CLAIMS

1. A method of forming a silicon-and-carbon-containing material, the method comprising:

flowing a silicon-oxygen-and-carbon-containing precursor into a processing region of a semiconductor processing chamber, wherein a substrate is housed within the processing region of the semiconductor processing chamber, and wherein the silicon-oxygen-and-carbon-containing precursor is characterized by a carbon-to-oxygen ratio that is less than 4:1;

forming a plasma within the processing region of the silicon-oxygen-and-carbon-containing precursor, wherein the plasma is formed at a frequency below 15 MHz; and

depositing a silicon-and-carbon-containing material on the substrate, wherein the silicon-and-carbon-containing material as-deposited is characterized by a dielectric constant below or equal to 3.5, wherein a deposition rate of the silicon-and-carbon-containing material is greater than 500 Å/min, and wherein the silicon-and-carbon-containing material as-deposited is characterized by a methyl incorporation less than 2.5%.

2. The method of forming a silicon-and-carbon-containing material of claim 1, wherein the method further comprises flowing oxygen (O_2) gas into the processing region of the semiconductor processing chamber.

3. The method of forming a silicon-and-carbon-containing material of claim 1, wherein the silicon-and-carbon-containing material as-deposited is characterized by a hardness of greater than or equal to 3 GPa.

4. The method of forming a silicon-and-carbon-containing material of claim 1, wherein the plasma is formed at a frequency of less than or equal to 13.56 MHz.

5. The method of forming a silicon-and-carbon-containing material of claim 1, wherein the silicon-and-carbon-containing material as-deposited is characterized by a dielectric constant ranging from 3.1 to 3.3.

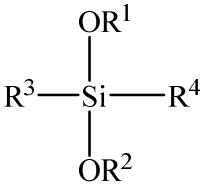
6. The method of forming a silicon-and-carbon-containing material of claim 1, wherein the silicon-and-carbon-containing material as-deposited is characterized by a hardness of greater than or equal to 5 GPa.

7. The method of forming a silicon-and-carbon-containing material of claim 1, wherein the silicon-and-carbon-containing material as-deposited is characterized by a Young's modulus of greater than or equal to 5 GPa.

8. The method of forming a silicon-and-carbon-containing material of claim 1, wherein the silicon-and-carbon-containing material as-deposited is characterized by a Si-C-Si bond incorporation less than or equal to 0.5%.

9. A method of forming a silicon-and-carbon-containing material, the method comprising:

providing a deposition precursor into a processing region of a semiconductor processing chamber, wherein a substrate is housed within the processing region of the semiconductor processing chamber, and wherein the deposition precursor is characterized by Formula 1:



wherein R^1 may include a C_1-C_6 alkyl group, such as $–CH_3$, $–CH_2CH_3$, $–CH_2CH_2CH_3$, $–CH_2CH_2CH_2CH_3$, $–CH_2CH_2CH_2CH_2CH_3$, or $–CH_2CH_2CH_2CH_2CH_2CH_3$,

R^2 may include a C_1-C_6 alkyl group, such as $–CH_3$, $–CH_2CH_3$, $–CH_2CH_2CH_3$, $–CH_2CH_2CH_2CH_3$, $–CH_2CH_2CH_2CH_2CH_3$, or $–CH_2CH_2CH_2CH_2CH_2CH_3$,

R^3 may include $–OCH_3$, $–CH_3$, –H, $–(CH_2)_nCH_3$, $–O(CH_2)_nCH_3$, $–CH=CH_2$,$–CH_2–CH_2–(CH_2CH_3)_2$, or $–CH_2–CH(CH_3)_2$, and

R^4 may include $–OCH_3$, $–CH_3$, –H, $–(CH_2)_nCH_3$, $–O(CH_2)_nCH_3$, $–CH=CH_2$, $–CH_2–CH_2–(CH_2CH_3)_2$, or $–CH_2–CH(CH_3)_2$;

forming a plasma within the processing region of the deposition precursor, wherein the plasma is formed at a frequency less than 13.56 MHz; and

depositing a silicon-and-carbon-containing material on the substrate, wherein the silicon-and-carbon-containing material as-deposited is characterized by a dielectric constant below 3.5, wherein a deposition rate of the silicon-and-carbon-containing material is greater than 500 Å/min, and wherein the silicon-and-carbon-containing material as-deposited is characterized by a hardness of greater than 3 GPa.

10. The method of forming a silicon-and-carbon-containing material of claim 9, wherein the method further comprises providing oxygen (O_2) gas into the processing region of the semiconductor processing chamber with the deposition precursor.

11. The method of forming a silicon-and-carbon-containing material of claim 9, wherein the deposition precursor is characterized by a ratio of oxygen to silicon of greater than or equal to 2.

12. The method of forming a silicon-and-carbon-containing material of claim 9, wherein the silicon-and-carbon-containing material as-deposited is characterized by a dielectric constant ranging from 3.1 to 3.3.

13. The method of forming a silicon-and-carbon-containing material of claim 9, wherein the silicon-and-carbon-containing material as-deposited is characterized by a hardness of greater than or equal to 3 GPa.

14. The method of forming a silicon-and-carbon-containing material of claim 9, wherein the silicon-and-carbon-containing material as-deposited is characterized by a Young's modulus of greater than or equal to 5 GPa.

15. The method of forming a silicon-and-carbon-containing material of claim 9, wherein the silicon-and-carbon-containing material as-deposited is characterized by a methyl incorporation less than or equal to 2.5%.

16. The method of forming a silicon-and-carbon-containing material of claim 9, wherein the silicon-and-carbon-containing material as-deposited is characterized by a Si-C-Si bond incorporation less than or equal to 0.5%.

17. A method of forming a silicon-and-carbon-containing material, the method comprising:

flowing a silicon-oxygen-and-carbon-containing precursor into a processing region of a semiconductor processing chamber, wherein a substrate is housed within the processing region of the semiconductor processing chamber;

forming a plasma within the processing region of the silicon-oxygen-and-carbon-containing precursor, wherein the plasma is formed at a frequency less than or equal to 13.56 MHz; and

depositing a silicon-and-carbon-containing material on the substrate, wherein the silicon-and-carbon-containing material as-deposited is characterized by a dielectric constant below or equal to 3.5 and a hardness of greater than or equal to 3 GPa, wherein a deposition rate of the silicon-and-carbon-containing material is greater than 500 Å/min, and wherein the silicon-and-carbon-containing material as-deposited is characterized by a methyl incorporation less than 2.5%.

18. The method of forming a silicon-and-carbon-containing material of claim 17, wherein the silicon-and-carbon-containing material as-deposited is characterized by a Young's modulus of greater than or equal to 5 GPa.

19. The method of forming a silicon-and-carbon-containing material of claim 17, wherein the silicon-and-carbon-containing material as-deposited is characterized by a Si-C-Si bond incorporation less than or equal to 0.5%.