hydrocarbon.

12. The method of claim 11, wherein the precursor gas is any one of acetylene (C_2H_2), methane (CH_4), ethane (C_2H_6), propane (C_3H_8), propene (C_3H_6), cyclopropane (C_3H_6), butane (C_4H_{10}), pentane (C_5H_{12}), hexane (C_6H_{14}), heptane (C_7H_{16}), octane (C_8H_{18}), nonane (C_9H_{20}), decane ($C_{10}H_{22}$), undecane ($C_{11}H_{24}$), or dodecane ($C_{12}H_{26}$).

13. The method of claim 12, wherein the hydrocarbon is propene (C_3H_6).

14. The method of claim 13, wherein the precursor gas is introduced at a flow rate of 300 sccm to 900 sccm.

15. The method of claim 10, wherein the deposition process is performed as a deposition rate of 2500 Angstroms/minute to 8000 Angstroms/minute.

16. The method of claim 10, wherein the argon containing gas is atomic argon.

17. The method of claim 10, wherein the nitrogen containing gas is diatomic nitrogen.

18. The method of claim 1, wherein the nitrogen doped carbon hardmask has a thickness of 0.5 um to 6 um and a thickness profile uniformity of less than 3%.

19. The method of claim 10, wherein the nitrogen doped carbon hardmask has a relative thickness loss between 0.075% and 0.25% and a bow of the nitrogen doped carbon hardmask is 30 um to 40 um.

20. A method of processing a substrate, comprising:

flowing an elemental argon gas into a process chamber;

flowing a diatomic nitrogen gas into the process chamber, wherein a diatomic nitrogen gas to elemental argon gas ratio is 1:3 to 1:6;

applying a radio frequency power to the diatomic nitrogen gas and elemental argon gas mixture to ignite a plasma in the process chamber;

flowing a precursor gas into the process chamber after igniting the plasma, wherein a ratio of a flow rate of the precursor gas to a flow rate of the combined argon containing and nitrogen containing gases is 1:6 to 1:9;

performing a deposition process at a temperature of 600 degrees C to 650 degrees C; and

forming a nitrogen doped carbon hardmask, wherein the nitrogen doped carbon hardmask has an atomic nitrogen composition of 3% nitrogen to 10% nitrogen and a change in a thickness of the nitrogen doped carbon hardmask for an outer 20 mm of a radius of the nitrogen doped carbon hardmask is 55 nm to 25 nm.

21. The method of claim 20, wherein a pressure during the deposition process is 8 Torr to 10 Torr, an internal stress within the nitrogen-doped carbon hardmask is 30 MPa to 37 MPa, and an average post location relative thickness loss is 0.075% to 0.25%.