

INTEGRATED CIRCUIT PACKAGE EMPLOYING A TRANSPARENT
ENCAPSULANT AND A METHOD OF MAKING THE PACKAGE

5

FIELD OF THE INVENTION

The present invention relates to integrated circuit packages, and in particular to a package for an integrated circuit device having circuitry whose
10 functioning requires the transmission of light through the package.

BACKGROUND OF THE INVENTION

Integrated circuits devices are typically housed
15 in packages. Typical packages are made of plastic, ceramic, or metal. The packages include internal and external conductive structures, such as metallized vias, metal traces, bond wires, and solder interconnection balls or leadless chip carrier ("LCC")
20 pads, for electrically connecting the integrated circuit device in the package to external circuitry, such as a circuit board.

Certain types of integrated circuit devices, such as erasable programmable read-only memory devices
25 ("EPROM"), charge coupled devices ("CCD") or optical sensing devices, such as those used in document scanners, fingerprint recognition equipment, or other consumer products, require a selected or continuous transmission of light of a selected frequency through
30 the top surface of the package onto the surface of the integrated circuit die within the package. Typically,

the packages for such integrated circuit devices have a glass or quartz window in the otherwise opaque top surface of the package. This transparent window is located above the die, and the selected frequency of light passes through the window and impinges on the top surface of the die. Unfortunately, packages having such glass or quartz inserts are relatively expensive to fabricate, which raises the cost of the products in which the integrated circuit devices are used. A less expensive alternative would have wide application.

SUMMARY OF INVENTION

Embodiments of an improved package for integrated circuit devices, such as EPROM and CCD or other optical devices whose functioning requires a selective or continuous transmission of light through a portion of the package, are disclosed. Exemplary methods of making such packages are also described.

The package has a planar insulating substrate base, which may be formed of an epoxy laminate or ceramic. The substrate has a first surface and an opposite second surface. Metallized vias extend through the substrate. An integrated circuit die having light-sensitive circuitry, such as a die for a CCD device, is affixed to the first surface of the substrate. Bond wires are installed which electrically connect the conductive bonding pads on the die to conductive structures on the first surface of the substrate, such as metal traces and contact pads. These conductive structures are in turn electrically

connected to the metallized vias through the substrate. Conductive structures on the second surface of the substrate, such as solder interconnection balls or LCC pads, for connecting the package to external circuitry
5 are electrically connected to the metallized vias and hence to the die.

After the bond wires are installed, a bead of an adhesive material such as epoxy plastic is deposited onto the first surface of the substrate peripherally
10 around the die. The bead covers the peripheral side surfaces of the die and the periphery of the upper first surface of the die, including the bonding pads of the die. The bead also covers the bond wires and the conductive structures on the first surface of the
15 substrate. The height of the bead around the die exceeds both the height of the die above the substrate and the height of the normally bowed bond wires, thus forming a central cavity above and with the upper first surface of the die.

20 After a step of hardening the bead material, a layer of a transparent encapsulating material, such as clear TEFLON® polymeric resin, is deposited onto the die, within the central cavity formed by the bead and the upper first surface of the die. The layer of
25 transparent encapsulating material is subsequently hardened, forming a solid transparent exterior package surface above the optical sensing circuitry of the die.

An alternative method of making the package employs a relatively larger substrate having a
30 plurality of sites which are adapted for the formation

of an array of individual integrated circuit packages. Each site has one or more conductive structures on its first and second surfaces, and one or more metallized vias extending through the substrate. An integrated
5 circuit die is attached to each site of the array, and is electrically connected to the metallized vias through the substrate. A bead of adhesive material is deposited onto the first surface of the substrate so that a bead surrounds each die in the array. The beads
10 cover the side surfaces of the dies, the periphery of the upper first surface of the dies, and the bond wires. Together, the bead and the upper first surface of the die define a cavity above each die into which a layer of encapsulating material is deposited.

15 One way of applying the bead material is to deposit crisscrossing perpendicular beads of the adhesive material on the substrate adjacent to all sides of the dies in the array. The rows and columns of bead material meld together, forming a continuous
20 bead around each die in the array. After the bead material is hardened, a layer of a transparent encapsulating material is placed onto the die within the cavity formed by the bead and the first surface of the die. The encapsulating material is then hardened,
25 and the individual packages in the array are separated.

Among other virtues, the packages and methods described herein provide a lower cost solution to the problem of designing reliable packages for EPROM, CCD, and other optical devices.

BRIEF DESCRIPTION OF DRAWINGS

Figure 1 is a cross-sectional side view of an integrated circuit package.

Figure 2 is a plan view of an integrated circuit package prior to encapsulation.

Figure 3 is a flow chart of a method of assembling an integrated circuit package.

Figure 4 is a top view of an array of incomplete integrated circuit packages, before bead material is applied onto the array.

DETAILED DESCRIPTION

Figure 1 is a cross-sectional side view of an exemplary integrated circuit package 10 in accordance with the present invention. Substrate 11 forms an insulating base of package 10. Substrate 11 has an upper first surface 12 and a lower second surface 13. Substrate 11 may be formed, for example, of a conventional epoxy laminate or ceramic. Examples of suitable substrates include Mitsubishi BT, Arlon 45N, and Nelco BT laminate substrates.

An exemplary thickness of substrate 11, between first surface 12 and second surface 13, is between 0.36 mm and 0.56 mm, but the thickness of substrate 11 may vary depending on the application. The perimeter of substrate 11 may be a variety of shapes, again depending on the packaging application. For example, the perimeter of substrate 11 may be square or rectangular.

Integrated circuit die 14 rests on and is affixed to first surface 12 of substrate 11. Die 14 has an

upper first surface 21 containing peripheral bonding pads 19, peripheral side surfaces 22, and a lower second surface 23 opposite first surface 21.

Conventional epoxy die attach compound, such as QMI 696
5 available from the QMI Company of San Diego, California, may be used to affix lower second surface 23 of die 14 to first surface 12 of substrate 11.

Typically, EPROM, CCD or other optical integrated circuit dies have vision cells or other light-sensitive
10 circuitry on their upper surfaces, which must be selectively or continuously exposed to light of a selected frequency for some functioning of the completed device. In Figure 1, such circuitry is exemplified by polyimide vision cell 24 on a central
15 portion of upper first surface 21 of die 14. Other non-optical circuitry, not shown in Figure 1, may also be exposed on first surface 21 of die 14, depending on the application.

Conductive metallized via 15 extends through
20 substrate 11, between first surface 12 and second surface 13. Via 15 may be formed, for example, by drilling a hole through substrate 11, and plating the hole with metal, such as copper, using conventional methods. Via 15 provides a conductive path for
25 electrically connecting conductive structures on first surface 12 and second surface 11 of substrate 11.

In Figure 1, conductive structures on or adjacent to first surface 12 of substrate 11 electrically connect die 14 to metallized via 15. For example, at
30 the intersection of via 15 and first surface 12 of

substrate 11, a first end of a metal trace 16 is electrically connected to via 15. Metal trace 16 extends laterally away from via 15, and its second end is electrically connected to a metal contact 17 on
5 first surface 12 of substrate 11. The term "electrically connected" is used broadly herein to mean a conductive path exists between the "electrically connected" structures, which may be due to a direct or indirect physical connection.

10 Contact 17 is electrically connected to a first end of a metal bond wire 18. An opposite second end of bond wire 18 is electrically connected to a conductive bonding pad 19 on a peripheral portion of upper first surface 21 of die 14.

15 Metal trace 16 and metal contact 17 may be formed, for example, of copper that is plated on first surface 12 of substrate 11 using conventional electroplating methods. Bond wire 18 may be formed of gold or aluminum.

20 A typical package like Figure 1 will have multiple metallized vias 15, metal traces 16, contacts 17, bond wires 18, and bonding pads 19, the number of which would depend on the application. For clarity, only two of each of these structures are shown in Figure 1.

25 Metallized via 15 also intersects lower second surface 13 of substrate 11. At second surface 13, a first end of metal trace 31 is electrically connected to metallized via 15. Metal trace 31 extends laterally on lower second surface 13 away from via 15. A second
30 end of metal trace 31 is electrically connected to a

planar metal interconnection ball land (not shown), which is also formed on lower second surface 13 of substrate 11. A metallic solder interconnection ball 33 is joined to the land. Interconnection balls 33 are used to electrically connect package 10, and hence die 14, to external circuitry such as a circuit board. In alternative embodiments, an interconnection ball land may be formed on the lower second surface of the substrate around the metallized via, as opposed to a lateral distance from the via, so that an interconnection ball may be placed directly below the via.

A typical package like Figure 1 would have multiple metal traces 31, metal lands, and interconnection balls 33 on the lower second surface 13 of its substrate 11, the number of which would depend on the packaging application. For clarity, only two of these structures are shown in Figure 1.

The interconnection balls 33 of Figure 1 are characteristic of a ball grid array ("BGA") package. Such interconnection balls are generally arranged in an array pattern, such as X and Y axis rows of balls, on second surface 13 of substrate 11. The particular pattern selected may depend, for example, on the external circuitry to which package 10 is ultimately electrically connected.

The interconnections of the various conductive structures described above, including metallized vias 15, metal traces 16 and 31, contacts 17, bond wires 18, metal lands, and interconnection balls 33, provide an

electrically conductive path between bonding pads 19 of die 14 and interconnection balls 33. Metallized vias 15 provide the portion of the conductive path that extends through substrate 11.

5 There are, of course, other ways known to practitioners to electrically connect an integrated circuit die (or dies) in a package to conductive structures on the exterior of the package or to connect the package itself to external circuitry. As an
10 example, instead of using solder interconnection balls 33, a patterned array of planar metal contacts may be formed on lower second surface 13 of substrate 11, as in a conventional leadless chip carrier ("LCC") package. As another alternative, instead of using bond
15 wires, tape automated bonding may be employed.

Returning to Figure 1, bead 20 is adjacent to and covers the peripheral edges of die 14 on first surface 12 of substrate 11. Bead 20 has a top first portion 25, an opposite lower second portion 26, a outer third
20 portion 27, and an inner fourth portion 28 adjacent to die 14. Top first portion 25 of bead 20 forms a peripheral portion of the top surface of package 10. Lower second portion 26 of bead 20 is on and fixed to first surface 12 of substrate 11. Outer third portion
25 27 of bead 20 forms the peripheral side walls of package 10. Inner fourth portion 28 of bead 20 covers side surfaces 22 of die 14, as well as the outer periphery of upper first surface 21 of die 14, including the interconnections between bond wires 18
30 and bonding pads 19 on die 14.

As shown in Figure 1, bead 20 protectively covers each metal trace 16, contact 17, bond wire 18, and bonding pad 19 located on or adjacent to first surface 12 of substrate 11. Bead 20 also covers side surfaces 22 of die 14 and the periphery of upper first surface 21 of die 14, including bonding pads 19. Bead 20 does not, however, cover the central portion of upper first surface 21 of die 14 where polyimide vision cell 24 is located, to avoid interference with the light-sensitive functioning of vision cell 24. The height of bead 20 above first surface 12 of substrate 11 exceeds the height of die 14 and bond wires 18 above first surface 12. Accordingly, bead 20 and upper first surface 21 of die 14 together form and define a cavity, above die 14, into which a thin layer of transparent encapsulating material 29 is deposited.

Figure 2 is a top view of an incomplete package 10, before a transparent encapsulant is placed onto die 14. In Figure 2, bead 20 surrounds die 14, contacting side surfaces 22 of die 14 all the way around die 14. To illustrate that bead 20 also covers the periphery of upper first surface 21 of die 14, the periphery of first surface 21 of die 14 is shown by dashed lines. Although die 14 and bead 20 are shown as having square perimeters in Figure 2, the perimeters of die 14 and bead 20 may vary depending on the application. For example, die 14 and bead 20 may have rectangular perimeters.

Bead 20 is formed of a material that is adhesive. The material of bead 20 should also be somewhat viscous

and flowable when initially applied onto first surface 12 of substrate 11, but should be readily hardenable by air drying or heating or the like so that bead 20 forms solid, protective side and top surfaces of package 10.

5 An example material useful for bead 20 is epoxy, such as Ciba Nagase 9006 epoxy from the Ciba Nagase Company of Japan. Hardening of this epoxy is normally accomplished by heating for about 60 minutes at 150°C. Other suitable epoxy materials usable for bead 20
10 include Hysol 4451 from Hysol Corporation of City of Industry, California. Alternatively, instead of epoxy material, bead 20 may be formed of a silicone rubber, such as silicon rubber number 3140 from the Dow Corning Company.

15 In Figure 1, a planar layer of transparent encapsulant 29 covers first surface 21 of die 14, including the central portion of first surface 21 of die 14 where polyimide vision cell 24 is located. When hardened, encapsulant 29 forms a top exterior surface
20 of package 10.

Encapsulant 29 is contained within the square-sided cavity above die 14 which was formed by first surface 21 of die 14 and that part of inner fourth portion 28 of bead 20 whose height above first surface
25 12 of substrate 11 is greater than the height of die 14 above first surface 12 of substrate 11.

In Figure 1, the exemplary planar upper first surface 30 of encapsulant 29 is slightly lower, for example, about 0.005 mm lower, than top first portion

25 of bead 20, which may provide protection from abrasions to first surface 30.

The appropriate thickness of the layer of encapsulant 29 depends, for example, on the packaging application and the material chosen for encapsulant 29. A typical material appropriate for encapsulant 29 has a light transmission value that is a function of its thickness.

Encapsulant 29 is formed of a material that is adhesive. The material of encapsulant 29 should be somewhat viscous and flowable when initially applied onto first surface 21 of die 14, but should be hardenable so that the layer of encapsulant 29 forms a solid, protective top surface of package 10 adjacent to die 14.

As discussed above, the EPROM, CCD, and other optical sensing device applications suited for a package such as Figure 1 require that a surface of the packaged die be selectively or continuously exposed to light of a selected frequency. In such applications, the material chosen for encapsulant 29 should be transparent to the particular frequency of light needed by the application.

In the example of Figure 1, die 14 has a polyimide vision cell 24 located on a central portion of first surface 21 of die 14. As is typical in CCD or other optical sensing applications, such a vision cell requires exposure to visible light. For such applications, as shown in Figure 1, encapsulant 29 is formed of a clear material, such as clear TEFLON®

synthetic polymeric resin (polytetrafluoroethylene) from the E. I. Dupont Chemical Company, or an equivalent transparent, protective material. A layer of TEFLON® resin having a thickness of about 0.20 mm
5 may be hardened by heating at a temperature of about 150°C for about 60 minutes. Alternatively, a layer of water white clear epoxy may be used for encapsulant 29.

The dimensions of a package like Figure 1 will vary with the particular packaging application. As an
10 example, dimensions of components of package 10 may include an approximately 10 mm x 10 mm square substrate 11; an approximate 8 mm by 8 mm square die 14; a bead 20 having an approximate 9 mm x 9 mm square perimeter; a bead 20 height between top first portion 25 and first
15 surface 12 of substrate 11 ranging from approximately 0.60 mm to 0.80 mm; a bead 20 width between outer third portion 27 and side surfaces 22 of die 14 ranging from approximately 0.60 mm to 0.80 mm; and a relatively thin layer of a transparent encapsulant 29 having a
20 thickness, i.e., a height between upper first surface 21 of die 14 and upper first surface 30 of encapsulant 29, ranging from approximately 0.10 mm to 0.30 mm. As an example, the thickness of encapsulant 29 may be 0.20 mm. Again, such dimensions will vary with the
25 packaging application. For example, larger dies typically require larger packages.

Figure 3 shows a flow chart for an example method of making a package in accordance with the present invention. As a first step A in the process shown in
30 Figure 3, an insulating substrate base is provided

having conductive structures on and between its first and second surfaces. As an example, substrate 11 of Figure 1 is provided. In Figure 1, substrate 11 has metal traces 16 and 31, metallized vias 15, contacts 17, metal lands, and interconnection balls 33, all of which are electrically connected.

As a second step B, an integrated circuit die is provided and placed on the first surface of the substrate. A conventional epoxy die attach material may be used to affix the die to the substrate.

As a third step C, the integrated circuit die is electrically connected to the conductive structures on and through the substrate. Using the example of Figure 1, bond wires 18 are connected between bonding pads 19 on the periphery of die 14 and contacts 17 on substrate 11 so that die 14 may be electrically connected to metallized vias 15, and hence to interconnection balls 33. A conventional bond wire attaching machine may be used to perform this step.

A fourth step D is the application of a bead of a viscous, hardenable, adhesive material onto the first surface of the substrate, around the integrated circuit die. The bead should be applied so that its height relative to the upper first surface of the substrate exceeds the height of the die above the substrate. In this way, a cavity is formed above the upper first surface of the die into which the transparent encapsulant material may be deposited. Figures 1 and 2 show an exemplary bead 20. In those figures, the bead was applied onto the substrate so as to cover the side

surfaces of the die and the periphery of the upper first surface of die, as well as the bond wires and other conductive structures on the first surface of the substrate. The bead material does not cover the die's
5 light-activated circuitry.

An example bead material is epoxy, such as Ciba Nagase 9006. Such an epoxy bead may be applied using a syringe. Alternatively, a conventional autodispense machine, such as model 5000 of the Camelot Company or
10 the Millennium model of the Asymtek Company, may be used.

A fifth step E is to harden the bead material. The hardened bead material forms solid, protective side and top surfaces of the package. Figure 1 shows an
15 example of a solid bead 20. Where epoxy material is used for the bead, the step of hardening the bead material may be performed by heating to a temperature of approximately 150°C for about 60 minutes.

After the hardening step, a sixth step F is to
20 apply a layer of a viscous, hardenable, adhesive, and selectively-transparent encapsulating material onto the exposed upper first surface of the die, within the three-dimensional cavity formed by the upper first surface of the die and the now-hardened bead material
25 that surrounds the die. Figure 1 shows how an embodiment of a package appears after a layer of transparent encapsulant 29 is deposited onto upper first surface 21 of die 14.

Where, for example, the package is for CCD applications or other optical applications, the encapsulating material should be clear so as to be transparent to visible light. An example material is clear TEFLON® resin.

The step of applying a layer of a selectively transparent encapsulating material onto the die may be performed, for example, with a syringe or a conventional autodispense machine. The amount of encapsulating material used affects the thickness of the layer.

A seventh step G is to harden the layer of encapsulating material applied onto the die. This hardening step is performed so that the encapsulating material forms a solid and protective top exterior surface of the package. This hardening step may be performed, for example, by heating the package after the encapsulating material is applied.

Depending on the package configuration, as an additional eighth step H, conductive structures such as solder interconnection balls are placed by conventional methods onto metallizations provided on the underside of the substrate of the package. For example, Figure 1 shows a package 10 having solder interconnection balls 33 on second surface 13 of substrate 11. Alternatively, such conductive structures could be initially provided on the substrate.

In an alternative method, instead of constructing each package individually, an array of packages similar to those of Figures 1-2 are created on a single,

relatively larger substrate, and then the array is cut apart to separate the individual packages from each other.

Figure 4 is a top view of an array 40 of four incomplete packages 10, before the step of applying bead material is performed. While array 40 shows only four incomplete packages, the number of packages in the array can vary, depending, for example, on the size of the substrate and dies.

In this alternate method, the first three steps A-C of Figure 3 are performed, i.e. providing an insulating substrate having conductive structures, providing and affixing an integrated circuit die to the substrate, and electrically connecting the die to the conductive structures on the substrate, except that a larger substrate 41 having four sites for placement of integrated circuit dies is provided, and the other steps are repeated to accommodate each of the four integrated circuit die that are affixed to substrate 41.

A fourth step is to apply a square bead, like bead 20 in Figures 1 and 2, peripherally around each die on array 40 of Figure 4. In an alternative embodiment, the step of applying a bead of adhesive material is performed by applying a first set of parallel beads of adhesive material adjacent to the integrated circuit dies, and then applying a second set of parallel beads of adhesive material perpendicularly across the first set of parallel beads, so that a crisscrossing pattern of rows and columns of bead material is deposited on

the substrate around all sides of each die. The crisscrossing beads meld to form a continuous bead around each die in the array. As discussed above, the bead and the upper first surface of the die together
5 define a cavity above the die, into which the layer of encapsulating material is deposited.

Referring to Figure 4, after the step of applying bead material onto substrate 41 is performed, the fifth through eighth steps E-H of Figure 3 are performed for
10 each package in the array, i.e. the steps of hardening the beads, applying the layers of encapsulant within the cavities formed by the beads, hardening the layers of encapsulant, and placing conductive structures such as interconnection balls on the second surface of the
15 substrate for each site on the array.

Subsequently, a step of separating the individual packages in the array of packages from each other is performed. This step may be performed, for example, by cutting through the substrate and bead material using a
20 conventional wafer saw.

The embodiments of packages and assembly methods described above are merely examples of the present invention. Artisans will appreciate that variations are possible within the scope of the claims set forth
25 below.

CLAIMS

1. An integrated circuit package comprising:

5 a substrate having a first surface and an opposite second surface, said second surface having a first conductive structure thereon;

10 an integrated circuit die, said die having a first surface and an opposite second surface, wherein said second surface of the die is adjacent to said first surface of said substrate;

15 an electrical interconnection between the first surface of the substrate and the second surface of the substrate, wherein said integrated circuit die is electrically connected to said first conductive structure;

20 a bead of an adhesive material on said first surface of said substrate, said bead surrounding said integrated circuit die and forming a cavity above and with said first surface of the die; and

25 a layer of an adhesive transparent material on said first surface of the die within said cavity.

30 2. The package of claim 1, wherein said integrated circuit die has a perimeter, and peripheral side surfaces at said perimeter; and

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said bead contacts said side surfaces and a peripheral portion of said first surface of said die.

3. The package of claim 2, including a
5 multiplicity of bond wires electrically connected to said integrated circuit die, and wherein said bead covers said bond wires.

4. The package of claim 3, wherein said bead is
10 formed of an epoxy material.

5. The package of claim 4, wherein said
transparent adhesive material is a
polytetrafluoroethylene resin.

15 6. The package of claim 1, including a light-sensitive cell in said cavity, and wherein said layer of an adhesive transparent material has a thickness of from about 0.1 mm to about 0.30 mm and transmits light
20 to said cell.

7. The package of claim 1, wherein said
electrical interconnection includes a metallized via extending through said substrate between the first and
25 second surfaces of the substrate.

8. The package of claim 7, wherein said
integrated circuit die has a perimeter, and peripheral side surfaces at said perimeter; and

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said bead contacts said side surfaces and a peripheral portion of said first surface of said die.

9. The package of claim 8, including a
5 multiplicity of bond wires electrically connected to said integrated circuit die, and wherein said bead covers said bond wires.

10. A method of making an integrated circuit
10 package comprising:

providing a substrate having a first surface, an opposite second surface, an electrical interconnection between said first surface and said second surface, and
15 a first conductive structure on said second surface;

providing an integrated circuit die, said die having a first surface and an opposite second surface;

20 placing said second surface of said die onto said first surface of the substrate;

electrically connecting said integrated circuit die to said first conductive structure on the second
25 surface of the substrate;

applying a bead of an adhesive material onto said first surface of the substrate around said die, wherein said bead and said first surface of the die form a
30 cavity above the die;





hardening said adhesive bead;

5 applying a layer of a transparent adhesive
material onto said first surface of the die within said
cavity; and

hardening said layer of transparent adhesive
material.

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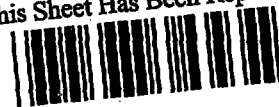
11. The method of claim 10, wherein said
integrated circuit die has a perimeter, and side
surfaces at said perimeter; and

15 the step of applying a bead of an adhesive
material onto said first surface of the substrate
includes covering said side surfaces and a peripheral
portion of said first surface of said die with said
bead of an adhesive material.

20

12. The method of claim 11, further including a
step of electrically connecting a bond wire to said
integrated circuit die; and

25 wherein the step of electrically connecting said
integrated circuit die to said first conductive
structure includes an electrical connection through a
metallized via through the substrate; and





wherein the step of applying a bead of an adhesive material onto said first surface of the substrate around said die includes covering said bond wire with said bead.

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13. The method of claim 12, wherein said adhesive material is an epoxy material.

14. The method of claim 13, wherein said
10 transparent adhesive material is
polytetrafluoroethylene resin.

15. A method of making an integrated circuit package comprising:

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providing a substrate having a first surface, an opposite second surface, and a plurality of sites adapted for the formation of an array of individual integrated circuit packages thereon;

20

wherein each said site has a metallized via extending through said substrate between said first surface and said second surface, and a first conductive structure on said second surface;

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providing an integrated circuit die for each site of the array, each said die having an upper first surface and an opposite second surface;

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placing the second surface of an integrated die
onto the first surface of the substrate for each site;

electrically connecting the integrated circuit die
5 placed on each site to the first conductive structure
of the site through the metallized via of the site;

applying an adhesive material onto said first
surface of the substrate so that a bead of the adhesive
10 material is formed around each die and said bead and
said upper first surface of the die form a cavity above
each die;

hardening the bead surrounding each die;
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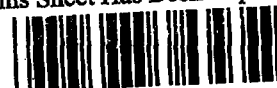
applying a layer of a transparent adhesive
material onto the first surface of each die within the
cavity above each die;

20 hardening said transparent adhesive material; and
separating the array into individual packages.

16. The method of claim 15, wherein each
25 integrated circuit die has a perimeter, and side
surfaces at said perimeter; and

the step of applying an adhesive material includes
covering said side surfaces and a peripheral portion of
30 said first surface of each said die with said bead.

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17. The method of claim 16, wherein the step of electrically connecting the integrated circuit die placed on each site to the first conductive structure
5 of the site includes electrically connecting a bond wire to the die; and

the step of applying an adhesive material onto said first surface of the substrate includes covering
10 each said bond wire with said bead.

18. The method of claim 17, wherein the step of applying an adhesive material onto the first surface of the substrate includes applying first parallel beads of
15 the adhesive material adjacent to each die, and then applying second parallel beads of the adhesive material adjacent to each die in a crisscrossing pattern with said first parallel beads.

20 19. The method of claim 18, wherein said adhesive material is an epoxy material.