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SEMICONDUCTOR DEVICE AND MANUFACTURING METHOD THEREOF

BACKGROUND OF THE INVENTION

Field of the Invention

This invention relates to a resin-sealed type of semiconductor device that is manufactured with the use of a tape carrier technique called either tape automated bonding (TAB) or tape carrier package (TCP), and a method of manufacturing such a semiconductor device.

Prior Art

One example of this type of semiconductor device is produced by the technique disclosed in Japanese Patent Application Laid-Open No. Hei 4-124846. With this technique, two different types of die-cut portions 1 and 3 as well as a single aperture portion 5 are formed in a film tape 2, as shown in Fig. 15. Four lead groups 4a to 4d, each comprising a large number of leads 4, and an integrated circuit chip 6 that is connected to these leads 4 are also formed in every one frame of the film tape 2. A characteristic of this technique is the way in which the aperture portion 5 is formed between the lead group 4a and the lead group 4d, within a resin sealing region, so that molten resin can move through this aperture portion 5 during the resin sealing process.

The die-cut portions 1 are also formed within the resin sealing region in which the lead groups 4a to 4d are arranged, separate from this aperture portion 5. The configuration is such that the molten resin can move also through these die-cut portions 1 during the resin sealing. Note that the die-cut portions indicated by reference number 3 in Fig. 15 are outer lead holes that act as aperture portions for punching the semiconductor

device out after the resin sealing has been completed.

In accordance with this configuration, when the integrated circuit chip is being resin-sealed by a method such as transfer molding, the molten resin will mainly flow through the aperture portion 5 from the side that has the larger rate of flow to the side that has the smaller one, even if the rates of flow of resin into the resin injection chambers of the upper and lower dies are different, so the rates of flow of the resin in the upper and lower resin injection chambers can be kept balanced.

However, the above described advantage presents this semiconductor device with a problem in that, since the die-cut portions 1 are formed to extend along a wide range along the edges of the film, a tensile force F acting on the film tape during its transportation, for example, could easily cause the film tape to deform as shown by broken lines in Fig. 16. This deformation could cause the leads 4 formed on the film tape to break.

SUMMARY OF THE INVENTION

The present invention was devised to solve this problem with the prior art technique and has as its objective the provision of a semiconductor device that can suppress deformation of the film caused by resin pressure in a transfer molding step, and thus prevent peeling of a resin sealing portion. It also provides a method of manufacturing such a semiconductor device.

The semiconductor device of this invention comprises: an electrically insulating film having a device hole; lead groups, each consisting of a large number of leads, arranged in a predetermined pattern that is formed in a plurality of lead formation regions on the surface of the film; an integrated circuit chip which is arranged within the device hole of the film

and which has electrodes connected to ends of the leads; and a resin sealing portion that seals in at least the integrated circuit chip, the film, and the lead groups. The film comprises: a first group of aperture portions which consists of at least one aperture portion and which is provided within a region other than the lead formation regions, and a second group of aperture portions which consists of a plurality of aperture portions and which is provided within the lead formation regions. In this semiconductor device, each of the leads comprises an inner lead portion protruding into the device hole and an outer lead linkage portion protruding outward beyond the film, and it is preferable that this outer lead linkage portion is connected to an outer lead that has a mechanical strength greater than that of the outer lead linkage portion.

With this semiconductor device, since a first group of aperture portions having at least one aperture portion is provided in a region in which no leads are formed, and also a second group of aperture portions is formed in the lead formation regions, molten resin can flow through these aperture portions during a molding step such as, for example, during transfer molding. As a result, the resin can connect the two sides of the film, the join between the resin sealing portion and the object that is sealed into it, such as the film, can be made secure, and peeling of the resin sealing portion is prevented. Further, since the second group of aperture portions consists of a plurality of separated aperture portions, sufficient mechanical strength is ensured, and thus deformation of the film due to the action of tensile forces while the film is being transported, for example, is suppressed. As a result, breaking and short-circuiting of the leads caused by deformation of the film are prevented.

With this semiconductor device, there are long, narrow

linking portions between mutually adjacent aperture portions forming the second group of aperture portions, and the longitudinal directions of these long, narrow linking portions are preferably orientated so as to intersect the edges of the film. Forming the long, narrow linking portions in directions that intersect the edges of the film ensures that, if tensile forces should act in the film, for example, those tensile forces are dispersed and absorbed by the long, narrow linking portions, and thus deformation of the film is controlled in an effective manner.

The long, narrow linking portions are also preferably orientated such that their longitudinal directions are perpendicular to the leads. Providing the long, narrow linking portions orientated perpendicular to the leads ensures that the film can be given sufficient mechanical strength with respect to the tensile forces acting in the axial direction of the leads. Providing the long, narrow linking portions orientated perpendicular to the leads also allows the leads to be shorter at the second group of aperture portions, so that occurrence of short circuits or breakages of the leads can be reduced.

To ensure that the plurality of aperture portions forming the second group of aperture portions absorb the tensile forces acting on the film as uniformly as possible, they are preferably arranged symmetrically along the edges of the film.

The aperture portions forming the second group of aperture portions are also preferably formed at positions separated from bend portions of the leads. This is because, if aperture portions were to be positioned at such bend portions, the mechanical strength of the bend portions would be less than that of the other, straight portions, making the leads readily deformable.

In this semiconductor device, side leads positioned at the

outermost sides of the leads forming the lead groups preferably be thicker and have a greater mechanical strength than the other leads. Making the side leads fatter than the other leads, for example, prevents problems such as the possibility of erroneous recognition during the image recognition used in the positioning of the film and lead frame. This also increases the mechanical strength of the side leads, making it possible to obtain sufficient resistance to, for example, resin pressure during molding.

In this semiconductor device, the integrated circuit chip is preferably positioned at substantially the center in the depthwise direction within the resin sealing portion. Positioning the integrated circuit chip, which has the largest volume among components constituting the semiconductor device, at substantially the center of the resin sealing portion ensures that the volumes of the upper and lower cavities separated by the object to be sealed can be made substantially equal during the transfer molding, for example. This means that the excess pressure that would be applied to the object to be sealed by the flow of the molten resin in the vertical direction if the volumes of the upper and lower cavities were different can be suppressed. As a result, deformation of the film or leads and displacement of the IC chip can be prevented.

In this semiconductor device, it is preferable to form a resin layer consisting of a resin having good adhesive properties with respect to the leads and the resin forming the resin sealing portion, in a region encompassing the inner lead portions of the leads and the electrodes of the integrated circuit chip. This provision of an additional resin layer ensures that the portions surrounding the electrodes of the integrated circuit chip can be protected by a resin with good adhesive properties, and thus the

occurrence of peeling or cracking of the sealing portion can be prevented.

In this semiconductor device, a radiator portion is preferably connected to the integrated circuit chip, so that heat from the integrated circuit chip is radiated to the outside by this radiator portion.

A method of manufacturing a semiconductor device in accordance with this invention comprises the steps of:

(A) forming, in a film carrier, at least a device hole, a first group of aperture portions consisting of at least one aperture portion within a region outside lead formation regions, and a second group of aperture portions consisting of a plurality of aperture portions within lead formation regions;

(B) attaching a conductive film to the film carrier, using photolithography and etching to form leads that each comprise an inner lead portion protruding into the device hole and an outer lead linkage portion, within the lead formation regions of the film carrier, then placing an integrated circuit chip within the device hole and connecting electrodes of the integrated circuit chip to the inner lead portions;

(C) superimposing on a predetermined position of the film carrier a lead frame having outer leads arranged at the same pitch as the outer lead linkage portion and having a mechanical strength greater than that of the outer lead linkage portion, and connecting the outer lead linkage portion to the outer leads; and

(D) using transfer molding to seal the integrated circuit chip, the leads, and part of the outer leads in resin.

This manufacturing method ensures that the semiconductor device of this invention can be manufactured efficiently and with a high yield.

Thus, by providing the film with a first group of aperture

portions consisting of at least one aperture portion within a region outside the lead formation regions and a second group of aperture portions consisting of a plurality of aperture portions within the lead formation regions, the present invention provides a semiconductor device in which deformation of the film caused by resin pressure during the transfer molding step can be suppressed, and peeling of the resin sealing portion can be prevented. It also provides a method of manufacturing such a semiconductor device.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a plan view simply showing essential components of a semiconductor device of a first embodiment of this invention;

Fig. 2 is an enlarged plan view of part of the semiconductor device of Fig. 1;

Fig. 3 is a vertical cross sectional view of the semiconductor device of the first embodiment;

Fig. 4 is a plan view simply showing a variation of the aperture portions of the first embodiment;

Fig. 5 is a plan view simply showing a sheet of film used to illustrate the manufacturing process of the semiconductor device of the first embodiment;

Fig. 6 is a plan view simply showing a lead frame used to illustrate the manufacturing process of the semiconductor device of the first embodiment;

Fig. 7 is a vertical cross sectional view simply showing the semiconductor device of the second embodiment of this invention;

Fig. 8 is a partial enlarged cross sectional view of essential components of the semiconductor device of Fig. 7;

Fig. 9 is a vertical cross sectional view simply showing a

variation on the second embodiment of this invention;

Fig. 10 is a vertical cross sectional view simply showing the semiconductor device of the third embodiment of this invention;

Fig. 11 is a vertical cross sectional view of a variation on the third embodiment of this invention;

Fig. 12 is a vertical cross sectional view simply showing the fourth embodiment of this invention;

Fig. 13 is a plan view of the radiator portion shown in Fig. 12.

Fig. 14 is a vertical sectional view showing a modification of the fourth embodiment of the present invention.

Fig. 15 is a partial plan view of an example of a prior art semiconductor device; and

Fig. 16 is a view simply showing a state in which the film of the semiconductor device of Fig. 15 is deformed.

DESCRIPTION OF THE PREFERRED EMBODIMENT

First Embodiment

A plan view simply showing the essential components of a semiconductor device 1000 of the first embodiment of this invention is shown in Fig. 1, a partial enlarged plan view of a part (a corner portion) of Fig.1 is shown in Fig. 2, and a cross sectional view taken vertically through substantially the center of the semiconductor device 1000 is shown in Fig. 3.

The semiconductor device 1000 of this embodiment comprises an electrically insulating film 10, a plurality of lead groups 30A to 30D formed on one surface of the film 10, an integrated circuit chip (IC chip) 20, and a resin sealing portion 50.

A device hole 12 for mounting the IC chip 20 is formed at

the center of the film 10. Lead formation regions 100 to 400 are formed on the surface of the film 10 as four regions separated along lines that cut substantially diagonally across the film 10. Each of these lead formation regions 100 to 400 is separated from its neighboring regions by a predetermined spacing, and regions 500 to 800 in which no leads are formed are provided therebetween.

Slit-shaped first aperture portions 14a to 14d are formed along the diagonals of the film 10, in the respective regions 500 to 800 in which no leads are formed. These first aperture portions 14 (14a to 14d) are preferably formed to be as large as possible, without adversely affecting the mechanical strength of the film 10, to make it easy for the molten resin to flow therethrough during the transfer molding.

The lead groups 30A to 30D, each consisting of a large number of leads 30, are formed to be arranged in a predetermined pattern on the film 10 in the respective lead formation regions 100 to 400. Each of the leads 30 has an inner lead portion (finger) 32 that protrudes toward the device hole 12 and an outer lead linkage portion 34 that protrudes outward from the edge 10a of the film 10. Each inner lead portion 32 is connected to an electrode 22 of the IC chip 20 that is arranged within the device hole 12, whereas each outer lead linkage portion 34 is connected to an outer lead 40. The inner lead portion 32 has a protrusion (bump) 32a at the tip thereof, and this protrusion 32a is connected to the electrode 22. This connection method is called the mesa bump method (the photo-engraved bump method) and will be described in more detail later.

The leads 30 forming the lead groups 30A to 30D are bent where they cross lines that are indicated by reference letters A and B in Fig. 2, in an arrangement such that the lead pitch on the

outer lead linkage portion 34 side is greater than the lead pitch on the inner lead portion 32 side. For example, the lead pitch on the inner lead portion 32 side could be set to between 40 μm and 200 μm, with that on the outer lead linkage portion 34 side being set to between 100 μm and 500 μm.

In this embodiment, a side lead 36 that is positioned at each outermost side of each of the lead groups 30A to 30D is formed to have a diameter that is greater than that of the other leads 30. More specifically, the side leads 36 preferably have a diameter that is of the order of 1.5 to 3 times that of the other leads. For example, if the diameter of the other leads 30 is between 80 and 100 μm, that of the side leads 36 is set to be between 160 and 200 μm.

Making the side leads 36 at each side of the lead groups 30A to 30D fatter in this manner ensures that there will be no problems such as erroneous recognition in the image recognition performed during the positioning of the film and the lead frame. Making the diameter of the side leads 36 larger also increases their mechanical strength, making it possible to ensure that they have sufficient resistance to forces such as resin pressure during molding. When such densely packed leads are formed, it is usually necessary to make their diameter smaller so that their mechanical strength is less, and thus these leads, particularly the side leads positioned at the outermost ends, are subjected to stresses and can easily break.

The material of the film 10 is not particularly limited, but it is preferable that, in addition to an electrical insulating property, it can resist heat, such as, for example, polyimide resin, polyetherimide resin, polyester resin, or epoxy resin with glass fibers. Polyimide resin is particularly preferable. Such ceramic materials as alumina, aluminum nitride, and silicon

carbide, which has good mechanical strength and heat conductivity, can also be used as the material of the film 10.

A second group of aperture portions 16 consisting of a plurality of aperture portions 16a to 16e is formed in each of the lead formation regions 100 to 400. These aperture portions 16a to 16e are arranged symmetrically along the edges (10a) of the film 10. Each of the aperture portions 16a to 16e is also formed so that edges 10a of adjacent aperture portions are substantially parallel, and thus linking portions 18a to 18d are formed between adjacent aperture portions 16a to 16e. These linking portions 18 (18a to 18d) are formed in directions that intersect the edges 10a of the film 10. In this embodiment, the direction of the linking portions 18a and 18c on the right side with respect to the edge 10a is opposite to that of the linking portions 18b and 18d on the left side, and all of them are formed to be at approximately 45 degrees to the axis intersecting the edge 10a.

Forming the linking portions 18 in directions that intersect the edges 10a of the film 10 ensures that, if tensile forces (indicated by F in Fig. 1) should act in the film 10, stresses generated by these tensile forces F will be generated along the linking portions 18, and thus the tensile forces F will be dispersed and absorbed. As a result, the amount by which the film is displaced in the direction of pull can be reduced, with the effect that deformation of the film 10 is suppressed.

The linking portions 18 are also preferably formed in directions that are perpendicular to the leads 30. More specifically, as shown in Fig. 2, since the linking portion 18(18c) is provided in a direction that is perpendicular to the leads 30, sufficient mechanical strength with respect to the tensile forces acting in the axial direction of the leads 30 can be ensured for the film 10. Further, it is preferable that no

aperture portions are positioned at the bend portions (portions indicated by A and B in Fig. 2) of the leads 30. This is because, if aperture portions were to be positioned at these bend portions, the mechanical strength of the bend portions would be less than that of the other, straight portions, making the leads readily deformable.

In this manner, by arranging the second group of aperture portions 16 consisting of a plurality of aperture portions 16a to 16e in each of the lead formation regions 100 to 400, this embodiment can achieve the effect of reinforcing the suppression of deformation of the film 10, while enabling the flow of resin during molding. As a result, breakage of the leads 30 caused by deformation of the film 10 can be prevented.

As described above, since the semiconductor device 1000 of this embodiment is not only provided with the first group of aperture portions 14 in regions 500 to 600 in which leads are not formed but it is also provided with the second group of aperture portions 16 in each of the lead formation regions 100 to 400, molten resin flows through these aperture portions 14 and 16 during the transfer molding, so that the molding resin can link the two sides of the film 10 and peeling of the resultant resin sealing portion is prevented.

Further, since the second group of aperture portions 16 is divided into a plurality of aperture portions 16a to 16e to ensure the mechanical strength of the film 10, deformation of the film 10 caused by tensile forces acting during operations such as film transport is suppressed, and thus breakage of the leads 30 caused by deformation of the film is prevented.

In this embodiment, the shapes and numbers of the first group of aperture portions 14 and second group of aperture portions 16 are not particularly limited and can take many forms

within a range such that the molten resin can flow and the strength of the film 10 can be ensured. For example, in a variation of the first and second groups of aperture portions 14 and 16 shown in Fig. 4, the configuration could be such that substantially triangular aperture portions 16f to 16h are arranged to alternate in the vertical direction.

An example of the process used to manufacture this semiconductor device 1000 will now be described. Note that description of the configurations of the film 10, the lead groups 30A to 30D, and the aperture portions 14 and 16 provided in the film 10 are omitted.

First, as shown in Fig. 5, the device hole 12, sprocket holes 72, outer lead holes 74, the first group of aperture portions 14, and the second group of aperture portions 16 are formed in a long film carrier 70 (thickness: 75 to 125 μm) that is the base material, by being punched out by a die. Next, copper foil (usually of a thickness of 18 to 35 μm) is attached to the film carrier 70 by an adhesive, and then photolithography techniques are used to paint a photoresist on both surfaces of the film, subject it to mask exposure and develop it, and finally etch it, to form the lead groups 30A to 30D consisting of leads 30 in a predetermined pattern. The leads 30 are usually plated with a material such as Sn, Au, or solder. The leads of this embodiment are implemented by Ni-plating on a copper wire surface, then by Au-plating.

Next, the IC chip 20 is arranged at a predetermined position within the device hole 12, and electrodes 22 on the surface of the IC chip 20 and the inner lead portions 32 of the leads 30 are connected and subjected to inner lead bonding (ILB) by the pressurization and heating (usually to 300 to 400°C) using a heating tool.

A lead frame 80 on which the outer leads 40 are formed (see Fig. 6) is prepared separately. This lead frame 80 is mounted onto the film 70 and is positioned so that the outer leads 40 are superimposed over the outer lead linkage portions 34 of the leads 30. The outer lead linkage portions 34 and the outer leads 40 are then connected in a batch by coupling means such as welding or soldering (outer bonding).

Subsequently, a region that includes the IC chip 20, the leads 30, and parts of the outer leads 40 is sealed in resin by transfer molding, to form a resin sealing portion 50. The outer leads 40 are then plated with solder, then the outer leads 40 are cut off by a press to complete the manufacturing of the semiconductor device. Subsequently, the outer leads 40 could be bent and shaped if necessary to facilitate their insertion into a printed circuit board or the like.

The above manufacturing process has the advantage that, since the outer leads 40 are formed by using the lead frame 80, the dimensions and strength of the outer leads 40 can be set independently of those of the leads.

In the above described process, any of the generally-used bump method, transfer bump method, or mesa bump method could be used as the coupling means between the inner lead portions 32 and the electrodes (not shown in the figure) of the IC chip 20, but it is preferable to use the mesa bump method. The mesa bump method uses a half-etching process to form bumps that are integral with the leads at the lead tips. A specific method of manufacturing mesa bumps is disclosed in, for example, Japanese Patent Application Laid Open No. Sho 55-162253. The mesa bump method has various advantages, such as it does not require any special equipment for forming the bumps on the IC chip, it enables the use of aluminum-pad IC chips, it has a high yield but low mounting

costs, and it also enables slim mounting packages.

Further, in the above described process, in order to increase the coupling force between the IC chip 20 and the resin that forms the resin sealing portion 50, it is preferable to form small irregularities on the under-surface of the IC chip 20 by a method such as grinding or etching. In order to increase its adhesion with the resin that forms the resin sealing portion 50, the surface of the film 10 is preferably subjected to plasma processing in a vapor phase including, for example, inert gas (argon, helium, or the like), reactive gas (oxygen, CF_4, or the like), or reducing gas (hydrogen or the like).

In comparison with packages obtained by other mounting methods such as the wire bonding method, the package obtained by this TAB technique has various advantages in that it enables the mounting of thin packages at a high density, each step of bonding the inner leads and bonding the outer leads can be done in a single batch, electrical characteristics can be tested while the chip is still on the tape, and mounting yields are not deteriorated, even with multi-chip assemblies.

Second Embodiment

A cross sectional view simply showing a semiconductor device 2000 of a second embodiment of this invention is shown in Fig. 7, with a partial enlarged cross sectional view of essential components of the semiconductor device 2000 being shown in Fig. 8.

The semiconductor device 2000 has the same basic structure as the semiconductor device 1000, and therefore substantially identical components thereof are given the same reference numbers and detailed description thereof is omitted. The semiconductor device 2000 of this embodiment differs from the semiconductor device 1000 in that the IC chip 20 is configured to be positioned

at substantially the center of the semiconductor device 2000 in the depthwise direction thereof.

In the above semiconductor device 1000 shown in Fig. 3, the leads 30 extend straight outward from the surface of the film 10, the outer lead linkage portions 34 thereof and the outer leads 40 are joined together, and then the tips of the inner lead portions 32 are connected to the IC chip 20 with the IC chip 20 suspended underneath them. Therefore, the IC chip 20 is positioned below the center of the resin sealing portion 50.

In contrast, in the semiconductor device 2000 of this embodiment, the center of the IC chip 20 is positioned at the center line C.L. in the depthwise direction of the resin sealing portion 50. To enable this configuration, the inner lead portion 32 and outer lead linkage portion 34 of each of the leads 30 are shaped. The amount of this forming (the depth of forming) is determined in such a manner that the following equation (see Fig. 8) is satisfied:

Equation:

$$1/2\ (d_{LF}) + d_{TAB} + d_{OF} = d_{IF} + d_{IL} + 1/2\ (d_{IC})$$

where: d_{LF}: thickness of outer lead (lead frame)

d_{TAB}: thickness of lead

d_{OF}: depth of forming of outer lead linkage portion

d_{IF}: depth of forming of inner lead portion

d_{IL}: thickness of inner lead portion

d_{IC}: thickness of IC chip

The depths of forming d_{OF} and d_{IF} in the above equation must be designed to suit the thicknesses of the leads 30, the outer leads 40, and the IC chip 20. In the current state of the art, the thickness of the IC chip is greater than that of the other components, so the thickness of the resin sealing portion 50 is actually dependent on the thickness of the IC chip. For example,

if the thickness d_{IC} of the IC chip 20 is between 200 μm and 600 μm, the thickness d_{TAB} of the leads 30 is between 10 μm and 40 μm, the thickness d_{LF} of the outer leads 40 is between 100 μm and 300 μm, and the thickness d_{IL} of inner lead portion 32 is between 5 μm and 30 μm, the depth of forming d_{IF} of the inner lead portion 32 is set to between 50 μm and 200 μm, and the depth of forming d_{OF} of the outer lead linkage portion 34 is set to between 85 μm and 720 μm. Here, the sign "-" indicates forming in the opposite direction to that of Fig. 8. In such a semiconductor device, the thickness of the resin sealing portion 50 is generally between 1 mm and 5 mm. In the future, as the thicknesses of IC chips decrease, this thickness could fall to the order of 100 μm to 200 μm. Such a thickness would be substantially the same as that of the outer leads, abd the depths of forming of the inner lead portion 32 could be made even smaller (they could be set within the range of between 0μm and 50 μm, for example), so that the thickness of the resin sealing portion could be reduced even further to about between 200 μm and 1000 μm.

Positioning the IC chip 20 at the center in the depthwise direction of the resin sealing portion 50 in the manner of this embodiment ensures that the useful functions described below can be achieved.

There is a transfer molding as one of the sealing techniques that could be used for manufacturing this type of semiconductor device. A particularly important part of the transfer molding process is the balance between the volumes of the upper and lower cavities separated by the object to be sealed (the assembly of the film carrier 70 and lead frame 80, with the IC chip 20 mounted thereon (see Fig. 3)) that is inserted into the mold. With this type of molding, the molten resin is usually injected through a single gate, so that, if the volumes of the separate cavities are

unbalanced, the cavity with the smaller volume will be filled first by the molten resin, then the molten resin will flow toward the cavity that is still not filled, and thus resin pressure will act vertically on the object to be sealed. The resultant tilting of the IC chip or deformation of the film could cause breaking or short-circuiting of the leads.

In the semiconductor device 2000 of this embodiment, the IC chip 20, which takes up the greatest volume, is positioned at substantially the center of the mold (at the boundary between the upper and lower dies), so that the volumes of the upper and lower cavities separated by the object to be sealed can be made substantially equal. As a result, since it is possible to suppress the above described excess pressure that would be applied to the object to be sealed by the flow of the molten resin in the vertical direction, deformation of the film or leads and displacement of the IC chip can be prevented. Note that, since it is difficult to accurately align the center line of the IC chip 20 at the center line of the resin sealing portion, a certain amount of error is permissible so that, for example, the center line of the resin sealing portion could be positioned anywhere in the depthwise direction within the IC chip.

In this manner, in addition to the effects of the first embodiment, this embodiment has the advantage that deformation of the device caused by resin pressure during the transfer molding can be suppressed.

A cross sectional view simply showing a variation on this embodiment is shown in Fig. 9. A semiconductor device 3000 of this embodiment differs from that of the above described semiconductor device 2000 in that the tip portions of the outer leads 40 are shaped instead of the outer lead linkage portions 34 of the leads 30. Joint ends 42 of these outer leads 40 are shaped when the lead

frame is formed, and the depth of forming thereof is set to replace the depth of forming d_{OF} of the above equation.

Third Embodiment

A cross sectional view simply showing a semiconductor device 4000 of a third embodiment of this invention is shown in Fig. 10. Since this semiconductor device 4000 has the same basic structure as the first embodiment, substantially identical components thereof are given the same reference numbers and detailed description thereof is omitted. This semiconductor device 4000 differs from the semiconductor device 1000 of the first embodiment in that a resin layer 52 of a resin that is different from that of the resin sealing portion 50 is formed in a region that includes at least the inner lead portions 32 of the leads and the IC chip 20.

The resin layer 52 is configured of a resin that has excellent adhesive properties with respect to the metal of the inner lead portions 32, particularly the metal Au or Sn for example plated over their surfaces, and also the resin of the resin sealing portion 50. A rubber-denaturalized epoxy resin, a phenol resin, a polyimide resin, or a silicon resin could be suitably used as this resin.

Since the epoxy resin that is often used for the resin sealing portion usually has poor adhesive properties with respect to the plated layer of the leads, heat, moisture, or mechanical shock could cause problems such as peeling or cracking between the leads and the resin sealing portion, and invasion of water or active ion through these peeled or cracked portions could cause corrosion of the aluminum electrodes of the IC chip. In particular, factors such as differences in coefficient of thermal expansion between the leads and the resin sealing portion could cause peeling or cracking to occur in portions with poor adhesive

properties, due to heating during the step of the semiconductor device mounting.

In this embodiment, the provision of the resin layer 52 ensures that, in addition to the effects of the first embodiment, the portions around the electrodes 22 of the IC chip 20 can be protected by a resin with good adhesive properties and with small stress, so that the occurrence of peeling or cracking can be prevented.

Before the formation of the resin sealing portion 50 during the manufacturing of this semiconductor device 4000, the resin layer 52 is formed in the predetermined region by a method that includes steps such as potting, painting, and injection molding, then the resin sealing portion 50 is formed as usual by transfer molding.

In the semiconductor device 4000 described above, a resin layer 52 is formed of a resin that has good adhesive properties with respect to both the leads 30 and the resin of the resin sealing portion 50, so that the occurrence of peeling or cracking of the sealing portion can be prevented. In particular, since the electrodes 22 of the IC chip 20 are completely sealed in by the resin layer 52, their corrosion can be reliably prevented.

A cross sectional view of a variation of this embodiment is shown in Fig. 11. A semiconductor device 5000 of this embodiment is basically the same as the semiconductor device 4000, except that the region covered by the resin layer 52 is larger, and it is formed to cover not only the area surrounding the IC chip 20, but a wider region excluding only the outer lead linkage portions 34 of the leads 30. In this case, considering the adhesive properties with the resin forming the film 10 (such as polyimide resin), an epoxy type of polyimide resin, or silicon resin could preferably be used.

Fourth Embodiment

A cross sectional view simply showing a semiconductor device 6000 of a fourth embodiment of this invention is shown in Fig. 12. This semiconductor device 6000 is basically the same as the semiconductor device 1000 of the first embodiment, therefore substantially identical components thereof are given the same reference numbers and detailed description thereof is omitted.

The semiconductor device 6000 of this embodiment differs from the semiconductor device 1000 of the first embodiment in that a radiator portion 60 is provided on the lower surface of the IC chip 20. This radiator portion 60 has a joint portion 66 for the IC chip 20 at the center of one surface thereof, as shown in Fig. 13, as well as a large number of aperture portions 62 that will allow the passage of molten resin during the transfer molding. The radiator portion 60 also preferably has radially extending linear linking portions 64 to ensure the mechanical strength of the radiator portion 60. Further, indentations are preferably formed by grinding or by etching on the surface of the radiator portion 60 (the surface opposite to that on which IC chip 20 is mounted), in order to increase the adhesive properties of the resin sealing portion 50. To increase the heat-radiating effect of the radiator portion 60, it is preferably made to have as high a thermal conductivity as possible, and is preferably made of a metal such as copper, aluminum, or of a ceramic such as BeO, SiC. The size of the radiator portion 60 is not particularly limited but, considering its heat radiation efficiency, it could be formed to be, for example, at least two times the size of the IC chip 20.

In the semiconductor device 6000 of this embodiment, use of the radiator portion 60 to facilitate the radiation of heat from the IC chip 20 that is sealed in by the resin sealing portion 50 formed of a resin with low thermal conductivity ensures that

deterioration of the characteristics of the IC device due to heat can be suppressed.

Fig. 14 is a vertical sectional view showing a modification of the present embodiment. In the semiconductor device 7000, the radiator portion 68 is thicker than the aforementioned radiator portion 60, and one of the surface 68a of the radiator portion 68 is arranged to protrude from the resin sealing portion 50. Therefore, the radiator portion 68 has thickness corresponding to the distance between lower surface of the IC chip 20 and the lower surface of the resin sealing portion 50 in Fig. 14.

According to the semiconductor device 7000 of such arrangements the radiator portion 68 offers not only the effective heat-dissipation, but also the simpler processing. The simpler processing is brought about by the radiator portion functioning as a spacer during the transfer-molding thus making the precision placing of the IC chip 20 unnecessary.



WHAT IS CLAIMED IS:

1. A semiconductor device comprising:

an electrically insulating film having a device hole;

lead groups, each consisting of a large number of leads, arranged in a predetermined pattern that is formed in a plurality of lead formation regions on the surface of said film;

an integrated circuit chip which is arranged within said device hole of said film and which has electrodes connected to ends of said leads; and

a resin sealing portion that seals in at least said integrated circuit chip, said film, and said lead groups;

wherein said film comprises:

a first group of aperture portions which consists of at least one aperture portion and which is provided within a region other than said lead formation regions, and

a second group of aperture portions which consists of a plurality of aperture portions and which is provided within said lead formation regions.

2. A semiconductor device according to claim 1, wherein:

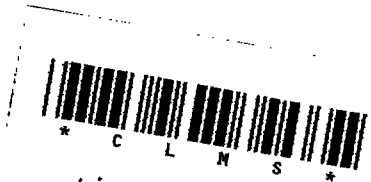
each of said leads comprises an inner lead portion protruding into said device hole and an outer lead linkage portion protruding outward beyond said film, and said outer lead linkage portion is connected to an outer lead of a mechanical strength greater than that of said outer lead linkage portion.

3. A semiconductor device according to claim 1 or claim 2, wherein:

linking portions are formed between adjacent of said aperture

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portions forming said second group of aperture portions.

4. A semiconductor device according to claim 3, wherein:

said linking portions are orientated such that the longitudinal directions thereof intersect edges of said film.

5. A semiconductor device according to claim 3 or claim 4, wherein:

said linking portions are orientated such that the longitudinal directions thereof are perpendicular to said leads.

6. A semiconductor device according to any one of claim 1 to claim 5, wherein:

said plurality of aperture portions forming said second group of aperture portions are arranged symmetrically along the edges of said film.

7. A semiconductor device according to any one of claim 1 to claim 6, wherein:

said aperture portions forming said second group of aperture portions are formed at positions separated from bend portions of said leads.

8. A semiconductor device according to any one of claim 1 to claim 7, wherein:

side leads positioned at the outermost sides of said leads forming said lead groups have a mechanical strength greater than that of the other leads.

9. A semiconductor device according to any one of claim 1 to claim 8, wherein:

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said integrated circuit chip is positioned at substantially the center in the depthwise direction of said resin sealing portion.

10. A semiconductor device according to claim 9, wherein:

the position of said integrated circuit chip is set by the depth of forming of an inner lead portion and an outer lead linkage portion of said leads.

11. A semiconductor device according to claim 9, wherein:

the position of said integrated circuit chip is set by the depth of forming of an inner lead portion and said outer leads of said leads.

12. A semiconductor device according to any one of claim 1 to claim 11, wherein:

a resin layer consisting of a resin having good adhesive properties with respect to said leads and the resin forming said resin sealing portion is formed in a region encompassing inner lead portions of said leads and electrodes of said integrated circuit chip.

13. A semiconductor device according to any one of claim 1 to claim 12, wherein:

a radiator portion is connected to said integrated circuit chip.

14. A semiconductor device according to claim 13, wherein:

a plurality of aperture portions are formed in said radiator portion.

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15. A semiconductor device according to claim 13 or 14, wherein:

at least a part of said radiator portion protrude from said resin sealing portion.

16. A method of manufacturing a semiconductor device, comprising the steps of:

(A) forming, in a film, at least a device hole, a first group of aperture portions consisting of at least one aperture portion within a region outside lead formation regions, and a second group of aperture portions consisting of a plurality of aperture portions within lead formation regions;

(B) attaching a conductive film to said film, using photolithography and etching to form leads that each comprise an inner lead portion protruding into said device hole and an outer lead linkage portion, within said lead formation regions of said film, then placing an integrated circuit chip within said device hole and connecting electrodes of said integrated circuit chip to said inner lead portions;

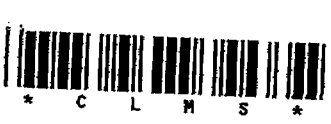
(C) superimposing on a predetermined position of said film a lead frame having outer leads arranged at the same pitch as said outer lead linkage portion and having a mechanical strength greater than that of said outer lead linkage portion, and connecting said outer lead linkage portion to said outer leads; and

(D) using transfer molding to seal said integrated circuit chip, said leads, and part of said outer leads in resin.

17. A method of manufacturing a semiconductor device according to claim 16, wherein:

in said step (B), said integrated circuit chip is arranged to be positioned at substantially the center in the depthwise

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direction of said resin sealing portion.

18. A method of manufacturing a semiconductor device according to claim 16 or claim 17, further comprising a step of:

before said step (D), forming a resin layer consisting of a resin having good adhesive properties with respect to said leads and the resin forming said resin sealing portion, in a region encompassing inner lead portions of said leads and electrodes of said integrated circuit chip.

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ABSTRACT

Semiconductor device and manufacturing method thereof.

A semiconductor device 1000 comprises an electrically insulating film 10 having a device hole 12; lead groups 30A to 30D, each consisting of a large number of leads 30 arranged in a predetermined pattern, in a plurality of lead formation regions 100 to 400 on the surface of the film 10; an integrated circuit chip 20 positioned within the device hole 12 and with electrodes 22 connected to inner lead portions of the leads 30; and a resin sealing portion 50 that seals in at least the integrated circuit chip 20, the film 10, and the lead groups 30A to 30D.

The film 10 comprises a first group of aperture portions 14 consisting of aperture portions 14a to 14d provided in regions 500 to 800 outside the lead formation regions and a second group of aperture portions 16 consisting of a plurality of aperture portions 16a to 16e provided in the lead formation regions 100 to 400.

Fig. 1.

FIG. 1

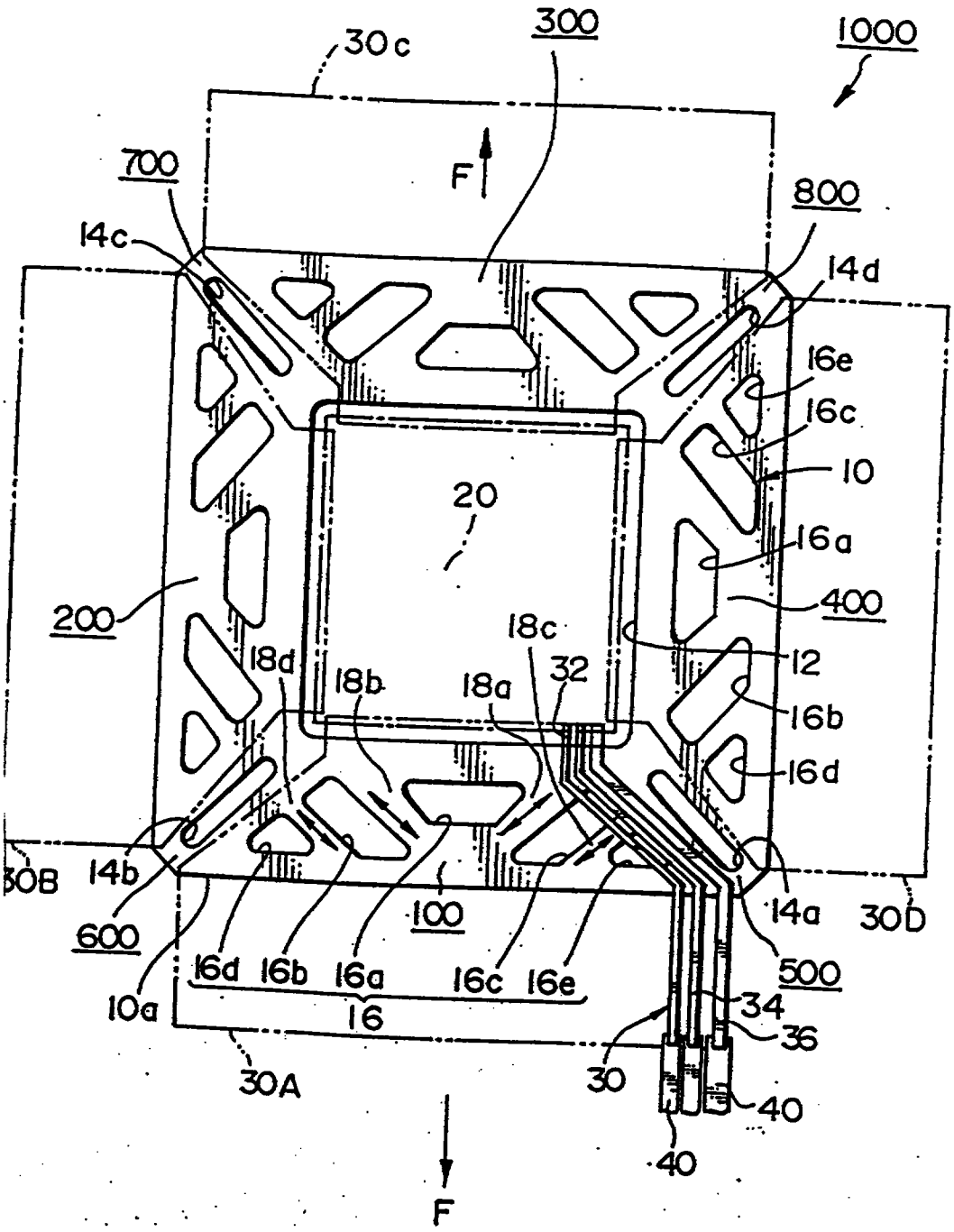

1000
300
30c
700
800
F
14c
14d
16e
16c
10
20
16a
400
200
18c
12
18d
18b
18a
32
16b
16d
30B
14b
14a
30D
100
600
500
16d 16b 16a 16c 16e
16
34
36
10a
30A
30
40
40
F

FIG. 2

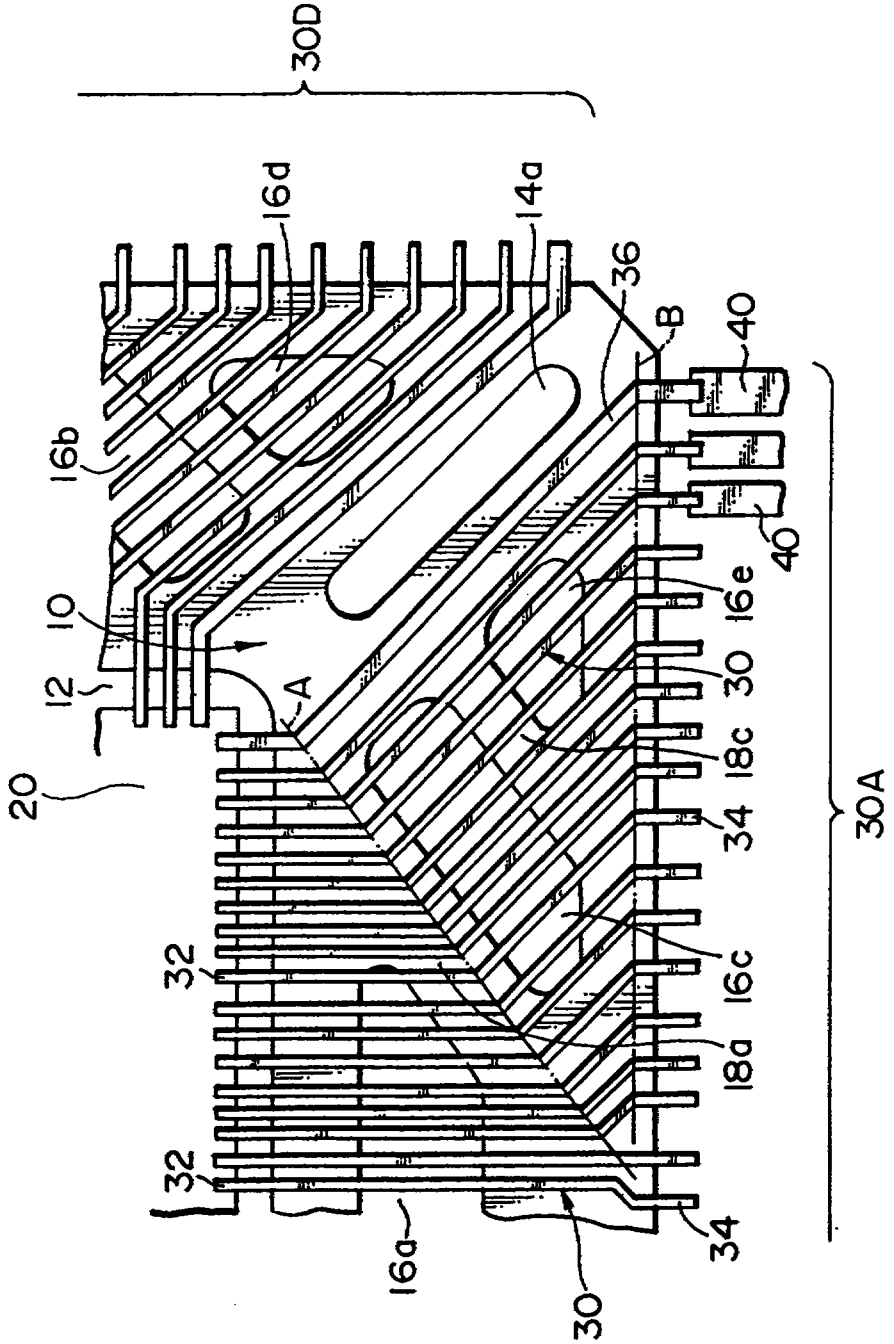

30D
16d
14a
36
B
40
16b
40
10
16e
12
A
30
18c
20
34
30A
32
16c
18a
32
34
16a
30

FIG. 3

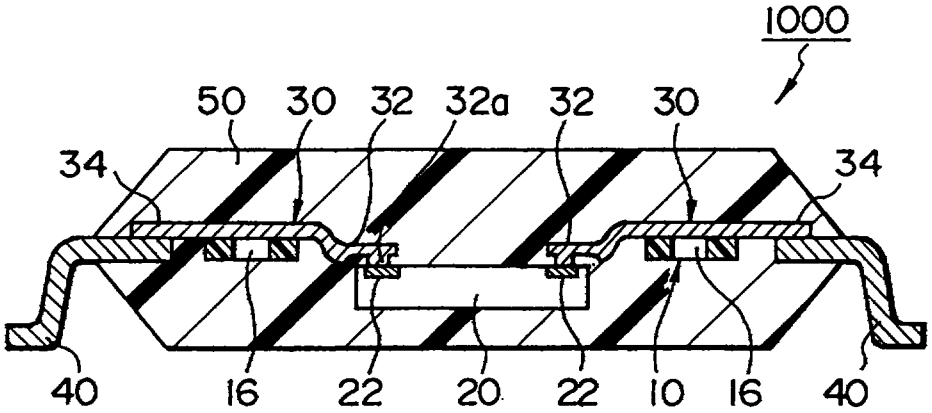

1000
50
30
32
32a
32
30
34
34
40
16
22
20
22
10
16
40

FIG. 4

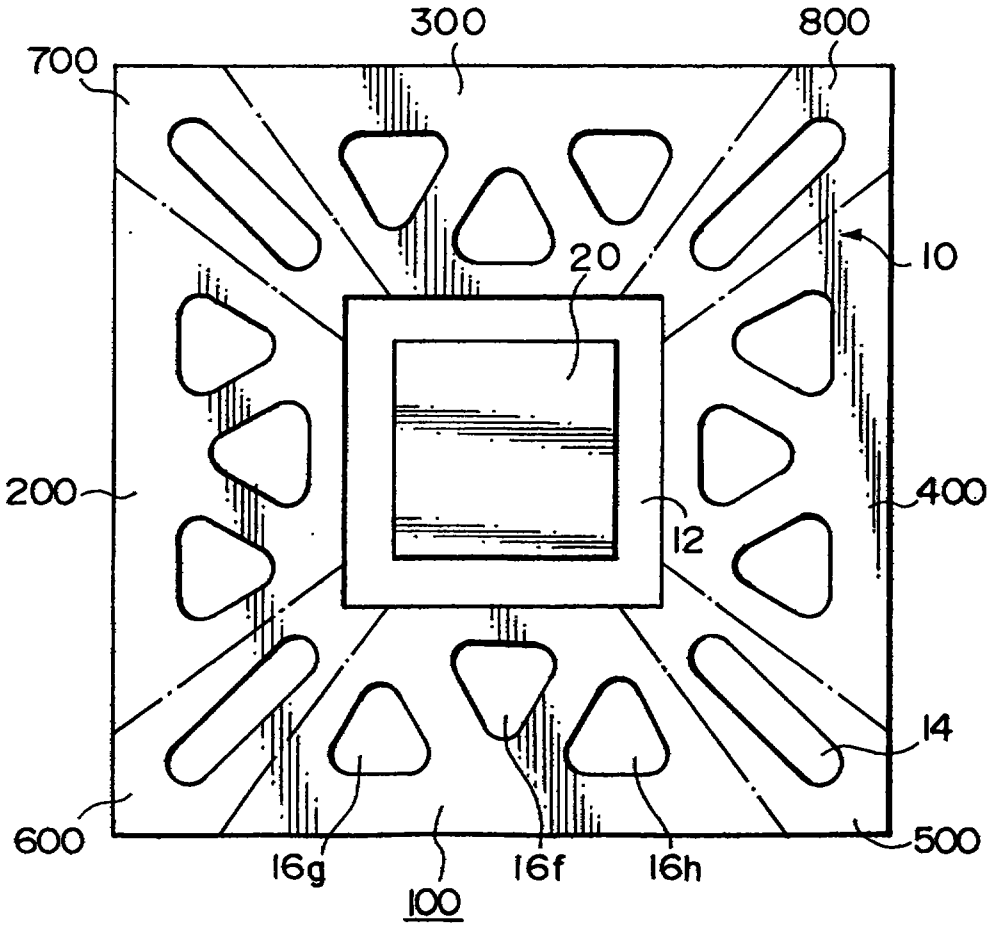

300
800
700
10
20
200
400
12
14
600
500
16g
16f
16h
100

FIG. 5

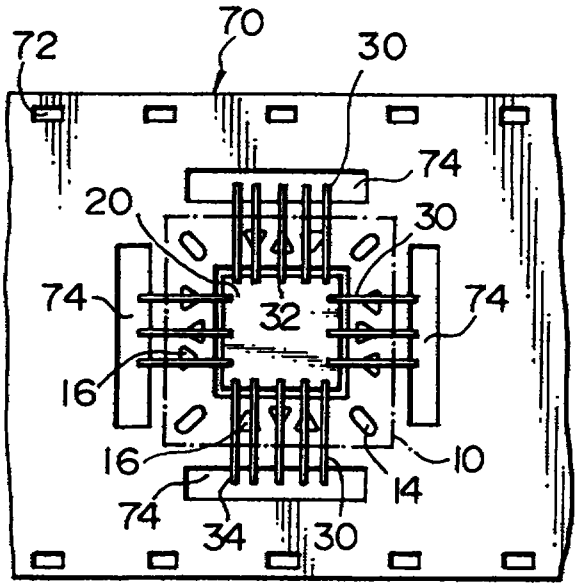


FIG. 6

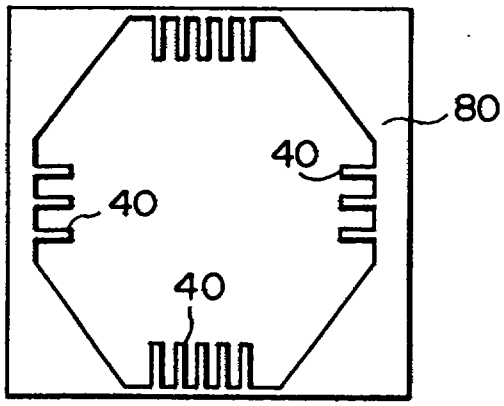


FIG. 7

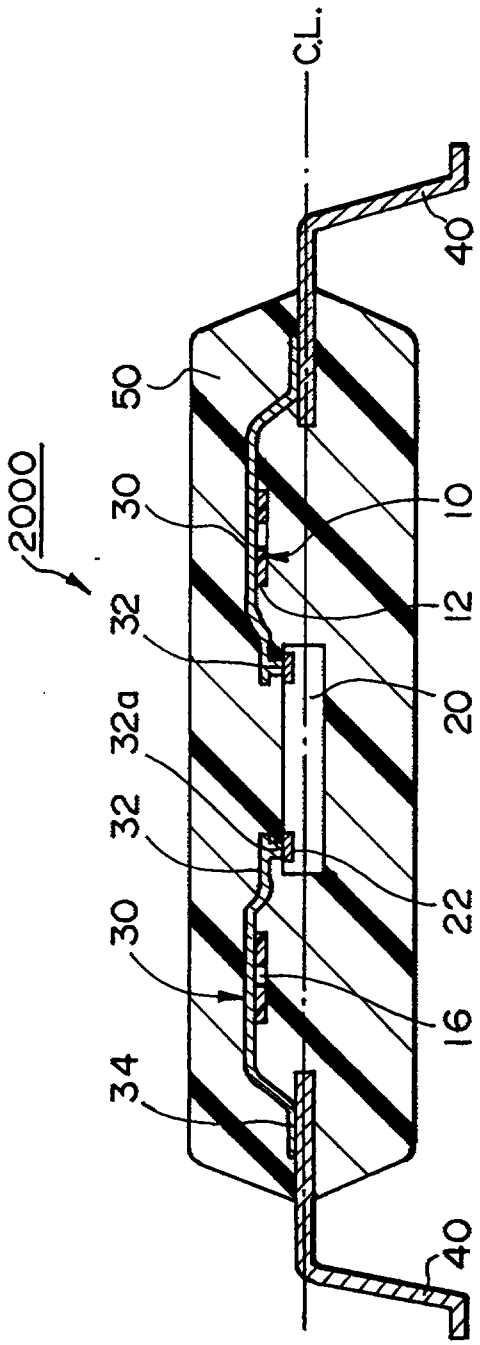


FIG. 8

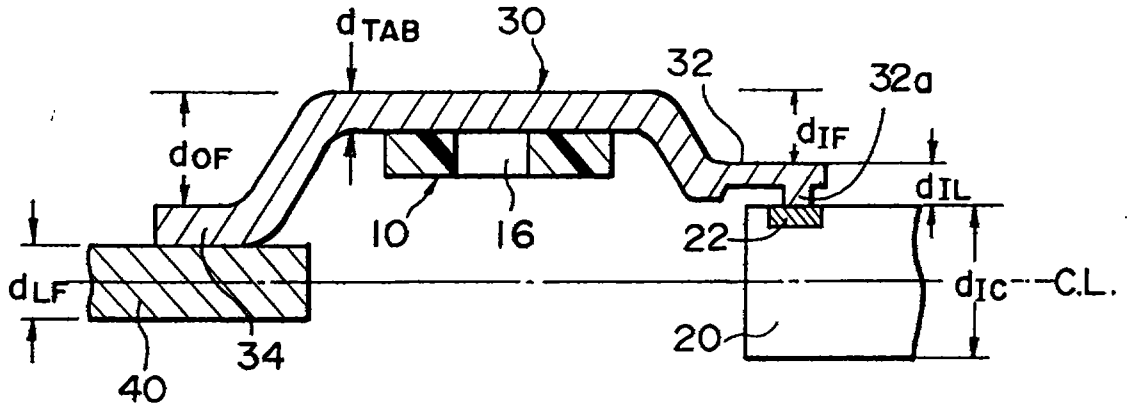

dTAB
30
32
32a
dOF
dIF
dIL
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16
22
dLF
dIC
C.L.
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34
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FIG. 9

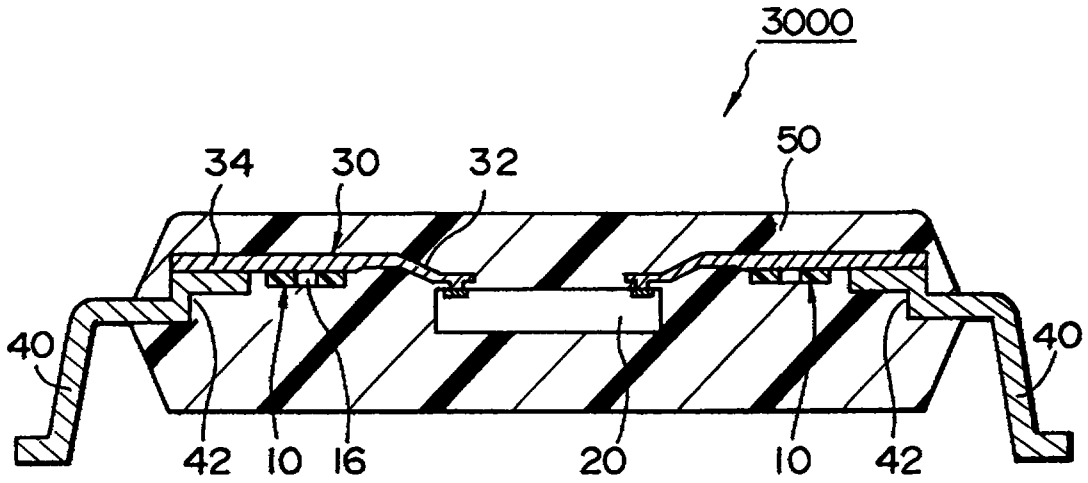

3000
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32
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42

FIG. 10

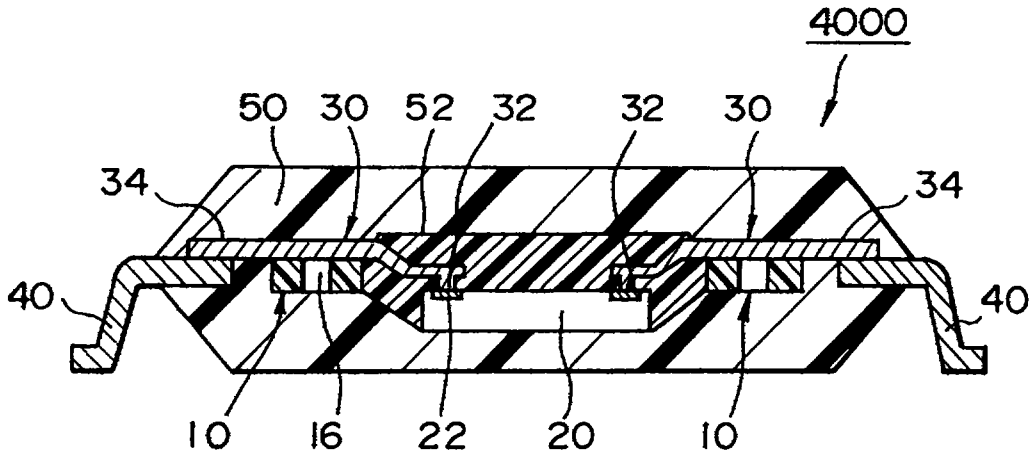

4000
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52
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16
22
20
10

FIG. 11

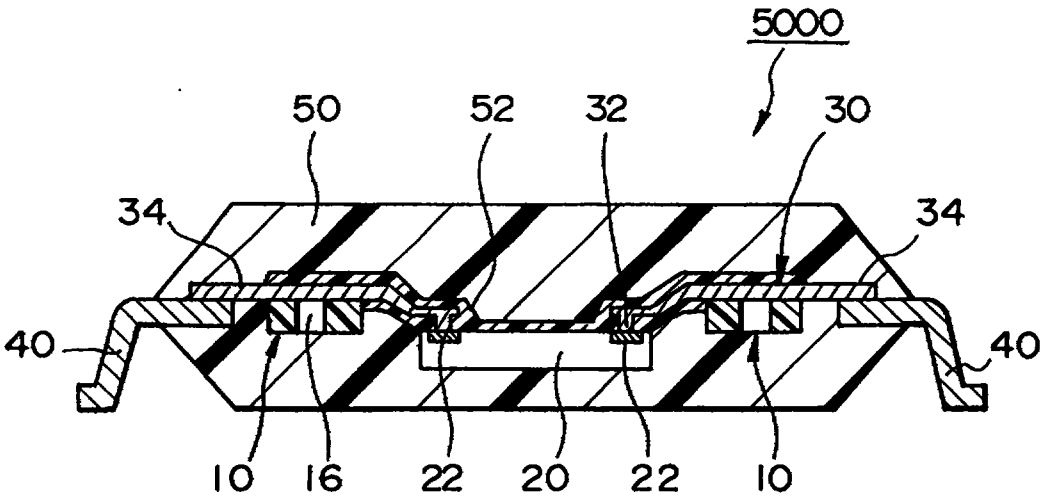

5000
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52
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34
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20
22
10

FIG. 12

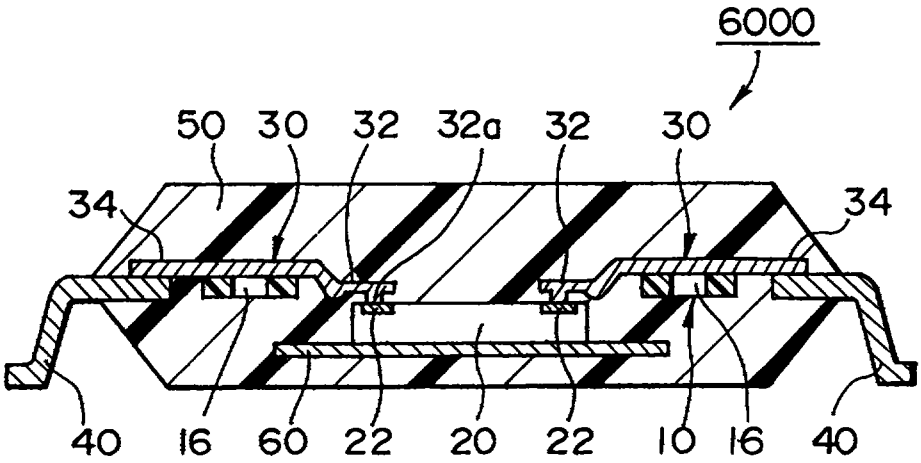

6000
50
30
32
32a
32
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34
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16
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16
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FIG. 13

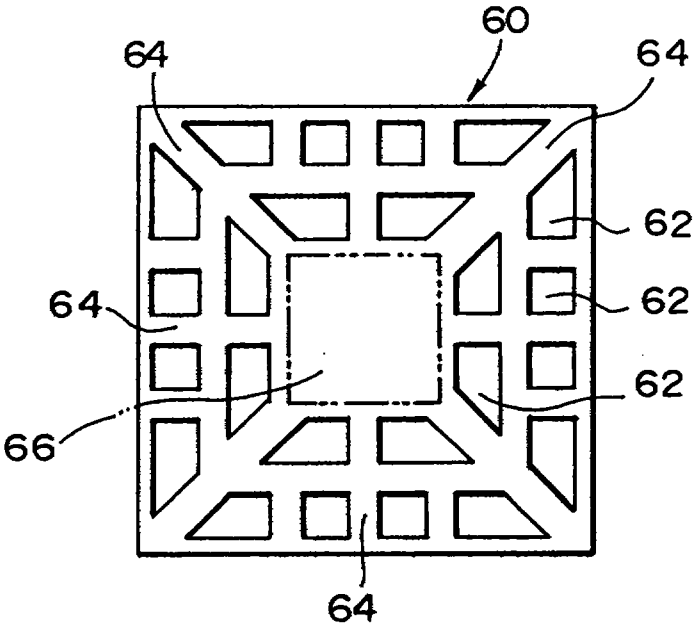

60
64
64
62
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62
62
66
64

FIG. 14

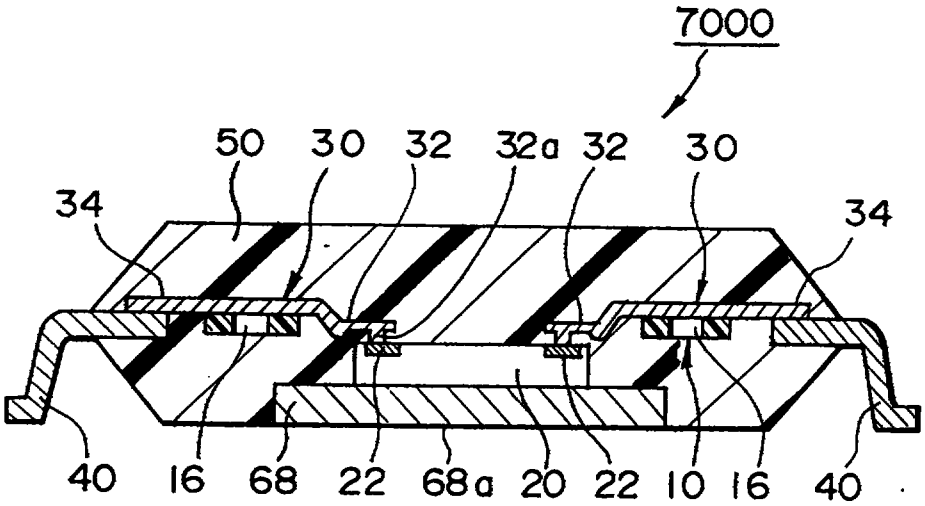


FIG. 15

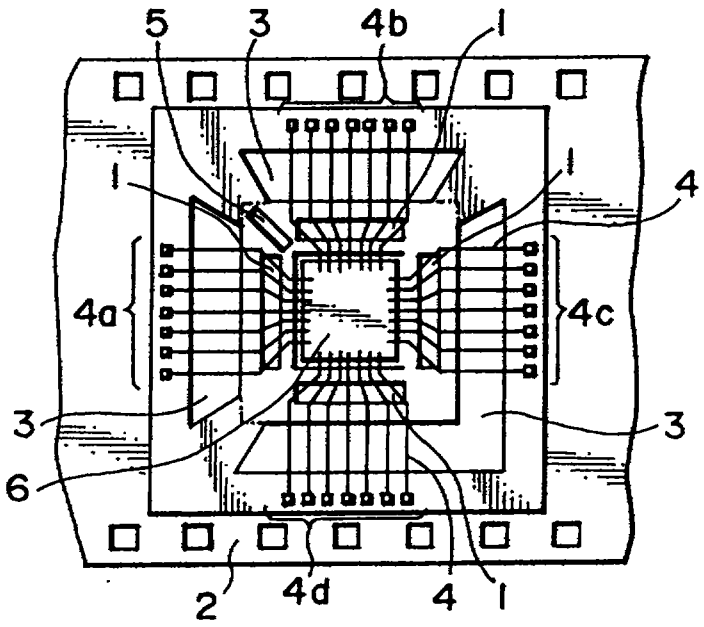
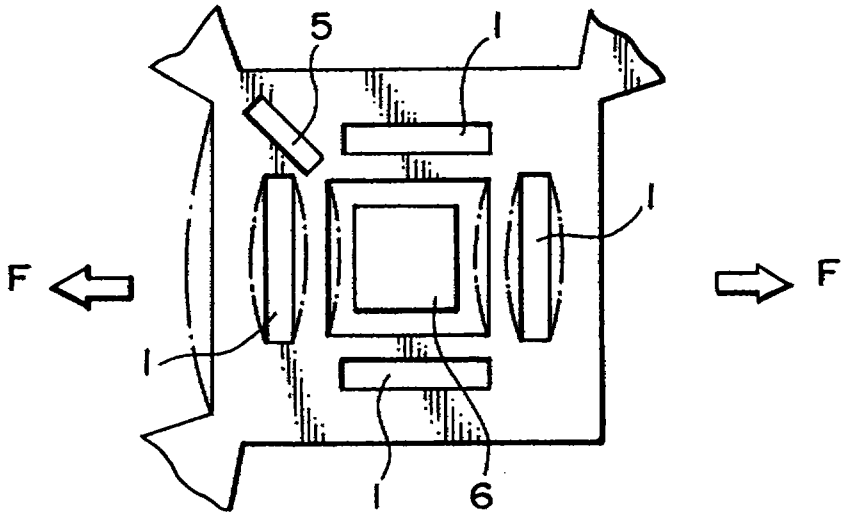


FIG. 16



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REPLACEMENT SHEETS SG
☐ Description : paged ..... to paged .....
☑ Claim(s) : paged 23 to paged 29
☐ Drawing(s) : paged ..... to paged .....
☐ Abstract : paged ..... to paged .....
DATE OF RECEIPT 23/7/99

WHAT IS CLAIMED IS:

1. A semiconductor device comprising:

an electrically insulating film (10) having a device hole (12);

a plurality of lead groups (30A-30D), each comprising a plurality of leads (30), arranged in a predetermined pattern that is formed in a corresponding plurality of lead formation regions (100-400) on the surface of said film, each lead formation region being located between said device hole and a respective outer edge (10a) of said film;

an integrated circuit chip (20) which is arranged within said device hole of said film and which has electrodes connected to ends of said leads;

a first group of aperture portions (14a-14d) which consists of at least one aperture portion and which is provided within a region (500-800) other than said lead formation regions;

a second group (16) of aperture portions (16a-16e) provided in each of said lead formation regions, each second group (16) consisting of a plurality of aperture portions with linking portions (18a-18d) defined between adjacent aperture portions; and

a resin sealing portion (50) that seals in at least said integrated circuit chip, said film, and said lead groups;

characterized in that each linking portion (18a-18d) is defined between a pair of parallel linear edges, one edge of each of two adjacent aperture portions, and a longitudinal direction of each

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linking portion, which is perpendicular to said pair of edges, intersects edges (10a) of said film (10) at an angle of approximately 45^0.

2. A semiconductor device according to claim 1, wherein each of said leads (30) comprises an inner lead portion (32) protruding into said device hole (12) and an outer lead linkage portion (34) protruding outward beyond said respective outer edge (10a) of said film (10), said outer lead linkage portion being connected to an outer lead (40) of a mechanical strength greater than that of said outer lead linkage portion.

3. A semiconductor device according to claim 1 or claim 2, wherein said linking portions (18a-18d) are orientated such that said longitudinal directions of each linking portion is perpendicular to the leads (30) formed on that linking portion.

4. A semiconductor device according to any one of claim 1 to claim 3, wherein said plurality of aperture portions in each second group of aperture portions define a line of symmetry which is perpendicular to said respective outer edge (10a) of said film (10) and with respect to which the aperture portions are arranged in axial symmetry.

5. A semiconductor device according to any one of claim 2 to claim 4, wherein said leads (30) have straight portions and bend portion so as to allow the pitch of said inner lead portions (32) to be smaller than that of said outer lead linkage portions (34), and

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said plurality of aperture portions (16a-16d) of each second group (16) are formed at positions separated from those where said bend portions of said leads are formed.

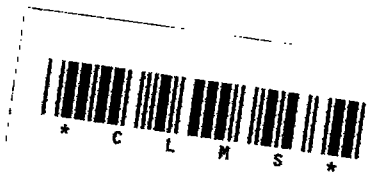
6. A semiconductor device according to any one of claim 1 to claim 5, wherein side leads (36) forming the two outermost leads of each lead groups (30A-30D) have a mechanical strength greater than that of the remaining leads (30) of the respective lead group.

7. A semiconductor device according to any one of claim 1 to claim 6, wherein said integrated circuit chip (20) is positioned at substantially the center of said resin sealing portion (50) in a direction perpendicular to the plane of said film (10).

8. A semiconductor device according to claim 7, wherein each of said leads (30) comprises an inner lead portion (32) protruding into said device hole (12), an outer lead linkage portion (34) protruding outward beyond said respective outer edge (10a) of said film (10) and an intermediate lead portion, each lead being bent such that said outer lead linkage portions, said inner lead portions and said intermediate lead portions are in a first, a second and a third one, respectively, of three parallel planes displaced with respect to each other in the direction perpendicular to the plane of said film (10), and the position of said integrated circuit chip (20) is set by the distance (d_{OF}) between said first and said third plane and the distance (d_{IF}) between said second and said third plane.

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9. A semiconductor device according to claim 9, wherein each of said leads (30) comprises an inner lead portion (32) protruding into said device hole (12), an outer lead linkage portion (34) protruding outward beyond said respective outer edge (10a) of said film (10) and an intermediate lead portion, each lead being bent such that said inner lead portions and said intermediate lead portions are in a first and a second one, respectively, of two parallel planes displaced with respect to each other in the direction perpendicular to the plane of said film (10), and the position of said integrated circuit chip (20) is set by the distance between said first and said second plane and by outer leads (40) connected to said outer leads linkage portions.

10. A semiconductor device according to any one of claim 1 to claim 9, wherein, in a region encompassing inner lead portions of said leads (30) and said electrodes of said integrated circuit chip (20)connected to ends of said inner lead portions, a resin layer (52) consisting of a resin having good adhesive properties with respect to both said leads (30) and the resin forming said resin sealing portion (50) is formed between the former and the latter.

11. A semiconductor device according to any one of claim 1 to claim 10, wherein a radiator portion (60; 68) is connected to said integrated circuit chip (20).

12. A semiconductor device according to claim 11, wherein a plurality of aperture portions (62) are formed in said radiator portion (60).

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13. A semiconductor device according to claim 11 or 12, wherein at least a part (68a) of said radiator portion (68) is exposed from said resin sealing portion (50).

14. A method of manufacturing a semiconductor device, comprising the steps of:

(A) forming, in an electrically insulating film (10), a device hole (12), a first group of aperture portions (14a-14d) consisting of at least one aperture portion within a region (500-800) outside of lead formation regions (100-400), and a second group (16) of aperture portions provided in each of said lead formation regions, each second group (16) consisting of a plurality of aperture portions (16a-16d) with linking portions (18a-18d) defined between adjacent aperture portions;

(B) attaching a conductive film to said film, using photolithography and etching to form leads (30) that each comprise an inner portion protruding into said device hole and an outer lead linkage portion, within said lead formation regions of said film, then placing an integrated circuit chip (50) within said device hole and connecting electrodes of said integrated circuit chip to said inner lead portions:

(C) superimposing on a predetermined position of said film a lead frame (80) having outer leads (40) arranged at the

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same pitch as said outer lead linkage portions and having a mechanical strength greater than that of said outer lead linkage portions, and connecting said outer lead linkage portions to said outer leads; and

(D) using transfer molding to form a resin sealing portion (50) so as to seal said integrated circuit chip, said leads, and part of said outer leads therein;

characterized in that step (A) comprises forming said aperture portions (16a-16d) of said second group (16) such that each linking portion (18a-18d) is defined between a pair of parallel linear edges, one edge of each of two adjacent aperture portions, and a longitudinal direction of each linking portion, which is perpendicular to said pair of edges, intersects edges (10a) of said film (10) at an angle of approximately 45^0.

15. A method of manufacturing a semiconductor device according to claim 16, wherein in said step (B), said integrated circuit chip (20) is arranged to be positioned such that it will be at substantially the center of said resin sealing portion (50) formed in step (D) in a direction perpendicular to the plane of said film (10).

16. A method of manufacturing a semiconductor device according to claim 14 or 15, further comprising a step of forming, before step (D), a resin layer (52) consisting of a resin having good adhesive properties with respect to both said leads (30) and the resin used

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in step (D), in a region encompassing inner lead portions of said leads and electrodes of said integrated circuit chip (20).

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