exposure, development, etching, cleaning, and/or removal of the material or photoresist as required in forming a described structure.

Referring now to FIG. 1, therein is shown a cross-sectional view of an integrated circuit packaging system 100 in a first embodiment of the present invention taken along a line 1--1 of FIG. 2. The integrated circuit packaging system 100 can preferably include a device 102 such as die with a through silicon via (TSV), a TSV flip-chip, a stack package, an interposer with circuitry, or an integrated circuit assembly. The device 102 can have a thickness less than 70 micrometers.

The device 102 can include a first surface depression 104, such as a surface ditch, a surface groove, a surface channel, or similar surface indentation, adjacent or in a stack side 108 and along non-horizontal sides 120 of the device 102. The cross-section of the first surface depression 104 is shown having a semi-circular shape. The cross-section of the first surface depression 104 can have any cross-sectional shape.

The first surface depression 104 surrounds an area of the stack side 108 having an end of conductors 122 such as contacts, pads, TSVs, pins, posts, or columns exposed at the stack side 108. The first surface depression 104 can be formed using processes such as water-jet guided laser etching, laser grooving, or laser marking.

For illustrative purposes, the present invention is shown and described as having one of the first surface depression 104 adjacent or in the stack side 108. The present invention can have any number of the first surface depression 104, each non-overlapping with different positions, depths, sizes, or shapes. For example, the stack side 108 could have a square shaped surface depression formed between a smaller rectangular shaped surface depression and a larger circular shaped surface depression.

An end of the conductors 122 opposite the end of the conductors 122 exposed at the stack side 108 can be at an active side of the device 102 opposite and facing away from the stack side 108. The first surface depression 104 surrounds and encloses the conductors 122 exposed at the stack side 108 and the active side 109. The conductors 122 can provide connectivity between the active side of the device 102, the stack side 108, or circuitry within the device 102.

The active side of the device 102 can be mounted over a circuitry side 124 of a package substrate 126. Internal connectors 128 such as balls, bumps, pins, posts, leads, or pillars, can connect the end of the conductors 122 exposed at the active side of the device 102

or the active side of the device 102 with conductive material 130 adjacent the circuitry side 124.

The package substrate 126 includes the conductive material 130 adjacent the circuitry side 124, a side opposite the circuitry side 124 of the package substrate 126, and imbedded within the package substrate 126. The conductive material 130 can provide connectivity between the circuitry side 124 and the side opposite the circuitry side 124 of the package substrate 126.

A base underfill 132 can be used to surround the internal connectors 128 between the active side of the device 102 and the circuitry side 124 of the package substrate 126. The base underfill 132 can cover the active side of the device 102 and substantially fill an area or space between the active side of the device 102 and the package substrate 126. The base underfill 132 can cover part or all of the first surface depression 104. During fabrication of the present invention, the first surface depression 104 can prevent the base underfill 132 from entering any area within a perimeter formed by the first surface depression 104.

An active side of a first component 134 having circuitry can be connected to the end of the conductors 122 exposed at the stack side 108 of the device 102 using the internal connectors 128. A first underfill 136 can be used to surround the active side of the first component 134 and the internal connectors 128 between the active side of the first component 134 and the stack side 108 of the device 102.

The first underfill 136 can be in direct contact with and cover the active side of the first component 134 and the area of the stack side 108 ~~within a perimeter formed by the first surface depression 104~~. The first underfill 136 can contact an inner edge 101 of the first surface depression isolated from the conductors 122. The first underfill 136 can substantially fill an area or space between the active side of the first component 134 and the area of the stack side 108 ~~within the perimeter~~ to the inner edge 101 closest to the conductors 122. During the fabrication of the present invention, the first surface depression 104 can be used to confine the first underfill 136 within and above the perimeter formed by the first surface depression 104.

It has been discovered that the present invention can provide significantly improved product yields with minimal impact to production costs. Standard laser based manufacturing equipment can be used to form the first surface depression 104 and provide improved product yields due to reduced fill overflow incidents. Thus, the present invention provides a combination of increased yields without significant additional investment such as new equipment, additional personnel, new fabrication processes, or additional employee training.

It has also been discovered, the present invention can effectively minimize thermal stress of an assembly. The first surface depression 104 can be formed having any shape and placement around the active side of the first component 134. The shape and placement of the

horizontal side 512. The first surface depression 504 can be formed using processes such as water-jet guided laser etching, laser grooving, or laser marking.

Openings 520, such as a through holes, passages, a tunnels, or similar through openings, can be formed within the first surface depression 504 through the horizontal side 512, the device 502, and the active side. The openings 520 can surround the area having the conductors 510.

There can be any quantity of the openings 520 having any position, width, or size within the first surface depression 504. An end of the conductors 510 opposite the end of the conductors 510 exposed at the stack side 506 can be adjacent an active side of the device 502 opposite the stack side 506. The conductors 510 can provide connectivity between the active side of the device 502, the stack side 506, or circuitry within the device 502.

The active side of the device 502 can be mounted over a circuitry side 522 of a package substrate 524. Internal connectors 526 such as balls, bumps, pins, posts, leads, or pillars, can connect the end of the conductors 510 exposed at the active side of the device 502 or the active side of the device 502 with conductive material 528 adjacent the circuitry side 522.

The package substrate 524 includes the conductive material 528 adjacent the circuitry side 522, a side opposite the circuitry side 522 of the package substrate 524, and imbedded within the package substrate 524. The conductive material 528 can provide connectivity between the circuitry side 522 and the side opposite the circuitry side 522 of the package substrate 524.

A base underfill 530 can be used to surround the internal connectors 526 between the active side of the device 502 and the circuitry side 522 of the package substrate 524. The base underfill 530 can cover the active side of the device 502 and space below the active side of the device 502. The base underfill 530 can be applied or cover part or all of the horizontal side 512 and fill the openings 520 of the first surface depression 504.

During fabrication of the present invention, the first surface depression 504 can prevent the base underfill 530 from contacting the stack side 506 of the device 502. An active side of a first component 532 having circuitry , positioned above the device 502 and the base underfill 520, can be connected to the end of the conductors 510 exposed at the stack side 506 of the device 502 using the internal connectors 526. A first underfill 534 can be used to surround the internal connectors 526 between the active side of the first component 532 and the stack side 506 of the device 502.

CLAIMS

What is claimed is:

1. A method of manufacture of an integrated circuit packaging system comprising:

providing a device ~~having a conductor with ends exposed on opposite sides of the device~~ formed as a die having a stack side, an active side opposite and facing away from the stack side, and a conductor with an end exposed at the stack side and an opposite end of the conductor exposed at the active side;

forming a first surface depression on the device, the first surface depression surrounding the conductor exposed at the stack side and the active side; ~~around the conductor;~~

connecting a first component over the conductor and surrounded by the first surface depression; and

applying a first underfill between and in direct contact with the first component and the device, the first underfill substantially filled ~~within a perimeter of the first surface depression~~ to a side of an inner edge and within a perimeter of the first surface depression isolated from the conductor;

wherein:

forming the first surface depressing includes an opening within the first surface depression; and further comprising:

applying a base underfill within a portion of the opening.

2. The method as claimed in claim 1 further comprising:

providing a second conductor;

forming a second surface depression around the second conductor;

connecting a second component over the second conductor surrounded by the second surface depression; and

applying a second underfill between the second component and the device, the second underfill substantially filling a perimeter of the second surface depression.

3. The method as claimed in claim 1 wherein forming the first surface depression includes forming the first surface depression having a horizontal side and a vertical side.

4. The method as claimed in claim 1 further comprising a base underfill under the first component and covering a portion of the first surface depression.

~~5.The method as claimed in claim 1 wherein:~~

~~forming the first surface depression includes an opening within the first surface depression; and~~

~~further comprising:~~

~~applying a base underfill within a portion of the opening.~~

~~6.~~5. A method of manufacture of an integrated circuit packaging system comprising:

providing a device formed as a die having a stack side, an active side opposite and facing away from the stack side, and a conductor with ~~ends exposed at the stack side and a side opposite the stack side~~ an end exposed at the stack side and an opposite end of the conductor exposed at the active side;

forming a first surface depression on the device, the first surface depression surrounding ~~and around the end of~~ the conductor exposed at the stack side and the active side;

connecting a first component over the end of the conductor exposed at the stack side and surrounded by the first surface depression;

applying a first underfill between and in direct contact with the first component and the stack side, the first underfill substantially filled ~~within a perimeter of the first surface depression;~~to a side of and within an inner edge and a perimeter of the first surface depression isolated from the conductor;

connecting a package substrate below the device; and

applying a base underfill between the device and the package substrate, the base underfill substantially outside a perimeter of the first surface depression;

wherein:

forming the first surface depression includes an opening within the first surface depression; and

filling the opening with the base underfill.

~~7.~~6.The method as claimed in claim ~~6~~5 further comprising:

providing a second conductor with ends exposed at opposite sides of the device;

forming a second surface depression next to the first surface depression and around the second conductor;

connecting a second component over the end of the second conductor and surrounded by the second surface depression; and

applying a second underfill between the second component and the stack side.

~~8.~~7.The method as claimed in claim ~~6~~5 wherein forming the first surface depression includes forming the first surface depression having a horizontal side, a vertical side, and an opening through the horizontal side.

~~9.~~8.The method as claimed in claim ~~6~~5 wherein applying the base underfill can cover a portion of a horizontal side of the first surface depression.

~~10.The method as claimed in claim 6 wherein:~~

~~forming the first surface depression includes an opening within the first surface depression; and~~

~~filling the opening with the base underfill.~~

~~11.~~9. An integrated circuit packaging system comprising:

a device formed as a die having ~~a conductor with ends on opposite sides of the device~~ a stack side, an active side opposite and facing away from the stack side, and a conductor with an end exposed at the stack side and an opposite end of the conductor exposed at the active side;

a first surface depression formed on the device ~~around the conductor~~, the first surface depression surrounding the conductor exposed at the stack side and the active side;

a first component connected over the conductor surrounded by the first surface depression; and

a first underfill between and in direct contact with the first component and the device, the first underfill substantially filled ~~within a perimeter of the first surface depression.~~ to an inner edge and within a perimeter of the first surface depression isolated from the conductor;

wherein:

the first surface depression formed with an opening within the first surface depression; and further comprising:

a base underfill applied wihin a portion of the opening.

~~12.~~10. The system as claimed in claim ~~11~~9 further comprising:

a second conductor;

a second surface depression formed around the second conductor;

a second component connected over the second conductor surrounded by the second surface depression; and

a second underfill between the second component and the device and a perimeter of the second surface depression substantially filled with the second underfill.

~~13.~~11. The system as claimed in claim ~~11~~9 wherein the first surface depression formed with a horizontal side and a vertical side.

~~14.~~12. The system as claimed in claim ~~11~~9 further comprising a base underfill under the first component, the base underfill covers a portion of the first surface depression.

~~15.The system as claimed in claim 11 wherein:~~

~~the first surface depression formed with an opening within the first surface depression; and~~

~~further comprising:~~

~~a base underfill applied within a portion of the opening.~~

~~16.~~13. The system as claimed in claim ~~11~~9 wherein:

~~the device having a stack side and the conductor with ends at a stack side and a side opposite the stack side;~~

~~the first surface depression formed on the device and around the end of the conductor at the stack side;~~

the first component connected over the end of the conductor at the stack side and surrounded by the first surface depression;

the first underfill between the first component and the stack side ~~having the first underfill substantially filled within the perimeter of the first depression~~; and

further comprising:

a package substrate connected below the device; and

a base underfill between the device and the package substrate and substantially outside ~~the~~a perimeter of the first surface depression.

~~17.~~14. The system as claimed in claim ~~16~~13 further comprising:

a second conductor with ends at opposite sides of the device;

a second surface depression formed next to the first surface depression and around the second conductor;

a second component connected over the end of the second conductor and surrounded by the second surface depression; and

a second underfill between the second component and the stack side.

~~18.~~15. The system as claimed in claim ~~16~~13 wherein the first surface depression formed having a horizontal side, a vertical side, and an opening through the horizontal side.

~~19.~~16. The system as claimed in claim ~~16~~13 wherein the base underfill can cover a portion of a horizontal side of the first surface depression.

~~20.The system as claimed in claim 16 wherein:~~

~~the first surface depression formed with an opening within the first surface depression; and~~

~~the opening filled with the base underfill.~~