

METHOD AND APPARATUS FOR SELECTIVE REMOVAL OF MATERIAL

Field of the Invention

5 The present invention relates to removal of material from a surface, and more particularly to selectively removing portions of a layer of material on a semiconductor wafer to expose terminals.

Background of the Invention

10

A semiconductor die has an interconnect surface with pads thereon and a back surface opposite the interconnect surface. A wafer level chip scale package (WLCSP) is one where the packaged die is substantially the size of the die itself. A WLCSP typically comprises a semiconductor die with a layer of insulation formed on its interconnect surface, and with terminals that are coupled to the pads on the die and that extend through the layer of insulation.

As its name implies a WLCSP is formed when the die is part of a semiconductor wafer. A method of forming a WLCSP is to first form conductive bumps on the pads. Then form a layer of insulation on the interconnect surface of the wafer, such that the bumps are submerged in the layer of insulation, and then remove a portion of the layer of insulation to expose the upper portions of the bumps. For example, when the layer of insulation comprises epoxy, then a subsequent etching process, such as plasma etching, can be applied to remove a portion of the layer of epoxy and expose the upper portions of the bumps. The wafer can then be singulated to produce the WLCSPs.

Mold compound comprises polymer and filler, and when the layer of insulation comprises mold compound, a disadvantage of the combination of epoxy and plasma etching is that only the polymer in the mold compound is effectively removed leaving the majority filler on the wafer.

Another method of forming WLCSPs is to form the bumps on the pads of the die, and form the layer of insulation, as before. Then instead of plasma etching, a mechanical grinding process is employed to remove a portion of the layer of insulation along with upper portions of the bumps, thus exposing the ground surface of the bumps. The layer of insulation can comprise epoxy or mold compound. When mold compound is used, the layer of insulation is molded on the interconnect surface of the semiconductor wafer.

A disadvantage of the grinding process is that the bumps are flattened to become level with the layer of insulation. This is not desirable because when solder is subsequently disposed on the bumps, the solder can only adhere to the exposed ground surface of the bumps. In contrast, it is desirable to have the bump protrude beyond the surface of the layer of insulation, so that the solder can adhere to the exposed top and side surfaces of the bumps, as this results in more reliable solder joints. Another disadvantage of the grinding process is the risk of over-grinding, due to the relatively poor accuracy of the grinding process. When the resultant thickness of the layer of insulation becomes too thin to provide good insulation, the reliability of the WLCSP can be adversely affected.

When mold compound is used to form the layer of insulation, plasma etching cannot be used to remove a portion of the layer of insulation as plasma does not remove mold compound efficiently. An alternative method of forming a WLCSP is to employ laser etching where a laser beam is scanned on the layer of insulation and a portion of the layer of insulation is removed by ablation. In contrast with plasma etching, laser etching is a dry process and is capable of ablating mold compound selectively, i.e. wherever the laser beam is directed.

Mold compound primarily comprises a combination of polymer and a filler, such as silicon dioxide (SiO_2). In a conventional laser etching process, such as that taught by Engelsberg et al. in US patent 5,643,472, a laser beam is directed at a target location on a substrate,

with the laser beam normal to the surface of the substrate. When a laser beam is applied in this way to a layer of mold compound, a suspension of ablated material forms above the target location, and the suspension obscures and inhibits the laser beam. Consequently, this
5 reduces the efficiency of the laser etching process. In addition, some of the ablated material descends from the suspension back to the surface of the layer of mold compound.

Engelsberg et al. further teaches directing a flow of inert gas over the target location to assist in carrying away the ablated material. While
10 the flow of inert gas carries away some of the ablated material, some of the ablated material still descends back to the layer of insulation. Hence, a disadvantage of this method is the need to subsequently clean residual ablated material off the ablated surface.

Elliott et al. in US patent 5,814,156 teaches directing a shaped
15 laser beam at a target location on a substrate while directing a reactive gas over the target location. However, Elliott's method is suitable for cleaning foreign material on the surface of a semiconductor wafer and does not address the requirement of ablating material, particularly mold compound formed on a semiconductor wafer.

Engelsberg et al. in US patent 5,800,625 teaches directing a laser
20 beam at a target location on a substrate, where the laser beam is directed at an angle that is oblique to the surface of the substrate for cleaning purposes. The non-perpendicular laser reduces the likelihood of damage to the substrate. A disadvantage of this method when applied
25 to removing a portion of mold compound is as described earlier, that some of the ablated material returns back to the ablated surface.

As before, Engelsberg et al. in US patent 5,800,625, further teaches directing a flow of inert gas over the target location to assist in carrying away the ablated material. A disadvantage of this method is
30 that, while the flow of inert gas carries away some of the ablated material, some of the ablated material still descends back to the layer of insulation. Hence, a disadvantage of this method is the need to

subsequently clean residual ablated material off the ablated surface, as described earlier.

Brief Summary of the Invention

5

The present invention seeks to provide a method and apparatus for selective removal of material, which overcomes or at least reduces the abovementioned problems of the prior art.

Accordingly, in one aspect, the present invention provides an
10 apparatus for selectively removing material comprising:

a mount for securing a substrate thereon, the substrate having an interconnect surface with interconnect bumps extending therefrom, and the substrate having a layer of insulation formed on the interconnect surface, wherein the bumps are substantially covered by
15 the layer of insulation, the mount for positioning the substrate with the layer of insulation in the range of a target location;

a laser for directing at least one laser beam at the target location on the layer of insulation to ablate at least a portion of the layer of insulating material at the target location, wherein the at least one laser
20 beam is directed at a predetermined angle to a reference normal to the substrate; and

a reactive removal system located proximal to the target location for removing material ablated from the layer of insulating material by the laser beam.

25 In another aspect the present invention provides an apparatus for selectively removing at least a portion of a layer of insulation on a bumped semiconductor wafer, the apparatus comprising:

a movable mount for securing the bumped semiconductor wafer thereon, the bumped semiconductor wafer having an interconnect
30 surface with bumps extending therefrom, and the bumped semiconductor wafer having a layer of insulating material formed on the interconnect surface, wherein the bumps are substantially covered by

the layer of insulating material, the movable mount for moving to scan at least one target location on the layer of insulating material;

a directable laser for directing at least one laser beam at the at least one target location, the laser for ablating at least a portion of the layer of insulating material at the at least one target location, wherein
5 the at least one laser beam is directed at a predetermined angle to a reference normal to the semiconductor wafer; and

a reactive removal system located proximal to the target location for removing material ablated from the layer of insulating material by
10 the at least one laser beam.

In yet another aspect the present invention provides a method for selectively removing at least a portion of a layer of insulation on a bumped semiconductor wafer, the method comprising the steps of:

- a) providing a bumped semiconductor wafer with a bumped surface,
15 the bumped semiconductor wafer having a layer of insulating material on the bumped surface, wherein the layer of insulation covers the bumps on the bumped surface;
- b) positioning the bumped semiconductor wafer to have at least one target location on the layer of insulating material;
- 20 c) directing at least one laser beam set to a predetermined high power at the at least one target location, wherein the at least one laser beam is directed at a first predetermined angle relative to a reference normal;
- d) scanning the at least one laser beam across the layer of
25 insulating material to remove a portion of the layer of insulation;
- e) directing the at least one laser beam set to a predetermined low power at the at least one target location, wherein the at least one laser beam is directed at a second predetermined angle relative to a reference normal;
- 30 f) scanning the at least one laser beam across the layer of insulating material to remove a subsequent residual portion of the layer

of insulation on the bumps, thereby exposing at least a portion of the bumps; and

- g) concurrent with steps (d) and (f), directing a flow of reactive gas over the target location and sucking at least the reactive gas and material removed by the laser beam.

Brief Description of the Drawings

An embodiment of the present invention will now be more fully described, by way of example, with reference to the drawings of which:

FIG. 1 shows a functional block diagram of a laser etching system in accordance with the present invention;

FIG. 2 shows a more details of the optical system in FIG. 1;

FIG. 3 shows a flowchart detailing a process for laser etching a semiconductor wafer using the laser etching system in FIG. 1;

FIG. 4A-4D show side sectional views of a semiconductor wafer being etched in accordance with the laser etching process in FIG. 3; and

FIG. 5A and 5B show alternate orientations for the semiconductor wafer.

Detail Description of the Drawings

A bumped molded semiconductor wafer is held on a movable mount, and a laser beam is directed at an angle at a target location. The movable mount moves the molded semiconductor wafer to scan the target location across the molded surface of the semiconductor wafer. The laser is first set to a predetermined high power setting, and the movable mount moved to scan the angled laser beam across the surface of the mold compound to primarily remove the filler in the mold compound. While the laser is being applied, a reactive gas, such as oxygen, is directed over the target location and a vacuum inlet positioned close to the target location to remove the oxygen and any

resulting reacted material or material removed from the layer of mold compound. This reduces the amount of ablated material that can contaminate the ablated surface. When a substantial portion of the layer of mold compound has been ablated away, a layer of polymer
5 remains on the bumps on the semiconductor wafer. The laser is then set to a predetermined low power setting, and the movable mount again moved to scan the laser beam over the surface of the residual layer of polymer on the bumps of the semiconductor wafer. As before, the reactive gas and the vacuum are applied during the second low power
10 scan. This results in the bumps on the semiconductor wafer being exposed, and the bumps extending beyond the ablated surface of the surrounding mold compound.

This advantageously preserves the integrity of the layer of mold compound, thus providing a reliable layer of insulation for the
15 semiconductor wafer. And, as the reactive gas substantially reduces residual ablated material that can contaminate the ablated surface, the need for a subsequent cleaning process diminishes and may even be avoided.

FIG. 1 shows a laser etching system 100, in accordance with the
20 present invention, comprising a laser source 105, an optical system 110, a movable mount 120, and a controller 125, that is coupled to control the laser source 105, the optical system 110, and the movable mount 120. In addition, the laser etching system 100 comprises a reactive gas supply (not shown) coupled to a nozzle 140, and a vacuum
25 inlet 145 coupled to a vacuum source (not shown). The reactive gas nozzle 140 is positioned to direct reactive gas at a target location 132 of the laser beam 135, and the vacuum inlet 145 is located close to the target location 132, opposite the reactive gas nozzle 145. The vacuum inlet 145 and the vacuum source provide an extractor or exhaust
30 system.

The laser source 105 generates a laser beam 130, which is directed at the optical system 110, which then directs a laser beam 135, at a

selected angle 137 to a reference normal 139, at a target location 132 on a semiconductor wafer 115, which is secured on the movable mount 120.

The controller 125 provides control settings to the laser source 105, and this can include laser power settings to produce a laser pulse energy having a high power of 250 millijoules (mJ) or a low power of 50 mJ. The beam area on the targeted surface ranges from 1-4 square millimeters. The high power setting is selected to provide a high ablation rate, while the low power setting is selected to provide a relatively low ablation rate. The controller 125 also provides settings to the optical system 110 to position of the laser beam 135 at the target location 132 at the angle 137. The movable mount 120 receives inputs from the controller 125 that determines the location of the molded semiconductor wafer 115 relative to the target location 132. The controller 125 also provides inputs that determine speed of the movement of the movable mount when scanning the target location 132 on the molded semiconductor wafer 115.

The laser source 105 comprises a Krypton-fluoride (KrF) Excimer laser, such Model LPX220I supplied by Lambda Physics of Germany. The laser source 105 has a wavelength of 248 nano-meters (nm). One skilled in the art will appreciate that the selection of the laser source 105 is dependent on a variety of parameters that can include the laser power settings and the composition of the mold compound on the molded semiconductor wafer.

With reference to FIG. 2 the optical system 100 comprises a mirror 205, and a lens 210. The mirror 205 is movably mounted, however the mechanisms for securing the mirror 205 and for moving the mirror 205 are not shown. The mirror 205 has several degrees of movement as indicated by the arrows 215, to allow the mirror 205 to be positioned to reflect the laser beam 130, as the laser beam 135, at the target location 132 at the angle 137 to the reference normal 139. The lens 210 is

aligned with the laser beam 135 and focuses the laser beam 135 at the target location 132.

Returning now to FIG.1, the movable mount 120 has three degrees of movement as shown by the arrows 150. Typically, the movable mount
5 120 is moved along the X and Y axes under the control of the controller 125, when scanning the target location 132 on the molded semiconductor 115. In addition, the movable mount 120 may be moved along the Z axis when setting up for different types of molded semiconductor wafers which have different thickness'.

10 The reactive gas supply at the nozzle 140, which provides oxygen, is regulated, and the flow of oxygen may be set between 6-30 liters per minute. The vacuum intensity at the vacuum inlet 145 is capable of taking away the oxygen and any reacted material at at least 6-30 liters per minute, but preferably should be set to a higher rate.

15 With reference to FIG. 3 and FIGS. 4A-4E, a process 300 of removing a portion of the layer of mold compound on the bumped molded semiconductor 115 starts 305 with the controller 125 setting 310 the laser source 105 to provide the laser beam 130. The controller 125 then sets 310 the optical system 110 to provide the reflected laser
20 beam 135 directed at the target location 132 at the selected angle 137 of between fifty and eighty degrees relative to the normal reference 139. It has been found that when the angle 137 is between fifty and fifty-five degrees, the results are favorable, producing high cleaning efficiency and high laser power utilization. This step also includes focussing the
25 laser beam 135 at the target location 132. The target location can be at the surface of the molded semiconductor wafer 115, lower than the surface of the molded semiconductor wafer 115, or higher than the surface of the molded semiconductor wafer 115. The selection of the position of the target location is dependent on the requirement of
30 deflashing speed and surface sensitivities to the laser induced plasma.

FIG. 4A shows enlarged view of the molded bumped semiconductor wafer 115 prior to application of the laser etching process 300. The

molded semiconductor wafer 115 comprises a silicon wafer having bumps 410 extending from pads on the interconnect surface. The bumps can comprise copper bumps, but may be solder bumps, copper bumps with a solder cap, and the like. Mold compound 415 is molded
5 on the in the semiconductor wafer 405 which submerges the bumps 410. The mold compound 415 comprises polymer 420 and filler 425.

Next, the controller 125 sets 315 the laser power at the laser source 105 to the high power setting of 250 mJ, and the flow of reactive gas from the nozzle 140 and the vacuum at the vacuum inlet 145 are
10 started 320. Other parameters that are set include focal length of the lens 210 at 200 millimeters, scanning number of pulses per site set to 70, scanning speed of 20 millimeters per second, and a laser beam size of 3 square millimeters. Typically, these parameters are entered via a user interface (not shown) that is coupled to the controller 125.

15 After receiving inputs from the controller 125, the movable mount 120 positions a predetermined starting point on the molded semiconductor wafer 115 at the target location 132, and the laser source 105 is activated 325 to produce the laser beam 130 at the high power setting. The movable mount 120 then moves the molded
20 semiconductor wafer 115 in a predetermined scanning pattern to have the target location 132 scan the molded semiconductor wafer 115.

At the target location 132, the laser beam 135 ablates the mold compound and the flow of oxygen across the target location 132 takes the ablated material away from the ablated surface. With reference to
25 FIG. 4B, as described earlier, when the laser beam 135 ablates the mold compound at the target location 132, the ablated material forms a suspension 430 over the target location 132. However, as the laser beam 135 is advantageously directed at the target location 132 at an angle, the laser beam 135 is not significantly affected by the suspension
30 430 of ablated material. Consequently, the laser beam 135 can ablate the mold compound 415 more effectively.

The removal of ablated material occurs in two ways, firstly, the flow of oxygen carries the ablated material away, and is sucked in by the vacuum inlet. Secondly, the oxygen reacts with the ablated material to produce by reacted material that is also carried away by the flow of oxygen. Hence, the present invention, as described, advantageously takes the ablated material away from the ablated surface more effectively.

The ablation process as described applies when the molded semiconductor wafer 115 is mounted horizontally as shown in FIG. 4B, however, in this orientation relative to the force of gravity, indicated by the arrow 432, ablated material from the suspension 430 may still descend onto the mold compound 415.

FIG. 5A shows the molded semiconductor wafer 115 inverted. In this orientation, the gravitational force 432 assist in preventing ablated material in the suspension 430 from returning to the surface of the mold compound 415. Alternatively, in FIG. 5B the molded semiconductor wafer 115 is held vertically, where the gravitational force 432 assist in preventing ablated material in the suspension 430 from returning to the surface of the mold compound. In addition, with the flow of reactive gas arranged to flow downward in the same direction as the force of gravity 432, the removal of ablated material may be further enhanced. It will be appreciated that when any of these alternative orientations for the molded semiconductor wafer 115 is adopted, the laser source 105, the optical system 110, and the movable mount 120 will necessarily be modified to operate as described.

Typically, the movable mount 120 moves the molded semiconductor wafer 115 repeatedly along the X or Y axis, until a determination 330 is made by the controller 125 that the laser beam 135 has completed scanning the molded semiconductor wafer 115 at the high power. However, any scanning pattern can be adopted. FIG. 4C shows the molded semiconductor wafer 115 after the high power laser has been applied. This first scan primarily removes the filler 425,

however, there remains a layer of polymer 438 on the top surface 435 of the bumps 410.

As an enhancement of the laser etching process, both the power of the laser beam 135, and the movement of the movable mount may be made to vary dynamically, when scanning the laser beam 135 across the molded surface of the molded semiconductor wafer 115. For example, the laser power may be increased and the movement of the movable mount slowed when the laser beam 135 scans locations on the molded semiconductor wafer 115 with one of the bumps 415 below, relative to non-bump locations. Of course, this will require that the pattern of bumps 415 be captured and made available to the controller 125 for each semiconductor wafer, such that the locations of the bumps 415 on the respective semiconductor wafer 115 mounted on the mount 120 are provided or determined by the controller 125. With this information, and necessary indexing of the molded semiconductor wafer on the movable mount, the controller 125 can dynamically control the power of the laser beam 135 and movement of the movable mount 120.

Next, the laser power of the laser source 105 is set 335 to the low power setting to produce a laser pulse energy of 50 mJ. Under the control of the controller 125, the laser source 105 and the movable mount 120 activated so that the laser beam 135 scans across the layer of polymer 438. The laser beam 135 ablates the layer of polymer 438, and the flow of oxygen removes the ablated material away from the molded semiconductor wafer 115. Here, the angle 137 of the laser beam reduces risk of damage to the semiconductor wafer without impeding the efficiency of the laser beam 135. As before, the movable mount 120 moves the molded semiconductor wafer 115 repeatedly along the X or Y axis, until a determination 345 is made by the controller 125 that the laser beam 135 has completed scanning the molded semiconductor wafer 115 at the low power. The process 300 then ends 350.

FIG. 4D shows the molded semiconductor wafer 115 after the second scan of the laser beam 135. The bumps 415 extend beyond the

surface of the mold compound 415, and the upper surfaces 435 of the bumps 410 are clean and clear of both filler 425 and polymer 420.

5 The present invention, as described, allows a portion of a layer of mold compound on a molded bumped semiconductor wafer to be removed, with the bumps extending from the surface of the mold compound. In addition, when the molded bumped semiconductor wafer is singulate, the individual WLCSP have bumps that are ready for subsequent mounting, without the need for further cleaning.

10 This is accomplished by scanning a laser twice on the layer of mold compound while directing a flow of reactive gas at the laser's target location. The first scan with the laser set to high power to remove filler in the mold compound, and the second scan to remove polymer. The flow of reactive gas carries the material ablated by the laser away, and also reacts with the ablated material and carries the reacted material
15 away. Hence, the effective removal of a portion of the layer of mold compound results in the bumps on the semiconductor wafer extending beyond the surface of the ablated layer of mold compound, and the exposed portions of the bumps being sufficiently clean to avoid the need for further cleaning.

20 Thus, the present invention, as described provides a method and apparatus for selective removal of material, which overcomes or at least reduces the abovementioned problems of the prior art.

It will be appreciated that although only particular embodiments of the invention has been described in detail, various modifications and
25 improvements can be made by a person skilled in the art without departing from the scope of the present invention.

Claims

1. An apparatus for selectively removing material comprising:
a mount for securing a substrate thereon, the substrate having
5 an interconnect surface with interconnect bumps extending therefrom,
and the substrate having a layer of insulation formed on the
interconnect surface, wherein the bumps are substantially covered by
the layer of insulation, the mount for positioning the substrate with the
layer of insulation in the range of a target location;
10 a laser for directing at least one laser beam at the target location
on the layer of insulation to ablate at least a portion of the layer of
insulating material at the target location, wherein the at least one laser
beam is directed at a predetermined angle to a reference normal to the
substrate; and
15 a reactive removal system located proximal to the target location
for removing material ablated from the layer of insulating material by
the laser beam.
2. An apparatus in accordance with claim 1 wherein the substrate is
20 orientated to lie substantially horizontal, and the substrate being
substantially perpendicular to the force of gravity, and with the layer of
insulation facing upwards relative to the force of gravity.
3. An apparatus in accordance with claim 1 wherein the substrate is
25 orientated to lie substantially horizontal, and the substrate being
substantially perpendicular to the force of gravity, and with the layer of
insulation facing downwards relative to the force of gravity.
4. An apparatus in accordance with claim 1 wherein the substrate is
30 orientated to lie substantially vertical, and the substrate being
substantially parallel to the force of gravity.



5. An apparatus in accordance with claim 1 wherein the mount is movable relative to the laser beam to scan the target location across the layer of insulating material.
- 5 6. An apparatus in accordance with claim 1 wherein the laser beam is movable relative to the mount to scan the target location across the layer of insulating material.
7. An apparatus in accordance with claim 1 wherein the
10 predetermined angle is within the range of 50 to 85 degrees.
8. An apparatus in accordance with claim 1 wherein the reactive removal system comprises a reactive gas removal system.
- 15 9. An apparatus in accordance with claim 1 wherein the reactive gas removal system comprises at least one nozzle for directing at least one reactive gas at the target location.
10. An apparatus in accordance with claim 9 wherein the reactive gas
20 removal system further comprises a vacuum inlet for sucking in at least the at least one reactive gas.
11. An apparatus for selectively removing at least a portion of a layer of insulation on a bumped semiconductor wafer, the apparatus
25 comprising:
a movable mount for securing the bumped semiconductor wafer thereon, the bumped semiconductor wafer having an interconnect surface with bumps extending therefrom, and the bumped semiconductor wafer having a layer of insulating material formed on the
30 interconnect surface, wherein the bumps are substantially covered by the layer of insulating material, the movable mount for moving to scan at least one target location on the layer of insulating material;



a directable laser for directing at least one laser beam at the at least one target location, the laser for ablating at least a portion of the layer of insulating material at the at least one target location, wherein the at least one laser beam is directed at a predetermined angle to a reference normal to the semiconductor wafer; and

a reactive removal system located proximal to the target location for removing material ablated from the layer of insulating material by the at least one laser beam.

12. An apparatus in accordance with claim 11 wherein the directable laser comprises a laser source for generating at least one laser beam; and an optical system for receiving the at least one laser beam from the laser source, and for directing the at least one laser beam at the at least one target location.

15

13. An apparatus in accordance with claim 12 wherein the laser source comprises a Krypton-fluoride Excimer laser.

14. An apparatus in accordance with claim 12 wherein the optical system comprises at least one movably mounted mirror for directing the at least one laser beam, and at least one lens for focusing the at least one laser beam.

15. An apparatus in accordance with claim 11 wherein the reactive removal system comprises a reactive gas removal system.

16. An apparatus in accordance with claim 15 wherein the reactive gas removal system comprises at least one nozzle for directing at least one reactive gas at the at least one target location.

30

17. An apparatus in accordance with claim 16 wherein the at least one reactive gas comprises oxygen.



18. An apparatus in accordance with claim 16 wherein the reactive removal system further comprises at least one vacuum inlet for sucking in the at least one reactive gas and ablated material from the at least one target location.

19. An apparatus in accordance with claim 11 wherein the predetermined angle is within the range of 50 to 85 degrees.

20. A method for selectively removing at least a portion of a layer of insulation on a bumped semiconductor wafer, the method comprising the steps of:

- a) providing a bumped semiconductor wafer with a bumped surface, the bumped semiconductor wafer having a layer of insulating material on the bumped surface, wherein the layer of insulation covers the bumps on the bumped surface;
- b) positioning the bumped semiconductor wafer to have at least one target location on the layer of insulating material;
- c) directing at least one laser beam set to a predetermined high power at the at least one target location, wherein the at least one laser beam is directed at a first predetermined angle relative to a reference normal;
- d) scanning the at least one laser beam across the layer of insulating material to remove a portion of the layer of insulation;
- e) directing the at least one laser beam set to a predetermined low power at the at least one target location, wherein the at least one laser beam is directed at a second predetermined angle relative to a reference normal;
- f) scanning the at least one laser beam across the layer of insulating material to remove a subsequent residual portion of the layer of insulation on the bumps, thereby exposing at least a portion of the bumps; and



g) concurrent with steps (d) and (f), directing a flow of reactive gas over the target location and sucking at least the reactive gas and material removed by the laser beam.

5 21. A method in accordance with claim 20 wherein step (a) comprises the step of securing the bumped semiconductor wafer on a movable mount with the layer of insulating material exposed.

10 22. A method in accordance with claim 21 wherein step (b) comprises the step of instructing the movable mount to position the bumped semiconductor wafer to have the at least one target location on a predetermined location on the layer of insulating material.

15 23. A method in accordance with claim 21 wherein step (d) comprises the step of scanning the at least one laser beam across the layer of insulating material to remove primarily filler in the portion of the layer of insulation.

20 24. A method in accordance with claim 21 prior to step (c) comprises the step of setting the first predetermined angle.

25 25. A method in accordance with claim 21 prior to step (e) comprises the step of setting the second predetermined angle.

26. A method in accordance with claim 24 prior to step (e) comprises the step of setting the second predetermined angle to the same angle as the first predetermined angle.

30 27. A method in accordance with claim 24 prior to step (e) comprises the step of setting the second predetermined angle to a different angle as the first predetermined angle.



28. A method in accordance with claim 21 wherein step (f) comprises the step of scanning the at least one laser beam across the layer of insulating material to remove primarily residual polymer on the bumps, thereby exposing at least a portion of the bumps.

