SUMMARY OF THE INVENTION

According to a first aspect, there is provided a temporary bonding method comprising: applying a lift-off layer to a device surface of a first substrate; forming a bonding layer on the lift-off layer; positioning a carrier surface of a second substrate proximate to a surface of the bonding layer; moving the carrier surface of the second substrate and the surface of the bonding layer into contact with each other; bonding the carrier surface of the second substrate to the surface of the bonding layer to form a bonded stack; and separating the first substrate from the second substrate by treating the lift-off layer.

According to a second aspect, there is provided a temporary bonding method comprising: applying a lift-off layer to a device surface of a first substrate; forming a bonding layer on the lift-off layer; positioning a carrier surface of a second substrate proximate a surface of the bonding layer; moving the carrier surface of the second substrate and the surface of the bonding layer into contact with each other; bonding the carrier surface of the second substrate to the surface of the bonding layer to form a bonded stack; heating the bonded stack to a predetermined temperature to soften the bonding layer; and separating the first substrate from the second substrate wherein at least a portion of the lift-off layer remains on the first substrate.

~~The present invention overcomes the prior art problems by providing~~Disclosed herein is a temporary bonding method comprising providing a stack comprising:

a first substrate having a back surface and a device surface;

a first bonding layer adjacent the device surface and having a softening temperature;

a second bonding layer adjacent the first bonding layer and having a softening temperature, wherein the softening temperature of the first bonding layer is at least about 20℃ greater than the softening temperature of the second bonding layer; and

a second substrate having a carrier surface, the second bonding layer being adjacent the carrier surface. The first and second substrates are then separated.

~~The invention also provides~~Disclosed herein is an article comprising a first substrate having a back surface and a device surface. The article further comprises a first bonding layer adjacent the device surface and having a softening temperature. There is a second bonding layer adjacent the first bonding layer and having a softening temperature, with the softening temperature of the first bonding layer being at least about 20°C greater than the softening temperature of the second bonding layer. The article also includes a second substrate having a carrier surface, with the second bonding layer being adjacent the carrier surface.

~~In a further embodiment of the invention,~~Disclosed herein is a temporary bonding method ~~is provided. In the method, a stack is provided, and the stack comprises~~comprising providing a stack comprising:

a first substrate having a back surface and a device surface;

a first rigid layer adjacent the device surface;

a bonding layer adjacent the first rigid layer; and

a second substrate having a carrier surface, the bonding layer being adjacent the carrier surface. The stack further comprises one or both of the following:

a lift-off layer between the device surface and the first rigid layer; or

a second rigid layer between the bonding layer and the carrier surface.

The first and second substrates are then separated.

~~The invention also provides~~Disclosed herein is an article comprising a first substrate having a back surface and a device surface. The article further comprises a first rigid layer adjacent the device surface, a bonding layer adjacent the first rigid layer, and a second substrate having a

carrier surface. The bonding layer is adjacent the carrier surface, and the article further comprises one or both of the following:

a lift-off layer between the device surface and the first rigid layer; or

a second rigid layer between the bonding layer and the carrier surface.

~~In yet another embodiment of the invention,~~ Disclosed herein is a temporary bonding method ~~is provided where the method comprises~~ comprising providing a stack comprising:

a first substrate having a back surface and a device surface, the device surface having a peripheral region and a central region;

a second substrate having a carrier surface;

an edge bond adjacent the peripheral region and the carrier surface; and

at least one layer selected from the group consisting of:

a lift-off layer between the edge bond and the device surface;

a lift-off layer between the edge bond and the carrier surface;

an adhesion promoter layer between the edge bond and the device surface;

an adhesion promoter layer between the edge bond and the carrier surface;

a bonding layer between said edge bond and said device surface; and

a bonding layer between said edge bond and said carrier surface.

The first and second substrates are then separated.

~~In a final embodiment of the invention,~~ Disclosed herein is an article ~~is provided. The article comprises~~comprising a first substrate having a back surface and a device surface, and the device surface has a peripheral region and a central region. The article further comprises a second substrate having a carrier surface, an edge bond adjacent the peripheral region and the carrier surface, and at least one layer selected from the group consisting of:

a lift-off layer between the edge bond and the device surface;

a lift-off layer between the edge bond and the carrier surface;

an adhesion promoter layer between the edge bond and the device surface;

an adhesion promoter layer between the edge bond and the carrier surface;
a bonding layer between said edge bond and said device surface; and
a bonding layer between said edge bond and said carrier surface.

BRIEF DESCRIPTION OF THE DRAWINGS

CLAIMS:

1. A temporary bonding method comprising:

applying a lift-off layer to a device surface of a first substrate;

forming a bonding layer on the lift-off layer ;

bonding a second substrate to the bonding layer to form a bonded stack.

2. The method of claim 1, wherein the lift-off layer is applied by spin-coating.

3. The method of claims 1, wherein the lift-off layer has a thickness T1 of less than about 3 μm.

4. The method of claims 1, wherein the lift-off layer 44 is a conformal layer.

5. The method of claims 1, wherein compositions used to form lift-off layer 44 are selected so that the said lift-off layer is soluble in solutions selected from the group consisting of 1% hydrochloric acid aqueous solution, 50% acetic acid aqueous solution, isopropanol, 1-dodecene, R-limonene, cyclopentanone, PGME, and tetramethylammonium hydroxide.

6. The method of claims 1, wherein the device surface includes at least one structure selected from the group consisting of: solder bumps; metal posts; metal pillars; and structures formed from a material selected from the group consisting of silicon, polysilicon, silicon dioxide, silicon (oxy)nitride, metal, low k dielectrics, polymer dielectrics, metal nitrides, and metal silicides.

7. The method of claims 1, wherein the second substrate includes one of the following materials: silicon, sapphire, quartz, metals (e.g., aluminum, copper, steel), and various glasses and ceramics.

8. The method of claim 3, wherein the thickness T1 is about 0,5 μm to about 3 μm.

9. The method of claim 8, wherein the tickness T1 is about 1,0 μm to about 1.5 μm.

CLAIMS

1. A temporary bonding method comprising:

applying a lift-off layer to a device surface of a first substrate;

forming a bonding layer on the lift-off layer;

positioning a carrier surface of a second substrate proximate to a surface of the bonding layer;

moving the carrier surface of the second substrate and the surface of the bonding layer into contact with each other;

bonding the carrier surface of the second substrate to the surface of the bonding layer to form a bonded stack; and

separating the first substrate from the second substrate by treating the lift-off layer.

2. The method of claim 1, wherein the lift-off layer is applied by spin-coating.

3. The method of claim 1, wherein the lift-off layer has a thickness T1 of less than about 3 μm.

4. The method of claim 1, wherein the lift-off layer is a conformal layer.

5. The method of claim 1, wherein compositions used to form the lift-off layer are selected so that the lift-off layer is soluble in solutions selected from the group consisting of 1% hydrochloric acid aqueous solution, 50% acetic acid aqueous solution, isopropanol, 1-dodecene, R-limonene, cyclopentanone, PGME, and tetramethylammonium hydroxide.

6. The method of claim 1, wherein the device surface includes at least one structure selected from the group consisting of: solder bumps; metal posts; metal pillars; and structures formed from a material selected from the group consisting of silicon, polysilicon, silicon dioxide, silicon (oxy)nitride, metal, low k dielectrics, polymer dielectrics, metal nitrides, and metal silicides.

7. The method of claim 1, wherein the second substrate includes one of the following materials: silicon, sapphire, quartz, metals (e.g., aluminum, copper, steel), and various glasses and ceramics.

8. The method of claim 3, wherein the thickness T1 is about 0.5 μm to about 3 μm.

9. The method of claim 8, wherein the thickness T1 is about 1.0 μm to about 1.5 μm.

10. The method of claim 1, wherein the step of separating the first substrate from the second substrate includes dissolving the lift-off layer.

11. A temporary bonding method comprising:

applying a lift-off layer to a device surface of a first substrate;

forming a bonding layer on the lift-off layer;

positioning a carrier surface of a second substrate proximate a surface of the bonding layer;

moving the carrier surface of the second substrate and the surface of the bonding layer into contact with each other;

bonding the carrier surface of the second substrate to the surface of the bonding layer to form a bonded stack;

heating the bonded stack to a predetermined temperature to soften the bonding layer; and

separating the first substrate from the second substrate wherein at least a portion of the lift-off layer remains on the first substrate.

12. The method of claim 11, further including a step of dissolving the lift-off layer after said step of separating the first substrate from the second substrate.

MULTIPLE BONDING LAYERS FOR THIN-WAFER HANDLING

ABSTRACT

Multiple bonding layer schemes that temporarily join semiconductor substrates are provided. In the inventive bonding scheme, at least one of the layers is directly in contact with the semiconductor substrate and at least two layers within the scheme are in direct contact with one another. The present invention provides several processing options as the different layers within the multilayer structure perform specific functions. More importantly, it will improve performance of the thin-wafer handling solution by providing higher thermal stability, greater compatibility with harsh backside processing steps, protection of bumps on the front side of the wafer by encapsulation, lower stress in the debonding step, and fewer defects on the front side.

Fig. 2