CLAIMS

1. A method comprising:

forming a film stack on a substrate, the film stack comprising a plurality of alternating layers of an oxide material and a nitride material and the film stack having a stack thickness;

etching the film stack to a first depth to form an opening with at least one sidewall and a bottom, the first depth being less than the thickness;

depositing a non-conformal liner on the at least one sidewall and the bottom of the opening, the non-conformal liner on the bottom of the opening having a thickness less than a thickness of the non-conformal liner on the at least one sidewall of the opening;

etching the non-conformal liner from the bottom of the opening to reduce the thickness of the non-conformal liner on the bottom of the opening;

selectively etching the film stack relative to the non-conformal liner to a second depth to form a hole; and

annealing the film stack in an oxidizing atmosphere to remove the non-conformal liner.

2. The method of claim 1, wherein the stack thickness is in a range of about 1 μM to about 10 μM.

3. The method of claim 1, further comprising forming a patterned hard mask on the film stack before etching.

4. The method of claim 3, wherein openings in the patterned hard mask expose portions of the film stack to be etched.

5. The method of claim 4, wherein the openings in the patterned hard mask have a width in a range of about 1 nm to about 3000 nm.

6. The method of claim 1, wherein the non-conformal liner comprises one or more of boron, carbon, or nitrogen.

7. The method of claim 1, wherein the non-conformal liner is deposited by chemical vapor deposition.

8. The method of claim 1, wherein the non-conformal liner is formed by exposing the substrate to a boron-containing precursor and a reactant.

9. The method of claim 1, wherein the hole comprises one or more of a memory hole or a word line slit .

10. The method of claim 1, wherein the second depth is in a range of about 1 μM to about 10 μM.

11. The method of claim 1, wherein the hole has a reduced bow critical dimension of about 50 nm.

12. The method of claim 1, wherein the non-conformal liner has a thickness in a range of about 1 nm to about 50 nm.

13. The method of claim 1, wherein the non-conformal liner is completely removed from the bottom of the opening.

14. The method of claim 1, wherein the annealing is performed at a temperature greater than or equal to about 500 °C.

15. A method comprising:

forming a film stack on a substrate, the film stack comprising a plurality of alternating layers of an oxide material and a nitride material and the film stack having a stack thickness;

forming a patterned hard mask on the film stack;

etching the film stack through the hard mask to a first depth to form an opening with at least one sidewall and a bottom surface, the first depth being less than the stack thickness;

depositing a non-conformal liner by atomic layer deposition on the at least one sidewall and the bottom surface of the opening, the non-conformal liner on the

bottom surface of the opening having a thickness less than a thickness of the non-conformal liner on the at least one sidewall of the opening, the non-conformal liner comprising one or more of boron, nitrogen, or carbon;

etching the non-conformal liner from the bottom surface of the opening to reduce the thickness of the non-conformal liner on the bottom surface of the opening;

selectively etching the film stack relative to the non-conformal liner to a second depth to form a hole; and

performing an anneal of the substrate to remove the non-conformal liner, wherein the anneal is performed in an oxidizing atmosphere.

16. The method of claim 15, wherein the non-conformal liner is formed by exposing the substrate to a boron-containing precursor and a reactant.

17. The method of claim 16, wherein the non-conformal liner has a thickness in a range of about 1 nm to about 50 nm.

18. The method of claim 15, wherein the anneal is performed at a temperature greater than or equal to about 400 °C.

19. The method of claim 15, wherein the non-conformal liner is completely removed from the bottom surface of the opening.