Claims

Claim 1. A method of forming a plug comprising:

providing a base layer;

providing an intermediate oxide layer above an upper surface of the base layer;

providing an upper layer above an upper surface of the intermediate oxide layer;

etching a trench including a first trench portion extending through the upper layer, a second trench portion extending through the oxide layer, and a third trench portion extending into the base layer;

depositing a first material portion within the third trench portion;

depositing a second material portion within the second trench portion; and

depositing a third material portion within the first trench portion.

Claim 2. The method of claim 1, further comprising:

etching a fourth trench portion within the oxide layer and directly below an un-etched area of the upper layer.

Claim 3. The method of claim 2, wherein etching a fourth trench portion comprises:

performing an isotropic oxide etch.

Claim 4. The method of claim 1, further comprising:

etching a fifth trench portion within the base layer and directly below an un-etched area of the oxide layer.

Claim 5. The method of claim 4, wherein etching a fifth trench portion comprises:

performing an isotropic silicon etch.

Claim 6. The method of claim 1, wherein:

the method further comprises etching a fifth trench portion within the base layer, and a sixth trench portion within the oxide layer;

the fifth trench portion and the sixth trench portion are straight below an un-etched area of the upper layer;

depositing a first material portion within the third trench portion comprises depositing the first material portion within the fifth trench portion; and

depositing a second material portion within the second trench portion comprises depositing the second material portion within the sixth trench portion, such that the maximum width of the first material and the maximum width of the second material is greater than the maximum width of the third material when viewed in cross section.

Claim 7. The method of claim 1, wherein the first material portion, the second material portion, and the third material portion comprise silicon nitride.

Claim 8. The method of claim 1, further comprising:

release etching at least a portion of the intermediate oxide layer adjacent to the second material.

Claim 9. A wafer comprising:

a base layer;

an intermediate oxide layer above an upper surface of the base layer;

an upper layer above an upper surface of the intermediate oxide layer;

a trench including a first trench portion extending through the upper layer, a second trench portion extending through the oxide layer, and a third trench portion extending only partially into the base layer; and

a plug, the plug including

a first material portion deposited within the third trench portion;

a second material portion deposited within the second trench portion; and

a third material portion deposited within the first trench portion.

Claim 10. The wafer of claim 9, further comprising:

a fourth trench portion within the oxide layer and directly below an un-etched area of the upper layer, wherein the plug further comprises:

a fourth material portion deposited within the fourth trench portion.

Claim 11. The wafer of claim 10, wherein the intermediate oxide layer is a silicon oxide layer.

Claim 12. The wafer of claim 9, further comprising:

a fifth trench portion within the base layer and directly below an un-etched area of the oxide layer.

Claim 13. The wafer of claim 12, wherein the base layer is a silicon substrate

Claim 14. The wafer of claim 9, further comprising:

a fifth trench portion within the base layer;

a sixth trench portion within the oxide layer and directly below an un-etched area of the upper layer;

a fourth material portion located within the fifth trench portion; and

a fifth material portion located within the sixth trench portion , wherein

the fifth and sixth trench portions are straight below the un-etched area of the upper layer, and

the maximum width of the combined first material and fourth material within the base layer, and the maximum width of the combined second material and fifth material within the intermediate oxide layer, are greater than the maximum width of the third material within the upper layer when viewed in cross section.

Claim 15. The wafer of claim 9, wherein the first material portion, the second material portion, and the third material portion comprise silicon nitride.

Claim 16. The wafer of claim 9, wherein at least a portion of an outermost surface of the second material portion is not in contact with the intermediate oxide layer.

The invention claimed is:

1. A method of forming a plug comprising: providing a base layer; providing an intermediate oxide layer above an upper surface of the base layer; providing an upper layer above an upper surface of the intermediate oxide layer; etching a first trench including a first trench portion extending through the upper layer, a second trench portion extending through the intermediate oxide layer, and a third trench portion extending into the base layer; depositing a first material portion within the third trench portion; depositing a second material portion within the second trench portion; depositing a third material portion within the first trench portion; and release etching at least a portion of the intermediate oxide layer adjacent to the second material.

2. The method of claim 1, wherein etching the first trench further comprises: etching a fourth trench portion within the intermediate oxide layer and directly below an un-etched area of the upper layer.

3. The method of claim 2, wherein etching a fourth trench portion comprises: performing an isotropic oxide etch.

4. The method of claim 1, wherein etching the first trench further comprises: etching a fifth trench portion within the base layer and directly below an un-etched area of the intermediate oxide layer.

5. The method of claim 4, wherein etching a fifth trench portion comprises: performing an isotropic silicon etch.

6. The method of claim 1, wherein: etching the first trench further comprises etching a fifth trench portion within the base layer, and a sixth trench portion within the intermediate oxide layer; the fifth trench portion and the sixth trench portion are straight below an un-etched area of the upper layer; depositing a first material portion within the third trench portion comprises depositing the first material portion within the fifth trench

portion; and depositing a second material portion within the second trench portion comprises depositing the second material portion within the sixth trench portion, such that the maximum width of the first material and the maximum width of the second material is greater than the maximum width of the third material when viewed in cross section.

7. The method of claim 1, wherein the first material portion, the second material portion, and the third material portion comprise silicon nitride.

8. The method of claim 1, wherein etching a first trench further comprises etching a fourth trench portion in an upper oxide layer above an upper surface of the upper layer, the method further comprising: depositing a fourth material portion within the fourth trench portion.

9. The method of claim 8, further comprising: release etching at least a portion of the upper oxide layer adjacent to the fourth material.

10. The method of claim 9, wherein etching the first trench further comprises: etching a fifth trench portion within the base layer and directly below an un-etched area of the upper oxide layer.

11. The method of claim 10, further comprising: depositing a fifth material directly above the un-etched area of the upper oxide layer.

12. The method of claim 9, wherein depositing the second material comprises: depositing a portion of the second material portion at a location directly below an un-etched portion of the upper layer.

13. The method of claim 12, wherein depositing the fourth material comprises: depositing a portion of the fourth material portion at a location directly above the un-etched portion of the upper layer.

14. The method of claim 8, further comprising: etching a second trench through the upper oxide layer, the upper layer, the intermediate oxide layer and into the base layer; and depositing a fifth material within the second trench, wherein release etching the at least a portion of the intermediate oxide layer adjacent to the second material comprises release etching all of the intermediate oxide layer between second material and the fifth material.

15. The method of claim 14, further comprising: release etching all of the upper oxide layer between the fourth material and the fifth material.

16. A method of forming a plug comprising: providing a base layer; providing an intermediate oxide layer above an upper surface of the base layer; providing an upper layer above an upper surface of the intermediate oxide layer; etching a trench including a first trench portion extending through the upper layer, a second trench portion extending through the intermediate oxide layer, a third trench portion extending into the base layer a fourth trench portion within the base layer straight below an un-etched area of the upper layer, and a fifth trench portion within the intermediate oxide layer straight below the un-etched area of the upper layer; depositing a first material portion within the third trench portion and the fourth trench portion; depositing a second material portion within the second trench portion and the fifth trench portion; and depositing a third material portion within the first trench portion, such that the maximum width of the first material and the maximum width of the second material is greater than the maximum width of the third material when viewed in cross section.

17. The method of claim 16, wherein etching the fifth trench portion comprises: performing an isotropic oxide etch.

18. The method of claim 16, wherein etching the fourth trench portion comprises: performing an isotropic silicon etch.

19. The method of claim 16, wherein the first material portion, the second material portion, and the third material portion comprise silicon nitride.

20. The method of claim 16, further comprising: release etching at least a portion of the intermediate oxide layer adjacent to the second material.