Claims

What is claimed is:

Claim 1. A semiconductor structure, comprising:

a first substrate; and

a first adhesive/bonding stack on a surface of said first substrate, wherein said first adhesive/bonding stack comprises a first adhesive layer and a first bonding layer, and materials of said first adhesive layer and said first bonding layer are different, a material of said first bonding layer comprises dielectric material of silicon, nitrogen and carbon, and a material of said first adhesive layer comprises dielectric material of silicon and nitrogen,

wherein said first adhesive layer is between said first substrate and said first bonding layer, an atomic concentration of carbon in said first bonding layer is larger than 0% and smaller than 50%,

wherein thickness of said first bonding layer is larger than thickness of said first adhesive layer, and

wherein an atomic concentration of carbon in said first bonding layer gradually changes in a direction of thickness of said first bonding layer.

Claim 2. The semiconductor structure of claim 1, wherein said first adhesive layer further includes carbon, and an atomic concentration of carbon in said first adhesive layer is smaller than said atomic concentration of carbon in said first bonding layer.

Claim 3. The semiconductor structure of claim 1, wherein an atomic concentration of silicon in said first adhesive layer is larger than 20%.

Claim 4. The semiconductor structure of claim 1, wherein a thickness of said first bonding layer is larger than 100 Å, and a thickness of said first adhesive layer is larger than 10 Å.

Claim 5. The semiconductor structure of claim 1, further comprising a second substrate, wherein a second adhesive/bonding stack is on a surface of said second substrate, and a surface of said second adhesive/bonding stack is correspondingly bonded to a surface of said first adhesive/bonding stack.

Claim 6. The semiconductor structure of claim 5, wherein said second adhesive/bonding stack and said first adhesive/bonding stack have the same material and structure.

Claim 7. The semiconductor structure of claim 5, further comprising:

a first bonding pad penetrating through said first adhesive/bonding stack; and

a second bonding pad penetrating through said second adhesive/bonding stack, wherein said first bonding pad is correspondingly bonded to said second bonding pad.

Claim 8. The semiconductor structure of claim 7, wherein said first bonding pad and said second bonding pad include a metal material.

Claim 9. The semiconductor structure of claim 8, wherein said metal material include copper (Cu) or tungsten (w).

Claim 10. The semiconductor structure of claim 6, wherein said first substrate comprises a substrate with 3D NAND memory, and said second substrate comprises a substrate with peripheral circuit.

Claim 11. A method of forming a semiconductor structure, comprising:

providing a first substrate;

forming a first adhesive layer on a surface of said first substrate; and

forming a first bonding layer on said first adhesive layer;

wherein materials of said first adhesive layer and said first bonding layer are different, a material of said first bonding layer comprises dielectric material of silicon, nitrogen and carbon, and a material of said first adhesive layer comprises dielectric material of silicon and nitrogen, an atomic concentration of carbon in said first bonding layer is larger than 0% and smaller than 50%,

wherein thickness of said first bonding layer is larger than thickness of said first adhesive layer, and

wherein an atomic concentration of carbon in said first bonding layer gradually changes in a direction of thickness of said first bonding layer.

Claim 12. The method of forming a semiconductor structure of claim 11, further comprising using plasma enhanced chemical vapor deposition (PECVD) processes to form said first adhesive layer.

Claim 13. The method of forming a semiconductor structure of claim 12, wherein reagent gas of PECVD processes includes SiH_4 and NH_3, with the flow ratio of SiH_4 to NH_3 larger than 0.5.

Claim 14. The method of forming a semiconductor structure of claim 12, further comprising using said PECVD processes to formed said first bonding layer, wherein using different process parameters to form said first adhesive layer and said first bonding layer.

Claim 15. The method of forming a semiconductor structure of claim 11, further comprising:

providing a second substrate;

forming a second adhesive layer on said second substrate;

forming a second bonding layer on said second adhesive layer; and

bonding a surface of said second bonding layer to a surface of said first bonding layer.

Claim 16. The method of forming a semiconductor structure of claim 15, further comprising:

forming a first bonding pad penetrating through said first adhesive layer and said first bonding layer;

forming a second bonding pad penetrating through said second adhesive layer and said second bonding layer; and

bonding said first bonding pad and said second bonding pad when bonding said surface of said second bonding layer to said surface of said first bonding layer.

Claim 17. A semiconductor structure, comprising:

a substrate;

a first bonding layer on said substrate, wherein a material of said first bonding layer comprises dielectric material of silicon, nitrogen and carbon; and

a second bonding layer bonded to said first bonding layer, said first bonding layer is between said substrate and said second bonding layer, said second bonding layer comprises dielectric material of silicon, nitrogen and carbon,

wherein element concentrations of the first bonding layer and the second bonding layer are different,

wherein thickness of said second bonding layer is larger than thickness of said first bonding layer, and

wherein an atomic concentration of carbon in said second

bonding layer gradually changes in a direction of thickness of said second bonding layer.

Claim 18. The semiconductor structure of claim 17, wherein a bonding interface of said first bonding layer and said second bonding layer comprises Si-O bonds.