WHAT IS CLAIMED IS:

1. A method of forming a dielectric layer on a substrate in a plasma-free substrate processing region in a substrate processing chamber, the method comprising:

flowing a nitrogen-and-hydrogen-containing gas into a plasma region to produce a radical-nitrogen precursor, wherein the nitrogen-and-hydrogen-containing gas comprises hydrogen (H_2) and nitrogen (N_2) allowing greater flexibility in choosing a nitrogen:hydrogen atomic flow ratio into the plasma region;

combining a silicon-containing precursor with the radical-nitrogen precursor in the plasma-free substrate processing region; and

depositing the dielectric layer on the substrate.

2. The method of claim 1 wherein the silicon-containing precursor is a carbon-free silicon-containing precursor.

3. The method of claim 1 wherein the silicon-containing precursor comprises at least one of silane, disilane or trisilane.

4. The method of claim 1 wherein the nitrogen:hydrogen atomic flow ratio is greater than 1:3 to improve film quality and reduce film shrinkage.

5. The method of claim 1 wherein the nitrogen:hydrogen atomic flow ratio is less than 1:3 to improve film flowability.

6. The method of claim 1 wherein the nitrogen:hydrogen atomic flow ratio is greater than or about 1:2.

7. The method of claim 1 wherein the nitrogen:hydrogen atomic flow ratio is less than or about 1:5.

8. The method of claim 1 wherein the nitrogen-and-hydrogen-containing gas is essentially devoid of ammonia.

9. The method of claim 1 wherein the nitrogen-and-hydrogen-containing gas is essentially devoid of hydrazine.

10. The method of claim 1 wherein the silicon-containing precursor comprises a silicon-and-nitrogen-containing precursor.

11. The method of claim 1 wherein the silicon-containing precursor comprises a carbon-nitrogen-and-silicon-containing precursor.

12. The method of claim 1 wherein the silicon-containing precursor comprises at least one of $H_2N(SiH_3)$, $HN(SiH_3)_2$ or $N(SiH_3)_3$.

13. The method of claim 1, wherein the dielectric layer comprises a carbon-free Si-N-H layer.

14. The method of claim 1 further comprising an operation of curing the dielectric layer by maintaining a temperature of the substrate at a curing temperature less than or about 400°C in an ozone-containing atmosphere.

15. The method of claim 1, wherein the plasma region is a partitioned portion of the substrate processing chamber separated from the plasma-free substrate processing region by a showerhead.

What is claimed is:

1. A method of forming a dielectric layer on a substrate in a plasma-free substrate processing region in a substrate processing chamber, the method comprising:

flowing precursors comprising hydrogen (H_2) and nitrogen (N_2) into a plasma region to produce a radical precursor, wherein a nitrogen:hydrogen atomic flow ratio into the plasma region is less than 1:3, and wherein the precursors are devoid of ammonia;

combining a vapor or gas silicon-containing precursor with the radical-nitrogen precursor in the plasma-free substrate processing region; and

depositing the dielectric layer on the substrate, wherein the dielectric layer is initially flowable as deposited.

2. The method of claim **1** wherein the vapor or gas silicon-containing precursor is a carbon-free silicon-containing precursor.

3. The method of claim **1** wherein the vapor or gas silicon-containing precursor comprises at least one of silane, disilane or trisilane.

4. The method of claim **1** wherein the nitrogen:hydrogen atomic flow ratio is greater than or about 1:2.

5. The method of claim **1** wherein the nitrogen:hydrogen atomic flow ratio is less than or about 1:5.

6. The method of claim **1** wherein the precursors are devoid of hydrazine.

7. The method of claim **1** wherein the vapor or gas silicon-containing precursor comprises a silicon-and-nitrogen-containing precursor.

8. The method of claim **1** wherein the vapor or gas silicon-containing precursor comprises a carbon-nitrogen-and-silicon-containing precursor.

9. The method of claim **1** wherein the vapor or gas silicon-containing precursor comprises at least one of $H_2N(SiH_3)$, $HN(SiH_3)_2$ or $N(SiH_3)_3$.

10. The method of claim **1**, wherein the dielectric layer comprises a carbon-free Si—N—H layer.

11. The method of claim **1** further comprising an operation of curing the dielectric layer by maintaining a temperature of the substrate at a curing temperature less than or about 400° C. in an ozone-containing atmosphere.

12. The method of claim **1** further comprising raising a temperature of the substrate to an oxygen anneal temperature above or about 600° C. in an oxygen-containing atmosphere.

13. The method of claim **12**, wherein the oxygen-containing atmosphere comprises one or more gases selected from the group consisting of atomic oxygen, ozone, and steam (H_2O).

14. The method of claim **1**, wherein the substrate is patterned and has a trench having a width of about 50 nm or less which is filled by the dielectric layer.

15. The method of claim **14**, wherein the dielectric layer in the trench is substantially void-free.

16. The method of claim **1**, wherein the plasma region is in a remote plasma system.

17. The method of claim **1**, wherein the plasma region is a partitioned portion of the substrate processing chamber separated from the plasma-free substrate processing region by a showerhead.

18. A method of forming a dielectric layer on a substrate in a plasma-free substrate processing region in a substrate processing chamber, the method comprising:

flowing hydrogen (H_2) and nitrogen (N_2) into a plasma region to produce a radical precursor, wherein a nitrogen:hydrogen atomic flow ratio into the plasma region is less than 1:3;

combining a vapor or gas silicon-containing precursor with the radical-nitrogen precursor in the plasma-free substrate processing region;

depositing a dielectric on the substrate, wherein the dielectric is initially flowable as deposited;

increasing a flow rate of nitrogen into the plasma region to increase the nitrogen:hydrogen atomic flow ratio;

depositing an additional dielectric on the substrate; and

curing the deposited dielectric in an oxygen environment to produce a silicon oxide film.

19. The method of claim **18**, wherein during the curing operation the silicon oxide film shrinks by about 17 vol. % or less.

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