CLAIMS

1. A method of processing a substrate, comprising:

positioning a substrate in a processing volume of a processing chamber;

depositing a diamond-like carbon (DLC) layer on the substrate; and

after depositing the DLC layer, reducing a film stress of the DLC layer by performing a plasma treatment, the plasma treatment comprising:

flowing a non-reactive gas into the processing volume at a flow rate of 500 sccm to 5,000 sccm for a 300 mm-sized substrate, the non-reactive gas comprising argon; and

generating a plasma from the non-reactive gas in the processing volume to treat the DLC layer by applying a radio frequency (RF) bias power of 100 W to 10,000 W.

2. The method of claim 1, wherein the RF bias power is from 100 W to 400 W.

3. The method of claim 1, wherein the non-reactive gas further comprises helium, N_2, or combinations thereof.

4. The method of claim 1, wherein the non-reactive gas further comprises N_2, helium, neon, krypton, xenon, radon, or combinations thereof.

5. The method of claim 4, wherein a thickness of the DLC layer is from 5 kÅ to 15 kÅ.

6. The method of claim 1, wherein depositing the DLC layer and performing the plasma treatment are performed in the same processing chamber.

7. The method of claim 1, wherein:

the substrate is maintained at a temperature from –40°C to about 40°C during the plasma treatment;

maintaining the processing volume is maintained at a pressure from about 1 mTorr to 500 mTorr during the plasma treatment; or

a combination thereof.

8. The method of claim 7, wherein, during the plasma treatment:
the temperature of the substrate is maintained at –10°C to 10°C;
the pressure of the processing volume is maintained at 5 mTorr to 100 mTorr;
or combinations thereof.

9. The method of claim 1, wherein the RF bias power is from 200 W to 5,000 W.

10. The method of claim 1, wherein an sp^3-content of the DLC layer after the plasma treatment is 60% or more, as determined by Raman spectroscopy.

11. The method of claim 1, wherein the film stress of the DLC layer is reduced by 10% to 50%, as determined by ellipsometry.

12. A method of processing a substrate, comprising:
positioning a substrate in a processing volume of a processing chamber;
depositing a diamond-like carbon (DLC) layer on the substrate; and
after depositing the DLC layer, reducing a film stress of the DLC layer by performing a plasma treatment, the plasma treatment comprising:
flowing a non-reactive gas into the processing volume at a flow rate of 500 sccm to 5,000 sccm for a 300 mm-sized substrate, the non-reactive gas comprising argon; and
generating a plasma from the non-reactive gas in the processing volume to treat the DLC layer by applying a radio frequency (RF) bias power of 100 W to 1,000 W.

13. The method of claim 12, wherein the non-reactive gas further comprises helium, N_2, or combinations thereof.

14. The method of claim 12, wherein the non-reactive gas further comprises N_2, helium, neon, krypton, xenon, radon, or combinations thereof.

15. The method of claim 14, wherein a thickness of the DLC layer is from 5 kÅ to 15 kÅ.

16. The method of claim 12, wherein the performing the plasma treatment further comprises:

maintaining the substrate at a temperature from –40°C to 40°C;

maintaining the processing volume at a pressure from 1 mTorr to 500 mTorr;

an RF bias power from 100 W to 400 W; or

combinations thereof.

17. The method of claim 16, wherein the temperature is from–10°C to 10°C, the pressure is from 5 mTorr to 100 mTorr, or a combination thereof.

18. A method of processing a substrate, comprising:

positioning a substrate in a processing volume of a processing chamber;

depositing a diamond-like carbon (DLC) layer on the substrate; and

after depositing the DLC layer, reducing a film stress of the DLC layer by performing a plasma treatment, the plasma treatment comprising:

flowing a non-reactive gas into the processing volume at a flow rate of 500 sccm to 5,000 sccm for a 300 mm-sized substrate, the non-reactive gas comprising argon and one or more of N_2 or helium;

generating a plasma from the non-reactive gas in the processing volume to treat the DLC layer by applying a radio frequency (RF) bias power of 1,000 W or less; and

maintaining the substrate at a temperature from –40°C to 40°C during the plasma treatment.

19. The method of claim 18, wherein the processing volume is at a pressure from 1 mTorr to 500 mTorr during the plasma treatment.

20. The method of claim 19, wherein, during the plasma treatment: the temperature of the substrate is from –10°C to 10°C; and the pressure is from 5 mTorr to 100 mTorr.