SUMMARY

[0006] The following presents a simplified summary of the disclosure in order to provide a basic understanding of some example aspects described in the detailed description.

[0007] ~~In a first aspect,~~There is disclosed a method ~~is provided~~ for processing a first substrate with a first major surface of the first substrate removably bonded to a first major surface of a carrier substrate. The method includes the step (I) of peeling the leading peripheral edge of the carrier substrate from the first substrate by applying pressure to a leading peripheral surface portion of a second major surface of the carrier substrate. The method further includes the step (II) of continuing to peel the carrier substrate from the first substrate until the carrier substrate is completely removed from the first substrate. The method further includes the step (III) of controlling a bend radius of the carrier substrate during step (II).

[0008] In one example ~~of the first aspect~~, a shape of the first substrate is fixed during step (I) and step (II). In a particular example, the method further comprises vacuum attaching the first substrate to a vacuum plate, wherein the vacuum attachment provides the shape of the first substrate that is fixed during step (I) and step (II).

[0009] In another example ~~of the first aspect~~, the first substrate comprises a substrate selected from the group consisting of: a glass substrate and a silicon wafer.

[0010] In still another example ~~of the first aspect~~, the first substrate includes a thickness of from about 100 microns to about 300 microns.

[0011] In yet another example ~~of the first aspect~~, the carrier substrate includes a thickness of from about 300 microns to about 700 microns.

[0012] In a further example ~~of the first aspect~~, a footprint of the carrier substrate is larger than a footprint of the first substrate.

[0013] In still a further example ~~of the first aspect~~, prior to step (I), the method further comprises the step of processing the first substrate while the first substrate is bonded to the carrier substrate.

[0014] In yet a further example ~~of the first aspect~~, the leading peripheral surface portion of the second major surface of the carrier substrate includes a length defined between a first lateral edge and a second lateral edge of the carrier substrate. Furthermore, step (I) applies pressure along substantially the entire length of the leading peripheral surface portion of the second major surface of the carrier substrate. In one particular example, step (I) includes uniformly applying the pressure along substantially the entire length of the leading peripheral surface portion. In another particular example, step (I) includes peeling the

leading peripheral edge of the carrier substrate from the first substrate substantially simultaneously along the entire length of the leading peripheral surface portion.

[0015] In another example ~~of the first aspect~~, the method further comprises the step of determining a bond strength between the carrier substrate and the first substrate based on information obtained during step (I).

[0016] In still another example ~~of the first aspect~~, step (I) includes vacuum attaching an attachment member to the leading peripheral surface portion of the second major surface of the carrier substrate and then applying the pressure to the leading peripheral surface portion with the attachment member.

[0017] In yet another example ~~of the first aspect~~, prior to step (I), the method further includes the step of reducing a bond strength between the carrier substrate and the first substrate.

[0018] The ~~first aspect~~example may be provided alone or in combination with any one or more of the examples ~~of the first aspect~~ discussed above.

[0019] ~~In a second aspect,~~ According to an aspect of the present invention, there is provided a method ~~is provided~~ for processing a first substrate with a first major surface of the first substrate removably bonded to a first major surface of a carrier substrate. The method includes the step (I) of extending an arm over the carrier substrate, wherein an attachment member is carried by the arm. The method further includes the step (II) of vacuum attaching the attachment member to ~~the~~ a leading peripheral surface portion of ~~the~~ a second major surface of the carrier substrate, and the step (III) of applying pressure to the leading peripheral surface portion with the attachment member. The method further includes the step (IV) of peeling the leading peripheral edge of the carrier substrate from the first substrate with the attachment member while the attachment member pivots relative to the arm.

[0020] In one example of the ~~second~~ aspect, the attachment member pivots relative to the arm by an angle within the range of greater than 0° to about 15°.

[0021] In another example of the ~~second~~ aspect, the method includes the step of continuing to peel the carrier substrate from the first substrate while the arm pivots relative to the first substrate. In one particular example, the method can include the step of controlling a bend radius of the carrier substrate while the arm pivots relative to the first substrate.

[0022] In yet another example of the ~~second~~ aspect, shape of the first substrate is fixed during the step (III) and step (IV). In one example, the method includes vacuum

attaching the first substrate to a vacuum plate, wherein the vacuum attachment provides the shape of the first substrate that is fixed during step (III) and step (IV).

[0023] In a further example of the ~~second~~ aspect, the first substrate comprises a substrate selected from the group consisting of: a glass substrate and a silicon wafer.

[0024] In yet a further example of the ~~second~~ aspect, the first substrate includes a thickness of from about 100 microns to about 300 microns.

[0025] In another example of the ~~second~~ aspect, the carrier substrate includes a thickness of from about 300 microns to about 700 microns.

[0026] In still another example of the ~~second~~ aspect, a footprint of the carrier substrate is larger than a footprint of the first substrate.

[0027] In still another example of the ~~second~~ aspect, prior to step (I), further comprising the step of processing the first substrate while the first substrate is bonded to the carrier substrate.

[0028] In a further example of the ~~second~~ aspect, the leading peripheral surface portion of the second major surface of the carrier substrate includes a length defined between a first lateral edge and a second lateral edge of the carrier substrate. The method further includes the step (III) of applying pressure along substantially the entire length of the leading peripheral surface portion of the second major surface of the carrier substrate. In one particular example, step (III) includes uniformly applying the pressure along substantially the entire length of the leading peripheral surface portion. In another example, step (I) includes peeling the leading peripheral edge of the carrier substrate from the first substrate substantially simultaneously along the entire length of the leading peripheral surface portion.

[0029] In another example of the ~~second~~ aspect, the method further comprises the step of determining a bond strength between the carrier substrate and the first substrate based on information obtained during step (I).

[0030] In still another example of the ~~second~~ aspect, prior to step (IV), the method further includes the step of reducing a bond strength between the carrier substrate and the first substrate.

[0031] The ~~second~~ aspect may be provided alone or in combination with any one or more of the examples of the ~~second~~ aspect discussed above.

[0032] ~~In a third aspect,~~There is disclosed a peeling apparatus ~~is~~ configured to peel a first substrate from a second substrate. The peeling apparatus includes a vacuum plate, a vacuum attachment member, and an arm supporting the vacuum attachment member and pivotally

attached relative to the vacuum plate. The arm is configured to extend across the vacuum plate, and the vacuum attachment member is configured to be moved away from the vacuum plate while the arm pivots relative to the vacuum plate.

[0033] In one example ~~of the second aspect~~, vacuum attachment member is configured to pivot relative to the arm. In one particular example, the vacuum attachment member is confined to pivot a maximum angle relative to the arm within a range of greater than 0º to about 15º.

[0034] In another example ~~of the third aspect~~, the vacuum plate is configured to translate while the vacuum attachment member moves away from the vacuum plate.

[0035] In yet another example ~~of the second aspect~~, the peeling apparatus further comprises a hinge pivotally attaching the arm relative to the vacuum plate.

[0036] In another example ~~of the third aspect~~, the hinge comprises a float hinge.

[0037] The ~~third aspect~~ example may be provided alone or in combination with any one or more of the examples ~~of the third aspect~~ discussed above.

BRIEF DESCRIPTION OF THE DRAWINGS

[0038] These and other aspects are better understood when the following detailed description is read with reference to the accompanying drawings, in which:

[0039] **FIG. 1** is a schematic side view of an example peeling apparatus;

[0040] **FIG. 2** is a front view of the peeling apparatus along line 2-2 of **FIG. 1**;

[0041] **FIG. 3** is a top view of a vacuum plate of the peeling apparatus along line 3-3 of **FIG. 2**;

[0042] **FIG. 4** is a bottom view of a vacuum attachment member and an arm of the peeling apparatus along line 4-4 of **FIG. 2**;

[0043] **FIG. 5** is a schematic side view of the peeling apparatus of **FIG. 1** in an open orientation;

[0044] **FIG. 6** is a schematic side view of the peeling apparatus of **FIG. 1** in an open orientation with a second carrier substrate vacuum attached to the vacuum plate;

[0045] **FIG. 7** is a schematic side view of the peeling apparatus of **FIG. 1** in a closed orientation with the second carrier substrate vacuum attached to the vacuum plate and the attachment member vacuum attached to a leading peripheral surface portion of a second major surface of a first carrier substrate;

What is claimed is:

~~1. A peeling apparatus configured to peel a first substrate from a second substrate comprising:~~

~~a vacuum plate;~~

~~a vacuum attachment member; and~~

~~an arm supporting the vacuum attachment member and pivotally attached relative to the vacuum plate, wherein the arm is configured to extend across the vacuum plate, and wherein the vacuum attachment member is configured to be moved away from the vacuum plate while the arm pivots relative to the vacuum plate.~~

~~2. The peeling apparatus of claim 1, wherein the vacuum attachment member is configured to pivot relative to the arm.~~

~~3. The peeling apparatus of claim 2, wherein the vacuum attachment member is confined to pivot a maximum angle relative to the arm within a range of greater than 0º to about 15º.~~

~~4. The peeling apparatus of any one of claims 1-3, wherein the vacuum plate is configured to translate while the vacuum attachment member moves away from the vacuum plate.~~

~~5. The peeling apparatus of any one of claims 1-4, further comprising a hinge pivotally attaching the arm relative to the vacuum plate, wherein the hinge comprises a float hinge.~~

~~6~~1. A method of processing a first substrate with a first major surface of the first substrate removably bonded to a first major surface of a carrier substrate, the method comprising the steps of:

(I) extending an arm over the carrier substrate, wherein an attachment member is carried by the arm;

(II) vacuum attaching the attachment member to ~~the~~a leading peripheral surface portion of ~~the~~a second major surface of the carrier substrate;

(III) applying pressure to the leading peripheral surface portion with the attachment member; and

(IV) peeling the leading peripheral edge of the carrier substrate from the first substrate with the attachment member while the attachment member pivots relative to the arm.

~~7. A method of processing a first substrate with a first major surface of the first substrate removably bonded to a first major surface of a carrier substrate, the method comprising the steps of:~~

~~(I) peeling the leading peripheral edge of the carrier substrate from the first substrate by applying pressure to a leading peripheral surface portion of a second major surface of the carrier substrate;~~

~~(II) continuing to peel the carrier substrate from the first substrate until the carrier substrate is completely removed from the first substrate; and~~

~~(III) controlling a bend radius of the carrier substrate during step (II).~~

~~8~~2. The method of claim ~~6~~1, wherein the attachment member pivots relative to the arm by an angle within the range of greater than 0º to ~~about~~ 15º.

~~9~~3. The method of claim ~~6~~1 or claim ~~8~~2, further including the step of continuing to peel the carrier substrate from the first substrate while the arm pivots relative to the first substrate, further comprising the step of controlling a bend radius of the carrier substrate while the arm pivots relative to the first substrate.

~~10~~4. The method of claim ~~6 or claim 7~~1, wherein a shape of the first substrate is fixed during at least one of the steps of peeling (step (III) in claim ~~6, as well as steps (I) and step (II) in claim 7~~1) and applying pressure (step (IV) in claim ~~6~~1).

~~11~~5. The method of claim ~~10~~4, further comprising vacuum attaching the first substrate to a vacuum plate, wherein the vacuum attachment provides the shape of the first substrate that is fixed during the at least one of the steps of peeling and applying pressure.

~~12~~6. The method of claim ~~6 or claim 7~~1, wherein the leading peripheral surface portion of the second major surface of the carrier substrate includes a length defined between a first lateral edge and a second lateral edge of the carrier substrate, and step (III) of claim ~~6 or step (I) of claim 7~~1 applies pressure along substantially the entire length of the leading peripheral surface portion of the second major surface of the carrier substrate.

~~13~~7. The method of any one of claims ~~6-12~~1-6, further comprising the step of determining a bond strength between the carrier substrate and the first substrate based on information obtained during step (I).

~~14~~8. The method of claim ~~6 or claim 7~~1, wherein prior to step (IV) of claim ~~6 or prior to step (I) of claim 7~~1, further including the step of reducing a bond strength between the carrier substrate and the first substrate.

~~15~~9. The method of any one of claims ~~6 14~~1-8, wherein the first substrate comprises a substrate selected from the group consisting of: a glass substrate and a silicon wafer.

~~16~~10. The method of any one of claims ~~6 15~~1-9, wherein the first substrate includes a thickness of from ~~about~~ 100 microns to ~~about~~ 300 microns.

~~17~~11. The method of any one of claims ~~6 16~~1-10, wherein the carrier substrate includes a thickness of from ~~about~~ 300 microns to ~~about~~ 700 microns.

~~18~~12. The method of any one of claims ~~6 17~~1-11, wherein a footprint of the carrier substrate is larger than a footprint of the first substrate.

~~19~~13. The method of any one of claims ~~6 18~~1-12, wherein prior to step (I), further comprising the step of processing the first substrate while the first substrate is bonded to the carrier substrate.

~~20~~14. The method of claim ~~6 or claim 7~~1, wherein step (III) of claim ~~6 or step (I) of claim 7~~1 includes uniformly applying the pressure along substantially the entire length of the leading peripheral surface portion.

~~21~~15. The method of claim ~~20~~14, wherein step (I) includes peeling the leading peripheral edge of the carrier substrate from the first substrate substantially simultaneously along the entire length of the leading peripheral surface portion.

~~22. The method of claim 7, wherein step (I) includes vacuum attaching an attachment member to the leading peripheral surface portion of the second major surface of the carrier substrate and then applying the pressure to the leading peripheral surface portion with the attachment member.~~