WHAT IS CLAIMED IS:

1. A method of forming a silicon oxide layer, the method comprising:
mixing a carbon-free silicon-and-nitrogen containing precursor with a radical precursor;
depositing a silicon-and-nitrogen containing layer on a substrate; and
converting the silicon-and-nitrogen containing layer to the silicon oxide layer.

2. The method of claim 1 wherein the radical precursor is a radical-nitrogen precursor.

3. The method of claim 1 wherein the radical precursor comprises hydrogen but essentially no nitrogen.

4. The method of claim 1 wherein the carbon-free silicon-and-nitrogen containing precursor comprises a silyl-amine.

5. The method of claim 4 wherein the silyl-amine comprises $N(SiH_3)_3$.

6. The method of claim 1 wherein the radical precursor is generated from a nitrogen-and-hydrogen containing gas using a plasma before being mixed with the carbon-free silicon-and-nitrogen containing precursor.

7. The method of claim 6 wherein the nitrogen-and-hydrogen containing gas comprises a gas selected from the group consisting of hydrazine, ammonia, N_2 and H_2.

8. The method of claim 1 wherein the silicon-and-nitrogen containing layer is converted to the silicon oxide layer by exposing the silicon-and-nitrogen containing layer to an oxygen-containing atmosphere.

9. The method of claim 8 wherein the oxygen-containing atmosphere comprises one or more gases selected from the group consisting of oxygen (O_2), ozone (O_3), and steam (H_2O).

10. A method of forming a silicon oxide layer with reduced volume shrinkage, the method comprising:
providing a substrate containing a least one gap;

depositing a carbon-free silicon-and-nitrogen containing layer on the substrate; and

heating the substrate in an oxygen-containing atmosphere to convert the carbon-free silicon-and-nitrogen containing layer to the silicon oxide layer, wherein the silicon oxide layer retains a volume of about 85% or more of the carbon-free silicon-and-nitrogen containing layer deposited in the gap.

11. The method of claim 10 wherein the carbon-free silicon-and-nitrogen containing layer is deposited on the substrate by the reaction of a silicon-and-nitrogen precursor with a radical precursor.

12. The method of claim 11 wherein the silicon-and-nitrogen precursor comprises $N(SiH_3)_3$ and the radical precursor is formed from plasma-activated NH_3.

13. The method of claim 10 wherein the carbon-free silicon-and-nitrogen containing layer comprises a Si-N-H layer.

14. The method of claim 10 wherein the substrate gap has a width of about 50 nm or less.

15. The method of claim 10 wherein the silicon oxide layer in the gap is substantially void-free.

What is claimed is:

1. A method of forming a silicon oxide layer, the method comprising:

generating a radical precursor in a remote plasma system then flowing the radical precursor through a perforated partition into a deposition chamber;

mixing a carbon-free silicon-and-nitrogen containing precursor with the radical precursor;

depositing a flowable silicon-and-nitrogen containing layer on a substrate; and

converting the flowable silicon-and-nitrogen containing layer to the silicon oxide layer, wherein

the conversion of the flowable silicon-and-nitrogen containing layer into the silicon oxide layer results in a silicon oxide layer with less pore formation and less volume shrinkage than silicon oxide layers produced by conventional SOG techniques.

2. The method of claim 1 wherein the radical precursor is a radical-nitrogen precursor.

3. The method of claim 1 wherein the radical precursor comprises hydrogen but essentially no nitrogen.

4. The method of claim 1 wherein the carbon-free silicon-and-nitrogen containing precursor comprises a silyl-amine.

5. The method of claim 4 wherein the silyl-amine comprises $N(SiH_3)_3$.

6. The method of claim 1 wherein the radical precursor is generated from a nitrogen-and-hydrogen containing gas using a plasma before being mixed with the carbon-free silicon-and-nitrogen containing precursor.

7. The method of claim 6 wherein the nitrogen-and-hydrogen containing gas comprises a gas selected from the group consisting of hydrazine, ammonia, N_2 and H_2.

8. The method of claim 1 wherein the silicon-and-nitrogen containing layer comprises a carbon-free Si--N--H layer.

9. The method of claim 1 wherein the silicon-and-nitrogen containing layer is converted to the silicon oxide layer by exposing the silicon-and-nitrogen containing layer to an oxygen-containing atmosphere.

10. The method of claim 9 wherein the oxygen-containing atmosphere comprises one or more gases selected from the group consisting of oxygen, ozone, and steam.

11. A plasma chemical vapor deposition method of forming a silicon oxide layer, the method comprising:

introducing a carbon-free silicon-and-nitrogen containing precursor, and a radical precursor to a reaction chamber containing a substrate;

forming a plasma from a mixture comprising the carbon-free silicon-and-nitrogen containing precursor and the radical precursor;

depositing a flowable silicon-and-nitrogen containing layer on the substrate from the plasma; and

converting the flowable silicon-and-nitrogen containing layer into the silicon oxide layer, wherein

the conversion of the flowable silicon-and-nitrogen containing layer into the silicon oxide layer results in a silicon oxide layer with less pore formation and less volume shrinkage than silicon oxide layers produced by conventional SOG techniques.

12. The method of claim 11 wherein the radical precursor is generated in a remote plasma system before being introduced to the reaction chamber.

13. The method of claim 12 wherein the radical precursor is generated from a plasma formed from a gas comprising at least one of hydrazine, NH_3, N_2 and H_2.

14. The method of claim 11 wherein the carbon-free silicon-and-nitrogen containing precursor comprises $N(SiH_3)_3$.

15. The method of claim 11 wherein the silicon-and-nitrogen containing layer comprises a carbon-free Si--N--H layer.

16. The method of claim 11 wherein the flowable silicon-and-nitrogen containing layer is converted to the silicon oxide layer by heating the flowable silicon-and-nitrogen containing layer in an oxygen-containing atmosphere.

17. The method of claim 11, wherein the silicon oxide layer has a volume of about 85% or more of the flowable silicon-and-nitrogen containing layer.