CLAIMS

1. A method for sidewall roughness control and structural defect reduction of features on a substrate for use in semiconductor manufacturing, the method comprising:

alternating steps of conformal deposition and angled particle beam etching;

wherein the deposition is with Atomic Layer Deposition, ALD; and

wherein the angled particle beam etching comprises adjusting the tilt angle of a particle beam for etching of at least one sidewall of the features.

2. The method of claim 1, further comprising a self-limiting reaction including one or more of chemisorption, deposition, extraction, oxidation, nitridation, and conversion.

3. The method of claim 1, wherein the particle beam comprises neutrals, radicals, photons, ions, electrons, or a combination thereof.

4. The method of claim 1, wherein the tilt angle of the particle beam ranges from 0-85 degrees from the angle of the normal of the substrate.

5. The method of claim 1, wherein the sidewall roughness control and structural defect reduction comprise adjusting the tilt angle of the particle beam during angled etching or self-limiting reaction, or a combination thereof.

6. The method of claim 5, wherein the deposition or etching or self-limiting reactions or their combination are selectively applied to specific areas.

7. The method of claim 1, wherein the features and particle beam are rotated with respect to each other during the angled etching.

8. The method of claim 1, wherein the angled etching is performed using atomic layer etching, ALE.

9. The method of claim 1, wherein the etch process is selective to silicon.

10. The method of claim 9, wherein the etch process is selective to silicon oxide.

11. The method of claim 1, wherein the deposited material is amorphous or glasslike.

12. The method of claim 1, wherein the beam particles have a lower atomic mass than at least one of the components of the exposed surface.

13. The method of claim 1, wherein the process further includes rapid surface temperature cycling.

14. The method of laim 1, wherein the deposited material is the same as the material being etched.