(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
1 February 2007 (01.02.2007)

PCT

(10) International Publication Number
WO 2007/012910 A1

(51) International Patent Classification:
H01L 21/60 (2006.01)

(21) International Application Number:
PCT/IB2005/002227

(22) International Filing Date: 28 July 2005 (28.07.2005)

(25) Filing Language: English

(26) Publication Language: English

(71) Applicant *(for all designated States except US)*: **INFINEON TECHNOLOGIES AG** [DE/DE]; St.-Martin-Str. 53, 81669 München (DE).

(72) Inventor; and

(75) Inventor/Applicant *(for US only)*: **HENG, Yang Hong** [MY/MY]; 162, Jalan Mawar 8, Taman Mawar, Muar Johor, 84000 (MY).

(74) Agent: **SCHÄFER, Horst**; c/o Kanzlei Schweiger & Partner, Karlstr. 35, 80333 München (DE).

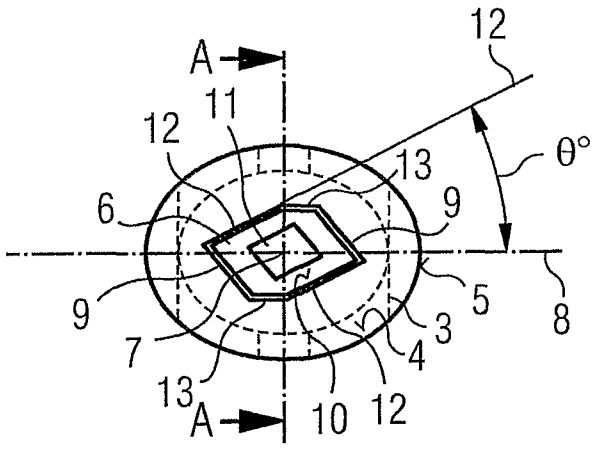
(81) Designated States *(unless otherwise indicated, for every kind of national protection available)*: AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BW, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NA, NG, NI, NO, NZ, OM, PG, PH, PL, PT, RO, RU, SC, SD, SE, SG, SK, SL, SM, SY, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, YU, ZA, ZM, ZW.

(84) Designated States *(unless otherwise indicated, for every kind of regional protection available)*: ARIPO (BW, GH, GM, KE, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HU, IE, IS, IT, LT, LU, LV, MC, NL, PL, PT, RO, SE, SI, SK, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Published:
— *with international search report*

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

(54) Title: METHOD FOR RELIABLY POSITIONING SOLDER ON A DIE PAD FOR ATTACHING A SEMICONDUCTOR CHIP TO THE DIE PAD AND MOLDING DIE FOR SOLDER DISPENSING APPARATUS



(57) Abstract: The rotational orientation of a die pad (14) about its longi-tudinal axis (16) is determined. The desired rotational orien-tation of a semiconductor chip (18) to be attached to the die pad (14) is determined. A molding die (1) is provided which comprises a body (3) with a cavity (6) disposed in a bottom surface (4). The rotational orientation of the body (3) of the molding die (1) about its longitudinal axis (7) is determined. The cavity (6) is positioned in the body (3) of the molding die (1) with a rotational orientation such that the cavity (6) is rotated with respect to the molding die (1) by an angle corresponding to the desired rotational orientation of the semiconductor chip (18) with respect to the die pad (14).

WO 2007/012910 A1

Description

Method for reliably positioning solder on a die pad for attaching a semiconductor chip to the die pad and molding die for solder dispensing apparatus

It is common practice to attach semiconductor chips, in particular power semiconductor chips, to the metallic die pad of a circuit carrier, such as a copper leadframe, by soft solder. The solder bond ensures that heat produced by the chip, while it is operating, can be more effectively dissipated by the die pad.

Typically, the solder is dispensed onto the die pad as a hemispherical mound and the semiconductor chip is pressed onto the solder deposit. It is also known to use a further pressing step to spread the solder deposit into a layer with a more uniform thickness by what is commonly referred to as a spanker or spanking tool. A layer of solder with a relatively uniform thickness increases the reliability of the bond between the semiconductor chip and the die pad since the chip is evenly coated by the solder and the formation of air bubbles at the interface can be avoided.

However, the lateral spread of the solder is unreliable so that either too large or too small an area is covered by the solder deposit. If solder spreads over the edges of the die pad. If the solder fails to cover the whole of the interface between the semiconductor chip and the die pad, the bond is unreliable.

In order to improve the reliability of the bonding process, it is known to more accurately control the quantity of solder deposited. However, the apparatus required to control the dispensing of the solder is complex and, therefore, relatively expensive. The problem of the inexact positioning of the pressed solder deposit on the die pad is also not completely eliminated.

Therefore, it is an object of the invention to provide a method by which a semiconductor chip can be reliably mounted on a die pad by a soft solder bond which is simple to control and cost-effective.

It is a further object of the invention to provide a molding tool which enables a reliable solder bond between a semiconductor chip and a die pad to be cost-effectively produced.

These objects are solved by the subject matter of the independent claims. Further advantageous developments arise from the subject matter of the dependent claims.

The invention provides a method for reliably positioning solder on a die pad for attaching a semiconductor chip to the die pad which comprises the following steps. Firstly, the rotational orientation of the die pad about a longitudinal axis which lies essentially perpendicular to its upper surface is determined. The rotational orientation of the die pad about the longitudinal defines a first line. The upper surface of the die pad is defined here as the surface onto which a semiconductor chip will be mounted.

The desired rotational orientation about the first longitudinal axis with respect to the first line is determined for a semiconductor chip which is to be attached to the die pad. The semiconductor chip is rotated by an angle with respect to the first line.

A molding die which comprises a body with a cavity is provided. The cavity is open on one side and disposed in a bottom surface of the body of the molding die. The body of the molding die has a second longitudinal axis lying essentially perpendicular to the bottom surface. The body of the molding die has a rotational orientation about the second longitudinal axis which defines a second line.

The cavity is positioned in the body of the molding die with a rotational orientation about the second longitudinal axis such that the cavity is rotated about the second longitudinal axis with respect to the second line by an angle corresponding to the rotational orientation of the semiconductor chip with respect to the first line. Angle is defined here as excluding an angle of 0°.

The molding die of the invention is adapted to be connected to solder dispensing apparatus, in particular a die bonder. The molding die of the invention is particularly suitable for use in the assembly of semiconductor packages in which the semiconductor chip is rotated with respect to the die pad of the leadframe substrate. The molding die according to the invention is adapted to be suitable for use when a semiconductor chip, when mounted on the die pad, is rotated about the longitudinal axis with respect to the die pad. In this arrangement, an edge of the semiconductor chip lies at an angle to the

first line which defined by the rotational orientation of the die pad. This angle is defined here to be an angle other than 0° or 90°.

The molding die, therefore, includes a cavity which lies at a rotated angle with respect to the body of the molding die as indicated by the second line. This angle corresponds to the desired rotational angle of the semiconductor chip with respect to the first line defined by the rotational orientation of the die pad.

After a solder deposit is dispensed onto the die pad. the shape and lateral spread of the deposit is modified by pressing the bottom surface of the body of the molding die onto the solder deposit. The molding tool is positioned with respect to the die pad so that the cavity is positioned over the solder deposit and the lateral spread of the solder deposit is controlled by the inner surfaces of the cavity. Therefore, the position of the solder deposit can be controlled during the pressing action and the position and, in particular, the rotational orientation of the pressed solder layer can be limited to the region onto which the semiconductor chip will be later mounted.

The semiconductor chip can, therefore, be mounted at the desired rotational angle essentially concentrically on the solder deposit which was positioned using the molding tool according to the invention. This, advantageously, limits the position of the solder deposit in the region of the interface between the semiconductor chip and the die pad and prevents the spread of the solder outside of the area occupied by the semiconductor chip.

The quantity of solder deposited can, therefore, be limited to the amount required to cover the interface between the semiconductor chip and the die pad. This reduces the materials costs. Since the solder deposit is positioned more exactly with respect to the desired position of the chip, the spread of the solder deposit onto areas of the die pad which are not covered by the semiconductor chip is limited. This has the advantage that the exposed areas of the die pad can be more reliably covered with an adhesion layer, such as a metal oxide. The adhesion between the die pad and the plastic encapsulation material which provides the housing of the package can, therefore, be improved.

To further improve the reliability of the solder bond and the reliability of the positioning of the solder deposit on the die pad, the following further steps may be performed. The lateral dimensions of the semiconductor chip are determined and the cavity provided with dimensions so that a solder deposit is produced which laterally corresponds to the lateral dimensions of the semiconductor chip. This further limits the positioning of the solder deposit to the region of the interface between the semiconductor chip and the die pad and further reduces the material usage.

The cavity can be provided with lateral dimensions which laterally fit within the die pad. This can result in the cavity having a lateral shape which does not correspond to the shape of the semiconductor chip. This can occur depending on the relative lateral size of the semiconductor chip and die pad and their rotational relationship.

If the die pad, the semiconductor chip and the cavity are laterally essentially rectangular, for example, two opposing corners of the cavity may be flattened to provide a cavity which, laterally, has a six-sided polygonal form. This ensures that the rotated solder deposit produced by the rotated cavity fits between the two long sides of the rectangular die pad.

In a further embodiment of the method, the body of the molding die may be laterally positioned with respect to the die pad such that the second line of the body lies in a plane parallel to the first line of the die pad. This further improves the positioning of the solder deposit on the die pad and limits the position to essentially the area which will be occupied by the semiconductor chip. The spread of the solder deposit outside of the interfacial area between the semiconductor chip and the die pad is, therefore, reduced.

The invention also provides a molding die for solder dispensing apparatus for attaching a semiconductor chip to a die pad. The molding die comprises a body having a longitudinal axis lying essentially perpendicular to a bottom surface. The body has a rotational orientation about the longitudinal axis, which defines a line. The body of the molding die also comprises a cavity which is open on one side and which is disposed in the bottom surface of the body. The cavity has a rotational orientation about the longitudinal axis and is rotated with respect to the line defined by the body of the molding die.

The molding die of the invention allows a solder deposit, which is positioned on the upper surface of a die pad, to be molded and positioned more accurately on the die pad with re-

spect to the area occupied by the semiconductor chip. Therefore, the amount of solder which is dispensed can be reduced. The spread of the solder on to areas of the die pad which remain uncovered by the semiconductor chip can be largely prevented. This enables a more reliable application of an adhesion layer to the die pad. The improved adhesive layer further improves the adhesion of the plastic encapsulation material to the die pad. The risk of crack formation at the interface between the die pad and plastic molding material due to the large difference in thermal expansion coefficient is reduced. Therefore, the risk of water penetration into the package is reduced and the reliability of the package further increased.

The cavity can have side walls and a base, the base of the cavity lying in a plane essentially parallel to the bottom surface of the body. The side walls of the cavity can lie approximately perpendicular to the base. This provides a cavity which is able to mold the solder deposit so that the upper surface of the deposit lies approximately parallel to the upper surface of the die pad. This improves the interfacial bonding between the semiconductor chip and the die pad. If the side walls are essentially perpendicular to the base, the lateral spread of the solder is more easily controlled so that it remains essentially in the region occupied by the semiconductor chip.

The side walls define a lateral shape of the cavity. In an embodiment, the lateral shape is a six-sided polygon. In an embodiment, the polygon includes two right angled corners at opposing sides of the polygon which are linked by two inclined side walls. Inclined in this sense means that each of the two

side walls has an internal angle of greater than 90° to the adjacent side wall of the right-angled corner.

The two inclined side walls lie essentially parallel to one another at opposing sides of the polygon. This enables the two inclined side walls to be aligned essentially parallel to two opposing edges of a square or rectangular die pad. The two right angled corners, therefore, extend towards the second opposing side walls of the die pad. This increases the size of the solder deposit which can be dispensed onto the die pad and, therefore, increases the size of the semiconductor chip which can be mounted on the die pad while limiting the position of the solder to the areas occupied by the semiconductor chip.

The perpendicular distance between the two inclined side walls is adapted, in an embodiment, to fit within the length of the die pad, the distance being smaller than the perpendicular distance between the two right angled corners. This lateral shape of the cavity is suitable for mounting a larger semiconductor chip, which is rotated with respect to the die pad, on a rectangular die pad.

The cavity further comprises a recess positioned in its base. This can advantageously provide a molded solder deposit in which the lateral centre of the molded layer has a greater thickness than the outer regions. This advantageously allows the solder deposit to laterally spread as the semiconductor chip is pressed onto the solder deposit. Therefore, the thickness of the deposit after the semiconductor chip has been mounted, is more uniform across the area occupied by the chip.

The recess has, in an embodiment, lateral dimensions of approximately half of the lateral dimensions of the cavity at the bottom surface. This provides a more uniform solder thickness after the mounting of the semiconductor die and additional lateral spreading of the solder deposit.

The recess may be laterally rectangular. This is advantageous is the semiconductor chip is laterally rectangular as the position and spread of the solder is more closely matched to the shape of the semiconductor chip.

Two opposing corners of the recess may be concentrically disposed with respect to the two right angled corners of the six sided polygon of the cavity. This further improves the positioning of the solder deposit with respect to the semiconductor chip.

The line defining the rotational orientation of the body may be adapted to be parallel to a side edge of a die pad. The cavity is, therefore, rotated about the longitudinal axis with respect to the edge of the die pad. This simplifies the alignment of the molding die with respect to the die pad. This further improves the positioning of the solder deposit on the die pad and prevents spreading of the solder over the edges of the die pad.

The body of the molding die, preferably, further comprises means for attaching the body of the molding die to solder dispensing apparatus. Therefore, the molding die of the invention can be used with existing solder dispensing apparatus. This reduces the start up costs and simplifies the use of the molding die within the existing manufacturing line. The molding

die, preferably, comprises material which is not wetted by solder. This prevents the adhesion of the molding die to the solder and improves the reliability of the process.

The invention, therefore, provides a method for reliably positioning solder on a die pad which enables a semiconductor chip to be reliably attached to the die pad. This is achieved by positioning the solder deposit such that the rotational orientation of the molded solder deposit on the die pad corresponds to the rotational orientation of the semiconductor chip on the die pad. This enables the quantity of solder deposited to be reduced.

Advantageously, the solder deposit is more reliably positioned so as to be largely disposed at the interface between the semiconductor chip and the die pad. Therefore, the exposed regions of the die pad remain free from solder. This enables an adhesion layer, such as a metal oxide layer, to be more reliably deposited or grown on the exposed regions of the die pad. Therefore, the adhesion between the die pad an plastic encapsulation is improved and the reliability of the package is further improved.

Embodiments of the invention will now be described with reference to the diagrams.

Figure 1 shows a cross-sectional view of a molding die according to the invention,

Figure 2 shows a perspective view of the bottom surface of the molding die of figure 1,

Figure 3 shows an enlarged view of the bottom surface of the cross-sectional view of figure 1,

Figure 4 shows an enlarged perspective view of the molding cavity of figure 2, and

Figure 5 illustrates the positioning of a solder deposit on a die pad using the molding die of Figures 1 to 4.

Figure 1 illustrates a cross-sectional view of a molding die 1 according to the invention. The molding die 1 is also known as a spanker or spanking tool. The same reference numbers are used in all of the diagrams to denote the same feature.

The molding die 1 comprises an upper portion 2 which is adapted to be attachable to solder dispensing apparatus. In this embodiment of the invention, the upper portion comprises a domed-shape cavity. However, the upper portion 2 may be provided with any means such as lugs or with a size so as to be connectable to the solder dispensing apparatus, which is, in particular, a die bonder suitable for the attachment of semiconductor c hips to a metal die pad. The lower portion 3 of the molding die 1 comprises the body of the molding die 1 and comprises, in this embodiment, a protruding cylinder with a bottom surface 4 and side surface 5.

The bottom surface 4 provides the molding surface of the molding die 1. As can be seen in figures 2 and 3, the bottom surface 4 of the molding die 1 includes a cavity 6. The cavity 6 has the form of a depression which is positioned in the bottom surface 4 of the molding die 1 and which is open on one side, i.e. the bottom surface 4. The molding die 1 has a longitudi-

nal axis 7 which is essentially perpendicular to the bottom surface 4.

The edge 21 between the bottom surface 4 of the protruding cylinder 3 and its side surface 5 is sharp. In order to mold the deposited solder, the bottom surface 4 of the molding die 1 is lowered downwards onto a solder deposit which is positioned on a die pad. The cavity 6 molds or shapes the solder deposit and limits the lateral spread of the deposit to the area within the lateral area of the cavity 5. Therefore, the sharp edge between the bottom surface 4 and the side wall 5 of the lower portion 3 of the molding die 1 ensures that the molding die 1 makes a reliable contact to the die pad and prevents the spread of the solder outside of the molding die 1.

Figure 2 shows a perspective view of the bottom surface 4 of the molding die 1 of figure 1 including the cavity 6. The longitudinal axis 7 of the molding die 1 is, therefore, represented by the point in the lateral centre of the bottom surface 4. The molding die 1 has a rotational orientation about the longitudinal axis 7 which is defined and, indicated in Figure 2, by a line 8. In the view of figure 2, the line 8 lies approximately horizontally.

As can be seen in conjunction with the enlarged cross-sectional view of Figure 3, the cavity 6 is essentially rectangular and is positioned in approximately the lateral centre of the bottom surface 4 of the molding die 1. The cavity 6 comprises side walls 9 and a base 10. The base 10 lies in a plane essentially parallel to the bottom surface 4 of the molding tool 1. The side walls 9 lie essentially perpendicular to the base 10 and the bottom surface 4 of the molding tool 1.

The perspective view of the bottom surface 4 shown in Figure 2, shows that the cavity 6 is rotated around the longitudinal axis 7 with respect to the rotational orientation of the moulding die 1 as defined by the line 8. The long side 12 of the cavity 6 lies at an angle, shown in the diagram as θ°, to the line 8 which defines the rotational orientation of the body 3 of the molding die 1. The angle θ° has a value of between approximately 2° to approximately 88° or, preferably, between approximately 2° to approximately 40°, or more preferably, between approximately 15° to approximately 25°.

In the embodiment shown in figure 2, two opposing corners of the cavity 6 include a chamfer 13. Therefore, the cavity 6 has the lateral form of a six sided polygon. The two chamfered edges or inclined sides 13 lie in a plane essentially parallel to the first line 8 which defines the rotational orientation of the molding die 1.

The cavity 6 also includes a recess 11 positioned in approximately the lateral centre of the base 10, as shown in the enlarged view of cross-sectional view of the bottom surface 4 of Figure 3. The recess is also rectangular and has lateral dimensions of approximately half the lateral dimensions of the cavity 6 defined by the edge of the side walls 8 with the bottom surface 4 of the molding die 1. The dimensions of an embodiment are indicated in the enlarged view of figure 4. The recess 11 is positioned concentrically with respect to the long side walls 12 of the cavity 6. Therefore, the long side of the recess 11 also lies at an angle θ° with respect to the line 8 defined by the molding die 1. In this embodiment, the dimension x is 2.97 mm and the dimension y is 2.47 mm. The

rectangular recess 11 has lateral dimensions of 1.485 mm and 1.235 mm.

Figure 5 shows a schematic diagram of a die pad 14 including a solder deposit 15 which was molded using the molding die 1 of figures 1 to 4.

The die pad 14 is part of a leadframe suitable for a power transistor which comprises the die pad 14 and three leads or pins 22 which are positioned on one side of the die pad 14. The die pad 14 is essentially rectangular with its long side lying essentially horizontally as shown in the view of figure 5. The die pad 14 also has a longitudinal axis 16 which lies essentially perpendicular to the upper surface of the die pad 14. This is indicated by the point 16 positioned in approximately the lateral centre of the die pad 14. The die pad 14 has a rotational orientation about the axis 16 which is defined and is indicated by a line 17. In the view of figure 5, the line 17 lies essentially parallel to the long edge of the die pad 14.

A solder deposit was dispensed on to approximately the centre of the die pad 14. The molding die 1 was rotationally orientated so that its rotational orientation, as indicated by the line 8 lay parallel to the rotational orientation of the die pad 14 has indicated by the line 17. Therefore, the orientation between the solder deposit 15 and the die pad 14 corresponds to the orientational relationship between the cavity 6 and the molding die 1 as shown in Figures 1 to 4. The molding die 1 of figures 1 to 4 was then pressed down onto the solder deposit 15. Therefore, the molded solder deposit 15 has the approximate dimensions of the cavity 6 and lies at a rota-

tional angle of θ° to the line 17 defining the rotational orientation of the die pad 14.

The desired position of the semiconductor chip 18 is indicated by the dotted line 19, as can be seen in figure 5. The solder deposit 15 is, therefore, molded so as to be essentially concentric with the desired position of the semiconductor chip 18.

A method to more reliably position the solder deposit 15 on the die pad 14 comprises the following steps. Firstly, the rotational orientation of the die pad 14 about the longitudinal axis 16 is defined and, in this case, is indicated by the line 17. The desired rotational orientation of the semiconductor chip 18 with respect to the longitudinal axis 16 is then determined. The semiconductor chip should be rotated with respect to the line 17, defining the roational orientation of the die pad 14, by approximately θ°.

A molding die 1 comprising a cavity 6 is provided. The body of the molding die 1 has a longitudinal axis 7 which is perpendicular to its bottom surface 4. The rotational orientation of the molding die 1 about the longitudinal axis 7 is determined and defines a line which is indicated in the figures by a line 8.

The position of the cavity 6 disposed in the lower surface 4 of the molding die 1 is then provided such that the rotational orientation of the cavity 6 with respect to the orientational orientation of the molding die 1 corresponds to the desired rotational relationship between the semiconductor chip and the die pad 14. Therefore, the cavity 6 lies at a rotational angle

of θ° to the defined rotational orientation of the molding die 1 indicated by the line 8.

Therefore, after the solder deposit 15 is positioned in approximately the lateral centre of the die pad 14, the molding die 1 is rotationally orientated so that it is essentially in the same rotational orientation as the die pad 14. In this embodiment, the lines 8 and 17 indicating the rotational orientation of the molding die 1 and die pad 14 lie essentially parallel to one another. The respective longitudinal axes 7, 16 of the molding die 1 and die pad 14, therefore, lie in essentially parallel planes. The molding die 1 is then pressed onto the solder deposit, the solder deposit 15 spreads and its lateral dimensions are controlled by the cavity 6. Therefore, the solder deposit 15 on the die pad can be reliably positioned so that it is concentric with the desired position of the semiconductor chip 18.

The semiconductor chip 18 is then pressed onto the molded deposit 15. The electrical connections between the semiconductor chip 18 and leads 22 of the package, which are not shown in figure 5, are then produced by bond wires. The areas 20 of the die pad which remain uncovered by solder are coated by a metal oxide adhesion layer. The die pad 14, semiconductor chip 18 and bond wires are encapsulated in plastic material to form the package.

By controlling the position of the solder using the method of the invention, the remaining exposed areas 20 of the die pad 14 can be reliably coated with an adhesive layer which promotes the adhesion between the plastic encapsulation material and the die pad. The risk of crack formation at the interface

between the die pad 14 and the plastic molding or encapsulation material is, therefore, reduced and water penetration into the package can be avoided. The reliability of the package can, therefore, be improved.

Reference numbers

1 molding die
2 attaching means
3 body
4 bottom surface
5 side surface
6 cavity
7 longitudinal axis
8 defined rotational orientation of body
9 side wall
10 base
11 recess
12 long side of cavity
13 side wall
14 die pad
15 solder deposit
16 longitudinal axis
17 defined rotational orientation of die pad
18 semiconductor chip
19 position of semiconductor chip
20 exposed surface of die pad
21 edge
22 leads of leadframe

Patent claims

1. Method for reliably positioning solder (15) on a die pad (14) for attaching a semiconductor chip (18) to the die pad (14), comprising:
   - determining the rotational orientation of the die pad (14) about a longitudinal axis (16) perpendicular to its upper surface (20), the rotational orientation defining a first line (17);
   - determining the desired rotational orientation about the longitudinal axis with respect to the first line (17) of a semiconductor chip (18) to be attached to the die pad (14), the semiconductor chip (18) being rotated with respect to the first line (17) by an angle;
   - providing a molding die (1) comprising a body (3) with a cavity (6) open on one side and disposed in a bottom surface (4), the body (3) of the molding die (1) having a second longitudinal axis (7) lying perpendicular to the bottom surface (4) and a rotational orientation about the second longitudinal axis (7) defining a second line (8),
   - positioning the cavity (6) in the body (3) of the molding die (1) with a rotational orientation about the second longitudinal axis (7) such that the cavity (6) is rotated about the second longitudinal axis (7) with respect to the second line (8) by an angle corresponding to the rotational orientation of the semiconductor chip (18) with respect to the first line (17).

2. Method for reliably positioning solder (15) on a die pad (14) according to claim 1, further comprising:

- determining the lateral dimensions of the semiconductor chip (18);
- dimensioning the cavity (6) to provide a solder deposit (15) which laterally corresponds to the lateral dimensions of the semiconductor chip (18).

3. Method for reliably positioning solder (15) on a die pad (14) according to claim 1 or claim 2 further comprising: providing the cavity (6) with lateral dimensions which laterally fit within the die pad (14).

4. Method for reliably positioning solder (15) on a die pad (14) according to one of claims 1 to 3 further comprising: aligning the body (3) of the molding die (1) with respect to the die pad (14) such that the second line (8) of the body (3) lies in a plane parallel to the first line (17) of the die pad (14).

5. Molding die (1) for solder dispensing apparatus for attaching a semiconductor chip (18) to a die pad (14), comprising a body (3) having a longitudinal axis (7) lying perpendicular to a bottom surface (4), the body (3) having a rotational orientation about the longitudinal axis (7), the rotational orientation defining a line (8), wherein the body (3) comprises a cavity (6) open on one side, the cavity (6) being disposed in the bottom surface (4) of the body (3), wherein the cavity (6) has a rotational orientation about the longitudinal axis (7) and is rotated with respect to the line (8).

6. Molding die (1) according to claim 5 characterized in that

the cavity (6) has side walls (9, 12, 13) and a base (10), wherein the base (10) of the cavity (6) lies in a plane essentially parallel to the bottom surface (4) of the body (3) and wherein the side walls (9, 12, 13) of the cavity (6) are approximately perpendicular to the base (10).

7. Molding die (1) according to claim 5 or claim 6 characterized in that the side walls (9, 12, 13) define a lateral shape of the cavity, wherein the lateral shape is a six-sided polygon.

8. Molding die (1) according to claim 7 characterized in that the polygon includes two right angled corners at opposing sides of the polygon linked by two inclined side walls (13) lying essentially parallel to one another at opposing sides of the polygon.

9. Molding die (1) according to claim 8 characterized in that the perpendicular distance between the two inclined side walls (13) is adapted to fit within the length of the die pad (14), the distance being smaller than the perpendicular distance between the two right angled corners.

10. Molding die (1) according to one of claims 5 to 9 characterized in that the cavity (6) further comprises a recess (11) positioned in its base (10).

11. Molding die (1) according to claim 10 characterized in that

the recess (11) has lateral dimensions of approximately half of the dimensions of the cavity (6) at the bottom surface (4) of the body (3) of the molding die (1).

12. Molding die (1) according to claim 10 or claim 11 characterized in that
the recess (11) is laterally rectangular.

13. Molding die (1) according to one of claims 10 to 12 characterized in that
two opposing corners of the recess (11) are concentrically disposed with respect to the two right angled corners of the six sided polygon of the cavity (6).

14. Molding die (1) according to one of claims 5 to 13 characterized in that
the line (8) defining the rotational orientation of the body (3) is adapted to be parallel to a side edge of a die pad (14) and the cavity (6) is rotated about the longitudinal axis (7) with respect to the edge of the die pad (14).

15. Molding die (1) according to one of claims 5 to 14 characterized in that
the body (3) of the molding die (1) further comprises means (2) for attaching the body (3) of the molding die (1) to solder dispensing apparatus.

FIG 1

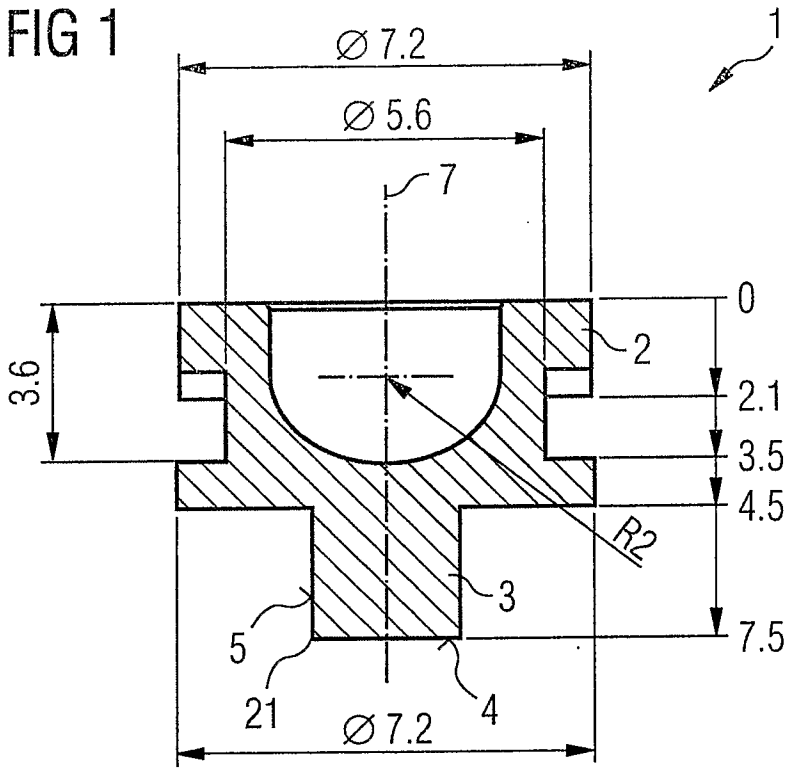


FIG 2

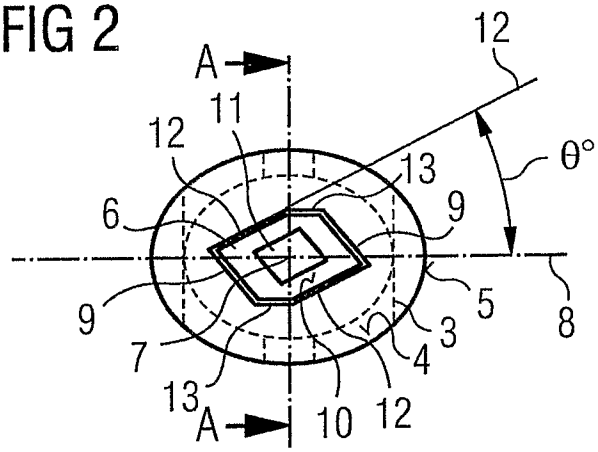


FIG 3

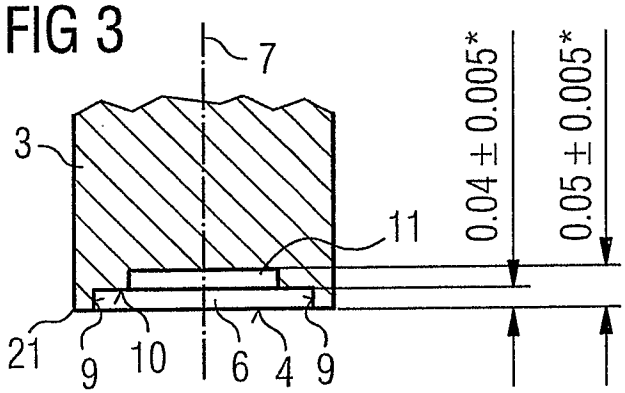


FIG 4

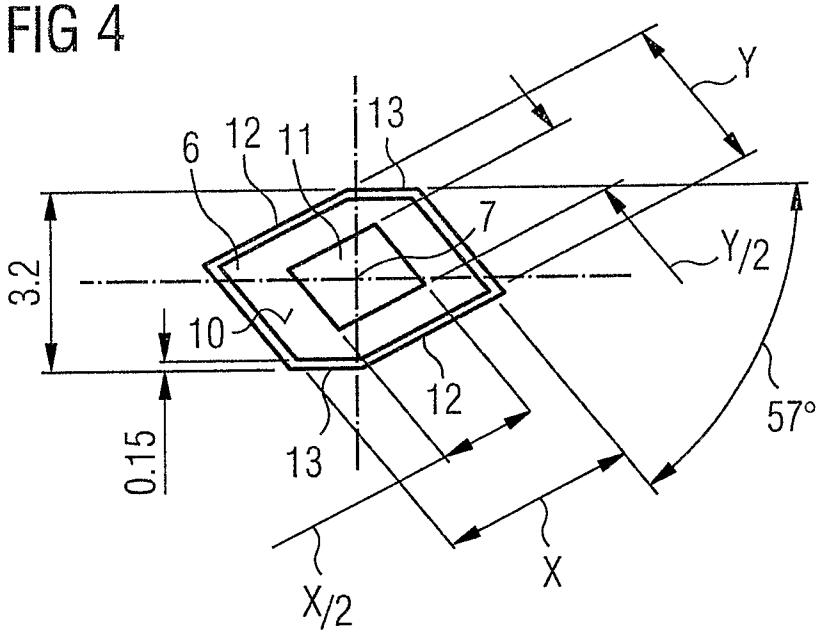
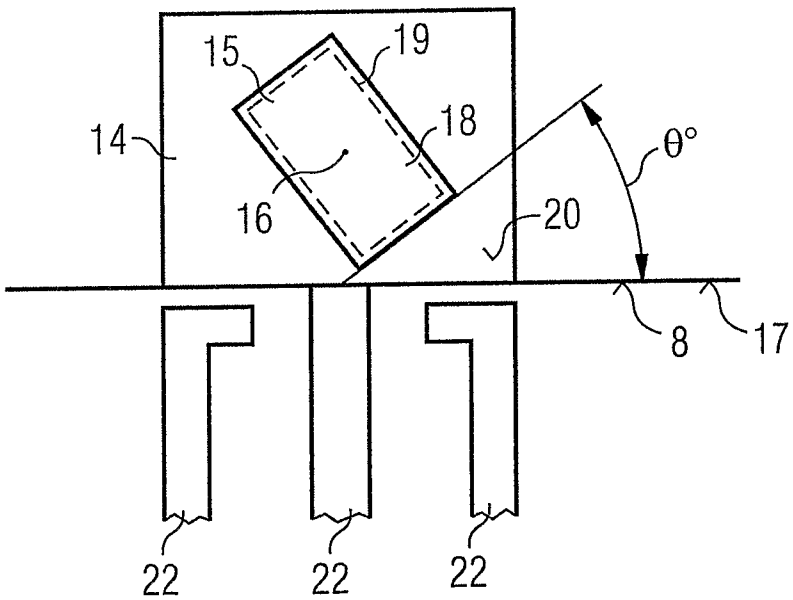


FIG 5



INTERNATIONAL SEARCH REPORT

International Application No
PCT/IB2005/002227

A. CLASSIFICATION OF SUBJECT MATTER
H01L21/60

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
H01L

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)
EPO-Internal, WPI Data, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2004/051185 A1 (KONISHI MASAHIRO ET AL) 18 March 2004 (2004-03-18) the whole document, in particular claims 1 and 6	1-15
X	US 6 355 499 B1 (WU SHYH-ING ET AL) 12 March 2002 (2002-03-12) the whole document, in particular claim 1	1-15
X	US 2003/068850 A1 (FUKUDA MASATOSHI ET AL) 10 April 2003 (2003-04-10) the whole document, in particular claims 1, 6 and 9	1-15

☐ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

° Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
18 November 2005	28/11/2005

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL – 2280 HV Rijswijk Tel. (+31–70) 340–2040, Tx. 31 651 epo nl, Fax: (+31–70) 340–3016	Cortes Rosa, Joao

INTERNATIONAL SEARCH REPORT

International Application No
PCT/IB2005/002227

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 2004051185 A1	18-03-2004	NONE	
US 6355499 B1	12-03-2002	NONE	
US 2003068850 A1	10-04-2003	NONE	