

PATENT SPECIFICATION

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DRAWINGS ATTACHED

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(54) FABRICATION OF SEMICONDUCTOR DEVICES HAVING MOLDED ENCLOSURES

(71) We, RCA CORPORATION (formerly RADIO CORPORATION OF AMERICA), a corporation organised under the laws of the State of Delaware, United States of America, of 30 Rockefeller Plaza, City and State of New York, United States of America, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to the fabrication of semiconductor devices and particularly to molding encapsulation of such devices.

Certain types of semiconductor devices, e.g. integrated circuits, comprise a semiconductor pellet embedded in an enclosure of a molded, plastic-like material. A plurality of leads are connected to the pellet and extend outwardly through and beyond the enclosure.

In the fabrication of such devices, the leads are first connected to the pellet, the pellet assembly is placed in the cavity of a mold with the leads extending outwardly thereof, and encapsulating material is forced into the mold cavity to flow around and encapsulate the pellet and a portion of the length of the extending leads.

For the purpose of providing device enclosures having accurate dimensions, for proper mounting of the devices, it is necessary that the flow of the encapsulating material be carefully controlled. A problem in the past has been the difficulty of preventing flow of the encapsulating material outwardly between the leads during the molding process. This problem is especially severe in devices of small size having a large number of closely spaced leads.

While specially formed and carefully dimensioned molds have been used in the past to accurately control the flow of the encapsulating material, a problem with such molds is that they are expensive and require careful loading and positioning of the pellet assemblies therein. This reduces the rate of production of the devices and causes an increase in the manufacturing costs of the devices.

According to the invention we provide a new method of encapsulating a semiconductor device comprising providing a semiconductor pellet and a lead assembly having a plurality of leads connected by portions of said lead assembly; placing said pellet and said lead assembly in a mold cavity, said leads extending outward of said cavity, said connecting portions of said lead assembly being disposed just outside said cavity; and forcing encapsulating material into said mold cavity to encapsulate said pellet and the portion of said leads within the mold cavity, the flow of encapsulating material outwardly between said leads during said encapsulation being prevented by said connecting portions of said lead assembly.

In the accompanying drawings,

Figure 1 is a plan view of a semiconductor device;

Figure 2 is a plan view of a pellet and lead assembly mounted in the lower half of a mold assembly;

Figure 3 is a sectional view along line 3-3 of Figure 2 together with both halves of the mold assembly;

Figure 4 is a plan view of the molded pellet and lead assembly; and

Figure 5 is a sectional view along line 5-5 of Figure 4.

An example of an enclosure molded device 8 is shown in Figure 1. The device 8 comprises a solid enclosure 10 of rectangular shape of a plastic encapsulating material, and a plurality of terminals or leads 12 and 13 extending outwardly from the enclosure. The different reference numerals 12 and 13 distinguish, for convenience, between the end and middle leads of each side of the device. Within the enclosure 10 is a pellet to which the inner ends of the leads 12 and 13 are connected. The encapsulating material can comprise any of several known materials used for encapsulating purposes, such as transfer molding silicones or epoxies.

Figure 2 shows a pellet and lead assembly 14 mounted on the lower half 16 of a mold assembly 18. The pellet and lead assembly 14 comprises a thin and flat (see Figure 3)

rectangular frame 20 having a central strap 22 on which a semiconductor pellet 24 is mounted, as by brazing, and a plurality of inwardly extending straps or leads 12 and 13. The lead assembly 14 can be formed, by known stamping or etching techniques, for example, from a flat sheet of metal. The inner ends of the leads 12 and 13 are connected, as by fine bonding wires 26, to different areas on the pellet 24. In one embodiment, not shown, the bonding wires 26 are omitted, and the leads 12 and 13 are connected directly to the pellet 24. Each adjacent pair of leads 12 and 13 on each side of the frame 20 is joined by a separate connector strap or stop 28. Stops 28' are also provided joining the end leads 13 to the side members 30 of the frame 20. The central strap extends between the two side members 30. The stops 28 and 28', as well as the side members 30, are disposed relative to the pellet 24 such that, in the encapsulated device, the stops and side members 30 are located just outside the device enclosure 10. While the exact positioning of the stops and side members relative to the enclosure is not critical, as a practical matter, for a reason disclosed hereinafter, the stops and side members are preferably as close to the enclosure as possible within the tolerances of the molding system.

The mold assembly 18, as shown in Figure 3, comprises two halves 16 and 34, each of which has a recess 36. The recesses 36 form, when the mold halves are joined, a cavity 40 having the shape and dimensions of the capsule or the device enclosure 10. The mold half 16 has a pair of alignment pins 42 for providing alignment of the recesses 36 when the mold halves are joined. The frame 20 is provided with two openings 46 by means of which the pellet and lead assembly 14 is also positioned by the pins 42.

The upper mold half 34 has a passageway 50 opening into its recess 36 for the introduction of the encapsulating material, under pressure, into the cavity 40. Means for doing this are known.

In the molding operation, the pellet and lead assembly 14 is mounted between the mold halves 16 and 34 with the pellet 24 centered within the cavity. The inner ends of the leads 12 and 13 and the bonding wires 26 are also within the cavity. The stops 28 and 28' and the side members 30 of the frame 20 are disposed just outside the cavity.

As shown in Figure 3, the opposing surfaces 56 and 58 of the two mold halves 16 and 34, respectively, are spaced apart by the thickness of the frame 20. During the molding processes, flow of the encapsulating material out of the cavity 40 through the spaces between the leads 12 and 13 is limited by the presence of the stops 28 and 28'. That is, instead of flowing outwardly between the

leads all the way to the outer portions of the frame 20, as was the case in the past, the encapsulating material flows no further than the stops 28 and 28'. The side members 30 of the frame also limit the outward flow of the encapsulating material.

After the encapsulating material has hardened, the mold halves 16 and 34 are opened. As shown in Figures 4 and 5, the molded enclosure 10 has a substantially solid-rectangular shape with thin projections or ledges 60 extending therefrom which fill the spaces between the enclosure 10 and the stops 28 and 28' and the frame side members 30. The upwardly extending projection 62 is formed from the encapsulating material in the mold passageway 50 (Figure 3). To provide the finished device 8, the stops 28 and 28' and the frame 20 are cut from the leads, and the projection 62 is broken from the enclosure. Although the projections 60 can also be removed, they are generally left in place if they are small enough. The width of the projections, that is, the distance they extend from the enclosure is determined by the distance of the stops 28 and 28' and the frame sides 30 from the enclosure. In one embodiment, for example, the projections 60 extend about 0.005 inch from the main body of the enclosure 10, hence are barely noticeable and are not removed.

As disclosed in Figure 3 the connecting elements 28, 28' and 30 form a continuous portion of the wall of the cavity 40, such that when the mold is tightly held together and the encapsulating material is forced into the mold, these connecting portions prevent the flow of the encapsulating material outwardly between the leads 12, 13, as described above, as well as limiting the flow of the material out of the ends of the cavity 40. It has been described and shown that the members 28, 28' and 30 are positioned just outside of the enclosure 40 and that the encapsulating material when hardened form the thin projections 60. The purpose of spacing these connecting elements from the main portion of cavity 40 is to permit an easier separation of the leads 12 and 13 from each other by removing the connecting portions 28 and 28'. The spacing facilitates this process although this can also be done if these connecting portions were not spaced from the main portion of cavity 40. The spacing, of course, is not critical and may amount to a distance of around 5 mils.

WHAT WE CLAIM IS:—

1. A method of encapsulating a semiconductor device comprising providing a semiconductor pellet and a lead assembly having a plurality of leads connected by portions of said lead assembly; placing said pellet and said lead assembly in a mold cavity, said leads extending outward of said



rectangular frame 20 having a central strap 22 on which a semiconductor pellet 24 is mounted, as by brazing, and a plurality of inwardly extending straps or leads 12 and 13. The lead assembly 14 can be formed, by known stamping or etching techniques, for example, from a flat sheet of metal. The inner ends of the leads 12 and 13 are connected, as by fine bonding wires 26, to different areas on the pellet 24. In one embodiment, not shown, the bonding wires 26 are omitted, and the leads 12 and 13 are connected directly to the pellet 24. Each adjacent pair of leads 12 and 13 on each side of the frame 20 is joined by a separate connector strap or stop 28. Stops 28' are also provided joining the end leads 13 to the side members 30 of the frame 20. The central strap extends between the two side members 30. The stops 28 and 28', as well as the side members 30, are disposed relative to the pellet 24 such that, in the encapsulated device, the stops and side members 30 are located just outside the device enclosure 10. While the exact positioning of the stops and side members relative to the enclosure is not critical, as a practical matter, for a reason disclosed hereinafter, the stops and side members are preferably as close to the enclosure as possible within the tolerances of the molding system.

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In the molding operation, the pellet and lead assembly 14 is mounted between the mold halves 16 and 34 with the pellet 24 centered within the cavity. The inner ends of the leads 12 and 13 and the bonding wires 26 are also within the cavity. The stops 28 and 28' and the side members 30 of the frame 20 are disposed just outside the cavity.

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5 cavity, said connecting portions of said lead assembly being disposed just outside said cavity; and forcing encapsulating material into said mold cavity to encapsulate said pellet and the portion of said leads within the mold cavity, the flow of encapsulating material outwardly between said leads during said encapsulation being prevented by said connecting portions of said lead assembly.

10 2. A semiconductor device made according to the method of claim 1, comprising an array of elongated leads joined together intermediate the ends thereof by connecting elements, a semiconductor pellet adjacent ends of each of the leads being electrically connected to the pellet, and a molded enclosure enclosing the pellet and the adjacent ends of the leads, the connecting elements being disposed just outside said enclosure.

20 3. A semiconductor device as claimed in Claim 1, wherein the leads are part of a lead frame having side members disposed just outside the enclosure.

25 4. A semiconductor device as claimed in Claim 3 wherein the frame comprises a flat sheet of metal having apertures therein defining the leads and side members.

30 5. A semiconductor device as claimed in Claim 3, wherein the frame has a rectangular shape and the leads extend inwardly of the frame from two opposite sides thereof, the other two sides of the frame being disposed just outside the enclosure.

35 6. A semiconductor device as claimed in claim 5, wherein the pellet is mounted on a portion of the frame, and bonding wires connect the leads to the pellet.

40 7. A semiconductor device substantially as herein described with reference to Figures 4 and 5 of the accompanying drawings.

45 8. A mold assembly for carrying out the method of encapsulating a semiconductor device according to Claim 1, comprising a mold having two halves tightly fitted together to form a cavity and with a thin flat sheet

of metal forming a lead assembly extending between and separating the halves of the mold, the metal sheet including a plurality of spaced straps forming leads, a continuous portion of the metal sheet extending completely around the outside of the cavity and forming a portion of the cavity wall to limit the flow of encapsulating material between the halves of the mold during casting. 50 55

9. A mold assembly as claimed in Claim 8, wherein the spaced straps of the metal sheet extend from the continuous portion of the metal sheet and terminate at inner ends within the cavity. 60

10. A mold assembly as claimed in claim 8 or 9 wherein another strap extends within the cavity as a support for a semiconductor device. 65

11. A mold assembly as claimed in any one of claims 8-10, wherein the metal sheet is formed as a frame joining together the outer ends of the straps and from which the straps extend through the continuous portion into the mold cavity. 70

12. A mold assembly as claimed in any one of claims 8-11, wherein means are provided to hold the mold halves and the metal sheet in alignment. 75

13. A mold assembly as claimed in any one of claims 8-12, wherein the continuous portion of the metal sheet is spaced outwardly from the cavity formed by the two halves of the mold. 80

14. A mold assembly substantially as herein described with reference to Figure 3 of the accompanying drawings.

15. A semiconductor device substantially as described with reference to Figure 4 of the accompanying drawing. 85

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