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SEMICONDUCTOR DEVICE AND METHOD OF PRODUCING THE SAME

Background of the Invention

The present invention relates to a semiconductor device, to a lead frame useful in making such a device, and to a method of making such a device.

In general, it is easier to make a semiconductor device of the flat package type and to increase the number of its pins than to do so with a semiconductor device of the dual in-line package type. Moreover, the installation of the former on a mounting circuit board (printed circuit board requires similar mounting operations as a semiconductor device of the chip carrier package type. Owing to these advantages, the demand for flat package devices is increasing. A semiconductor device of the flat package type usually has a semiconductor element fastened to a lead frame obtained by punching and shaping a metal sheet, to which it is electrically connected by leads. The pellet and the connected parts of the leads are then encapsulated with a resin (plastics) to form a package body. When the package is rectangular in plan, one corner of a package body 1 is removed to form a chamfered portion 2, as illustrated in Figure 1 of the accompanying drawings, and the chamfered portion 2 is utilized as an index for plurality of leads 3 which are connected within the package body 1 to electrode pads on the semiconductor element.

In recent years, semiconductor devices have had a tendency to have an increasingly high density of integra-

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tion and a large number of pins. On the other hand, it is sometimes necessary to keep the geometry of the package body constant for reasons such as design, fabrication or mounting. A larger number of pins is achieved by making the pitches between the leads 3 as small as possible and positioning the leads 3 with the perimeter of the four sides of the package body 1 utilized to the utmost.

In the prior-art semiconductor device, however, the chamfered portion 2 is provided to form an index, so that no lead 3 is provided in this portion. This lowers the degree of utilization of the sides of the package body, and forms an obstacle to the increase of the number of pins. Moreover, since no lead is disposed in the chamfered portion 2, it is impossible, particularly on side faces 1a and 1b adjoining the chamfered portion 2, for the pins to be symmetric with respect to the centre 0 of the package body 1. This sometimes leads to disadvantages in design, fabrication or mounting. Also, as will be described in detail later, since there is no lead in the chamfered portion 2, the part of the lead frame corresponding thereto also has no lead. For this reason, plastics material leaks out in the operation of molding with the plastics, resulting in the problem that degradation in the external appearance or chipping of the package is incurred, which spoils the marketability of the semiconductor device.

In one aspect, this invention provides a semiconductor device comprising a rectangular package body encapsulating

a semiconductor element, and a plurality of leads which jut out from the package body, the leads including leads which are connected to electrode pads on the semiconductor element, the leads connected to the electrode pads projecting from each of the four sides of the package body and from a chamfered portion in at least one corner of the package body.

In a second aspect, the invention provides a lead frame having a tab for supporting a semiconductor element, a rectangular dam, a frame portion supporting the dam, and a plurality of leads extending from the dam towards the tab and being arranged around the tab, the leads including tab support leads which extend from the dam to the tab and connection leads which extend a part of the way from the dam to the tab, the connection leads immediately adjacent the tab support means being positioned sufficiently close to the tab support leads that, when the tab is encapsulated in a package body, the tab support leads and the immediately adjacent connection leads extend from the damage to at least one chamfered portion at the corner of the package body and the other connection leads project from the four sides of the package body.

In a third aspect, the invention provides a method of forming a semiconductor device, comprising:

preparing a lead frame having a tab and a plurality of leads,

fastening a semiconductor element to the tab,

connecting electrode pads of the semiconductor element to the leads, and

molding a package body of resin around the tab, the semiconductor element, and parts of the leads, such that other parts of the leads jut out from the package body; wherein

the leads are located such that they project from each of the four sides of the package body and from a chamfered portion in at least one corner of the package body.

Embodiments of the invention will now be described in detail, by way of example, with reference to the accompanying drawings, in which:

Figure 1 is a plan view of a prior-art semiconductor device;

Figure 2 is a perspective view of a semiconductor device according to an embodiment of the present invention;

Figure 3 is a perspective view, partly broken away, of the semiconductor device shown in Figure 2;

Figure 4 is a general schematic plan view of a lead frame which is used for producing a semiconductor device according to the present invention;

Figure 5 is an enlarged view of the essential portions of the lead frame shown in Figure 4;

Figure 6 is a sectional view of the molded state when the lead frame shown in Figure 5 is encapsulated;

Figure 7 is a partial enlarged view, corresponding to Figure 5, of a lead frame in the prior art; and

Figure 8 is a sectional view of a molded state in the prior art.

The present invention will be described in connection with illustrated embodiments.

Figure 2 is a general perspective view of a device according to the present invention, while Figure 3 is a fragmentary sectional view thereof. Numeral 10 designates a package body, and numeral 11 leads (pins) which are protrusively disposed on the four perimetric side faces of the package body 10. The package body 10 is made generally flat by such an expedient as molding a resin (plastics) material, and its shape in plan is a square such as oblong. It encapsulates the inner end parts of the leads 11, namely, inner leads 12 and a semiconductor element pellet 13 therein. The semiconductor pellet 13 is fastened on the upper surface of a tab 14 which is substantially in the shape of a rectangle, preferably a regular square, and the electrode pads thereof and the inner leads 12 of the respective leads 11 are connected by wires 15. In addition, the package body 10 has one corner thereof removed, and the resulting chamfered portion is formed as an index 16. On the other hand, the leads 11 are juxtaposed on each of the four perimetric sides of the package body 10 at equal pitches, and their outer leads 17 protrude in the four perimetric directions. In this case, the outer leads 17 are bent stepwise so that their fore end parts can contact with the wiring leads

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of a mounting printed circuit board, not shown, when the package body 10 is placed on the printed circuit board. In addition, the outer leads 17 are disposed so as to be symmetric with respect to the central position of the package body 10 and so as to utilize the perimeter of the package body 10 effectively to the utmost. Accordingly, some of the leads 11 or leads 11a and 11b in the present example are disposed on the chamfered portion, namely, the face of the index 16 of the package body 10. The corresponding outer leads 17a and 17b protrude from this face in directions which are orthogonal to each other.

Now, a method of producing the semiconductor device having the above construction will be described.

First, as shown in Figure 4, a metal sheet of "42 alloy" or the like is punched to form an elongate lead frame 18. In the present example, this lead frame 18 is constructed as a multiple frame in which leads etc. corresponding to five packages are provided next to each other. Each component for one package has the inner leads 12 of a plurality of leads 11 disposed radially around a square tab 14 formed in the central part thereof, as also shown in Figure 5. In addition, the respective leads 11 are integrally coupled by a frame-like dam 19, and their outer leads 17 extend in the four

perimetric directions at equal pitches and coupled to a frame portion 20. Tab suspending leads 21 are respectively provided at the four corners of the tab 14, and they are coupled to the dam 19 thereby to support this tab 14 on the frame portion 20. Guide holes are shown by numeral 23. The leads 11a and 11b disposed on the index 16 are arranged in proximity to the tab suspending lead 21 so that the interspaces 22 between the leads 11a, 11b and the tab suspending lead 21 may become as small as possible. By the way, a conventional lead frame 18A shown in Figure 7 does not include such leads 11a and 11b, so that the interspaces 22A between the tab suspending lead 21 and the adjacent leads 11 are large.

One corner of each package of the lead frame 18 is provided with an unpunched gate top plate portion 29, so as to regulate the flow of a resin in a resin molding operation as will be described later. Symbol 29A indicates a gate top plate portion in the prior art (Figs. 7 and 8). The plurality of guide holes 23 are formed on both the sides of the lead frame 18 as shown in Figure 4, and are utilized for feeding in an automatic assembly operation.

Secondly, the tab 14 and the inner leads 12 of the lead frame 18 are plated with gold or the like. Thereafter, the semiconductor element pellet 13 is fastened on the surface of the tab 14 by a gold-silicon eutectic or the

like, and the pellet 13 and the inner leads 12 are joined by the wires 15 to perform electrical connection. Thereafter, as illustrated in Figure 6, the lead frame 18 is set in upper and lower resin molding templets 24 and 25 to arrange the tab 14, inner leads 12, pellet 13 and wires 15 within the cavity 26 of the molding templets, and the molding resin 28 is forcibly introduced into the cavity 26 through a gate 27 which is formed in the lower molding templet 25. At this time, the gate top plate portion 29 provided at one corner of the lead frame 18 is arranged in a position directly above the gate 27, so that the resin introduced from the gate 27 is guided into a deeper place. The resin forcibly fed into the cavity passes through the interspaces of the lead frame 18 and fills up the whole cavity. With the lead frame according to the present embodiment, therefore, leakage (overflow) of the resin to a part B in Figure 5 can be suppressed owing to the small interspaces between the leads 11a, 11b and the tab suspending lead 21. In contrast, with the prior-art lead frame 18A shown in Figure 7, resin leakage 30 is liable to occur in the parts A of the figure as illustrated in Figure 8, on account of the large interspaces 22A. When it is intended to eliminate the leakage part after molding and solidification, the drawback is involved that chipping of the package body 10 is incurred.

After the molding encapsulation has been finished in the way described above, the frame portion 20 and dam 19 of the lead frame 18 and also the tab suspending leads 21 thereof are cut away, and the outer leads 17 are bent stepwise by press work. Then, the foregoing semiconductor device can be obtained.

With the semiconductor device of the present example, accordingly, since the package body 10 is provided with the index 16 formed by removing one corner, recognition of the leads 11 can of course be effected as in the prior art, and since the leads 11a and 11b are disposed also on the index 16, increase in the number of leads is achieved to that extent and an enhanced density of integration as well as an increased number of pins can be coped with. In addition, the disposition of the leads on the index makes it possible to dispose the leads symmetrically with respect to the center of the package body. This can facilitate the design fabrication and mounting of the semiconductor device or the mounting circuit board etc.

Moreover, according to the producing method of the present embodiment, the pellet fastening operation, wire connecting operation and resin molding operation are carried out by the use of the lead frame in which the leads are disposed in the index part of the package body to be formed. Therefore, the leakage of the resin molding is suppressed, and the overflow of the resin

and the attendant chipping etc. are prevented, so that a semiconductor device of high marketability can be produced.

Here, it goes without saying that the constructions of the illustrated semiconductor device and lead frame are mere examples and that various modifications may be made.

As set forth above, in the present semiconductor device, leads are also disposed in the index portion of a package body. This is effective for enhancing the density of integration or increasing the number of pins of a semiconductor device, and simultaneously permits the symmetric arrayal of leads to facilitate design, fabrication and mounting. Besides, according to the present method, a lead frame with small interspaces is used. This can suppress the overflow of a resin and prevent chipping etc., so that enhancement in the external appearance and enhancement in the marketability can be achieved.

In addition, with the present lead frame, leads are disposed in the index portion of a package body. This prevents resin leakage and chipping during the resin molding of the package, to prevent the marketability from degrading. Another effect is to cope with enhancement in the density of integration and increase in the number of pins of a semiconductor device to which this lead frame is applied, and to facilitate design, fabrication and mounting.

CLAIMS:

1. A semiconductor device comprising a rectangular package body encapsulating a semiconductor element, and a plurality of leads which jut out from the package body, the leads including leads which are connected to electrode pads on the semiconductor element, the leads connected to the electrode pads projecting from each of the four sides of the package body and from a chamfered portion in at least one corner of the package body.

2. A semiconductor device according to claim 1, wherein the leads are symmetric with respect to the centre of the package body.

3. A semiconductor device according to claim 1 or claim 2, wherein the package body is made of a resin.

4. A semiconductor device according to any one of claims 1 to 3, wherein the leads are bent so as to form steps each therein.

5. A semiconductor device according to any one of the preceding claims, having an additional lead projecting from the or each chamfered portions of the package body, the additional leads being for supporting the semiconductor element in the package body.

6. A semiconductor device substantially as described herein with reference to Figs. 2 to 6.

7. A lead frame having a tab for supporting a semiconductor element, a rectangular dam, a frame portion supporting the dam, and a plurality of leads extending from

the dam towards the tab and being arranged around the tab, the leads including tab support leads which extend from the dam to the tab and connection leads which extend a part of the way from the dam to the tab, the connection leads immediately adjacent the tab support means being positioned sufficiently close to the tab support leads that, when the tab is encapsulated in a package body, the tab support leads and the immediately adjacent connection leads extend from the dam to at least one chamfered portion at the corner of the package body and the other connection leads project from the four sides of the package body.

8. A lead frame according to claim 7, wherein the tab is rectangular.

9. A lead frame according to claim 7 or claim 8, wherein the tab is central within the dam.

10. A lead frame substantially as described herein with reference to Figs. 2 to 6.

11. A method of forming a semiconductor device, comprising:

preparing a lead frame having a tab and a plurality of leads,

fastening a semiconductor element to the tab,

connecting electrode pads of the semiconductor element to the leads, and

molding a package body of resin around the tab, the semiconductor element, and parts of the leads, such that other parts of the leads jut out from the package body;

wherein

the leads are located such that they project from each of the four sides of the package body and from a chamfered portion in at least one corner of the package body.

12. A method according to claim 11, wherein the lead frame is formed by punching a metal sheet.

13. A method according to claim 11 or claim 12 wherein the electrode pads of the semiconductor element and the leads are electrically connected by wires.

14. A method according to any one of claims 11 to 13, wherein a dam of the lead frame is cut away after the resin molding step.

15. A method of producing a semiconductor device substantially as described herein with reference to Figs. 2 to 6.