TITLE OF THE INVENTION

Method for Manufacturing Semiconductor Device and Heat-Resistant Pressure-Sensitive Adhesive Tape for Use Therein

BACKGROUND OF THE INVENTION

Field of the Invention

The present invention relates to a method for manufacturing a semiconductor device using a metal lead frame attached with a heat-resistant pressure-sensitive adhesive tape and relates to a heat-resistant pressure-sensitive adhesive tape for use in the method.

Description of the Related Art

In recent years, LSI packaging technology has focused on Chip Size/Scale Package (CSP) technology. This technology typically includes the Quad Flat Non-lead package (QFN), whose lead terminals are placed inside the package. This is one of the particularly spotlighted forms in terms of miniaturization and high integration density. In recent years, a particularly spotlighted method for manufacturing the QFN includes the steps of systematically arranging QFN chips on die pads in a package pattern region of a lead frame, sealing the chips with a sealing resin at a time in a die cavity, and cutting the sealed body into individual QFN structures. Such a method can drastically increase the productivity per area of the lead frame.

In this QFN process including the step of simultaneously

sealing a plurality of semiconductor chips, the molding dies clamp only the portions outside the resin sealing region which lie outside beyond the package pattern region. Therefore, the pressure from the molding dies for holding the outer lead face can be insufficient in the package pattern region, particularly at the center portion thereof. Therefore, it can be very difficult to prevent the leak of the sealing resin into the outer lead side, and the QFN terminals or the like can tend to be undesirably covered with the resin.

Against this problem, a pressure-sensitive adhesive tape can be attached to the outer lead side of the lead frame in the QFN process. Such a process obtains the sealing effect based on the autohesion (masking) property of the pressure-sensitive adhesive tape and may be particularly effective at preventing the leak of the resin to the outer lead side in the resin sealing step.

In such a process, it is substantially difficult to attach the heat-resistant pressure-sensitive adhesive tape after the step of mounting the semiconductor chips on the lead frame or after the step of wire bonding, in terms of handling. In a preferred manner, therefore, the heat-resistant pressure-sensitive adhesive tape is attached to the outer pad face of the lead frame at an early stage and then maintained during the step of mounting the semiconductor chips and the step of wire bonding before the resin sealing step. Therefore, the heat-resistant pressure-sensitive adhesive tape must not only prevent the leak of the sealing resin but also satisfy all the necessary properties such as high heat

resistance against the process of mounting the semiconductor chips and no interference with the sophisticated operation in the wire bonding step.

If high stickiness is emphasized for the purpose of preventing the resin leak, a general heat-resistant pressure-sensitive adhesive can be selected. However, such a general heat-resistant pressure-sensitive adhesive tape can interfere with the wire bonding due to a high elasticity of the pressure-sensitive adhesive. In this case, the necessary functions during a series of the processes can be contradictory and difficult to be satisfied at the same time.

In order to solve these problems, a process of a semiconductor device proposed by the inventors uses a heat-resistant pressure-sensitive adhesive tape having a pressure-sensitive adhesive layer with a thickness of 10 μm or less (Japanese Patent Application No. 2001-020395 not published on the priority date of this application). In this process, a series of steps including wire bonding can be carried out free from the resin leak.

Recently, the number of the packages arranged per lead frame has been increased in terms of productivity. Therefore, not only the package itself has been made finer, but also the arrangement number has been so increased that more packages can be sealed in one sealing portion. Therefore, the above-mentioned heat-resistant pressure-sensitive adhesive tape with a relatively

thin adhesive layer for a reduction in cushion may have difficulty in balancing sufficient sealing property with other properties and therefore may not appropriately achieve the basic purpose, the prevention of the resin leak.

It is therefore an object of this invention to provide a method for manufacturing a semiconductor device in which the heat-resistant pressure-sensitive adhesive tape can appropriately prevent the resin leak during the step of sealing to form the recent fine type of QFN, in particular, during the step of simultaneously sealing a large number of packages in a large matrix pattern, and in which the attached tape can hardly cause trouble in the series of manufacturing steps, and to provide a heat-resistant pressure-sensitive adhesive tape for use in such a method.

SUMMARY OF THE INVENTION

The inventors have made active investigations on physical properties, materials, thickness and the other properties of the heat-resistant pressure-sensitive adhesive tape and found that the above object can be achieved by using a heat-resistant pressure-sensitive adhesive tape comprising a pressure-sensitive adhesive layer that has a specific thickness, is made of an acrylic resin and has a suitable storage elastic modulus at high temperature. Based on the finding, the present invention has been completed.

In accordance with an aspect of the present invention, there

is provided a method for manufacturing a semiconductor device, comprising the steps of: mounting and bonding semiconductor chips onto die pads of a metal lead frame having an outer pad side to which a heat-resistant pressure-sensitive adhesive tape is attached; wiring a bonding wire between each termination of the lead frame and each electrode pad on the semiconductor chips; sealing semiconductor chips in a sealing resin from one side; and cutting the sealed body into individual semiconductor devices, wherein the heat-resistant pressure-sensitive adhesive tape comprises a base layer made of a polyimide resin and a pressure-sensitive adhesive layer with a thickness of 1 to 20 μm that is made of an acrylic resin and has a storage elastic modulus of 1.0×10^5 Pa or more at 200°C

The heat-resistant pressure-sensitive adhesive tape with the base layer of the polyimide resin may have a high heat resistance, in addition, its linear thermal expansion coefficient may be close to that of the metal lead frame. Therefore, the tape can hardly produce warping or peeling when thermally expanded. The tape can maintain a high sealing effect and therefore can appropriately prevent the resin leak in the sealing step. In addition, the base layer of the polyimide resin can provide a good workability and a good handleability. The pressure-sensitive adhesive layer has a suitable storage elastic modulus at high temperature and therefore can totally maintain a suitable cushion effect even where it has a relatively large thickness of about 20 μm. In the bonding step

with such a heat-resistant pressure-sensitive adhesive tape attached, the loss of the bonding energy can be low, and the wire bonding can be well performed in a more reliable manner. In the process of the recent fine type of QFN, particularly the large matrix pattern type with a large number of packages simultaneously sealed, the sealing material has to produce a sufficient packing effect to appropriately prevent the resin leak during the molding step. In this regard, the pressure-sensitive adhesive layer should have an appropriate thickness of 1 μm or more. Therefore, the acrylic pressure-sensitive adhesive layer with a thickness of 1 to 20 μm may provide a suitable thickness as well as a suitable storage elastic modulus. In the inventive process of manufacturing a semiconductor device, therefore, the resin leak may appropriately be prevented in the sealing step with the heat-resistant pressure-sensitive adhesive tape, and the attached tape can hardly cause trouble in a series of the steps.

The present invention may also be directed to a heat-resistant pressure-sensitive adhesive tape for use in such a method for manufacturing a semiconductor device, comprising: a base layer made of a polyimide resin; and a pressure-sensitive adhesive layer with a thickness of 1 to 20 μm that is made of an acrylic resin and has a storage elastic modulus of 1.0×10^5 Pa or more at 200°C.

In accordance with another aspect of the present invention, there is provided a method of using a heat-resistant

pressure-sensitive adhesive tape, comprising the steps of: attaching the heat-resistant pressure-sensitive adhesive tape to an outer pad side of a metal lead frame; and using the lead frame to form a semiconductor device comprising a semiconductor chip and a sealing resin in which the semiconductor chips are sealed from one side, wherein the heat-resistant pressure-sensitive adhesive tape comprises a base layer made of a polyimide resin and a pressure-sensitive adhesive layer with a thickness of 1 to 20 μm that is made of an acrylic resin and has a storage elastic modulus of 1.0×10^5 Pa or more at 200°C.

The present invention may, if the heat-resistant pressure-sensitive adhesive tape is heated at 200°C for one hour while being attached to a stainless steel plate, preferably have an adhesive strength of 5.0 N/19 mm width or less. In such a case, a desired adhesive strength for preventing the resin leak can be ensured in the sealing step, and after the sealing step, such a tape can easily be peeled off without causing breakage of the sealing resin.

BRIEF DESCRIPTION OF THE DRAWINGS

Figs. 1(a) to 1(e) are diagrams for showing an example of the process for manufacturing a semiconductor device according to the present invention; Figs. 2(a) to 2(c) show an example of the lead frame used in this invention, wherein Fig. 2(a) is a front view, Fig. 2(b) is a magnified view of an essential part, and Fig. 2(c) is a

sectional view showing a configuration after the resin sealing step; and Fig. 3 is a vertically sectional view for showing an example of the resin sealing step in this invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Embodiments of the present invention are described below with reference to the drawings. Referring to Figs. 1(a) to 1(e), an example of the inventive process for manufacturing a semiconductor device is described below.

As shown in Figs. 1(a) to 1(e), the inventive method for manufacturing a semiconductor device includes the step of mounting semiconductor chips 15, the wiring step with bonding wires 16, the sealing step with a sealing resin 17, and the step of cutting the sealed body 21.

Referring to Figs. 1(a) and 1(b), the mounting step includes bonding semiconductor chips 15 onto die pads 11c of a lead frame 10, wherein a heat-resistant pressure-sensitive adhesive tape 20 is attached to an outer pad side (the lower side of each drawing) of the lead frame 10.

For example, the lead frame 10 is made of metal such as copper and has a formed QFN terminal pattern. The electric contact portions of the lead frame 10 may be coated or plated with such a material as silver, nickel, palladium, or gold. The lead frame 10 generally has a thickness of 100 to 300 μm. However, thin portions formed by partial etching or the like may not have

such a thickness.

The lead frame 10 preferably has systematically arranged QFN patterns so as to be easily divided in the later cutting step. Referring to Figs. 2(a) and 2(b), for example, the configuration of the lead frame 10 with two-dimensional matrix patterns, so called matrix QFN or MAP-QFN, is one of the most preferred lead frame configurations. Recently, the number of the packages arranged per lead frame has been increased in terms of productivity. Therefore, not only the package itself has been made finer, but also the arrangement number has significantly been increased so that more packages can be sealed in one sealing portion.

Referring to Figs. 2(a) and 2(b), the lead frame 10 has package pattern regions 11. In each of the regions 11, QFN package designs are systematically arranged, in which a plurality of terminal portions 11b are arranged around each of adjacent openings 11a. For a general QFN, each package design (corresponding to each lattice region in Fig. 2(a)) comprises terminal portions 11b which are arranged around the opening 11a and each have an outer lead face on the lower side, a die pad 11c placed at the center of the opening 11a, and die bars 11d that support the die pad 11c from the four corners of the opening 11a.

The heat-resistant pressure-sensitive adhesive tape 20 is preferably attached outside at least the package pattern region 11 and preferably attached to a region that includes the whole perimeter outside the region to be sealed in resin. In the vicinity

of the side edge, the lead frame 10 generally has guide pin holes 13 for the positioning in the resin sealing step. Therefore, the tape 20 is preferably attached to a region that does not include the holes 13. A plurality of resin sealing regions are arranged in the longitudinal direction of the lead frame 10. Therefore, the pressure-sensitive adhesive tape 20 is preferably attached so as to continuously extend over the plurality of the resin sealing regions.

On the lead frame 10 as described above, semiconductor chips 15, which are silicon wafer chips each forming a semiconductor integrated circuit, are mounted. Mounting areas for fixing the semiconductor chips 15, each called the die pad 11c, are provided on the lead frame 10. The step of bonding (fixing) each semiconductor chip 15 to each die pad 11c may be carried out by any method such as a method using an electrically conductive paste 19, an adhesive tape, an adhesive, or the like. When die bonding is performed using the electrically conductive paste, a thermosetting adhesive or the like, heat curing is generally carried out at a temperature of about 150 to 200°C for 30 to 90 minutes.

Referring to Fig. 1(c), the wiring step includes electrically connecting a bonding wire 16 between the tip of each terminal portion 11b (each inner lead) of the lead frame 10 and each electrode pad 15a on each semiconductor chip 15. For example, the bonding wire 16 is a gold wire or an aluminum wire. The wire bonding is generally carried out in a heated state at a temperature

of 120 to 250°C under combined application of ultrasonic oscillation energy and contact bonding energy. In this step, the face of the heat-resistant pressure-sensitive adhesive tape 20 attached to the lead frame 10 may be vacuum-sucked to be surely held on a heat block.

Referring to Fig. 1(d), the sealing step includes sealing semiconductor chips 15 in sealing resin 17 from one side. The sealing step is carried out to protect the semiconductor chips 15 mounted on the lead frame 10 and the bonding wires 16. In the sealing step, the sealing resin 17 such as epoxy resin is typically molded in dies. Referring to Fig. 3, in such a case, a die unit 18 composed of an upper die 18a and a lower die 18b each having a plurality of cavities is generally used to carry out the sealing step in which a plurality of portions are simultaneously sealed in the sealing resin 17. For example, the resin sealing is carried out at a heating temperature of 170 to 180°C, at which curing is carried out for several minutes, and then post-mold curing is carried out for several hours. In a preferred manner, the heat-resistant pressure-sensitive adhesive tape 20 is peeled off prior to the post-mold curing.

Referring to Fig. 1(e), the cutting step includes cutting the sealed body 21 into individual semiconductor devices 21a. In the cutting step, a rotary cutting blade such as a dicing saw is generally used to cut each cutting site 17a of the sealing resin 17.

According to this invention, the heat-resistant

pressure-sensitive adhesive tape 20 used in the above-described process comprises: a base layer made of a polyimide resin; and a pressure-sensitive adhesive layer with a thickness of 1 to 20 μm that is made of an acrylic resin and has a storage elastic modulus of 1.0×10^5 Pa or more at 200°C. The heat-resistant pressure-sensitive adhesive tape 20 is preliminarily attached to the lead frame 10 and then heated in the process as described above. In the step of die-bonding the semiconductor chips 15, for example, heat curing is generally carried out at a temperature of about 150 to about 200°C for about 30 to about 90 minutes. In the step of wire bonding, for example, at a temperature of about 120 to about 250°C, it can take one hour or more per lead frame to complete the bonding of all the semiconductor devices, if one lead frame is used to form a large number of semiconductor devices. The resin sealing step also has to use a temperature at which the resin is sufficiently melted. Such a temperature may be about 175°C. Under such conditions, therefore, the heat-resistant pressure-sensitive adhesive tape has to satisfy the required level of heat resistance.

The lead frame 10 to which the heat-resistant pressure-sensitive adhesive tape 20 will be attached is made of metal such as copper as described above and therefore generally has a linear thermal expansion coefficient of about 1.8×10^{-5} to about 1.9×10^{-5} /K. If the lead frame significantly differs from the heat-resistant pressure-sensitive adhesive tape 20 to be attached

thereto in linear thermal expansion coefficient, distortion caused by the difference between both thermal expansions may lead to warping or peeling of the tape when both are heated in the bonded state. Therefore, it is preferred that the base layer of the heat-resistant pressure-sensitive adhesive tape has a linear thermal expansion coefficient close to that of the lead frame material.

For example, such a base material is a polyimide resin with a linear thermal expansion coefficient of about 1.5×10^{-5} to about 2.8×10^{-5} /K, which can have a high workability and a high handleability. Such a material is preferably used in this invention. The linear thermal expansion coefficient herein is a value determined by Thermo-Mechanical Analysis (TMA) according to ASTM D696.

Examples of the film made of such a polyimide resin include Kapton® (Du Pont-Toray Co., Ltd.), Upilex (trade name) (Ube Industries, Ltd.), and Apical® (Kaneka Corporation) and the like.

The base layer of the heat-resistant pressure-sensitive adhesive tape 20 preferably has a thickness of 10 to 100 μm in terms of prevention of breakage or tearing and in terms of good handleability.

The adhesive layer of the pressure-sensitive adhesive tape 20 should be elastic to some extent in terms of pressure-sensitive adhesion function. If the adhesive layer is too soft as a whole, however, the lead frame, to which the pressure-sensitive adhesive tape is attached, can be insufficiently fixed due to the inhibition by

the elastic force of the pressure-sensitive adhesive layer in the step of connecting the bonding wire. As a result, the contact bonding energy from pressing can be damped, and failures can occur in the bonding step.

In order to prevent such bonding failures and to ensure a sufficient adhesive strength for preventing the resin leak in the sealing step, or in order to ensure the performances which would otherwise be mutually contradictory, the pressure-sensitive adhesive layer has a storage elastic modulus of 1.0×10^5 Pa or more, more preferably 5.0×10^5 Pa or more and has a thickness of 1 to 20 μm, more preferably 5 to 15 μm, according to this invention. Such a pressure-sensitive adhesive layer can maintain a slight cushion performance as a whole so that the wire bonding can be appropriately carried out in a more reliable manner. In the sealing step, such a pressure-sensitive adhesive layer with an appropriate thickness can provide a sufficient sealing performance. The storage elastic modulus herein is a shear storage elastic modulus value determined with a viscoelastic spectrometer at a frequency of 1 Hz and at a temperature rise rate of 5°C/min.

The heat-resistant pressure-sensitive adhesive tape is peeled off at any stage after the sealing step. If the pressure-sensitive adhesive tape has a too strong adhesive strength, the peeling can be difficult to achieve and in some cases, the molded resin can be peeled off or broken by the tape-peeling stress. Therefore, a pressure-sensitive adhesive which has an adhesive strength

stronger than necessary to prevent the overrunning of the sealing resin would rather be unpreferred. In this regard, after heated at 200°C for one hour while being attached to a stainless steel plate, the pressure-sensitive adhesive tape preferably has an adhesive strength of 5.0 N/19 mm width or less, more preferably 2.0 N/19 mm width or less through the measurement according to JIS Z0237.

A preferred example of the pressure-sensitive adhesive having the above physical properties is an acrylic pressure-sensitive adhesive, which can easily provide a suitable storage elastic modulus and suitable adhesion strength. For example, such an adhesive comprises an acrylic copolymer formed by copolymerization of monomers including at least alkyl (meth)acrylate. Examples of the alkyl (meth)acrylate include methyl (meth)acrylate, ethyl (meth)acrylate, butyl (meth)acrylate, isoamyl (meth)acrylate, n-hexyl (meth)acrylate, 2-ethylhexyl (meth)acrylate, isooctyl (meth)acrylate, isononyl (meth)acrylate, decyl (meth)acrylate, and dodecyl (meth)acrylate.

The acrylic pressure-sensitive adhesive having a heat resistance may contain an acrylic polymer formed by copolymerization of a mixture of monomers including an imide group-containing (meth)acrylate and alkyl (meth)acrylate.

These acrylic pressure-sensitive adhesives may each contain an appropriate crosslinking agent. Examples of the crosslinking agent include isocyanate crosslinking agents, epoxy crosslinking

agents, aziridine crosslinking agents, and chelate crosslinking agents. The usage amount of the crosslinking agent is not particularly limited, but the crosslinking agent is preferably added in such an amount as to produce sufficient crosslinking for the purpose of achieving a desired elastic modulus. For example, such an amount is preferably 0.1 to 15 parts by weight, more preferably 1.0 to 10 parts by weight, based on 100 parts by weight of the acrylic polymer.

In this invention, the storage elastic modulus at 200°C may be adjusted within the desired range by adding the crosslinking agent in a relatively large amount. Alternatively, the type of the crosslinking agent, the type of the monomer, the copolymerization ratio, or the molecular weight of the material may be altered, or a filler may be added, for the purpose of adjusting the storage elastic modulus.

The acrylic adhesive may contain any other component. Examples of any other component include a variety of additives such as a plasticizer, a filler, a pigment, a dye, an antioxidant, and an antistatic agent and the like. The above-described acrylic pressure-sensitive adhesive has a relatively high heat resistance and can easily provide an appropriate storage elastic modulus and a suitable adhesive strength and therefore is preferably used in this invention. In addition, recoating including primer pretreatment for the pressure-sensitive adhesive or back surface treatment of the base material may be performed as needed.

The inventive heat-resistant pressure-sensitive adhesive tape for use in the inventive process comprises the base layer and the acrylic pressure-sensitive adhesive layer as described above. The heat-resistant pressure-sensitive adhesive tape may be attached to the lead frame under any condition. A variety of means or methods using a heat laminator, hand roller, press roller may be used in the step of attaching the heat-resistant pressure-sensitive adhesive tape. Generally, a method using a press roller is widely used in attaching the tape to the lead frame.

EXAMPLES

The features and effects of this invention are specifically shown in the examples below.

Example 1

A polyimide film with a thickness of 25 μm (Kapton®100H, Du Pont-Toray Co., Ltd.) was used as a base material. The polyimide film had a linear thermal expansion coefficient of 2.6×10^{-5} to 2.8×10^{-5} /K, which was obtained by measurement at a temperature rise rate of 10°C/min between 100°C and 200°C. An acrylic copolymer was used, which was composed of 100 parts by weight of a butyl (meth)acrylate monomer and 5 parts by weight of a (meth)acrylic acid monomer. To 100 parts by weight of this copolymer was added 2 parts by weight of an epoxy crosslinking agent (Tetrad-C, Mitsubishi Gas Chemical Company, Inc.) to form an acrylic pressure-sensitive adhesive. A pressure-sensitive

adhesive layer of the acrylic pressure-sensitive adhesive with a thickness of 10 μm was formed on the base material to form a heat-resistant pressure-sensitive adhesive tape. The pressure-sensitive adhesive had a storage elastic modulus of 9.0×10^5 Pa at 200°C, which was obtained by measurement with ARES (Rheometric Scientific F. E. Ltd.) at a frequency of 1 Hz at a temperature rise rate of 5°C/min with parallel plates with a sample size of 7.9 mmϕ in a shear storage elasticity mode. The pressure-sensitive adhesive tape was heated at 200°C for one hour while being attached to a stainless steel plate. The tape was then measured for adhesive strength according to JIS Z0237. The measured adhesive strength was 0.3 N/19 mm width.

The heat-resistant pressure-sensitive adhesive tape was attached to an outer pad side of a copper lead frame whose terminal potions were plated with silver and which had a 4 by 4 matrix for 16-pin side type QFN. Semiconductor chips were bonded to the respective die pad portions of the lead frame using an epoxy phenol-based silver paste and fixed by curing at 180°C for about one hour.

The lead frame was then vacuum-sucked from the heat-resistant pressure-sensitive adhesive tape side to be fixed on a heat block heated at 200°C. The peripheral portions of the lead frame were also held by a wind clamper. The semiconductor chips were then subjected to wire bonding with a 25 μmϕ gold wire (GMG-25, Tanaka Precious Metals) in a 115 kHz wire bonder

(UTC-300BIsuper, Shinkawa Ltd.) under the conditions below. It took about one hour to complete the bonding.

First bonding pressure:	80 g
Ultrasonic intensity in the first bonding:	550 mW
First bonding application time:	10 msec
Second bonding pressure:	80 g
Ultrasonic intensity in the second bonding:	500 mW
Second bonding application time:	8 msec

Thereafter, the semiconductor chips were sealed in an epoxy sealing resin (HC-300, Nitto Denko Corporation) using a molding machine (Model-Y-series, TOWA Corporation). The molding was carried out under the following conditions: 175°C, preheat for 3 seconds, an injection time of 12 seconds, and a curing time of 90 seconds. The heat-resistant tape was then peeled off. After post-mold curing was further carried out at 175°C for about 3 hours for the purpose of sufficient curing, a dicing saw was used to cut the sealed body into individual QFN type semiconductor devices.

The resulting QFNs had no overrunning of the resin, and the respective steps including the wire bonding were smoothly carried out without troubles.

Example 2

The process of Example 1 was used to form QFN type semiconductor devices except that the pressure-sensitive adhesive layer of the heat-resistant pressure-sensitive adhesive tape had a

thickness of 15 μm. The resulting QFNs had no overrunning of the resin, and the respective steps including the wire bonding were smoothly carried out without troubles.

Example 3

The process of Example 1 was used to form a heat-resistant pressure-sensitive adhesive tape except that the addition amount of the epoxy crosslinking agent was 0.5 parts by weight. The resulting tape had a storage elastic modulus of 2.0×10^5 Pa at 200°C and an adhesive strength of about 2.5 N/19 mm width after heated at 200°C. The pressure-sensitive adhesive layer of the tape had a thickness of about 5 μm. The heat-resistant pressure-sensitive adhesive tape was then attached to the outer pad side of the copper lead frame as used in Example 1, and the semiconductor chips were bonded under the same conditions. The lead frame was then vacuum-sucked from the heat-resistant pressure-sensitive adhesive tape side to be fixed on a heat block heated at 200°C. The peripheral portions of the lead frame were also held by a wind clamper. The semiconductor chips were then subjected to wire bonding with a 25 μmϕ gold wire (GLD-25, Tanaka Precious Metals) in a 60 kHz wire bonder (MB-2200, Nippon Avionics Co., Ltd.) under the conditions below. It took about one hour to complete the bonding.

First bonding pressure:	30 g
Ultrasonic intensity in the first bonding:	25 mW

First bonding application time:	**100 msec**
Second bonding pressure:	**200 g**
Ultrasonic intensity in the second bonding:	**50 mW**
Second bonding application time:	**50 msec**

Thereafter, the semiconductor chips were sealed in an epoxy sealing resin (HC-300, Nitto Denko Corporation) using a molding machine (Model-Y-series, TOWA Corporation). The molding was carried out under the following conditions: 175°C, preheat for 40 seconds, an injection time of 11.5 seconds, and a curing time of 120 seconds. The heat-resistant tape was then peeled off. After post-mold curing was further carried out at 175°C for about 3 hours for the purpose of sufficient curing, a dicing saw was used to cut the sealed body into individual QFN type semiconductor devices. The resulting QFNs had no overrunning of the resin, and the respective steps including the wire bonding were smoothly carried out without troubles.

Comparative Example 1

The process of Example 1 was used for investigation except that the base layer of the tape was a high density polyethylene film (with a thickness of 25 μm and a linear thermal expansion coefficient of 15×10^{-5} /K). At the time of the cure heating in the step of mounting the semiconductor chips, significant wrinkles and partial peeling were produced in the tape. In the molding step, the tape was not able to suppress the overrunning of the resin at

all.

Comparative Example 2

The process of Example 1 was used for investigation except that the pressure-sensitive adhesive tape was composed of a polyester base material and a 50 μm thick pressure-sensitive adhesive layer of a silicone based pressure-sensitive adhesive, which provided an adhesive strength of about 7 N/19 mm width after heated at 200°C. As a result, most of the wires were not sufficiently bonded in the second bonding due to the cushion of the tape, and bonding failures frequently occurred in the bonding step. In the step of peeling off the tape after the sealing step, the lead frame became deformed by the stress, and part of the sealing resin was also peeled off.

Comparative Example 3

The process of Example 1 was used for investigation except that a silicone based pressure-sensitive adhesive that had a storage elastic modulus of 1.1×10^4 Pa at 200°C was used to form the pressure-sensitive adhesive layer with a thickness of 30 μm. In the bonding step, most of the wires were not sufficiently bonded due to the cushion of the tape, and bonding failures frequently occurred.

WHAT IS CLAIMED IS:

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

mounting and bonding semiconductor chips onto die pads of a metal lead frame having an outer pad side to which a heat-resistant pressure-sensitive adhesive tape is attached;

wiring a bonding wire between each termination of said lead frame and each electrode pad on said semiconductor chips;

sealing semiconductor chips in a sealing resin from one side; and

cutting the sealed body into individual semiconductor devices, wherein

said heat-resistant pressure-sensitive adhesive tape comprises a base layer made of a polyimide resin and a pressure-sensitive adhesive layer with a thickness of 1 to 20 μm that is made of an acrylic resin and has a storage elastic modulus of at least 1.0×10^5 Pa at 200°C.

2. The method according to Claim 1, wherein if said heat-resistant pressure-sensitive adhesive tape is heated at 200°C for one hour while being attached to a stainless steel plate, it will have an adhesive strength of at most 5.0 N/19 mm width.

3. A heat-resistant pressure-sensitive adhesive tape for use in the method according to Claim 1, comprising:

a base layer made of a polyimide resin; and

a pressure-sensitive adhesive layer with a thickness of 1 to

20 μm that is made of an acrylic resin and has a storage elastic modulus of at least 1.0×10^5 Pa at 200°C.

4. The tape according to Claim 3, wherein if said tape is heated at 200°C for one hour while being attached to a stainless steel plate, it will have an adhesive strength of at most 5.0 N/19 mm width.

5. A method of using a heat-resistant pressure-sensitive adhesive tape, comprising the steps of:

attaching said heat-resistant pressure-sensitive adhesive tape to an outer pad side of a metal lead frame; and

using said lead frame to form a semiconductor device comprising a semiconductor chip and a sealing resin in which said semiconductor chips are sealed from one side, wherein

said heat-resistant pressure-sensitive adhesive tape comprises a base layer made of a polyimide resin and a pressure-sensitive adhesive layer with a thickness of 1 to 20 μm that is made of an acrylic resin and has a storage elastic modulus of at least 1.0×10^5 Pa at 200°C.

6. The method according to Claim 5, wherein if said pressure-sensitive adhesive tape is heated at 200°C for one hour while being attached to a stainless steel plate, it will have an adhesive strength of at most 5.0 N/19 mm width.