(13)



# METHOD OF FABRICATING A SEMICONDUCTOR DEVICE IN A MOLDED RESIN PACKAGE

This invention relates to a semiconductor device and also to a technique for sealing the same.

In fabricating a semiconductor integrated circuit (hereinafter called on "IC"), a number of IC units are generally fabricated integrally with one another, the integrated article is then molded inside a mold for each IC unit using a resin and after unnecessary portions such as leads are punched out, the resulting molded article is separated into the IC units.

In the resin molding method in the conventional IC fabrication procedures, a transfer molding method using a heat-setting resin such as an epoxy resin or a silicone resin has been widely employed. According to this molding method, a specific molding apparatus equipped at its mold with a runner for charging a molding resin and a dam for preventing outflow of the resin from the mold is necessary. Moreover, since a not inconsiderable period of time (60 to 180 seconds) is necessary for the resin to be cured, productivity is low. Moreover, because the resin undergoes curing inside the runner, the resin is wasted.

In view of these drawbacks of the resin molding method, the Applicant of this invention previously proposed an invention entitled "Molding method of integrated circuit" as Japanese Patent Application No. 22909/1975 (Japanese Patent Laid-Open No. 98969/1976). The invention disclosed in the prior patent application is characterized by clamping one unit of an IC by upper and lower molded articles that are prepared in advance, and then coupling the molded articles together at the clamp portion. Though this method is suited for mass-production and remarkably reduces the quantity of a necessary resin, it is not free from the drawbacks that the IC main body tends to be broken due to mechanical or thermal impact applied thereto at the time of coupling of the molded articles and the semiconductor element undergoes degradation of its characteristics since the moisture stays in gaps inside the molded articles after their coupling and sealing.

The present invention provides a method of fabricating a semiconductor device comprising the steps of:

fitting a semiconductor element on a lead frame and electrically connecting said semiconductor element to leads of the lead frame by means of metallic wires;

applying a coating of a resin material over said semiconductor element and parts of said metallic wires;

preparing molded upper and lower sealing articles of a resin material, said molded upper and lower sealing articles being shaped so that when placed together they define a cavity for enclosing the semiconductor element;

locating said molded upper and lower sealing articles

together in relation to said lead frame so as to interpose said frame therebetween and to enclose said semiconductor element and said metallic wires; and

melting the resin material of adjacent edge portions of said molded upper and lower sealing articles by heating them, to seal said molded upper and lower sealing articles together.

Preferred embodiments of the invention will now be described by way of example, with reference to the accompanying drawings, wherein:

Figs. 1(a) and 1(b) are schematic plan and sectional views of a semiconductor element affixed to a lead frame;

Fig. 2(a) is a schematic view showing a fabrication step of a semiconductor device;

Fig. 2(b) is an enlargement of part of Fig. 2(a);

Figs. 3 and 4 are schematic sectional views showing further fabrication steps;

Fig. 5 is a perspective view showing the shape of molded resin articles; and

Figs. 6, 7 and 8 are sectional views each showing an embodiment of a semiconductor device made using the present invention.

As shown in Figs.1(a) and 1(b), an IC chip (semiconductor element) 2 consisting of silicon is bonded to a tab lead 12 of each unit frame of a lead frame 1 consisting of a metal. Electrodes on the chip are bonded to respective leads 13 on the lead frame 1 by wires 3. A frame of dotted line $L_1$ represents the position at which molded resin articles to be described later are located.

Next, turning to Figure 2, a viscous soft material is deposited by potting over an area such as to encompass at least an exposed aluminium (Aℓ) electrode of the semiconductor element and the metal wire portion coming into contact with the electrode. In other words, as shown in Figure 2b, the exposed Aℓ electrode portion (bonding pad portion) $A_1$ and a part of the metal wire 3 are covered with a protective film 5 consisting of a soft insulating material. In Figure 2b, symbol $J_1$ represents a PN junction, reference numeral 10 represents an $SiO_2$ film and reference numeral 11 represents an insulation film such as phosphor glass or a polyimide type resin film such as polyimideisoindroquinazolindion. Suitable examples of the protective film 5

consisting of a soft material are silicone gel, silicone grease, silicone rubber and the like. Thereafter, treatment is made at a temperature of 100 to 200°C so that the soft material does not lose its softness or its elasticity but retains the state of the initial potting.

Next, molded articles 6, 7 in the form of a package and consisting of a thermoplastic resin (e.g. polyphenylene sulfide resin) are prepared in advance as shown in Figure 5 and are then arranged so as to clamp and support one unit of the abovementioned IC chip and lead frame from above and below as shown in Figure 3. The support portion 8 of the molded resin articles is then heated to the molding temperature of the molded articles, e.g., to about 350 to about 450°C, thereby coupling and sealing the molded resin articles together as shown in Figure 4. Heating of this support portion is carried out by first pre-heating it to about 200°C and then applying local heating within a short period of time by ultrasonic electric oscillation, high frequency heating, infrared heating, a hot jet or the like method. Thereafter, the frame portion is cut off from the leads protruding outwardly from the molded articles 6, 7, which are not shown, thereby to obtain the IC device of each unit.

This embodiment has the following advantages:

(1) If a gap is present between the molded resin articles and the element, the moisture that has entered the molded resin articles from inside or outside the resin molded articles penetrates into the gap to form water droplets, which water droplets in turn could ordinarily cause degradation of the characteristics of the element such as due to corrosion of aluminum. However, in the present embodiment, since the surface of the Al electrode of the element is covered intimately with the soft material, the water droplets or water films are not allowed to stay on the surface of the electrode of the semiconductor element. It is thus possible to prevent degradation of the characteristics.

(2) The protective film 5 consisting of the soft material has resiliency such as silicone rubber. Accordingly, mutual contact between the metallic wires, resulting from the vibration applied thereto at the time of coupling of the upper and lower resin molded articles, can be prevented by the resiliency of this soft covering material. When heating is made at the time of coupling of the molded articles, the degradation of the characteristics of the element due to the heat change can be prevented by this soft covering material. For these reasons, not only a part but also the entire portion of the metallic wire may be covered with this soft material as shown in Figure 7. It is by no means difficult to cover the entire portion of the metallic wire

with this soft material.

(3) The molded article package of this thermoplastic resin makes it possible to reduce the installation cost as well as the installation space to below 1/2 in comparison with the conventional transfer mold. This also makes it easy to automate the assembly procedures, thereby drastically improving productivity.

(4) Selection of suitable resin materials for the soft material and for the molded articles provides a counter-measure for the erroneous operation of an IC memory or the like, that would otherwise occur due to α rays, that has been the critical problem with the conventional ceramic package.

It is to be noted that the present invention is in no way restricted to the abovementioned embodiment.

Figure 6 shows an embodiment of a semiconductor device in which after the pellet-fitting portion (tab portion 12) of the lead frame 1 is bent in advance, the surface of the IC chip 2 is covered with the protective film 5 of the soft material and the upper molded article is put on and coupled with the lower molded article in such a manner as to clamp and support the lead frame while the lower surface of the tab portion 12 is brought into contact with the bottom of the lower molded article. According to this structure, it is possible to make effective use of the cavity within the

lower resin molded article so that the package for the semiconductor device can be made thin. As to the relationship of position between the lead surface, to which the metallic wire is to be connected, and the electrode surface of the semiconductor element, the electrode surface is positioned on the same plane as, or below, the electrode surface. For this reason, the wire is prevented from coming into contact with the corners of the element, thus making it possible to prevent breakage of the wire.

Figure 7 shows another embodiment in which, in covering the surface of the semiconductor element with the protective film of the soft material, an insulation tape 4 or sheet having an adhesive is applied on the lower surface of the lead frame. This tape 4 prevents outflow of the protective film and restricts its expansion in the transverse direction. Thus, the protection film can be used highly efficiently and its effect can be enhanced.

Figure 8 shows still another embodiment in which the tip of the lead 13, to which the surface of the semiconductor element and the wire are connected, is covered with the protective film 5. When the molded articles are sealed by oscillation heating such as ultrasonic oscillation, this embodiment prevents the wire connected to the lead from being cut by the abovementioned oscillation. As the material for the protective film 5, a polyimide type

resin (e.g., polyimide isoindroquinazolinedion) may be used. Since the polyimide type resin has higher heat resistance than the silicone type resin, it is possible to sufficiently preclude the thermal influence, caused by heating at the time of sealing the molded articles 6, 7, upon the semiconductor element. Furthermore, the polyimide type resin has the effect of preventing the erroneous operation of the element due to $\alpha$ rays.

As the lead frame for the connection of the semiconductor element, a lead frame not having a dam may also be used.

CLAIMS:

1. A method of fabricating a semiconductor device comprising the steps of:

fitting a semiconductor element on a lead frame and electrically connecting said semiconductor element to leads of the lead frame by means of metallic wires;

applying a coating of a resin material over said semiconductor element and parts of said metallic wires;

preparing molded upper and lower sealing articles of a resin material, said molded upper and lower sealing articles being shaped so that when placed together they define a cavity for enclosing the semiconductor element;

locating said molded upper and lower sealing articles together in relation to said lead frame so as to interpose said frame therebetween and to enclose said semiconductor element and said metallic wires; and

melting the resin material of adjacent edge portions of said molded upper and lower sealing articles by heating them, to seal said molded upper and lower sealing articles together.

2. A method of fabricating a semiconductor device as defined in claim 1, wherein the heating in said melting step is carried out by means of ultrasonic electric oscillation, high frequency heating or infrared heating, or by means of a hot jet.

3. A method of fabricating a semiconductor device as

defined in claim 1 or claim 2, wherein before the melting step, said molded upper and lower sealing articles are preheated.

4. A method of fabricating a semiconductor device as defined in claim 1, 2 or 3, wherein said resin material for the coating is elastic.

5. A method of fabricating a semiconductor device as defined in claim 4 wherein said resin material for the coating is a silicone type resin.

6. A method of fabricating a semiconductor device as defined in claim 5 wherein said silicone type resin is silicone gel, silicone grease or silicone rubber.

7. A method of fabricating a semiconductor device as defined in claim 1, 2 or 3 wherein said resin material for the coating consists of a polyimide type resin.

8. A method of fabricating a semiconductor device as defined in any one of the preceding claims, wherein the portions of said leads to which said wires are connected are also covered by a said coating of a resin material.

9. A method of fabricating a semiconductor device as defined in any one of the preceding claims, wherein said

wires are completely covered by said coating.

10. A method of fabricating a semiconductor device substantially as described herein with reference to the accompanying drawings.

The text of the specification has been reproduced by photocopying the applicants original typescript. It may contain a few amendments which are difficult to read. The original typescript containing these amendments may be inspected on the premises of the Patent Office