Description

BACKGROUND OF THE INVENTION
FIELD OF THE INVENTION

This invention relates in general to improved semiconductor devices and, more particularly, to improved plastic encapsulated power devices and methods for making such devices.

BACKGROUND ART

High power semiconductor devices are widely used but nonetheless costly. Their high cost stems principally from the use of expensive piece parts, and complicated means of assembly. The cost increases rapidly when it is desired to place more than one semiconductor die within the same power device enclosure. Thus, a need continues to exist for low cost, rugged, power semiconductor devices of simplified construction, particularly where multiple semiconductor die must be accommodated within the same package.

Accordingly, it is an object of the present invention to provide an improved semiconductor device of lower cost for a given performance rating.

SUMMARY OF THE INVENTION

In accordance with the present invention as claimed in claim 1 there is provided a semiconductor device comprising.

a semiconductor die having a contact portion;

a base member having a first face for supporting said semiconductor die and a second face adapted to seal against a first surface of a mold;

a terminal member having a first face adapted to seal against a second surface of said mold;

a compliant connector means for supporting said terminal member and for coupling said terminal member to said contact portion of said semiconductor die, wherein said compliant connector means is adapted to press said second face of said base member against said first surface of said mold and said first face of said terminal member against said second surface of said mold;

bonding means for joining said base member, said semiconductor die, said compliant connector means, and said terminal member in a stacked relation; and

wherein said compliant connector means can be deformed sufficiently to accommodate thickness tolerance variation of the base member, semiconductor die and terminal member after joining by the bonding means.

In accordance with the present invention as claimed in claim 9 there is provided a process for making semiconductor devices of a predetermined height comprising:

providing a base member, terminal member, and semiconductor die adapted for bonding;

providing a compliant connecting means adapted for bonding which can be deformed sufficiently to accommodate the combined thickness tolerance variation of said base member, said semiconductor die, said compliant connector means, and said terminal member, after bonding;

bonding together said base member, said semiconductor die, said compliant connector means, and said terminal member in a stacked relationship to form a flexible deformable assembly whose height exceeds said predetermined height;

inserting said assembly in a mold adapted to have an outward face of said base member engage a first mold face and an outward face of said terminal member engage an opposed second mold face;

seating said base member against said first mold face and said terminal member against said second mold face to align said terminal member and said base member in a predetermined relationship, and to inhibit exposure of said outward faces of said base member and said terminal member to an encapsulant while allowing exposure of portions of an inner face of said base member, an inner face of said terminal member, and said compliant connector member to said encapsulant so as to provide outward directed forces on said terminal member and said base member during molding,

closing said mold to compress said compliant connecting means to enhance said seating and reduce said height of said assembly to substantially said predetermined height; and

injecting said encapsulant into said mold under pressure so as to achieve said outward directed forces and maintain said outward faces against said mold faces.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 shows an exploded view of a power semiconductor device, according to the prior art.

FIG. 2A is a top view of an improved semiconductor device, according to the present invention.

FIG. 2B is a side and partial cut-away view of the device of FIG. 2A.

FIG. 2C is a side and partial cut-away view, similar to FIG. 2B, but illustrating a further embodiment of the present invention.

FIG. 3 shows an exploded view of the piece parts of a preferred embodiment of the semiconductor device of the present invention.

FIG. 4A shows a portion of the piece part assembly of the device of the present invention, in greater detail, and located in a mold, but prior to mold closure.

FIG. 4B shows the same portion as in FIG. 4A but after mold closure.

FIG. 5A shows a top view of a terminal and compliant connector member according to a further embodiment of the present invention.

FIG. 5B shows a side view of a first portion of the terminal and connector member of FIG. 5A, further including a semiconductor die assembly.

FIG. 5C shows a side view of a second portion of the terminal and connector member of FIG. 5A, further including a semiconductor die assembly.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT.

FIG. 1 shows an exploded view of a typical power semiconductor device of the prior art.

Power semiconductor device 10 has copper base plate 11, plastic housing 12 and cover 13. Terminals 15a-c are provided to permit external connection to the device. Mounted on base plate 11 are internal piece part assemblies 16a-b. Piece part assembly 16a-includes lower electrode assembly 17, interconnecting strap 19, semiconductor die assembly 20, and upper contact assembly 21. Lower electrode assembly 17 comprises ceramic isolator 17a and copper electrode pad 17b. Mounted on electrode pad 17b are copper interconnecting strap 19 and semiconductor die assembly 20. Copper interconnecting strap 19 includes lug portion 19a for making contact to adjacent piece part assembly 16b, and connecting post 19b for making contact to terminal 15a. Semiconductor die assembly 20 consists of semiconductor die 20a with lower contact electrode 20c. Upper contact assembly 21, comprising molybdenum electrode disk 21a and braided copper lead 21b, is attached to upper face 20b of semiconductor die assembly 20 and connected to terminal 15b. Optional control lead 21c may also be provided as a part of upper contact assembly 21. These piece parts are typically attached together by soldering. Piece part assembly 16b is generally similar to assembly 16a but without lug portion 19a. Lead 23 is also of braided copper.

After piece part assemblies 16a-b are assembled on base plate 11, housing 12 is slipped over assemblies 16a-b and attached to base plate 11 by an adhesive. Electrodes 15a-c protrude through holes 12a-c in housing 12. Cover 13, having holes 13a-c, is placed over electrodes 15a-c and sealed by means of an adhesive and sealant which is placed in the small cavity which remains in the top of housing 12, between housing 12 and cover 13. The space within housing 12 surrounding piece part assemblies 16a-b is then back-filled with nitrogen through filling tube 14 which is subsequently sealed.

It will be readily apparent to those of skill in the art that a large number of piece parts are required to construct device 10, and that the assembly procedure is correspondingly complex. In addition, the piece parts themselves are expensive. Semiconductor device 10 of FIG. 1 is illustrated as containing two interconnected semiconductor die. These can be diodes, transistors, thyristors, other devices, or a combination thereof. Where it is desired that the die be electrically connected to base plate 11, ceramic isolator 17a and electrode 17b can be omitted.

FIG. 2A shows a top view and FIGS. 2B-C show partial side and cut-away views of the improved semiconductor device of the present invention. Semiconductor device 30 comprises base member 31, typically of copper, having mounting holes 31a-b. Terminal members 33a-b for external connection and having therein threaded connection holes 34a-b are partially enclosed in plastic body 32. In the right half of FIGS. 2B-C plastic body 32 has been cut away to show the internal construction of terminal members 33a-b, and to show the presence of semiconductor die assemblies 61 mounted on base member 31 and connected to terminal member 33b by means of compliant connector member or means 39. The details of die assemblies 61 will be illustrated later. To provide good retention of terminal members 33a-b in plastic body 32, it is convenient that terminal members 33a-b have knurled region 40. Internal face 42 of terminal member 33b is coupled to compliant connector member 39, typically by soldering. Compliant connector member 39 seals the internal end of threaded connection hole 34b to prevent entry of plastic during molding. Outward face 41 of terminal member 33b is conveniently substantially flat, as is outward face 43 of base member 31. Terminal member 33a is similarly arranged.

FIG. 2C illustrates an alternative embodiment in which plastic body 32 is formed in two parts, part 32a covering the semiconductor die and piece parts associated with terminal 33a, and part 32b covering the die and parts associated with terminal 33b. This has the advantage of reducing the bending force experienced by base member 31 due to differential contraction of plastic body 32 following molding which can occur when body 32 extends continuously between terminals 33a-b.

FIG. 3 shows an exploded view of the piece parts conveniently used in constructing device 30 of FIGS. 2A-C. Piece parts 60 of FIG. 3 comprises base member 31, semiconductor die assemblies 61, terminal members or means 63 and compliant connector means 62. Base member 31 has therein notches 35 and deformed portions 36 which aid in retaining plastic body 32. Base member 31 may optionally also have depressed regions 52 to aid in alignment and retention of semiconductor die or die assemblies 61 while piece parts 60 are being bonded together. Semiconductor die assemblies 61 may consist, optionally, of round or square semiconductor die each having two or more contact regions or electrodes thereon. Semiconductor die assemblies 61 can include metallic electrode and/or contact disks bonded to either face of the semiconductor die. This will be discussed in more detail later. Base member 31 has lower (outward) face 43.

FIG. 3 illustrates the situation in which die assemblies 61 comprise two pairs of rectifier (two terminal die assemblies 50a-b and 51a-b. It will be recognized by those of skill in the art that other types of die could be used, e.g. transistors or thyristors, and additional leads provided.

Compliant connector means 62 comprising connector members 39a and 39b are used, respectively, to connect semiconductor die assemblies 51a-b and 50a-b to terminal members 41a and 41b. Compliant connector member 39a has contact means 54a for contacting semiconductor die assembly 51a and contact means 54b for contacting semiconductor die assembly 51b. Contact means 54a and 54b are conveniently in the form of depressed regions or dimples formed in connector member 39a and facing toward semiconductor die assemblies 51a-b. Compliant connector member 39a also has optional

additional contact tang 64a which may be used to connect to additional components intended to be enclosed within plastic body 32, or to an external signal lead. Tangs 64a-b also conveniently serve as alignment keys to aid in positioning compliant connector members 62 during assembly and bonding of piece parts 60, particularly so that contact means 54a-b, for example, align over semiconductor die assemblies 51a-b, and correspondingly for contact means 53a-b and assemblies 50a-b. Compliant connector member 39b has contact means 53a-b for making contact to semiconductor die assemblies 50a-b and optional tang 64b for contact and/or alignment. More than one tang can be used so that the alignment feature and contact feature are separate, and/or to permit multiple contacts. Face 42a of terminal member 33a is connected to face 55a of compliant connector member 39a. Face 42b of terminal member 33b is connected to face 55b of connector member 39b. Base member 31, semiconductor die assemblies 61, compliant connector means 62, and terminal members 63 are bonded together typically by soldering. Terminal members 33a-b have threaded connection holdes 34a-b, and base 31 has mounting holes 31a-b.

FIGS. 4A-B show, by way of illustration of the means and method of construction of device 30, portion 80 comprising approximately half of assembled piece parts 60. FIG. 4A illustrates the situation after piece parts 60 have been bonded together, i.e. assembled, and inserted in mold 81, but prior to complete closure of mold 81. Assembled piece part portion 80 comprises base member 31, semiconductor die assemblies 51a-b, compliant connector member 39a, and terminal member 33a. An important feature of the present invention is that compliant connector member 39a have sufficient compliance so as to be able to compensate for the variations in thickness which may occur during the fabrication of the individual piece parts, or the variations which may occur as piece parts 60 are bonded together.

In FIG. 4A, the construction of semiconductor die assemblies 51a-b are illustrated in greater detail. Semiconductor die assembly 51a comprises, for example, semiconductor die 70a, which may be of rectangular or circular shape, sandwiched between molybdenum electrodes 71a and 72a which may be of rectangular, circular, or other shape. Semiconductor die 70a and electrodes 71a and 72a are bonded together by bonding layers 74a and 75a, typically, of solder. Semiconductor die assembly 51b is of a similar construction and bonded together in a similar way using bonding layers 74b and 75b to connect die 70b to electrodes 72b and 71b respectively. Semiconductor die assemblies 51a-b are bonded, respectively, to contact means 54a-b of compliant connector member 39a and to base member 31 by bonding means 76a-b and 73a-b. Lead-tin (95:5) solders are conveniently used for bonding means 73a-b, 74a-b, 75a-b and 76a-b. Terminal member 33a is coupled to compliant connector member 39a by bonding means 77, also typically of the same solder. Methods for soldering piece parts together are well known in the art. While it is convenient that separate electrodes 71a-b and/or 72a-b be used in conjunction with semiconductor die 70a-b, it is not essential. Electrodes 71a-b and 72a-b could be formed as contacts directly on die 70a-b, and bonding layers 74a-b and 75a-b eliminated.

Assembled piece part portion 80 has been placed in mold 81 between lower mold-half 81a and upper mold-half 81b. Face 82 of mold portion 81a is designed to match or correspond to outward face 43 of base member 31. Mold face 84 of upper mold portion 81b is designed to match or correspond to outward surface 41a of terminal 33a. The height of assembled piece part portion 80 and the dimensions of mold 81 are chosen so that when faces 82 and 43 are in contact, faces 41a and 84 will also come in contact before mold 81 completely closes.

FIG. 4A illustrates the situation in which, due to the normal variations in manufacturing processes, bonding region 73b has a thickness greater than bonding region 73a so that terminal member 33a is slightly cocked with respect to base member 31, and outward face 41a of terminal member 33a is not parallel with corresponding mold face 84. It will be appreciated by those of skill in the art that while the variation in thickness has been illustrated as occurring in bonding layer 73b, variations in thickness can occur in any of the several bonding layers, and/or in any of the several piece parts comprising portion 80, that is, in terminal member 33a, in compliant connector member 39a, in bonding means 76a-b or 77 or in any of the elements or layers making up die assemblies 51a and/or 51b. These variations can produce an equivalent misalignment of outward face 41a with respect to face 84 of mold portion 81b, and/or can cause assembled portion 80 to be taller or shorter than the nominal value. In a similar way, variations in the other half (not shown in FIG. 4A) of assembled piece parts 60, can produce a misalignment of either or both of terminals 33a-b with respect to each other and/or base plate 31. FIGS. 4A-B are intended to exemplify all of these possibilities.

A feature of the present invention is that compliant connector members 39a-b have sufficient compliance or crushability so as to accommodate whatever thickness variations reasonably occur during manufacture. This insures that mold 81 can be closed despite height variations or misalignment of assembled portion 80, and without permanent damage to either mold 81 or assembled portion 80, in particular without damage to semiconductor die 70a-b.

FIG. 4B illustrates the same structure as shown in FIG. 4A but after closure of mold 81. In FIG. 4B, outward faces 43 and 41a are firmly seated against matching mold faces 82 and 84. The misalignment of assembled portion 80 and of face 41a of terminal member 33a with respect to mold face 84 has been eliminated, and overall height 85 of assembled portion 80 has been reduced to the

predetermined final device dimensions which are determined by the spacing of the closed mold. In FIG. 4B compliant connector member 39a has deformed sufficiently to accommodate both the change in overall height of assembled portion 80 and to correct the height differential which resulted from, in this example, the unequal thicknesses of bonding layers 73a and 73b. Those of skill in the art will recognize that a small amount of shrinkage of the plastic can occur during cooling of the part after molding. This is readily measured and can be compensated for in the design of the mold so that any predetermined dimensional value (e.g. height) can be achieved.

It is important that surface 42a of terminal member 33a have basal area or extent 89 which exceeds separation 87 of electrodes or contacts 71a-b of semiconductor die assemblies 51a-b. It is convenient that extent 89 of surface 42a of terminal member 33a correspond approximately to distance 90 separating center lines 88a-b of semiconductor die assemblies 51a-b. This is to insure that the compression which takes place in compliant connector member 39a during the molding operation, occurs principally in contact means 54a-b as opposed to occurring by flexure of main body portion 91 of compliant connector member 39a. As a consequence the forces originating from the mold closure and transmitted from connector 33a through contact means 54a-b to semiconductor die 70a-b, are substantially entirely compressive at semiconductor die 70a-b. These forces must also be distributed with sufficient uniformity across the surface of die 70a-b so as to avoid cracking die 70a-b and/or to avoid significant bending moments which would tend to cause, for example, cracking of bonding layer 76a-b at points 92a-b.

As illustrated in FIG. 4B, contact means 54a and 54b of compliant connector member 39a have compressed by different amounts to accommodate the difference in height of layers 73a and 73b of assembled portion 80. An analogous result occurs if the difference in height arises from other locations in assembled portion 80 or assembled piece parts 60.

Contact means 54a-b have the form, preferably, of bowl shaped depressions or dimples with inward sloping sidewalls 93a-b (see FIG. 4A). It is desirable that sidewalls 93a-b of contact means 54a-b approach or meet the surface of electrodes or contacts 71a-b respectively at an angle less than 90°. Under these conditions, when solder is used for bonding means 76a-b, solder fillet 99a-b is formed at the periphery of contact means 54a-b where contact means 54a-b are bonded to semiconductor die contacts 71a-b. This accommodates solder run-off and/or extrusion from between contact means 54a-b and contacts 71a-b which could otherwise cause shorts on or across die 70a-b.

Initial heights 95a-b of contact means 54a-b exceed the total anticipated deflection or compliance required: (1) to accommodate the expected variations and/or non-uniformity in the thickness of the piece parts and/or bonding means, so that no significant bending or deformation is required in body portion 91 of compliant connector member 39a; and (2) to allow for compression of assembled portion 80 and (assembled) piece parts 60 to the final predetermined height.

FIG. 5A illustrates a top view of terminal member 100 having threaded hole 101 and coupled to compliant connector member 102 having contact portions or means 103a-c. Terminal member 100 is intended to serve as a means for making external connection to the device, analogous to the function of terminal members 33a-b of FIGS. 2A-C. By way of example, FIG. 5A illustrates the situation in which three semiconductor die assemblies are to be coupled together by a single compliant connector member attached to a common terminal. For clarity the details of the semiconductor die assemblies have been omitted from FIG. 5A. Examples of the die assemblies are included FIGS. 5B-C. Contact means 103a-b of connector member 102 illustrate a configuration useful for two terminal devices, e.g. rectifiers. Contact means 103c of compliant connector member 102 illustrates a contact configuration useful for three terminal devices, e.g. a thyristor, wherein center control gate lead 125 surrounded by insulating sleeve 126 passes through central hole 127 in contact means 103c. It will be readily apparent to those of skill in the art that many semiconductor die can be coupled together in this fashion. A multiplicity of leads can also be accommodated.

FIG. 5B shows a portion of a sideview of terminal member 100 and compliant connector member 102 of FIG. 5A in the vicinity of contact means 103a, including two terminal semiconductor die assembly 110 consisting of semiconductor die 111 and contact portions (e.g. disks) 112a-b. Bonding means 113a-c couple together contact portion 112b, semiconductor die 111, contact portion 112a, and contact means 103a of compliant connector member 102. Bonding means 114 couples compliant connector member 102 and terminal member 100. A further bonding means, not shown here, couples contact 112b to base member 31, as for example layer 73a of FIG. 4A.

FIG. 5B further illustrates several possible positions of perimeter 100a of base portion 108 of terminal member 100; position 105 located to the right of inner edge 116 of contact 112a, i.e. further toward the center of connector member 102; position 106 corresponding roughly to the center line of semiconductor die assembly 110; and position 107 located beyond external perimeter or boundary 117 of compliant connector member 102. It has been found that when perimeter 100a is in position 105 that compliant connector member 102 has a tendency to bend in location 120 resulting in failure of bonding layer 113c approximately in location 121 or at corresponding positions in layers 113a-b. Failure can also occur by cracking of semiconductor die 111. As per-

imeter 100a is moved radially outward from location 105, that is, to the left in FIG. 5B, the loading on contact means 103a becomes increasingly uniform. The tendency for compliant connector member 102 to bend in region 120 disappears and compliance is obtained substantially by deformation of contact means 103a. Any position that is substantially outboard of perimeter 116 of semiconductor die contact 112a is useful; however, it has been found that better results are obtained if boundary 100a is located more centrally over contact means 103a, as for example in the general vicinity of location 106. Extending boundary 100a beyond perimeter 117, for example, to position 107, while it may further increase the loading uniformity, does not produce a significant further improvement in bond integrity, reliability, and/or manufacturing yield, but does result in increased material costs.

FIG. 5C shows a portion of a cross-section and sideview of terminal member 100 and compliant connector member 102 of FIG. 5A in the vicinity of contact means 103c, but further including three-terminal semiconductor die assembly 130. Die assembly 130 comprises semiconductor die 131, lower contact portion 112b and upper washer shaped contact portion 132. Control lead 125 covered by insulating sleave 126 passes through hole 127a in contact means 103c and hole 127b in contact portion 132. Lead 125 attaches to central portion 131a of die 131 by bonding means 133b. Washer shaped contact portion 132 attaches to peripheral portion 131b of die 131 by means of bonding layer 133a. Bonding means 134 is conveniently used to couple washer shaped contact portion 132 to contact means 103c. Layers 133a-b and 134 are conveniently of solder although other electrically conductive bonding means can be utilized. Terminal member 100 is relieved at 140 to allow for passage of lead 125. It will be further apparent from FIGS. 5B-C, that providing sloped sidewalls 104a,c on contact means 103a,c promotes the formation of solder filet 121,141. It is desirable that corners 150a or 150b where sidewalls 104a or 104c meet die contact portions 112a or 132 respectively, be within the perimeter of contact portions 112a or 132 so as to avoid spill-over of the solder or other bonding means which would cause shorts across die 111 or 131 respectively.

Referring again to FIG. 4B, when a liquified plastic encapsulant is injected into mold 81, substantial outward directed forces are exerted by the plastic on mold 81. The pressure is often quite high, typically 150-400 psi (1-2.8 MPa) and there is a significant tendency of the liquid plastic material to force its way between mating surfaces, as for example between surface 41a and surface 84, and between surfaces 82 and 43. The peak pressure within the mold may be sufficient to overcome the mechanical force being supplied by compliant connector member 39a which holds, for example, surfaces 41a and 84 together. This would allow the encroachment of plastic onto outward face 41a of terminal member 33a and into tapped hole 34a, both of which are undesirable. However, the arrangement of terminal member 33a, compliant connector member 39a, semiconductor die assemblies 51a-b, and base member 31 are such that the liquid encapsulant exerts an unbalanced hydrostatic force 86a against the inner surfaces of compliant connector member 39a, base member 31 and terminal member 33a such that the encapsulant itself produce net outward directed forces 86b-c tending to hold faces 41a and 84, and faces 43 and 82 in intimate contact. These net outward directed forces are in addition to the outward directed mechanical forces provided by compliant connector member 39a. When combined they insure that these matching (e.g. faces 41a and 84; and faces 43 and 82) faces remain firmly seated together during molding and that no plastic encroaches therebetween. As used herein the words "net force" or "outward directed force" are intended to refer to the sum of the mechanical and hydrostatic forces which combine to hold the matching faces together.

The following is an example of the practice of the method of the invention. Base plate 31 (FIG. 3) is fashioned typically from 0.125 inch (3.2 mm) copper to which is applied a thin plating of nickel. Mounting holes 31a-b, notches 35, deformed portions or bosses 36, and optional recesses 52 may be formed by any mechanical shaping means. Stamping is particularly convenient. Such means are well known in the art. Semiconductor die assembly 61 is conveniently formed by taking a rectangular semiconductor die, typically of silicon, having the necessary number of semiconductor junctions and appropriate contact regions, and sandwiching the die between nickel plated molybdenum disks. These are coupled to the semiconductor die conveniently by means of a lead-tin solder. Means for attaching metal electrodes to semiconductor die are well known in the art. Compliant connector members 39a-b are conveniently of 20 mil (0.5 mm) thick copper.

Contact means 53a-b, 54a-b of compliant connector means 62 of FIG. 3-4 or 103a-c of FIG. 5 are conveniently provided in the shape of bowl shaped depressions having sloped sidewalls. It has been found that a useful depth for these bowl shaped depressions is approximately one to three times the thickness of connector members 39a-b, that is, approximately 20-60 mils (0.5-1.5 mm) where members 39a-b are 20 mil (0.5 mm) thick. A narrower range of one to two times the thickness of connector members 39a-b is convenient, with 1 to 1.5 times the thickness being preferred. Stamping is a convenient means of forming these bowl shaped contact means. It is also desirable that compliant connector means 62 (e.g. 39a-b) be annealed following formation of contact means 53a-b, 54a-b, and/or 103a-c to a dead soft condition to facilitate deformation or crushing of the contact portions during the molding operation without damage to the semiconductor die, die contacts and/or bonding means. Terminal members 63 or 100 are conveniently formed from

brass covered with a thin nickel plate. The sides are knurled to provide a good grip to the plastic encapsulant, and a central through-hole is provided which is tapped to give a convenient means for external connection. A feature of the present design is that the threaded connection holes in the terminal members (e.g. holes 34a-b in members 63) can pass entirely through the terminal members and yet not become occluded with plastic encapsulant during the molding process. This results from two circumstances; (1) that compliant connector members 62 completely cover interior faces 42a-b of terminal members 63 after assembly of piece parts 60, and (2) that a tight seal is maintained against outward faces 41a-b during molding. Using a through hole in terminal members 63 and 100 is particularly desirable since through holes are much less expensive to bore and thread than blind holes. Thus the arrangement of parts in the present invention provides for lower piece part cost.

Base 31, semiconductor die assemblies 61, compliant connector members 62, and terminal members 63 are assembled in a stacked relationship with bonding means, such as solder pre-forms located, therebetween. The stacked assembly is passed through a hydrogen furnace to bond piece parts 60 made up of elements 31, 61, 62, and 63 together. The total height of the assembly is arranged to be greater than the desired finished height of the device. The difference will be taken up during compression of the assembly in the mold. The compliant connector member insures that the assembly is both compressible and deflectable to the extent necessary to correct for normal thickness variations in the individual piece parts and the bonding means used for coupling them together, and for any slight irregularities in the assembly and bonding process.

The bonded assembly is inserted into mold 81 adapted to engage outward face 43 of base member 31 and outward faces 41a-b of terminal members 33a-b (see FIGS. 3 and 4A-B). Outward faces 41a-b and 43 are seated against matching faces 84 and 82, respectively, of mold 81 so as to align terminal members 33a-b and base member 31 into their predetermined relationships and inhibit exposure of outward faces 41a-b and 43 to the encapsulant while allowing the inner portions of base member 31, terminal members 33a-b and compliant connector means 39a-b to be exposed to the encapsulant so as to provide outward directed imbalance of forces 86a-c which act on or through terminal members 33a-b and base member 31 during molding. The mold is closed to compress compliant connector means 39a-b, to reduce the height of assembled piece parts 60 to predetermined finished height 85, and to enhance the seating of outward faces 41a-b and 43 against mold faces 84 and 82. Plastic encapsulant is injected into the mold under pressure so as to enclose assembled piece parts 60 and achieve outward directed forces 86b-c necessary to maintain outward faces 41a-b and 43 of terminals 33a-b and base member 31, respectively, against matching mold faces 84 and 82, so that encroachment of encapsulant on outward faces 41a-b and 43 is substantially prevented. Injection molding materials suitable for encapsulating semiconductor devices are well known in the art. After an appropriate curing time, which depends upon the material being used and which is readily determinable by experiment, the mold is opened and the finished device removed.

Thus, it is apparent that there has been provided in accordance with this invention improved semiconductor devices, particularly power devices adapted to accommodate more than one semiconductor die, and which have fewer piece parts than comparable prior art devices. Additionally, there has been provided in accordance with this invention, an improved method for the fabrication of such devices wherein a minimum number of piece parts are utilized, wherein the piece parts are arranged in such a fashion that the assembled and bonded piece parts automatically align and self-seal against the mold faces during mold closure, and wherein the self-sealing is reinforced by a net imbalance of forces produced during the injection of the plastic molding compound.

While the invention has been described in terms of certain recommended materials and shapes, it will be readily apparent to those of skill in the art that both the invented structure and method are useful with other materials and shapes and a wide variety of semiconductor die of different configurations, which may differ in detail but preserve the central relationships among the various elements. Accordingly, it is intended to encompass all such variations as fall within the scope of the invention.

Claims

1. A semiconductor device (30) comprising:

a semiconductor die (70a) having a contact portion (71a 72a);

a base member (31) having a first face for supporting said semiconductor die and a second face (43) adapted to seal against a first surface (82) of a mold (81);

a terminal member (33a) having a first face (41a) adapted to seal against a second surface (84) of said mold (81);

a compliant connector means (39a) for supporting said terminal member (33a) and for coupling said terminal member (33a) to said contact portion (71a) of said semiconductor die (70a), wherein said compliant connector means (39a) is adapted to press said second face (43) of said base member (31) against said first surface (82) of said mold (81) and said first face (41a) of said terminal member (33a) against said second surface (84) of said mold (81); and

bonding means (73a, 74a, 75a, 76a, 77) for

brass covered with a thin nickel plate. The sides are knurled to provide a good grip to the plastic encapsulant, and a central through-hole is provided which is tapped to give a convenient means for external connection. A feature of the present design is that the threaded connection holes in the terminal members (e.g. holes 34a-b in members 63) can pass entirely through the terminal members and yet not become occluded with plastic encapsulant during the molding process. This results from two circumstances; (1) that compliant connector members 62 completely cover interior faces 42a-b of terminal members 63 after assembly of piece parts 60, and (2) that a tight seal is maintained against outward faces 41a-b during molding. Using a through hole in terminal members 63 and 100 is particularly desirable since through holes are much less expensive to bore and thread than blind holes. Thus the arrangement of parts in the present invention provides for lower piece part cost.

Base 31, semiconductor die assemblies 61, compliant connector members 62, and terminal members 63 are assembled in a stacked relationship with bonding means, such as solder pre-forms located, therebetween. The stacked assembly is passed through a hydrogen furnace to bond piece parts 60 made up of elements 31, 61, 62, and 63 together. The total height of the assembly is arranged to be greater than the desired finished height of the device. The difference will be taken up during compression of the assembly in the mold. The compliant connector member insures that the assembly is both compressible and deflectable to the extent necessary to correct for normal thickness variations in the individual piece parts and the bonding means used for coupling them together, and for any slight irregularities in the assembly and bonding process.

The bonded assembly is inserted into mold 81 adapted to engage outward face 43 of base member 31 and outward faces 41a-b of terminal members 33a-b (see FIGS. 3 and 4A-B). Outward faces 41a-b and 43 are seated against matching faces 84 and 82, respectively, of mold 81 so as to align terminal members 33a-b and base member 31 into their predetermined relationships and inhibit exposure of outward faces 41a-b and 43 to the encapsulant while allowing the inner portions of base member 31, terminal members 33a-b and compliant connector means 39a-b to be exposed to the encapsulant so as to provide outward directed imbalance of forces 86a-c which act on or through terminal members 33a-b and base member 31 during molding. The mold is closed to compress compliant connector means 39a-b, to reduce the height of assembled piece parts 60 to predetermined finished height 85, and to enhance the seating of outward faces 41a-b and 43 against mold faces 84 and 82. Plastic encapsulant is injected into the mold under pressure so as to enclose assembled piece parts 60 and achieve outward directed forces 86b-c necessary to maintain outward faces 41a-b and 43 of terminals 33a-b and base member 31, respectively, against matching mold faces 84 and 82, so that encroachment of encapsulant on outward faces 41a-b and 43 is substantially prevented. Injection molding materials suitable for encapsulating semiconductor devices are well known in the art. After an appropriate curing time, which depends upon the material being used and which is readily determinable by experiment, the mold is opened and the finished device removed.

Thus, it is apparent that there has been provided in accordance with this invention improved semiconductor devices, particularly power devices adapted to accommodate more than one semiconductor die, and which have fewer piece parts than comparable prior art devices. Additionally, there has been provided in accordance with this invention, an improved method for the fabrication of such devices wherein a minimum number of piece parts are utilized, wherein the piece parts are arranged in such a fashion that the assembled and bonded piece parts automatically align and self-seal against the mold faces during mold closure, and wherein the self-sealing is reinforced by a net imbalance of forces produced during the injection of the plastic molding compound.

While the invention has been described in terms of certain recommended materials and shapes, it will be readily apparent to those of skill in the art that both the invented structure and method are useful with other materials and shapes and a wide variety of semiconductor die of different configurations, which may differ in detail but preserve the central relationships among the various elements. Accordingly, it is intended to encompass all such variations as fall within the scope of the invention.

Claims

1. A semiconductor device (30) comprising:

a semiconductor die (70a) having a contact portion (71a 72a);

a base member (31) having a first face for supporting said semiconductor die and a second face (43) adapted to seal against a first surface (82) of a mold (81);

a terminal member (33a) having a first face (41a) adapted to seal against a second surface (84) of said mold (81);

a compliant connector means (39a) for supporting said terminal member (33a) and for coupling said terminal member (33a) to said contact portion (71a) of said semiconductor die (70a), wherein said compliant connector means (39a) is adapted to press said second face (43) of said base member (31) against said first surface (82) of said mold (81) and said first face (41a) of said terminal member (33a) against said second surface (84) of said mold (81); and

bonding means (73a, 74a, 75a, 76a, 77) for

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joining said base member (31), said semiconductor die (70a), said compliant connector means (39a), and said terminal member (33a) in a stacked relation;

wherein said compliant connector means (39a) can be deformed sufficiently to accommodate thickness tolerance variation of the base member (31), semiconductor die (70a) and terminal member (33a) after joining by the bonding means (73a, 74a, 75a, 76a, 77).

2. The device of claim 1 wherein said terminal member (33a), said compliant connector means (39a), and said base member (31) are adapted to insure that said terminal member (33a), said compliant connector means (39a), and said base member (31) are exposed during molding to a force from a pressurized liquified molding compound wherein said force seals said first face (41a) of said terminal member (33a) against said second surface (84) of said mold (81) and said second surface (43) of said base member (31) against said first surface (82) of said mold (81) so as to control a height (85) of said semiconductor device (30) after molding and substantially prevent molding compound from penetrating between said first face (41a) of said terminal member (33a) and said second surface (84) of said mold (81), and between said second surface (43) of said base member (31) and said first surface (82) of said mold (81).

3. The device of claim 1 further comprising at least two semiconductor die (70a-b) each having a contact portion (71a-b) and each supported in spaced apart relationship by said base member (31), and wherein said compliant connector means (39a) has at least two contact means (54a-b) for contacting said contact portions (71a-b) of said at least two semiconductor die (70a-b), each said contact means (54a-b) being substantially aligned facing one of said at least two contact portions (71a-b), and wherein each said contact means (54a-b) comprises a formed region protruding from said compliant connector means (39a) in the direction of said facing contact portion (71a-b), each said formed region including a deformable portion (93a-b).

4. The device of claim 3 wherein a part of said deformable portion (93a-b) of each said formed regions meets said contact portion (71a-b) at an angle less than ninety degrees.

5. The device of claim 1 wherein said compliant connector means (39a) has contact means (54a) aligned facing said contact portion (71a) of said semiconductor die (70a), and wherein each said contact means comprises a formed region protruding from said compliant connector means (39a) in the direction of said facing contact portion (71a), each said formed region comprising a deformable portion (93a), and wherein a part of said deformable portion (93a) of each said formed region meets said contact portion (71a) at an angle less than ninety degrees.

6. The semiconductor device of claim 1 further comprising:

two or more semiconductor die (70a-b) coupled to said base member (31) in spaced apart relationship by a first bonding means (73a-b);

wherein the base member (31) has therein one or more plastic engagement means (36) for gripping a plastic encapsulation (32);

wherein the terminal member (33a) has an axis arranged substantially perpendicular to said base member (31) and a basal portion (42a) substantially perpendicular to said axis and located facing said base member (31);

wherein the compliant connecting means couples said spaced apart semiconductor die (70a-b) and said basal portion (42a) of said terminal member (33a), wherein said compliant connector means (39a) is attached to said basal portion (42a) by a second bonding means (77), wherein said compliant connecting means (39a) has contact members (54a-b) aligned over said spaced apart semiconductor die (70a-b), and wherein each said contact member (54a-b) comprises a deformable portion (93a-b) coupled to said semiconductor die (70a-b) by a third bonding means (76a-b);

wherein said basal portion (42a) has a lateral extent (89) sufficient to at least extend between said spaced apart semiconductor die (70a-b) and wherein said base member (31), said at least one compliant connector means (39a), and said at least one terminal member (33a) are adapted to be exposed to liquified pressurized plastic encapsulant so that an outward directed force (86a) is created by said pressurized plastic encapsulant between said base member (31), said at least one terminal member (33a); and

wherein said at least one compliant connecting means (39a) can be deformed sufficiently to accommodate the combined thickness tolerance variations of said base member (31), said semiconductor die (70a), said at least one terminal member (33a), and said bonding means (73a, 74a, 75a, 76a, 77).

7. The device of claim 6 wherein at least one of said at least one terminal members (33a) has a hole (34a) for external connection parallel to said axis and penetrating through said terminal member but not through said compliant connector means (39a).

8. The device of claim 7 wherein said deformable portion comprises a compressible dimple (54a).

9. A process for making semiconductor devices of a predetermined height (85) comprising:

providing a base member (31), terminal member (33a), and semiconductor die (70a) adapted for bonding;

providing a compliant connecting means (39a) adapted for bonding which can be deformed sufficiently to accommodate the combined thickness tolerance variation of said base member (31), said semiconductor die (70a), said compliant connector means (39a), and said terminal member (33a), after bonding;

bonding together said base member (31), said semiconductor die (70a), said complaint connector means (39a), and said terminal member (33a)

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in a stacked relationship to form a flexible deformable assembly (80) whose height exceeds said predetermined height (85);

inserting said assembly (80) in a mold (81) adapted to have an outward face (43) of said base member (31) engage a first mold face (82) and an outward face (41a) of said terminal member (33a) engage an opposed second mold face (84);

seating said base member (31) against said first mold face (82) and said terminal member (33a) against said second mold face (84) to align said terminal member (33a) and said base member (31) in a predetermined relationship, and to inhibit exposure of said outward faces (43, 41a) of said base member (31) and said terminal member (33a) to an encapsulant (32) while allowing exposure of portions of an inner face of said base member (31), an inner face of said terminal member (33a), and said compliant connector member (39a) to said encapsulant so as to provide outward directed forces (86a-c) on said terminal member (33a) and said base (31) member during molding,

closing said mold (81) to compress said compliant connecting means (39a) to enhance said seating and reduce said height of said assembly to substantially said predetermined height (85); and

injecting said encapsulant (32) into said mold (81) under pressure so as to achieve said outward directed forces (86a-c) and maintain said outward faces (43,41a) against said mold faces (82,84).

10. The process of claim 9 wherein said first providing step further comprises providing a base member (31) having therein plastic encapsulant engagement means (36), and said injecting step further comprises injecting said encapsulant (32) into said engagement means (36).

Patentansprüche

1. Halbleitervorrichtung (30), enthaltend:

eine Halbleiterplatte (70a) mit einem Kontaktabschnitt (71a, 72a);

ein Basiselement (31) mit einer ersten Fläche zum Abstützen der Halbleiterplatte und einer zweiten Fläche (43), die dazu eingerichtet ist, an einer ersten Fläche (82) einer Form (81) abzudichten;

ein Anschlußelement (33a) mit einer ersten Fläche (41a), die dazu eingerichtet ist, an einer zweiten Fläche (84) der genannten Form (81) abzudichten;

eine nachgiebige Verbindungseinrichtung (39a) zum Abstützen des Anschlußelements (33a) und zum Verbinden des Anschlußelements (33a) mit dem Kontaktabschnitt (71a) der Halbleiterplatte (70a), wobei die nachgiebige Verbindungseinrichtung (39a) dazu eingerichtet ist, die zweite Fläche (43) des Basiselements (31) gegen die erste Fläche (82) der Form (81) und die erste Fläche (41a) des Anschlußelements (33a) gegen die zweite Fläche (84) der Form (81) zu drücken; und

eine Verbindungseinrichtung (73a, 74a, 75a, 76a, 77) zum Verbinden des Basiselements (31), der Halbleiterplatte (70a), der nachgiebigen Verbindungseinrichtung (39a) und des Anschlußelements (33a) in einem gestapelten Verhältnis;

wobei die nachgiebige Verbindungseinrichtung (39a) ausreichend verformt werden kann, um Dickentoleranzschwankungen des Basiselements (31), der Halbleiterplatte (70a) und des Anschlußelements (33a) nach dem Verbinden durch die Verbindungseinrichtung (73a, 74a, 75a, 76a, 77) aufzunehmen.

2. Vorrichtung nach Anspruch 1, bei der das Anschlußelement (33a), die nachgiebige Verbindungseinrichtung (39a) und das Basiselement (31) dazu eingerichtet sind sicherzustellen, daß das Anschlußelement (33a), die nachgiebige Verbindungseinrichtung (39a) und das Basiselement (31) während des Eingießens einer Kraft von einer unter Druck stehenden, verflüssigten Vergußmasse ausgesetzt werden, wobei die Kraft die erste Fläche (41a) des Anschlußelements (33a) gegen die zweite Fläche (84) der Form (81) und die zweite Fläche (43) des Basiselements (31) gegen die erste Fläche (82) der Form (81) abdichtet, um die Höhe (85) der Halbleitervorrichtung (30) nach dem Gießen zu beeinflussen und im wesentlichen zu verhindern, daß Vergußmasse zwischen die erste Fläche (41a) des Anschlußelements (33a) und die zweite Fläche (84) der Form (81) und zwischen die zweite Fläche (43) des Basiselements (31) und die erste Fläche (82) der Form (81) eindringt.

3. Vorrichtung nach Anspruch 1, weiterhin enthaltend wenigstens zwei Halbleiterplatten (70a-b), die jeweils einen Kontaktabschnitt (71a-b) aufweisen, die jeweils in Abstandsbeziehung von dem Basiselement (31) abgestützt sind, und wobei die nachgiebige Verbindungseinrichtung (39a) wenigstens zwei Kontakteinrichtungen (54a-b) aufweist, um die Kontaktabschnitte (71a-b) der genannten wenigstens zwei Halbleiterplatten (70a-b) zu kontaktieren, wobei jede Kontakteinrichtung (54a-b) im wesentlichen so ausgerichtet ist, daß sie einem der genannten wenigstens zwei Kontaktabschnitte (71a-b) gegenübersteht, und wobei jede der Kontakteinrichtungen (54a-b) einen geformten Bereich aufweist, der von der nachgiebigen Verbindungseinrichtung (39a) in Richtung des genannten gegenüberstehenden Kontaktabschnitts (71a-b) vorsteht, wobei jeder geformte Bereich einen verformbaren Abschnitt (93a-b) aufweist.

4. Vorrichtung nach Anspruch 1, bei der ein Teil des verformbaren Abschnitts (93a-b) eines jeden der geformten Bereiche den Kontaktabschnitt (71a-b) unter einem Winkel von weniger als 90° trifft.

5. Vorrichtung nach Anspruch 1, bei der die nachgiebige Verbindungseinrichtung (39a) eine Kontakteinrichtung (54a) aufweist, die dem Kontaktabschnitt (71a) der Halbleiterplatte (70a) gegenüberstehend ausgerichtet ist, und wobei jede der Kontakteinrichtungen einen geformten Abschnitt aufweist, der von der nachgiebigen Verbindungseinrichtung (39a) in Richtung auf den genannten gegenüberstehenden Kontaktab-

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schnitt (71a) vorsteht, wobei jeder der genannten geformten Bereiche einen verformbaren Abschnitt (93a) aufweist und ein Teil des genannten verformbaren Abschnitts (93a) eines jeden der geformten Bereiche den genannten Kontaktabschnitt (71a) unter einem Winkel von weniger als 90° trifft.

6. Halbleitervorrichtung nach Anspruch 1, weiterhin enthaltend:

zwei oder mehr Halbleiterplatten (70a-b), die mit dem Basiselement (31) in Abstandsbeziehung durch eine erste Verbindungseinrichtung (73a-b) verbunden sind;

wobei das Basiselement (31) eine oder mehr Plastikeingriffseinrichtungen (36) darin aufweist, um eine Plastikvergußmasse (32) zu ergreifen;

wobei das Anschlußelement (33a) eine Achse aufweist, die im wesentlichen senkrecht zu dem Basiselement (31) angeordnet ist, und einen Basisabschnitt (42a) aufweist, der im wesentlichen senkrecht zu der genannten Achse verläuft und dem genannten Basiselement (31) gegenüberliegend angeordnet ist;

wobei die nachgiebige Verbindungseinrichtung die im Abstand angeordneten Halbleiterplatten (70a-b) und den genannten Basisabschnitt (42a) des Anschlußelements (33a) verbindet, wobei die nachgiebige Verbindungseinrichtung (39a) an dem Basisabschnitt (42a) durch eine zweite Verbindungseinrichtung (77) befestigt ist, wobei die nachgiebige Verbindungseinrichtung (39a) Kontaktelemente (54a-b) aufweist, die über die im Abstand angeordneten Halbleiterplatten (70a-b) ausgerichtet sind, und wobei jedes der Kontaktelemente (54a-b) einen verformbaren Abschnitt (93a-b) aufweist, der mit den Halbleiterplättchen (70a-b) über eine dritte Verbindungseinrichtung (76a-b) verbunden ist;

wobei der Basisabschnitt (42a) eine Querausdehnung (89) hat, die ausreichend ist, um sich wenigstens zwischen die im Abstand angeordneten Halbleiterplättchen (70a-b) zu erstrekken, und wobei das Basiselement (31), die genannte wenigstens eine nachgiebige Verbindungseinrichtung (39a) und das genannte wenigstens eine Anschlußelement (33a) dazu eingerichtet sind, einer verflüssigten, unter Druck stehenden Plastikvergußmasse ausgesetzt zu werden, so daß eine auswärts gerichtete Kraft (86a) durch die genannte unter Druck stehende Plastikvergußmasse zwischen dem Basiselement (31) und dem genannten wenigstens einen Anschlußelement (33a) hervorgerufen wird; und

wobei die genannte wenigstens eine nachgiebige Verbindungseinrichtung (39a) ausreichend verformt werden kann, um die kombinierten Dickentoleranzschwankungen des Basiselements (31), des Halbleiterplättchens (70a) und des genannten wenigstens einen Anschlußelements (33a) und der Verbindungseinrichtungen (73a, 74a, 75a, 76a, 77) aufzunehmen.

7. Vorrichtung nach Anspruch 6, bei der wenigstens eines des genannten wenigstens einen Anschlußelements (33a) ein Loch (34a) für einen äußeren Anschluß parallel zu der Achse aufweist, das Anschlußelement, jedoch nicht die nachgiebige Verbindungseinrichtung (39a) durchdringt.

8. Vorrichtung nach Anspruch 7, bei der verformbare Abschnitt einen kompressiblen Vorsprung (54a) aufweist

9. Verfahren zum Herstellen von Halbleitervorrichtungen einer vorbestimmten Höhe (85), enthaltend:

Bereitstellen eines Basiselements (31), eines Anschlußelements (33a) und einer Halbleiterplatte (70a), die zum Verbinden geeignet sind;

Bereitstellen einer nachgiebigen Verbindungseinrichtung (39a), die zum Verbinden geeignet ist und die ausreichend verformt werden kann, um die kombinierten Dickentoleranzschwankungen des Basiselements (31), der Halbleiterplatte (70a), der nachgiebigen Verbindungseinrichtung (39a) und des Anschlußelements (33a) nach dem Verbinden aufzunehmen;.

Verbinden des Basiselements (31), der Halbleiterplatte (70a), der nachgiebigen Verbindungseinrichtung (39a) und des Anschlußelements (33a) in gestapeltem Zustand miteinander, um eine flexible verformbare Anordnung (80) zu bilden, deren Höhe die vorbestimmte Höhe (85) überschreitet;

Einsetzen dieser Anordnung (80) in eine Form (81), die dazu eingerichtet ist, daß eine äußere Fläche (43) des Basiselements (31) an einer ersten Formfläche (82) und eine Außenfläche (41a) des Anschlußelements (33a) an einer gegenüberliegenden zweiten Formfläche (84) anliegt.

Anbringen des Basiselements (31) an der ersten Formfläche (82) und des Anschlußelements (33a) an der zweiten Formfläche (84), um das Anschlußelement (33a) und das Basiselement (31) in einem vorbestimmten Verhältnis auszurichten und zu verhindern, daß die Außenflächen (43, 41a) des Basiselements (31) und des Anschlußelements (33a) einer Vergußmasse (32) ausgesetzt werden, während Abschnitte einer Innenseite des Basiselements (31), einer Innenseite des Anschlußelements (33a) und das nachgiebige Verbindungselement (39a) der Vergußmasse ausgesetzt bleiben können, um nach außen gerichtete Kräfte (86a-c) an dem Anschlußelement (33a) und dem Basiselement (31) während des Vergießens zu erzeugen;

Verschließen der Form (81), um die nachgiebige Verbindungseinrichtung (39a) zusammenzudrücken, um den Sitz zu verbessern und die Höhe der Anordnung auf im wesentlichen die vorbestimmte Höhe (85) zu reduzieren; und

Einspritzen der Vergußmasse (32) in die Form (81) unter Druck, um die genannten auswärts gerichteten Kräfte (86a-c) zu erzeugen und die Außenflächen (43, 41a) an den Formflächen (82, 84) zu halten.

10. Verfahren nach Anspruch 9, bei dem der erste Bereitstellungsschritt weiterhin umfaßt: Bereitstellen eines Basiselements (31), das darin eine Plastikvergußmasseneingriffseinrichtung (36) aufweist, wobei der Einspritzschritt weiterhin umfaßt: Einspritzen der Vergußmasse (32) in die Eingriffseinrichtung (36).

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Revendications

1. Composant semi-conducteur (30) comprenant:

un dé semi-conducteur (70a) ayant une partie de contact (71a, 72a),

un organe de base (31) ayant une première face destinée à supporter le dé semi-conducteur et une seconde face (43) destinée à coopérer de façon étanche avec une première surface (82) d'un moule (81),

une borne (33a) ayant une première face (41a) destinée à être en contact étanche contre une seconde surface (84) du moule (81),

un connecteur souple (39a) destiné à supporter la borne (33a) et à coupler la borne (33a) à la partie de contact (71a) du dé semi-conducteur (70a), le connecteur souple (39a) étant destiné à repousser la seconde face (43) de l'organe de base (31) contre la première surface (82) du moule (81) et la première face (41a) de la borne (33a) contre la seconde surface (84) du moule (81), et

des dispositifs de liaison (73a, 74a, 75a, 76a, 77) destinés à relier l'organe de base (31), le dé semi-conducteur (70a), le connecteur souple (39a) et la borne (33a) afin qu'ils soient empilés,

le connecteur souple (39a) pouvant être suffisamment déformé pour qu'il compense les variations d'épaisseur de l'organe de base (31), du dé semi-conducteur (70a) et de la borne (33a) dans les plages de tolérances après leur connexion par les dispositifs de liaison (73a, 74a, 75a, 76a, 77).

2. Composant selon la revendication 1, dans lequel la borne (33a), le connecteur souple (39a) et l'organe de base (31) sont destinés à assurer l'exposition de la borne (33a), du connecteur souple (39a) et de l'organe de base (31) pendant le moulage à une force due au composé liquéfié de moulage sous pression, cette force assurant la coopération étanche de la première face (41a) de la borne (33a) avec la seconde surface (84) du moule (81) et de la seconde surface (43) de l'organe de base (31) avec la première surface (82) du moule (81) si bien que la hauteur (85) du composant semi-conducteur (30) après moulage est réglée et que le composé de moulage ne peut pratiquement pas pénétrer entre la première face (41a) de la borne (33a) et la seconde surface (84) du moule (81), et entre la seconde surface (43) de l'organe de base (31) et la première surface (82) du moule (81).

3. Composant selon la revendication 1, comprenant au moins deux dés semi-conducteurs (70a, 70b) ayant chacun une partie de contact (71a, 71b) et supportés chacun à distance l'un de l'autre par l'organe de base (31), et dans lequel le connecteur souple (39a) a au moins deux dispositifs de contact (54a, 54b) destinés à être au contact des parties de contact (71a, 71b) des deux dés semi-conducteurs au moins (70a, 70b), chaque dispositif de contact (54a, 54b) étant pratiquement aligné en face de l'une des deux parties de contact au moins (71a, 71b), et dans lequel chacun des dispositifs de contact (54a, 54b) comprend une région mise en forme qui dépasse du connecteur souple (39a) du côté de la partie de contact (71a, 71b) placée en face, chacune de ces régions mises en forme comprenant une partie déformable (93a, 93b).

4. Composant selon la revendication 3, dans lequel une portion de la partie déformable (93a, 93b) de chacune des régions mises en forme se raccorde à la partie de contact (71a, 71b) avec un angle inférieur à 90°.

5. Composant selon la revendication 1, dans lequel le connecteur souple (39a) a des dispositifs de contact (54a) alignés en face de la partie de contact (71a) du dé semi-conducteur (70a), et dans lequel chaque dispositif de contact comporte une région mise en forme qui dépasse du connecteur souple (39a) vers la partie de contact (71a) placée en face, chaque région mise en forme ayant une partie déformable (93a), et dans lequel une portion de la partie déformable (93a) de chaque région mise en forme se raccorde à la partie de contact (71a) suivant un angle inférieur à 90°.

6. Composant à semi-conducteur selon la revendication 1, comprenant

au moins deux dés semi-conducteurs (70a, 70b) couplés à l'organe de base (31) à distance l'un de l'autre, par des premiers dispositifs de liaison (73a, 73b),

dans lequel l'organe de base (31) a un ou plusieurs dispositifs (36) de coopération avec la matière plastique destinés à accrocher un encapsulage de matière plastique (32),

dans lequel la borne (33a) a un axe sensiblement perpendiculaire à l'organe de base (31) et une partie de base (42a) sensiblement perpendiculaire à cet axe et disposée en face de l'organe de base (31),

dans lequel le dispositif de connexion souple couple les dés semi-conducteurs distants (70a, 70b) et la partie de base (42a) de la borne (33a), dans lequel le connecteur souple (39a) est fixé à la partie de base (42a) par un second dispositif de liaison (77), dans lequel le dispositif de connexion souple (39a) a des organes de contact (54a, 54b) alignés sur les dés semi-conducteurs distants (70a, 70b), et dans lequel chaque organe de contact (54a, 54b) a une partie déformable (93a, 93b) couplée au dé semiconducteur (70a, 70b) par un troisième dispositif de liaison (76a, 76b),

dans lequel la partie de base (42a) a une étendue latérale (89) suffisante pour qu'elle soit disposée au moins entre les dés semi-conducteurs distants (70a, 70b), et dans lequel l'organe de base (31), le connecteur souple au moins (39a) et la borne au moins (33a) sont destinés à être exposés à la matière plastique liquéfiée d'encapsulage sous pression de manière qu'une force dirigée vers l'extérieur (86a) soit créée par la matière plastique d'encapsulage sous pression entre l'organe de base (31) et la borne au moins (33a), et

dans lequel le dispositif souple de connexion au moins (39a) peut être suffisamment déformé pour qu'il compense les variations combinées d'épaisseur dues aux tolérances sur l'organe de base

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(31), le dé semi-conducteur (70a), la borne au moins (33a), et les dispositifs de liaison (73a, 74a, 75a, 76a, 77).

7. Composant selon la revendication 6, dans lequel l'une au moins des bornes (33a) a un trou (34a) destiné à une connexion externe parallèle à l'axe et passant à travers la borne mais non à travers le connecteur souple (39a).

8. Composant selon la revendication 7, dans lequel la partie déformable est une fossette compressible (54a).

9. Procédé de fabrication de composants semi-conducteurs de hauteur prédéterminée (85), comprenant

la disposition d'un organe de base (31), d'une borne (33a) et d'un dé semi-conducteur (70a) destinés à être reliés,

la disposition d'un dispositif de connexion souple (39a) destiné à assurer la liaison et qui peut être déformé suffisamment pour qu'il compense la variation combinée d'épaisseur due aux tolérances sur l'organe de base (31), le dé semi-conducteur (70a), le connecteur souple (39a) et la borne (33a), après leur liaison,

la liaison mutuelle de l'organe de base (31), du dé semi-conducteur (70a), du connecteur souple (39a) et de la borne (33a) sous forme empilée afin qu'un ensemble déformable flexible (80) dont la hauteur dépasse la hauteur prédéterminée (85) soit formé,

l'introduction de cet ensemble (80) dans un moule (81) de manière qu'une face externe (43) de l'organe de base (31) soit au contact d'une première face du moule (82) et qu'une face externe (41a) de la borne (33a) soit au contact d'une seconde face opposée (84) du moule,

l'appui de l'organe de base (31) contre la première face du moule (82) et de la borne (33a) contre la seconde face (84) du moule afin que la borne (33a) et l'organe de base (31) soient alignés avec une relation prédéterminée, et afin que l'exposition des faces externes (43, 41a) de l'organe de base (31) et de la borne (33a) ne soit pas exposée à une matière d'encapsulage (32), les parties d'une face interne de l'organe de base (31), d'une face interne de la borne (33a) et du connecteur souple (39a) pouvant cependant être exposées à la matière d'encapsulage afin que les forces dirigées vers l'extérieur (86a-86c) soient appliquées à la borne (33a) et à l'organe de base (31) pendant le moulage,

la fermeture du moule (81) afin que le dispositif de connexion souple (39a) soit comprimé et augmente l'appui et réduise la hauteur de l'ensemble pratiquement à la hauteur prédéterminée (85), et

l'injection de la matière d'encapsulage (32) dans le moule (81) sous pression afin que les forces dirigées vers l'extérieur (86a-86c) soient appliquées et que les faces externes (43, 41a) soient maintenues contre les faces du moule (82, 84).

10. Procédé selon la revendication 9, dans lequel la première étape de disposition comporte en outre la disposition d'un organe de base (31) ayant un dispositif (36) destiné à coopérer avec une matière plastique d'encapsulage, et l'étape d'injection comporte en outre l'injection de la matière d'encapsulage (32) dans le dispositif de coopération (36).

* C L M S *