CLAIMS

1. A method comprising:

providing a substrate having alternating oxide layers and nitride layers arranged in a staircase pattern comprising exposed horizontal nitride surfaces and exposed oxide and nitride sidewall surfaces;

depositing a silicon nitride (SiN) layer over the alternating oxide and nitride layers by a plasma enhanced chemical vapor deposition (PECVD) process using a plasma generated from a process gas comprising a silicon-containing precursor; and

treating the SiN layer to selectively densify the SiN layer deposited on the exposed horizontal nitride surfaces.

2. The method of claim 1, further comprising wet etching the treated SiN layer to form discrete SiN pads.
3. The method of claim 1, wherein the deposition and treating operations are performed in the same chamber.
4. The method of claim 1, wherein treating the SiN layer comprises exposing the substrate to a capacitively-coupled plasma generated.
5. The method of claim 1, wherein performing the depositing and treating operations comprises performing multiple cycles of depositing a portion of conformal SiN layer followed by treating the deposited portion.
6. The method of claim 5, wherein the conformal SiN layer comprises multiple sub-layers, wherein at least two sub-layers have different wet etch rates (WERs).
7. The method of claim 6, wherein one of the multiple sub-layers is an etch stop (ES) sub-layer having a lower WER than the other sub-layer or sub-layers of the multiple sub-layers.
8. The method of claim 7, wherein the ES layer has a WER of no more than 50 Å/min in a wet etchant.
9. The method of claim 7 or 8, wherein one of the multiple sub-layers is a sub-layer having a WER of at least 100 Å/min in a wet etchant.
10. The method of claim 8, wherein the ES sub-layer is disposed between two sub-layers each being thicker than the ES sub-layer and having a WER greater than the ES sub-layer.
11. The method of claim 7, wherein the ES sub-layer is the top layer of the SiN layer.
12. The method of claim 1, wherein the SiN layer is deposited from silane (SiH_4) and ammonia (NH_3).
13. The method of claim 12, wherein the SiH_4 and NH_3 are in a process gas that further comprises nitrogen (N_2).

14. The method of claim 2, wherein a discrete SiN pad is at least 10 nm from the near sidewall surface.

15. The method of claim 2, wherein a discrete SiN pad is at least 10 nm thick.

16. The method of claim 1, further comprising replacing the nitride layers with tungsten wordlines.

17. The method of claim 2, further comprising replacing the SiN pads with tungsten landing pads.

18. The method of claim 7, wherein the multiple sub-layers comprise a first sub-layer having a first WER and a second sub-layer having a second WER, wherein the second sub-layer is deposited on the first sub-layer and wherein the second WER is higher than the first WER.

19. The method of claim 1, wherein treating the SiN layer comprises exposing it to a low-frequency plasma.

20. The method of claim 1, wherein chamber pressure during the PECVD process ranges from 5 to 20 Torr.

21. The method of claim 1, further comprising pulsing RF power during the PECVD process.

22. The method of claim 1, wherein the step coverage of the SiN layer is between 70 and 90%.

23. A method comprising:

providing a substrate having horizontal and sidewall surfaces;

depositing a silicon nitride (SiN) layer over the horizontal and sidewall surfaces by a plasma enhanced chemical vapor deposition (PECVD) process using a plasma generated from a process gas comprising a silicon-containing precursor; and

treating the SiN layer to selectively densify the conformal SiN layer deposited on the horizontal surfaces.

24. The method of claim 23, further comprising wet etching the treated layer to form discrete SiN pads.

25. A method comprising:

providing a substrate having horizontal and sidewall surfaces;

performing one or more first cycles to form a first sub-layer, each of the one or more first cycles comprising:

depositing an amount of SiN on the horizontal and sidewall surfaces by PECVD and exposing the deposited amount of SiN to a capacitively coupled plasma generated from an inert gas;

performing one or more second cycles to form an etch stop sub-layer, each of the one or more second cycles comprising:

depositing an amount of SiN on the first sub-layer by PECVD and exposing the deposited amount of SiN to a capacitively coupled plasma generated from an inert gas using low frequency radio frequency (LFRF) power.

26. The method of claim 25, wherein the LFRF power in the one or more second cycles is greater than the LFRF power, if any, in the one or more first cycles.

27. An apparatus comprising:

a PECVD deposition chamber including a LFRF plasma generator and a HFRF plasma generator; and a controller comprising instructions to perform the method of any of claims 1-26.