A MOULD FOR INTEGRATED CIRCUIT ENCAPSULATION

This invention relates to a mould for integrated circuit encapsulation.

Plastic-moulded packages are the most common of available integrated circuits. In the manufacturing process for such packages, an integrated circuit chip is attached to a flat metal lead frame and wire bonding is then done to inter-connect the bond pads of the integrated circuit to the leads of the frame. The lead frame is then loaded into a multi cavity moulding tool and encapsulated in thermoset moulding compound using the transfer moulding process. This process step is illustrated in Figure 1 in which the lead frame 10 is placed between top 12 and bottom 14 mould sections under a clamping force F, compound being transferred through runner channel 16 to the mould cavity 18 under pressure.

One of the major problems of this technique is what is termed "mould bleed" in which a very thin layer of resin 17 not visible to the naked eye becomes deposited on the lead frame at the parting line 19 of the mould sections during compound transfer. The thin layer of resin prevents the base lead frame material from being electroplated and this part of the lead frame is consequently exposed after plating. This is usually termed "exposed copper" which is a serious quality problem. Current industry practice has been to add an additional process step called "deflash" to remove the mould bleed layer before plating. This not only increases the manufacturing time and costs but provides an additional quality control problem due to inconsistency in the deflash process.

It is an object of this invention to provide a mould which reduces the problem of mould bleed.

According to the invention there is provided a mould for integrated circuit encapsulation comprising first and second mould sections having respective first and second clamping surfaces engageable under pressure on either side of an integrated circuit lead frame wherein the area of the first clamping surface is less than the area of the second clamping surface and the outer peripheral edge of the second clamping surface projects beyond the outer peripheral edge of the first clamping surface.

With the described embodiment of the invention, the outer edge of the clamping surfaces are of different peripheral lengths, the outer edge of the second clamping surface projecting beyond the outer edge of the first clamping surface.

Preferably, a clamping surface of the runner channel, through which resin is forced into the mould is relieved relative to the clamping surfaces of the mould sections by an amount no greater than the required deformation of the leadframe during the moulding process. This enables the clamping pressure to be applied in two stages. In Stage 1, clamping pressure increased by the elimination of the runner clamping area helps to flatten uneveness in the leadframe surface, while in Stage 2 final clamping pressure before molding seals the runner channel also.

According to the invention, in a second aspect, there is provided a mould for integrated circuit encapsulation comprising first and second mould sections having respective first and second clamping surfaces engageable under pressure on either side of an integrated circuit

lead frame, the mould sections forming a mould cavity and a runner channel connected to the cavity for supply of plastics material thereto, the mould sections having co-operating surfaces for sealing the channel, the co-operating surfaces being relieved relative to the clamping surfaces.

An embodiment of the invention will now be described by way of example with reference to the accompanying drawings in which:

Figure 1 is a cross sectional view of a mould of a prior art.

Figure 2 is a cross sectional view of a lead of the lead frame of Figure 1.

Figures 3a, 3b and 3c show how the profile of the lead of Figure 2 is affected by increased pressure during the moulding process.

Figures 4a - 4d illustrate a prior art mould with Figure 4a in being a cross sectional view similar to Figure 1, Figure 4b being a cross sectional view in the plane A of Figure 4a, Figure 4c being an enlarged view of the clamping surfaces shown in Figure 4a and 4d being a cross sectional view of the runner clamping surface across B-B of Figure 4b.

Figure 5a - 5d show an embodiment of the invention with Figure 5a being a view similar to Figure 4a, Figure 5b being a view similar to Figure 4b, and Figures 5c and 5d being views similar to Figures 4c and 4d.

Before describing the embodiment of the invention, the applicants identification of the

causes of mould bleed will be described.

The applicants have found that the primary reason for mould bleed is associated with the shape of the leads of the lead frame. This is illustrated with referenced to Figure 2 which shows the cross section of a typical lead 20 of the lead frame 10. The lead 20 is stamped from a sheet of metal and as a result of the stamping process has an undulating top surface having a peak 22 leading to troughs 23 and burrs 24 at each side. The peak to trough distance H is generally of the order of 0.01 to 0.02 mm.

This cross sectional shape allows channels to form in the troughs 23 through which the resin can flow during moulding.

This problem can be reduced by increasing the pressure between the mould sections 12, 14 as illustrated in Figure 3 in which increase force F causes a reduction in the irregularities in the profile of lead 20 thus reducing the size of the channels through which the resin 28 can flow and reducing mould bleed accordingly

Although this process can reduce mould bleed, the increases in cost associated with the plant needed to provide the increased pressures are significant and it is not possible with currently available moulds and moulding machines to increase the pressure to a level which would reduce mould bleed to an acceptable level, so that 'deflash' stage can be eliminated in the process.

An embodiment of the invention shown in Figure 5 will now be described by comparison with a conventional mould shown in Figure 4 which comprises mould sections 12, 14

engageable to form a mould cavity 18 at upper and lower clamping surfaces 30, 32. The outer edges of the clamping surfaces 34 are in line although the inner edges of the clamping surfaces 36 may be of different sizes, depending upon the mould shape desired and to allow for mismatch between the mould sections 12, 14 during moulding.

The upper clamping surface 30 is shown in more detail in Figure 4b. The surface 30 surrounds the cavity 18 and is raised relative to the remainder of the mould section 12 along with runner clamp section 40 which seals against a corresponding runner channel 16 (Fig. 1) formed in lower mould 14.

With reference to Figure 5, the embodiment of the invention has two differences compared with the mould of Fig. 4. In Fig. 5, like reference numerals represent like parts in Fig. 4 with the addition of 100.

The primary difference concerns the clamping surfaces in that the outer periphery of the upper clamping surface 130 is of reduced size compared to outer periphery of the lower clamping surface. The reduction is caused by reducing the size of the clamping edge 130 from the outer peripheral edge 134 so that lower clamping surface 132 now projects outwardly of the upper clamping surface 130. The difference between outer clamping surfaces 132 and 134 is big enough to cover any tolerance in positioning of mould sections 112, 114 on the top of each other.

The inner peripheral edges 136 of the clamping surfaces are of the same size as in the prior art.

In addition to change in size of the clamping surface 130, the runner channel clamping surface 140 is relieved relative to the height of the sealing surface 130 so that there is a step 145 between the runner channel clamping surface 140 and clamping surface 130 as shown in Figure 5b and 5d. The depth D of the step is no greater than the degree of deformation, of the lead frame X (as shown in Figure 3) that takes place during the moulding process, generally 0.015 - 0.020 mm so that the integrity of the runner channel 116 is maintained while at the same time concentrating the clamping force on to the clamping surface 130.

An example of the embodiment of the invention will now be given, by comparison with the prior art.

A mould similar to that shown in Figure 4 is provided having a frame clamping area formed by the engaged clamping surfaces 30, 32 and runner frame clamping surface 40 of 10.8 sq cm. The upper clamping surface 130 is then reduced in cross sectional area by removing materials from the outer peripheral edge of the clamp surface 130 to reduce the size of the upper clamping surface 130 by 1.2 sq cm. The runner channel clamping surface 140 is then relieved to a depth of 0.015 mm to provide a further reduction in clamping area of 3.5 sq cm giving a total area reduction of 4.7 sq cm and thus providing a new clamping area of 6.1 sq cm.

Designed clamping force for this leadframe during molding is about 22 ton (215 KN), which transforms into 2000 kg / sq cm clamping pressure considering the existing clamp area of 10.8 sq cm. This pressure is increased to 3540 kg / sg cm by the new clamping area of 6.1 sg cm using the invention. Hence there is an increase of about 77 % in clamping pressure with the same force.

Usually, the lead frames used in the mould apparatus of the invention are positioned in the mould so that the undulating surface 22 - 24 shown in Figure 2 is upper most and is on the same side of the lead frame as the integrated circuit. With such an arrangement, the clamping surface of the reduced surface area is provided on the mould section facing the undulating surface, in example shown in Figure 5, on the clamping surface 130 of the top mould section 112. However, the invention may be used with other orientations of mould and lead frame, with the reduced clamping surface being provided on the lower mould, for example.

Claims

1. A mould for integrated circuit encapsulation comprising first and second mould sections having respective first and second clamping surfaces engageable under pressure on either side of an integrated circuit lead frame wherein the area of the first clamping surface is less than the area of the second clamping surface and the outer peripheral edge of the second clamping surface projects beyond the outer peripheral edge of the first clamping surface.

2. A mould as claimed in claim 1 wherein the first clamping surface is engageable regions of the lead frame having a non-flat surface.

3. A mould as claimed in claim 1 or claim 2 wherein the first clamping surface is engageable with the sides of the lead frame upon which the integrated circuit is mounted.

4. A mould as claimed in any one of the preceding claims having a runner channel formed therein, the mould sections having co-operating surfaces for sealing the channel, and said surfaces being relieved relative to the clamping surfaces.

5. A mould as claimed in claim 4 wherein the runner channel sealing surfaces are relieved relative to the clamping surfaces by an amount no greater than a deformation of the lead frame required during the moulding process.

6. A mould as claimed in any one of the preceding claims wherein the first and second mould sections have respective first and second mould cavities, the cavities being of

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different sizes.

7. A mould for integrated circuit encapsulation comprising first and second mould sections having respective first and second clamping surfaces engageable under pressure on either side of an integrated circuit lead frame, the mould sections forming a cavity and a runner channel connected to the cavity for supply of plastics material thereto, the mould sections having co-operating surfaces for sealing the channel, the co-operating surfaces being relieved relative to the clamping surfaces.

8. A mould as claimed in claim 7 wherein the co-operating surfaces are relieved relative to the clamping surfaces by an amount no greater than a required deformation of the lead frame during the moulding process.

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