

CLAIMS

1. A method for forming copper filled through silicon via features in a silicon wafer, comprising:
 - etching through silicon vias in the silicon wafer;
 - 5 forming an insulation layer within the through silicon vias;
 - forming a barrier layer within the through silicon vias;
 - depositing an oxide free silicon, germanium, or SiGe adhesion layer over the barrier layer;
 - 10 depositing a seed layer over the oxide free silicon, germanium, or SiGe adhesion layer;
 - annealing a stack comprising the insulation layer, the barrier layer, the oxide free silicon, germanium or SiGe adhesion layer and the seed layer;
 - filling the through silicon vias with copper or copper alloy; and
 - annealing a stack comprising the insulation layer, the barrier layer, the oxide free silicon, germanium or SiGe adhesion layer, the seed layer and the copper or copper alloy.
 - 15
2. The method, as recited in claim 1, further comprising providing a chemical mechanical polishing of the silicon wafer.
3. A method for forming copper filled features in a silicon layer, comprising:
 - forming a barrier layer within features in the silicon layer;
 - 20 depositing a silicon, germanium, or SiGe adhesion layer over the barrier layer;
 - depositing a seed layer over the silicon, germanium, or SiGe adhesion layer;
 - filling the features with copper or copper alloy; and
 - annealing the features.
4. The method, as recited in claim 3, wherein the filling the features with copper or copper alloy is an electroless deposition process or electroplating process.
- 25
5. The method, as recited in claim 4, further comprising depositing an insulator layer within the features before forming the barrier layer.

6. The method, as recited in claim 5, wherein the features are through silicon via features.
7. The method, as recited in claim 6, further comprising etching features in the silicon layer.
- 5 8. The method, as recited in claim 7, wherein the silicon, germanium, or SiGe adhesion layer is oxide free.
9. The method, as recited in claim 8, wherein the annealing is performed after filling the features.
- 10 10. The method, as recited in claim 9, providing a chemical mechanical polishing after the annealing.
11. The method, as recited in claim 8, wherein the annealing is performed after depositing the seed layer and before filling the features.
12. The method, as recited in claim 11, further comprising providing a chemical mechanical polishing after filling the features.
- 15 13. The method, as recited in claim 12, further comprising providing a second anneal after filling the features.
14. The method, as recited in claim 3, wherein the features are through silicon via features.
15. The method, as recited in claim 3, further comprising etching features in the silicon layer.
- 20 16. The method, as recited in claim 3, wherein the adhesion layer is oxide free.
17. The method, as recited in claim 3, wherein the annealing is performed after filling the features.
18. The method, as recited in claim 17, providing a chemical mechanical polishing after the annealing.
- 25 19. The method, as recited in claim 3, wherein the annealing is performed after depositing the seed layer and before filling the features.