CLAIMS

What is claimed is:

1. A method for forming a contact hole in a semiconductor device, comprising:

measuring a percentage of oxygen in an etching chamber; and

controlling the percentage of oxygen in the etching chamber to enlarge a temporary inner diameter near a top of the contact hole.

2. A method as defined in Claim 1 wherein the enlarged temporary inner diameter near the top of the contact hole increases a flow of etchant to a bottom of the contact hole.

3. A method as defined in Claim 1 wherein the enlarged temporary inner diameter near the top of the contact hole is less than a developed critical dimension (DCD).

4. A method as defined in Claim 1 wherein the enlarged temporary inner diameter near the top of the contact hole is less than a final critical dimension (FCD).

5. A method as defined in Claim 1, further comprising:

determining an optimal flow of etchant to a bottom of the contact hole,

wherein the percentage of oxygen is controlled to optimize the flow of etchant to the bottom of the contact hole.

6. A method as defined in Claim 1, further comprising:

comparing the temporary inner diameter near the top of the contact hole with a developed critical dimension (DCD),

wherein the percentage of oxygen is controlled to increase the dimension near the top of the contact hole without reaching the DCD.

7. A method as defined in Claim 1 wherein:

the contact hole is one of a plurality of contact holes; and

the percentage of oxygen is controlled to substantially equalize the temporary inner diameters near the tops of each of the plurality of contact holes, respectively.

8. A method as defined in Claim 1 wherein enlarging the top of the contact hole reduces a residue restriction near the top of the contact hole.

9. A method as defined in Claim 1 wherein enlarging the top of the contact hole reduces a polymer or polymer-like restriction near the top of the contact hole.

10. A method as defined in Claim 1, further comprising:

comparing a polymer-restricted dimension near the top of the contact hole with a developed critical dimension (DCD),

wherein the percentage of oxygen is controlled to reduce without eliminating the polymer restriction.

11. A method as defined in Claim 1 wherein:

the contact hole is one of a plurality of contact holes; and

the percentage of oxygen is controlled to substantially equalize polymer restrictions in each of the plurality of contact holes, respectively.

12. A method as defined in Claim 1 wherein controlling the percentage of oxygen takes place in a transition step after a first oxide etch and before a second oxide etch.

13. A method as defined in Claim 1 wherein controlling the percentage of oxygen comprises controlling the ratio of carbon-fluoride (C4F6) gas to oxygen (O2) gas.

14. A method as defined in Claim 1, further comprising:

controlling a process time for each of a plurality of flow rates through the enlarging temporary inner diameter near the top of the contact hole,

wherein the oxygen percentage and process time are control variables optimized to obtain a desired final critical dimension (FCD) at the bottom of the contact hole.

15. A method as defined in Claim 1 wherein a resulting critical dimension at the top of the contact hole is no greater than a developed critical dimension (DCD) at the top of the contact hole.

16. A method as defined in Claim 1 wherein a declination angle between a developed critical dimension (DCD) at the top of the contact hole and a final critical dimension (FCD) at the bottom of the contact hole is no less than 88 degrees.

17. A method as defined in Claim 1 wherein a final critical dimension (FCD) at a bottom of the contact hole is large enough to substantially prevent open circuit failures.

18. A method as defined in Claim 1 wherein the semiconductor device is a 45nm device and the final critical dimension (FCD) at a bottom of the contact hole is at least 50nm.

19. A method as defined in Claim 1, further comprising:

controlling a process time for each of a plurality of flow rates through the enlarging temporary inner diameter near the top of the contact hole,

wherein the oxygen percentage and process time are control variables optimized to obtain a desired final critical dimension (FCD) at the bottom of the contact hole, and

wherein the oxygen percentage and process time control variables are further optimized to obtain a resulting critical dimension at the top of the contact hole.

20. A method as defined in Claim 1 wherein a resulting critical dimension at the top of the contact hole is small enough to prevent short circuit failures.

21. A method as defined in Claim 1 wherein the semiconductor device is a 45nm device and a resulting critical dimension at the top of the contact hole is less than 65nm.

22. A computer-readable storage medium, readable by a machine to implement program steps for forming a contact hole in a semiconductor device, the program steps comprising:

measuring a percentage of oxygen in an etching chamber; and

controlling the percentage of oxygen in the etching chamber to enlarge a temporary inner diameter near a top of the contact hole.

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controlling the percentage of oxygen in the etching chamber to enlarge a temporary inner diameter near a top of the contact hole.

2. A method as defined in claim 1 wherein the enlarged temporary inner diameter near the top of the contact hole increases a flow of etchant to a bottom of the contact hole.

3. A method as defined in claim 1 wherein the enlarged temporary inner diameter near the top of the contact hole is less than a developed critical dimension (DCD).

4. A method as defined in claim 1 wherein the enlarged temporary inner diameter near the top of the contact hole is less than a final critical dimension (FCD).

5. A method as defined in claim 1, further comprising:

determining an optimal flow of etchant to a bottom of the contact hole, wherein the percentage of oxygen is controlled to optimize the flow of

etchant to the bottom of the contact hole.

6. A method as defined in claim 1, further comprising:

comparing the temporary inner diameter near the top of the contact hole with a developed critical dimension (DCD),

wherein the percentage of oxygen is controlled to increase the dimension near the top of the contact hole without reaching the DCD.

7. A method as defined in claim 1 wherein:

the contact hole is one of a plurality of contact holes; and

the percentage of oxygen is controlled to substantially equalize the temporary inner diameters near the tops of each of the plurality of contact holes, respectively.

8. A method as defined in claim 1 wherein enlarging the top of the contact hole reduces a residue restriction near the top of the contact hole.

9. A method as defined in claim 1 wherein enlarging the top of the contact hole reduces a polymer or polymer-like restriction near the top of the contact hole.

10. A method as defined in claim 1, further comprising:

comparing a polymer-restricted dimension near the top of the contact hole with a developed critical dimension (DCD),

wherein the percentage of oxygen is controlled to reduce without eliminating the polymer restriction.

11. A method as defined in claim 1 wherein:

the contact hole is one of a plurality of contact holes; and

the percentage of oxygen is controlled to substantially equalize polymer restrictions in each of the plurality of contact holes, respectively.

12. A method as defined in claim 1 wherein controlling the percentage of oxygen takes place in a transition step after a first oxide etch and before a second oxide etch.

13. A method as defined in claim 1 wherein controlling the percentage of oxygen comprises controlling the ratio of carbon-fluoride (C4F6) gas to oxygen (O2) gas.

14. A method as defined in claim 1, further comprising:

controlling a process time for each of a plurality of flow rates through the enlarging temporary inner diameter near the top of the contact hole,

wherein the oxygen percentage and process time are control variables optimized to obtain a desired final critical dimension (FCD) at the bottom of the contact hole.

15. A method as defined in claim 1 wherein a resulting critical dimension at the top of the contact hole is no greater than a developed critical dimension (DCD) at the top of the contact hole.

16. A method as defined in claim 1 wherein a declination angle between a developed critical dimension (DCD) at the top of the contact hole and a final critical dimension (FCD) at the bottom of the contact hole is no less than 88 degrees.

17. A method as defined in claim 1 wherein a final critical dimension (FCD) at a bottom of the contact hole is large enough to substantially prevent open circuit failures.

18. A method as defined in claim 1 wherein the semiconductor device is a 45 nm device and the final critical dimension (FCD) at a bottom of the contact hole is at least 50 nm.

19. A method as defined in claim 1, further comprising:

controlling a process time for each of a plurality of flow rates through the enlarging temporary inner diameter near the top of the contact hole,

wherein the oxygen percentage and process time are control variables optimized to obtain a desired final critical dimension (FCD) at the bottom of the contact hole, and

wherein the oxygen percentage and process time control variables are

further optimized to obtain a resulting critical dimension at the top of the contact hole.

20. A method as defined in claim 1 wherein a resulting critical dimension at the top of the contact hole is small enough to prevent short circuit failures.

21. A method as defined in claim 1 wherein the semiconductor device is a 45 nm device and a resulting critical dimension at the top of the contact hole is less than 65 nm.