

**METHOD OF ENCAPSULATING A SEMICONDUCTOR ELEMENT IN
RESIN OR SEALING IT THEREWITH, AND A MOULD THEREFOR**

This invention concerns a method of encapsulating a semiconductor element in resin or sealing it therewith, and a mould therefor.

In a prior method of encapsulating a semiconductor element, a flow of resin has been directed towards the semiconductor element from one direction only which has tended to damage the semiconductor element and/or its leads.

According, therefore, to the present invention, there is provided a method of encapsulating a semiconductor element in resin or sealing it with resin comprising mounting the semiconductor element and a lead frame in a mould cavity so that an active surface side and a back surface side of the semiconductor element respectively face respective parts of the mould cavity, the semiconductor element being electrically connected to the lead frame by wires, each of said parts having a respective resin inflow opening for receiving resin from a source or sources thereof otherwise than via the other said part; introducing separate flows of resin into said parts by way of the respective resin inflow openings so that both the said active surface side and the said back surface side are subjected to the pressure of a respective flow of resin such that the wires are not deformed or broken, and effecting setting of the resin so as to encapsulate the semiconductor element therein or sealing it therewith.

Preferably, the said separate flows of resin subject each of the said surfaces of the semiconductor element to substantially the same pressure.

Each resin inflow opening is preferably disposed in substantial alignment with the centre of the semiconductor element.

The said wires are preferably connected to internal leads of the lead frame.

Preferably, the said flows of resin and the said wires and internal leads all extend substantially radially from the centre of the semiconductor element.

The mould is preferably provided successively with an upper mould plate; a first mould cavity plate; a second mould cavity plate; and a lower mould plate; each of the said first and second mould cavity plates being provided with a respective said part of the mould cavity and with a respective resin inflow opening; and each of the said upper and lower mould plates having conduit means therein for the flow of resin to the respective resin inflow opening in the adjacent mould cavity plate.

The invention also comprises an encapsulated or sealed semiconductor element when produced by the method set forth above.

In the preferred form of the present invention, the resin inflow openings in the first and second mould cavity plates are, during moulding, disposed opposite the semiconductor element, and because of the fact that the pressure of the inflowing resin increases nearly uniformly on the active surface side and the back surface side of the semiconductor element which is carried by the lead frame, it becomes possible to avoid up and down movement on the lead frame. In particular, when for example the resin inflow openings are arranged so that they are substantially aligned with the centre of the semiconductor element, the directions in which the resin may flow from the resin inflow openings, the directions of the wires which connect the semiconductor element with the internal leads, and the directions of the internal leads may all be substantially in the radial direction from the centre of the semiconductor element so that there is no stress during moulding that would deform the internal leads and wires, thus avoiding deformation of the internal leads and of the contacts between adjoining wires, or the cutting of the wires.

The invention is illustrated, merely by way of example, in the accompanying drawings, in which:-

Figure 1(a) is a plan view of a mould for use in the present invention;

Figure 1(b) is a sectional view along A-A' in Figure 1(a);

Figure 2(a) is a plan of a prior mould; and

Figure 2(b) is a sectional view along A-A' in Figure 2(a).

In the use of the prior mould shown in Figures 2(a) and 2(b), a lead frame 1 was mounted in a mould cavity 12 in a mould comprising an upper mould part 13 and a lower mould part 14, the lead frame 1 carrying a

semiconductor element 8 which was fastened to a semiconductor element mount 6, e.g. by means of adhesive or an eutectic alloy. The semiconductor element 8 was connected to internal leads 2 of the lead frame 1 by wires 9, comprising fine metal wire such as gold and copper-aluminium. A dam bar 3 was formed between the internal leads 2 and external leads 4. An outer frame 7 having a pilot hole 5 was formed externally of the lead frame 1, the outer frame 7 being provided with the external leads 4.

A resin inflow opening 10 was formed in the lower mould part 14 so that it connected only into the side wall of a lower mould cavity part 12b of the mould cavity 12.

The lead frame 1 was arranged between the upper mould part 13 and the lower mould part 14 of the mould and the latter was heated at from 160°C to 180°C , the lead frame 1 being compressed at a specified pressure. Then a thermosetting resin which had a low viscosity because of the heated mould flowed through the resin inflow opening 10 to fill the mould cavity 12, the resin flowing to the opening 10 through a runner 11.

However, in such a mould, since the resin inflow opening 10 was disposed in the lower mould part 14 and thus on only one side relative to the lead frame 1, the thermosetting resin flowing in from the resin inflow opening 10 was partially blocked by the lead frame 1, so that the lower mould cavity 12b filled faster than an upper mould cavity 12a. Consequently, resin flowed from the lower mould cavity 12b to the upper mould cavity 12a so that the flow of the resin caused the semiconductor element mount 6 and the internal leads 2 to shift towards the upper mould cavity 12a, leading to the problems that: (1) the position of the semiconductor

element 8 was changed, (2) the internal leads 2 were deformed, and (3) adjoining wires were brought into contact or the wires were broken.

5 The object of the embodiment of the present invention described below is therefore to avoid problems that lead to functionally fatal defects in semiconductor apparatuses, such as deformation of internal leads, contact between adjoining wires and breaking of the wires.

10 In the embodiment of the present invention shown in Figures 1(a) and 1(b), use is made of a mould which is provided successively with an upper mould plate 13b; a first or upper mould cavity plate 13a; a second or lower mould cavity plate 14a; and a lower mould plate
15 14b. Each of the first and second mould cavity plates 13a, 14a is provided with a respective part 12a, 12b of a mould cavity 12 and with a respective resin inflow opening 10a, 10b. Each of the upper and lower mould plates 13b, 14b has conduit means therein comprising a
20 respective runner 11a, 11b of runner means 11 and a respective sub-runner 15a, 15b, said conduit means providing for a flow of resin to the respective resin inflow opening 10a, 10b in the adjacent mould cavity plate 13a, 14a.

25 The upper mould plate 13b and the lower mould plate 14b are, in use, loaded into a moulding machine (not shown) and a lead frame 1 is placed in the position prescribed by the lower mould cavity plate 14a which is heated at from 160°C to 180°C. A semiconductor element 8,
30 which is carried by the lead frame 1 during moulding, is electrically connected to the lead frame 1 by wires 9, the wires 9 being connected to internal leads 2 of the lead frame 1. The lead frame 1, with the semiconductor element 8 attached to a semiconductor element mount 6,

also has a dam bar 3. An outer frame 7 has external leads 4 and a pilot hole 5.

5 A connection pad on the active surface 8a of the semiconductor element 8 and the internal leads 2 are connected by wire made of fine gold wire.

10 The first mould cavity plate 13a is provided with the upper mould cavity 12a and with the upper resin inflow opening 10a which is attached to the upper mould plate 13b so that it is opposite to the second mould cavity plate 14a having the lower mould cavity 12b and the lower resin inflow opening 10b. The upper resin inflow opening 10a is arranged so as to be opposite to the active surface 8a of the semiconductor element 8, and the lower resin inflow opening 10b so as to be opposite to the back surface 8b of the semiconductor element 8. Each of the resin inflow openings 10a, 10b is in substantial alignment with the centre of the semiconductor element 8.

20 In operation, the second or lower mould cavity plate 14a, the lead frame 1 and the first or upper mould cavity plate 13a are first loaded at prescribed positions onto the lower mould plate 14b, which in turn is loaded into a moulding machine (not shown). The semiconductor element 8 is thus mounted in the mould cavity 12 so that the active surface side 8a and the back surface side 8b of the semiconductor element 8 respectively face the mould cavity parts 12a, 12b of the mould cavity 12. The upper mould plate 13b and the lower mould plate 14b are then heated at from 160°C to 180°C and are compressed by the moulding machine. After this, thermosetting resin extruded by a cylinder (not shown) has its viscosity reduced by the heating temperature of the semiconductor mould, flows simultaneously into the upper mould sub-runner 15a and into the lower mould sub-

runner 15b, and then flows respectively from the upper resin flow opening 10a and the lower resin inflow opening 10b into the upper mould cavity 12a and lower mould cavity 12b respectively. Because the upper and lower resin inflow openings 10a and 10b are much smaller than the upper and lower sub-runners 15a and 15b, the thermosetting resin from the upper and lower resin inflow openings 10a and 10b impacts forcefully againsts the active side 8a of the semiconductor element 8 and the back surface of the semiconductor element mount 6 so as to subject to pressure both the active side 8a and the back surface side 8b of the semiconductor element 8, the resin then flowing radially out from the places of impact to fill the cavity 12.

At this time the force and quantity of resin flowing from the upper resin inflow opening 10a into the upper mould cavity 12a are equal to the force and quantity of the resin flowing from the lower mould resin inflow opening 10b into lower mould cavity 12b. Moreover, the resin inflow pressures received by the semiconductor element 8 at the active surface side 8a thereof and at the back surface side 8b thereof are also substantially equal. Accordingly, the semiconductor element 8 and the semiconductor element mount 6 will not move in either the up or the down direction.

Further, by maintaining this state, the thermosetting resin is set by the mould heating temperature so as to encapsulate the semiconductor element 8 therein. After the thermosetting resin has been set, the compression of the upper mould plate 13b and the lower mould plate 14b in the moulding machine is stopped and they are depressurized. The lower mould plate 14b is then shifted downwards and a space is opened up between the upper mould cavity plate 13a, and

the upper plate 13b. Then the lower mould cavity plate 14a, and the lead frame 1 and the upper mould cavity plate 13a are shifted to different positions from the lower mould plate 14b, after which the thermosetting resin that has set in the runner means 11 and remains in the same form as in the upper mould sub-runner 15a is removed from the upper mould cavity plate 13a. Further, after removing the upper mould cavity plate 13a, the resin encapsulated lead frame 1 is removed from the lower mould cavity plate 14a and placed into a product container. The thermosetting resin set in the runner means 11 and remaining in the same form as in the lower mould sub-runner 15b is removed from the lower mould cavity plate 14a. The process described above makes up one cycle.

By enclosing the semiconductor element 8 and semiconductor element mount 6 and having the thermosetting resin flow from the opposite directions in this manner, the semiconductor element 8 and semiconductor element mount 6 are sealed and encapsulated in a stabilized state without moving upward or downward.

In the embodiment of the present invention described above, because the construction is such that the resin inflow openings 10a, 10b are mutually opposite the active surface side 8a and back surface side 8b of the semiconductor element 8, the pressure of the inflowing resin is applied nearly equally to the active surface and back surface sides 8a, 8b of the semiconductor element 8 carried by the lead frame 1, so that up and down movements of the lead frame 1 are avoided. Moreover, when for example the resin inflow openings 10a, 10b are arranged so as to be positioned nearly in the centre of the semiconductor element 8, the

direction of resin flow and the direction of the wires
9 connecting the internal leads 2 with the
semiconductor element 8 and the direction of the
arrangement of the internal leads 2 are each nearly in
5 conformance with the radial direction from the centre of
the semiconductor element 8, so that there is no stress
that is liable to deform the internal leads 2 and wires
9. Thus it is possible to provide a semiconductor
sealing or encapsulation mould that can avoid the
10 problems of internal lead deformation and contact
between adjoining wires or breaking of the wires.

CLAIMS

1. A method of encapsulating a semiconductor element in resin or sealing it with resin comprising mounting the semiconductor element and a lead frame in a mould cavity so that an active surface side and a back surface side of the semiconductor element respectively face respective parts of the mould cavity, the semiconductor element being electrically connected to the lead frame by wires, each of said parts having a respective resin inflow opening for receiving resin from a source or sources thereof otherwise than via the other said part; introducing separate flows of resin into said parts by way of the respective resin inflow openings so that both the said active surface side and the said back surface side are subjected to the pressure of a respective flow of resin such that the wires are not deformed or broken, and effecting setting of the resin so as to encapsulate the semiconductor element therein or sealing it therewith.
2. A method as claimed in claim 1 in which the said separate flows of resin subject each of the said surfaces of the semiconductor element to substantially the same pressure.
3. A method as claimed in claim 1 or 2 in which each resin inflow opening is disposed in substantial alignment with the centre of the semiconductor element.
4. A method as claimed in any preceding claim in which the said wires are connected to internal leads of the lead frame.



5. A method as claimed in claim 4 in which the said flows of resin and the said wires and internal leads all extend substantially radially from the centre of the semiconductor element.
6. A method as claimed in any preceding claim in which a mould is used which is provided successively with an upper mould plate; a first mould cavity plate; a second mould cavity plate; and a lower mould plate; each of the said first and second mould cavity plates being provided with a respective said part of the mould cavity and with a respective resin inflow opening; and each of the said upper and lower mould plates having conduit means therein for the flow of resin to the respective resin inflow opening in the adjacent mould cavity plate.
7. A method of encapsulating a semiconductor element in a resin or sealing it therewith substantially as hereinbefore described with reference to Figures 1(a) and 1(b) of the accompanying drawings.
8. An encapsulated or sealed semiconductor element when produced by the method claimed in any preceding claim.
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