

WHAT IS CLAIMED IS:

1. A method for removing a doped amorphous carbon mask from a semiconductor substrate, comprising:
 - generating a plasma to be used in treating the substrate, wherein the plasma comprises an oxygen containing gas, a halogen containing gas, and a hydrogen containing gas; and
 - treating the substrate by exposing the substrate to the plasma.
2. The method of claim 1, wherein the oxygen containing gas is O₂.
3. The method of claim 1, wherein the halogen containing gas includes fluorine.
4. The method of claim 3, wherein the halogen containing gas is tetrafluoromethane (CF₄).
5. The method of claim 1, wherein the halogen containing gas is present in an amount ranging from about 0.25% to about 4% based on the total gas volume.
6. The method of claim 1, wherein the hydrogen containing gas is H₂.
7. The method of claim 1, wherein the ratio of the amount of hydrogen containing gas to the amount of halogen containing gas in the plasma ranges from about 0.001 to about 1.
8. The method of claim 1, wherein the doped amorphous carbon mask is a boron doped amorphous carbon mask or a nitrogen doped amorphous carbon mask.
9. The method of claim 1, wherein the plasma is generated in a plasma chamber and is then exposed to the substrate in a downstream processing chamber.
10. The method of claim 1, wherein the mask removal is carried out at a source power ranging from about 125 watts to about 13,500 watts.
11. The method of claim 1, wherein the mask removal is carried out at a pressure ranging from about 1 milliTorr to about 4000 milliTorr.
12. The method of claim 1, wherein the substrate is exposed to the plasma at a temperature ranging from about 5°C to about 300°C.
13. The method of claim 1, wherein the substrate is treated by exposing the substrate to the first non-oxidizing plasma for a time period ranging from about 1 second to about 600 seconds.

14. The method of claim 1, wherein the doped amorphous carbon mask is removed at a rate ranging from about 1,000 Ångströms/minute to about 12,000 Ångströms/minute.

15. The method of claim 1, wherein the oxygen containing gas has a flow rate of from about 0.03 standard cubic centimeters per minute per square centimeter of the substrate to about 15 standard cubic centimeters per minute per square centimeter of the substrate.

16. The method of claim 1, wherein the halogen containing gas has a flow rate of from about 0.007 standard cubic centimeters per minute per square centimeter of the substrate to about 0.3 standard cubic centimeters per minute per square centimeter of the substrate.

17. The method of claim 1, wherein the hydrogen containing gas has a flow rate of from about 0.02 standard cubic centimeters per minute per square centimeter of the substrate to about 0.5 standard cubic centimeters per minute per square centimeter of the substrate.

18. The method of claim 1, wherein a pre-treatment gas is applied to the substrate before the substrate is exposed to the plasma, wherein the pre-treatment gas comprises oxygen, nitrogen, or a combination thereof.

19. The method of claim 18, wherein the pre-treatment gas flow rate ranges from about 0.03 standard cubic centimeters per minute per square centimeter of the substrate to about 15 standard cubic centimeters per minute per square centimeter of the substrate.

20. The method of claim 18, wherein the ratio of oxide critical dimension loss to nitride critical dimension loss ranges from about 0.75 to about 1.25.

21. The method of claim 1, wherein a post-treatment gas is applied to the substrate after the substrate is exposed to the plasma, wherein the post-treatment gas comprises oxygen, nitrogen, or a combination thereof.

22. The method of claim 21, wherein the post-treatment gas flow rate ranges from about 0.03 standard cubic centimeters per minute per square centimeter of the substrate to about 15 standard cubic centimeters per minute per square centimeter of the substrate.

CLAIMS

1. A method for removing a doped amorphous carbon mask from a semiconductor substrate, comprising:
generating a plasma to be used in treating the substrate, wherein the plasma comprises an oxygen containing gas, a halogen containing gas, and a hydrogen containing gas, wherein the halogen containing gas is present in an amount ranging from about 1% to about 2% based on the total gas volume, wherein the ratio of the amount of hydrogen containing gas to the amount of halogen containing gas in the plasma ranges from about 0.001 to about 1, wherein the plasma is generated in a plasma chamber; and
treating the substrate to remove the doped amorphous carbon mask by exposing the substrate to neutral particles from the plasma in a downstream processing chamber.
2. The method of claim 1, wherein the oxygen containing gas is O₂.
3. The method of claim 1, wherein the halogen containing gas includes fluorine.
4. The method of claim 3, wherein the halogen containing gas is tetrafluoromethane (CF₄).
5. The method of claim 1, wherein the hydrogen containing gas is H₂.
6. The method of claim 1, wherein the doped amorphous carbon mask is a boron doped amorphous carbon mask or a nitrogen doped amorphous carbon mask.
7. The method of claim 1, wherein the mask removal is carried out at a source power ranging from about 125 watts to about 13,500 watts.
8. The method of claim 1, wherein the mask removal is carried out at a pressure ranging from about 1 milliTorr to about 4000 milliTorr.
9. The method of claim 1, wherein the substrate is exposed to the neutral particles from the plasma at a temperature ranging from about 5° C to about 300° C.

10. The method of claim 1, wherein the substrate is treated by exposing the substrate to the neutral particles from the plasma for a time period ranging from about 1 second to about 600 seconds.

11. The method of claim 1, wherein the doped amorphous carbon mask is removed at a rate ranging from about 1,000 Ångströms/minute to about 12,000 Ångströms/minute.

12. The method of claim 1, wherein the oxygen containing gas has a flow rate of from about 0.03 standard cubic centimeters per minute per square centimeter of the substrate to about 15 standard cubic centimeters per minute per square centimeter of the substrate.

13. The method of claim 1, wherein the halogen containing gas has a flow rate of from about 0.007 standard cubic centimeters per minute per square centimeter of the substrate to about 0.3 standard cubic centimeters per minute per square centimeter of the substrate.

14. The method of claim 1, wherein the hydrogen containing gas has a flow rate of from about 0.02 standard cubic centimeters per minute per square centimeter of the substrate to about 0.5 standard cubic centimeters per minute per square centimeter of the substrate.

15. The method of claim 1, wherein a pre-treatment gas is applied to the substrate before the substrate is exposed to the neutral particles from the plasma, wherein the pre-treatment gas comprises oxygen, nitrogen, or a combination thereof.

16. The method of claim 15, wherein the pre-treatment gas flow rate ranges from about 0.03 standard cubic centimeters per minute per square centimeter of the substrate to about 15 standard cubic centimeters per minute per square centimeter of the substrate.

17. The method of claim 15, wherein the substrate includes a nitride layer having a critical dimension and an oxide layer having a critical dimension, wherein the method results in a ratio of oxide critical dimension loss to nitride critical dimension loss ranging from about 0.75 to about 1.25.

18. The method of claim 1, wherein a post-treatment gas is applied to the substrate after the substrate is exposed to the neutral particles from the plasma, wherein the post-treatment gas comprises oxygen, nitrogen, or a combination thereof.

19. The method of claim 18, wherein the post-treatment gas flow rate ranges from about 0.03 standard cubic centimeters per minute per square centimeter of the substrate to about 15 standard cubic centimeters per minute per square centimeter of the substrate.

20. The method of claim 1, wherein the substrate is exposed to the neutral particles from the plasma at a temperature ranging from about 15° C to about 50° C.

21. The method of claim 1, wherein the substrate is not directly exposed to the plasma in the plasma chamber.