ADHESIVE SHEET FOR PRODUCING SEMICONDUCTOR DEVICE, SEMICONDUCTOR DEVICE THEREWITH, AND MANUFACTURING METHOD THEREFOR

BACKGROUND OF THE INVENTION

Field of the Invention

The present invention relates to an adhesive sheet which may be used for manufacturing semiconductor devices, to a semiconductor device produced by using the adhesive sheet, and to a method of manufacturing the adhesive sheet. In the production of semiconductor devices, i.e., semiconductor packages such as QFN, etc., the adhesive sheet of the present invention is strippably adhered to lead frames or wiring boards. Priority is claimed on Japanese Patent Application No. 2003-378118, filed November 7, 2003, the content of which is incorporated herein by reference.

Description of Related Art

Recently, there is demand for mounting electronic parts at high density, and for miniaturizing and highly integrating electronic parts constituting electronic devices, as electronic machines such as portable personal computers, portable telephones, etc., which are to be miniaturized, made thinner, and made multifunctional. Under these circumstances, face-mount type semiconductor devices, called a "CSP", i.e., Chip Size Package are the focus of attention, instead of QFP (Quad Flat Package) and SOP (Small Outline Package). In CSP, and especially in QFN (Quad Flat Non-lead)is mainly used suitably as a low-number-of-terminals-type semiconductor device having 100 or fewer pins, because a QFN (Quad Flat Non-lead) can be manufactured by the manufacturing technology for conventional semiconductor devices.

Hereinafter the outline of the manufacturing method for the conventional QFN is explained referring to FIGS. 5A to 5D. FIGS.5A to 5D show sectional views of QFN in the middle of manufacture, which is cut perpendicularly with respect to the mounting surface of semiconductor device of a lead frame. First, as shown in FIG. 5A, the lead frame 120 having a plurality of semiconductor device mounting parts (die-pad portion) 121 and a large number of leads 122 provided along the periphery of the semiconductor device mounting parts (die-pad portion) 121 is prepared, and then onto a surface of the lead frame 120, the adhesion sheet 110 having the adhesive layer 112 and the

heat-resistant base material 111 formed on the adhesive layer 112 is adhered. Next, as shown in FIG. 5B, the semiconductor device 130 is mounted on each of semiconductor device mounting parts 121 of the lead frame 120, the semiconductor devices 130 and the leads 122 of the lead frame 120 are connected respectively through the bonding wire 131, and the semiconductor devices 130, etc., are sealed with the molding resin 140. Next, as shown in FIG. 5C, the adhesive sheet 110 is stripped from the lead frame 120 to obtain the QFN unit on which a plurality of QFN 150 are arranged.

As the adhesives used for the adhesive sheet 110, an epoxy resin / acrylonitrile-butadiene copolymer (NBR) type adhesives, and silicone type adhesives are generally used as shown in Japanese Unexamined Patent Application, First Publication No. H06-18127.

However, in the conventional adhesive sheet using an epoxy resin/NBR type adhesive or a silicone-type adhesive, it is common to make the adhesive layer as thin as possible, e.g., 5 micrometers, in order to suppress occurrence of what is called "adhesive residue", i.e., remaining adhesive in the stripped side of a lead frame when the adhesive sheet is stripped from the lead frame. There are the following problems with this conventional adhesion sheet.

In the case in which the conventional QFN150 is manufactured using an adhesive sheet having a thin adhesive layer, the adhesive cannot enter into a gap between the leads such that both the surface of the adhesive layer and the bottom of the lead frame are on the same plane as shown in FIG. 5A, and as a result, as shown in FIG. 6A, the bottom of the lead frame 12 (external connecting terminal side at the time of mounting in a wiring board, etc.) is positioned on the same plane with respect to the bottom of the molding resin 140.

In addition, FIG. 6A is a figure which shows the conventional QFN shown in FIG. 5D from the method of the illustration right, and shows signs that the lead has arranged in predetermined pitch. That is, the tip end of the lead which is an external connecting terminal cannot be projected from a molding resin surface in the conventional QFN. In such a QFN, in the case of being mounted on a wiring board using solder, the soldering is to be made with respect to the lead surface located on the plane on which the molding resin bottom is located. In addition, strictly speaking, it is possible to perform a soldering with respect to the lead exposed to the side surface when dicing the QFN unit to form QFN respectively. However, it is the lead mainly located on the same plane as

the molding resin bottom, that is used as an external connecting terminal. Hence, only this is referred to hereafter.

When the solder balls 160 are applied to QFN150 shown in FIG. 6A, as shown in FIG. 6B, the solder balls 160 are adhered only to the lead 122 bottom respectively, and the solder balls 160 form an approximate 2-dimensional face-bonding.

Therefore, the conventional QFN has a relatively low mounting strength when mounted on a wiring board with respect to circumference mounting type semiconductor devices, such as QFP adhered up in three dimensions, so that the solder might wrap terminals ranging over the side from the bottom of the external connecting terminal, and its mounting reliability, such as the bending strength of a wiring board, is relatively low.

Furthermore, as shown in FIG. 6C, in a case in which the foreign matter 171 (for example, adhering matter, such as dust, and a part where wiring, etc., buckled somewhat in response to mechanical damage) is present on the surface of the wiring board 170 to be mounted, the height of the foreign matter 171 cannot be compensated by the height of the solder ball 160, depending on the size thereof, so that the solder ball 160 cannot connect the wiring board 170 successfully, or it is possible that a poor electrical connection might be caused or the solder balls 160 might become easy to be stripped from the wiring board 170.

Moreover, in the resin molding process at the time QFN manufacture, resin molding of the semiconductor device is performed at a pressure of 5-10 GPa and heating at 150-200°C

Therefore, the adhesive layer of the adhesive sheet is exposed to a high temperature, such that the adhesive hardness (adhesive strength between the adhesive layer and the lead frame) declines relatively, and furthermore, a phenomenon called "mold flash", in which the adhesive layer is stripped partially from the lead frame and molding resin invades and adheres to the bottom side of the lead or the semiconductor device mounting portion since the pressure of molding resin is applied occurs, and hence a poor product might be produced.

SUMMARY OF THE INVENTION

In view of the above-mentioned situation, the present invention was made. That is, it is an object of the invention to provide an adhesive sheet for producing semiconductor devices, which has neither mold flash nor risk of adhesive residue

remaining in manufacturing the semiconductor device of a QFN and the like, and which can increase the mounting strength to the wiring board of the semiconductor device of the QFN and the like and the mounting reliability.

Moreover, it is another object of the invention to provide a semiconductor device and manufacturing method therefor, which has neither mold flash nor risk of the adhesive residue remaining in manufacturing the semiconductor device of a QFN and the like, a high mounting strength to the wiring board of the QFN and the like, and a high mounting reliability.

The inventors of the present invention thoroughly researched to solve the above-mentioned problems, and they invented the following adhesive sheets for manufacturing semiconductor devices, a semiconductor device, and a manufacturing method therefor.

The adhesive sheet for manufacturing a semiconductor device of the present invention is the adhesive sheet strippably adhered to a lead frame or a wiring board, for manufacturing a semiconductor device, comprising an adhesive layer on one surface thereof and a heat-resistant base material, wherein the adhesive layer contains a thermosetting resin (a) and a strippability imparting component (b).

Preferably, the above adhesive layer further contains a thermoplastic resin (c). As the strippability imparting component (b), silicone oil is preferred. Moreover, the adhesive layer preferably contains the strippability imparting component (b) which is chemically bonded with the thermosetting resin (a) or both the thermosetting resin (a) and the thermoplastic resin (c).

Furthermore, it is preferred that the minimum storage modulus in 150-250°C after heat curing of the above adhesive layer be not less than 1 MPa. Preferably, the above heat-resistant base material is a heat-resistant resin film having a glass transition temperature of not less than 150°C and a coefficient of thermal expansion of 5-50 ppm/°C, or a metallic foil having a coefficient of thermal expansion of 5-50 ppm/°C.

Moreover, it is desirable that the protection film be formed on the surface of the above heat-resistant base material opposite to the surface on which the above adhesives layer is applied.

It should be noted that, the measuring conditions of the "storage modulus" in this specification will be explained in "Working Examples" below.

The adhesive sheet for manufacturing a semiconductor device of the present

invention is the adhesive sheet strippably adhered to a lead frame or a wiring board, for manufacturing a semiconductor device, comprising an adhesive layer on one surface thereof and a heat-resistant base material, wherein a part of the adhesive layer enters into gaps formed on the lead frame and/or the wiring board upon being adhered to the lead frame or the wiring board.

Preferably, the thickness of the above adhesive layer is not less than 6 micrometers, and preferably the adhesive sheet for manufacturing a semiconductor device of the present invention is constituted so that the above adhesive layer enters into the gaps formed on the lead frame or the wiring board in a depth of not less than 2 micrometers when the adhesive sheet of the present invention is adhered to the lead frame or the wiring board.

The semiconductor device of the present invention includes a lead frame or a wiring board having semiconductor element mounting portions and external connecting terminals, and at least one semiconductor element mounted on the semiconductor element mounting portions and sealed with a molding resin, wherein the external connecting terminals are projected from the molding resin bottom.

It should be noted that, in this specification, portions in the vicinity of the tip end on the surface on which the semiconductors are mounted are referred as "the tip end" and the surface on which the semiconductors are mounted, in the case of looking at the semiconductor device in its thickness direction, is referred as "the bottom" of the molding resin.

The method for manufacturing a semiconductor device of the present invention includes the steps of: adhering strippably the above adhesive sheet for manufacturing a semiconductor device to a lead frame or a wiring board having semiconductor mounting portions such that a part of an adhesive layer enters into gaps formed on the lead frame or the wiring board; mounting semiconductor elements on the semiconductor mounting portions to electrically connect the semiconductor elements with external connecting terminals of the lead frame or the wiring board; sealing the lead frame or the wiring board and the semiconductor elements with a molding resin; and stripping the adhesive sheet for manufacturing a semiconductor device from the lead frame or the wiring board. Since the adhesive sheet of the present invention is excellent in strippability from the lead frame or the wiring board of the adhesive layer, if the semiconductor device of a QFN and the like is manufactured using this, there will be no possibility that the adhesive

will remain.

Furthermore, since a part of the adhesive layer can enter into the gaps formed on the lead frame or the wiring board, if the semiconductor device of a QFN and the like is manufactured using the adhesion sheet for manufacturing a semiconductor device of the present invention upon being adhered to the lead frame or the wiring board, there is no possibility that mold flash will occur in the sealing process using the molding resin.

Moreover, since the tip end of the external connecting terminal is projected from the molding resin bottom, solder can be applied to the external connecting terminal in 3-dimensional form, in mounting the obtained semiconductor device on the wiring board, etc., whereby mounting strength is increased, and mounting reliability is also increased.

In addition, since the gap between the wiring boards, etc., and semiconductor devices to be mounted can be widened compared to previously, by the existence of the external connecting terminal of which the tip end is projected from the molding resin bottom, as a result, poor electrical connection resulting from foreign matter existing on the surfaces, such as a wiring board, can be reduced, and mounting reliability can thereby be improved.

Moreover, by using the adhesive sheet for manufacturing a semiconductor device of the present invention, a semiconductor device of the QFN, etc., and the manufacturing method thereof having no mold flash and no risk of the adhesive residue remaining upon manufacturing, high mounting strength to the wiring board, etc., and an excellent mounting reliability are provided.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a schematic cross section of the adhesive sheet for manufacturing a semiconductor device of the present invention.

FIG. 2 is a plan view of a lead frame which is suitably used in manufacturing a QFN with the adhesion sheet for manufacturing a semiconductor device of the present invention.

FIGS. 3A to 3F are flowcharts showing the method of manufacturing a QFN using the adhesion sheet for manufacturing a semiconductor device of the present invention.

FIGS. 4A to 4C are figures showing the mounting process of the QFN produced

using the adhesion sheet for manufacturing a semiconductor device of the present invention.

FIGS. 5A to 5D are flowcharts showing the method of manufacturing a QFN using a conventional adhesion sheet for manufacturing a semiconductor device.

FIGS. 6A to 6C are figures showing the mounting process of the QFN obtained using a conventional adhesion sheet for manufacturing a semiconductor device.

DETAILED DESCRIPTION OF THE INVENTION

The present invention will be explained in detail below.

"An adhesive sheet for manufacturing a semiconductor device"

The adhesive sheet 10 of the present invention (adhesive sheet for manufacturing a semiconductor device) is an adhesive sheet to be strippably adhered to a lead frame or a wiring board, and as the cross section cut in a thickness direction being shown in FIG.1, the adhesive sheet 10 of the present invention is approximately constituted from the heat-resistant base material 11, and the adhesive layer 12 formed on one surface thereof. In the present invention, the composition of the adhesive layer 12 is a feature thereof.

(Heat-resistant base material)

As the heat-resistant base material 11, a heat-resistant resin film, a metallic foil, etc., are preferably used.

In manufacturing a semiconductor device such as a QFN, the adhesive sheet 10 of the present invention is exposed to a high temperature of 150-250°C in a die-attach process, a wire-bonding process, and a sealing process with a molding resin.

In the case of using a heat-resistant resin film as the heat-resistant base material 11, the coefficient of linear expansion of the heat-resistant resin film will increase rapidly if it increases above the glass transition temperature (Tg), and since a thermal expansion difference with the metallic lead frame, etc., becomes large, there is a possibility that curvature may occur in the lead frame on which the adhesive sheet is adhered, when it is cooled to room temperature. When the curvature occurs in the lead frame on which the adhesive sheet is adhered, in the sealing process with a molding resin, the positioning pin of a metallic mold cannot be equipped with the lead frame, etc., so that a poor positioning may occur. Therefore, when using a heat-resistant resin film as the heat-resistant base material 11, the glass transition temperature of the heat-resistant film

is preferably not less than 150°C, and more preferably not less than 180°C. Moreover, since it is desirable that the thermal expansion difference with the metal lead frame, etc., be small, the coefficient of thermal expansion in 150-250°C of the heat-resistant resin film is preferably 5-50 ppm/°C, and more preferably 10-30 ppm/°C.

As such a heat-resistant resin film having these properties, a film made of polyimide, polyamide, polyether sulfon, polyphenylene sulfide, polyether ketone, polyether ether ketone, thoria cetyl cellulose, polyether imide, and the like can be exemplified.

When using a metallic foil as the heat-resistant base material 11, similarly, the coefficient of thermal expansion in 150-250°C of the metallic foil to be used is preferably 5-50 ppm/°C, and more preferably 10-30 ppm/°C. As such a metallic foil, a foil made of gold, silver, copper, platinum, aluminium, magnesium, titanium, chromium, manganese, iron, cobalt, nickel, zinc, palladium, indium, tin, and the like, the alloy foil which is made of these metals as the principal component or a plating foil, and the like being made therefrom can be exemplified.

Moreover, in order to prevent the adhesive residue in the adhesion sheet stripping process in manufacturing a semiconductor device of a QFN, etc., the ratio (adhesion intensity ratio) of the adhesion strength Sa between the heat-resistant base material 11 and the adhesive layers 12, and the adhesion strength Sb between the molding resin and the lead frame, etc./the adhesive layers 12, i.e., Sa/Sb is preferably not less than 1.5.

In the case in which Sa/Sb is less than 1.5, the adhesive residue may occur in the stripping process, and hence it is not preferred. It should be noted that, in order to make the adhesion intensity ratio Sa/Sb be not less than 1.5, when the heat-resistant base material 11 is a heat-resistant resin film, it is preferred to conduct a roughening treatment in advance on the surface thereof on which the adhesives layer 12 is to be formed, so as to heighten the adhesion strength Sa between the heat-resistant resin film and the adhesive layer, such as corona treatment, plasma treatment, primer processing, and sandblast processing. Although a metallic foil is classified into a rolling metallic foil and an electrolysis metallic foil, in order to make adhesion strength ratio Sa/Sb be not less than 1.5, it is preferred to use the electrolysis metallic foil and to form the adhesive layer 12 on the roughened surface. Moreover, the electrolysis copper foil is particularly preferred in an electrolysis metallic foil.

"Adhesive layer"

The adhesive layer 12 of the present invention contains a thermosetting resin (a) and a strippability imparting component (b) as essential ingredients, and preferably further contains a thermoplastic resin (c).

The thermosetting resin (a) is a component which gives good elasticity and a good adhesive property to the adhesives layer 12, and by blending this in manufacturing a QFN, etc., good wire-bonding properties and resin leakproof properties are obtainable. As the thermosetting resin, a urea resin, a melamine resin, a benzo-guanamine resin, an aceto guanamine resin, a phenol resin, a resol phenol resin, a xylene resin, a furan resin, an unsaturated polyester resin, a diallyl phthalate resin, an isocyanate resin, an epoxy resin, a maleimide resin, a nadimide resin, etc. can be exemplified. One sort may be independently used for these thermosetting resins, and they may use two or more sorts together.

In particular, an epoxy resin and/or a phenol resin are preferred, because the adhesives layer 12 containing these resins can maintain a high rate of elasticity under the processing temperature of a wire-bonding process, and a high adhesion strength between the base material and the lead frame, etc., under the processing temperature of a molding process.

The strippability imparting component (b) is a component which is to be blended in order to increase the strippability in the adhesive sheet stripping process in manufacturing a QFN, etc., and to prevent the adhesive residue. As the strippability imparting component (b), a non-denaturalizing silicone oil and a denaturation silicone oil, etc., can be exemplified.

As the non-denaturalizing silicone oil, a dimethyl polysiloxane type, a methyl hydrogen polysiloxane type, a methyl phenyl polysiloxane type, etc., can be exemplified. As the denaturation silicone oil, any of the reactant silicone oil which has relative reactivity to the thermosetting resin (a) or to both the thermosetting resin (a) and the thermoplastic resin (c), and the non-reactivity silicone oil which has no relative reactivity to these resins may be used.

As the former reactant silicone oil, an amino denaturation type, an epoxy denaturation type, a carboxyl denaturation type, a carbinol denaturation type, a methacrylic denaturation type, a mercapto denaturation type, a phenol denaturation type, etc., can be exemplified, on the other hand, a polyether denaturation type, a methyl styryl

denaturation type, an alkyl denaturation type, a fatty-acid-ester denaturation type, an alkoxy denaturation type, a fluorine denaturation type, etc., can be exemplified, as the latter non-reactive silicone oil.

One sort may be independently used for these silicone oils, and it may use two or more sorts together.

In particular, the denaturation silicone oil having relative reactivity to a thermosetting resin (a) or to both the thermosetting resin (a) and the thermoplastic resin (c) is preferred, because the above denaturation silicone oil is chemically bonded firmly to the thermosetting resin (a) or to both the thermosetting resin (a) and the thermoplastic resin (c) when the adhesive layer is formed therewith, such that cohesiveness is increased, and as a result, the adhesive component thereof is stripped off in one piece in the stripping process, whereby the adhesive residue can be inhibited at a very high level.

If the adhesive layer 12 contains both the thermosetting resin (a) and the strippability grant component (b), a part of the adhesive layer 12 can enter into the gaps between adjacent terminals formed on the lead frame or the wiring board and the like in manufacturing the QFN, etc., although the details about this will be explained later.

Furthermore, by compounding the thermoplastic resin (c) in the adhesive layer 12, flexibility is imparted, a part of adhesive layer 12 becomes easy to enter into the gaps of the lead frame or the wiring board, and the workability as an adhesive sheet is further improved.

As the thermoplastic resin (c), an acrylonitrile-butadiene copolymer (NBR), an acrylonitrile-butadiene-styrene resin (ABS), a styrene-butadiene-ethylene resin (SEBS), a styrene-butadiene-styrene resin (SBS), a polybutadiene, a polyacrylonitrile, a polyvinyl butyral, a polyamide, a polyamide imide, a polyimide, a polyester, a polyurethane, a poly dimethyl siloxane, etc., can be exemplified.

In these, especially a polyamide having amide combination, a polyamide imide, and an acrylonitrile-butadiene copolymer resin, etc., are preferred because these are excellent in heat-resistance. One sort may be independently used for these thermoplastic resins, and they may use two or more sorts together.

Moreover, the weight average molecular weight of the thermoplastic resin (c) is preferably 2,000-1,000,000, more preferably 5,000-800,000, and especially preferably 10,000-500,000.

By limiting weight average molecular weight of the thermoplastic resin (c)

within the above range, the cohesive force of the adhesives layer 12 can be increased, the adhesive residue in the adhesive sheet stripping process can be further inhibited, and hence it is preferred.

Although the amount of each of the components is not particularly limited, in the case of compounding the thermoplastic resin (c), the mass ratio ((a) /(c)) of the thermosetting resin (a) and the thermoplastic resin (c) is preferably not more than 3.5, more preferably 0.3-3.5, much more preferably 0.3-2.5, and especially preferably 1-2.5.

In the case in which the mass ratio of the components (a) and (c), i.e., ((a)/(c)) is over 3.5, the flexibility of the adhesives layer 12 may decrease. In the sealing process with a molding resin in manufacturing a QFN, etc., the adhesive strength of the adhesive sheet may decrease, such that the lead frame, etc., and the adhesive sheet may partially stripped from each other, which may cause the mold flash. Moreover, there is also a possibility that a part of the adhesive layer 12 may not enter into gaps of the lead frame, etc.

On the other hand, in the case that the mass ratio ((a)/(c)) is less than 0.3, the elastic modulus may decrease, which may cause a poor wire-bonding.

Moreover, the mass ratio (((a) + (c)) /(b)) of the resin component total amount (total amount of the thermosetting resin (a) and the thermoplastic resin (c)), and the strippability imparting component (b) is preferably 6-2,000, more preferably 10-1,000, regardless of the existence or the absence of the thermoplastic resin (c).

In the case that the mass ratio of the resin component total amount and the strippability imparting component (b) is less than 6, the adhesive strength between the lead frame , etc., and the adhesive sheet may decrease, and there is a possibility that the lead frame , etc., and the adhesive sheet may partially stripped from each other in the sealing process with a molding resin, which may cause a mold flash.

On the other hand, in the case that the mass ratio of the resin component total amount and the strippability imparting component (b) is over 2,000, the adhesive strength between the lead frame , etc., and the adhesive sheet increases, and there is a possibility that the adhesive residue may remain in the adhesive sheet stripping process.

In particular, this is remarkable in the case of performing a plasma cleaning of the lead frame in order to clean the surface of the lead frame before a wire-bonding process.

In the adhesive layer 12, other components may be added if needed in addition

to the above components (a) - (c).

For example, in order to adjust a coefficient of thermal expansion, heat conductivity, surface tackiness, an adhesive property, etc., it is preferred to add an inorganic or an organic filler.

Here, as the inorganic filler, ground type silica, melting type silica, alumina, titanium oxide, beryllium oxide, magnesium oxide, calcium carbonate, titanium nitride, silicon nitride, boron nitride, titanium boride, tungsten boride, silicon carbide, titanium carbide, carbonization zirconium, carbonization molybdenum, mica, zinc oxide, carbon black, aluminium hydroxide, a calcium hydroxide, magnesium hydroxide, antimony trioxide, etc., as an inorganic filler, or a substance in which a trimethylsiloxyl group , etc., is introduced to its surface can be exemplified.

As an organic filler, a filler made of polyimide, polyamide imide, polyether ether ketone, polyether imide, polyester imide, nylon, silicone, etc., can be exemplified. In the adhesive sheet 10 of the present invention, the minimum storage modulus in 150-250°C after heat curing of the adhesive layer 12 is preferably not less than 1 MPa, more preferably not less than 10 MPa, and especially preferably not less than 50 MPa.

In the adhesive sheet 10 of the present invention, the minimum storage modulus in 150-250°C after heat curing of the adhesive layer 12 is preferably not less than 1 MPa, more preferably not less than 10 MPa, and especially preferably not less than 50 MPa.

It should be noted that "after heat curing" corresponds to after heat treatment of a die-attach process, and the above temperature range is equivalent to the heat treatment temperature of a wire-bonding process.

In the wire-bonding process, in manufacturing a QFN, etc., a 60-120 kHz ultrasonic wave is impressed with heating at 150-250°C to weld the both ends of the bonding wire, such that the semiconductor device and the lead frame, etc., is electrically connected to each other through bonding wires.

At that time, since the adhesive layer 12 of the adhesive sheet 10 located directly under the lead frame, etc., is exposed to the above temperature, its elasticity decreases, and is liable to absorb ultrasonic waves, and as a result, the lead frame, etc., may vibrate, and poor wire-bonding may occur.

However, if the minimum storage modulus in the temperature of the wire-bonding process (that is, within a range of 150-250°C) is not less than 1 MPa, the adhesive layer 12 can maintain its high elasticity in the wire-bonding process, and as a

result, it is difficult to absorb ultrasonic waves and poor wire-bonding can be avoided.

It should be noted that a storage modulus is controllable by the mass ratio of the thermosetting resin (a) and the thermoplastic resin (c), etc. In order to make the minimum storage modulus in 150-250°C be not less than 1 MPa, for example, it can be achieved by, for example, making the mass ratio of the thermosetting resin (a) and the thermoplastic resin (c) be not less than 0.3, although it depends on the kind of resin.

Although the manufacturing method of the adhesive sheet 10 of the present invention is not particularly limited, a casting method and a laminating method are preferred. In the casting method, the adhesive composition containing the thermosetting resin (a), the strippability imparting component (b), the thermoplastic resin (c) and other components if necessary is prepared, and then the adhesive composition is directly applied onto the heat-resistant base material 11, and dried to form the adhesive layer 12.

In the laminating method, the above adhesive composition is once applied to a releasable film, and is dried to form the adhesive layer 12, and thereafter, the adhesive layer is made to be transferred onto the heat-resistant base material 11.

It should be noted that, in view of paintablity, etc., it is preferred to prepare the adhesive composition by dissolving the thermosetting resin (a), the strippability imparting component (b), and if necessary the thermoplastic resin (c) into an organic solvent for more than 1 weight % respectively, preferably for more than 5 weight %.

As an organic solvent to be used, aromatic types such as toluene and xylene, ketone types such as acetone, methyl ethyl ketone, and methyl isobutyl ketone, non-proton types such as dimethyl formamide, dimethyl acetamide, and N-methyl -pyrolidone, and tetrahydrofuran, etc., can be exemplified. One sort may be independently used for these organic solvents, and they may use two or more sorts together.

In the adhesive sheet 10 of the present invention, a releasable protection film (not shown) may be formed over the adhesive layer 12, such that the protection film is released just before the semiconductor device is manufactured. In this case, damage to the adhesive layer 12 can be avoided after the adhesive sheet 10 is manufactured and before being used. As long as it is a film having releasable properties as the protection film, any type of film may be used, but films such as polyester, polyethylene, polypropylene, and polyethylene terephthalate, the film of which surface is processed to

be releasable with a silicone resin or a fluorine compound can be exemplified.

Since the adhesive layer 12 contains the strippability imparting component (b), the adhesive sheet 10 of the present invention is excellent in the strippability of the adhesive layer 12. Therefore, even if the thickness of the adhesive layer 12 is increased to be larger than before, in manufacturing a semiconductor device of a QFN, etc., in the adhesion sheet stripping process of stripping the adhesive sheet 10 from the lead frame, etc., the adhesive sheet 10 can be stripped smoothly and there is no possibility that the adhesive residue will remain.

Thus, since there is no fear of the adhesive residue remaining even if the adhesive layer 12 is thicker than before, the adhesive layer 12 can be thicker than before. As a result, when the adhesive sheet 10 of the present invention is adhered to the lead frame, etc., a part of the adhesive layer 12 can enter into the gaps between adjacent terminals formed on the lead frame and the like. Although the thickness of the adhesive layer 12 is not particularly limited, not less than 6 micrometers is preferred, and not less than 8 micrometers is especially preferred.

By specifying the thickness of the adhesive layer 12 to be not less than 6 micrometers, a part of the adhesive layer 12 can always enter into the gaps formed on the lead frame, etc., in a sufficient depth, concretely to a depth of not less than 2 micrometers, whereby a semiconductor device of which the tip end of the external connecting terminal is projected from the molding resin bottom by not less than 2 micrometers can be provided.

Furthermore, since a part of the adhesive layer 12 can be made to enter into the gaps formed on the lead frame and the like, the adhesion strength between the adhesive sheet 10 and the lead frame, etc., can be remarkably improved.

Therefore, there is also no possibility that mold flash will occur in the sealing process with the molding resin.

That is, the adhesive sheet 10 of the present invention possesses both a high adhesion strength and a high strippability, each of which is antinomic to each other.

Since the adhesive layer 12 of the adhesive sheet 10 of the present invention contains the thermosetting resin (a), in the wire-bonding process, the adhesive layer 12 maintains high elasticity so that the adhesive sheet 10 of the present invention does not have a possibility of causing a poor wire-bonding.

"The semiconductor device and the manufacturing method thereof"

Next, based on FIG. 2 and FIG. 3, one embodiment of the manufacturing method of the semiconductor device using the adhesive sheet of the present invention will be explained.

Hereafter, the case where two or more QFN(s) are simultaneously manufactured as a semiconductor device is explained as an example. It should be noted that FIG. 2 is a plan view of the lead frame viewed from the side on which a semiconductor element is to be mounted, and FIGS. 3A – 3F are the A-A' sectional views of the QFN in the middle of manufacture.

First, the lead frame 20 having the structure as shown in FIG. 2 is prepared. That is, the lead frame 20 is equipped with a plurality of the semiconductor element mounting portions (die-pad portion) 21 having an island-like shape, on which semiconductor elements, such as IC chips, are mounted, and numerous leads 22 formed along the periphery of each semiconductor element mounding portions 21.

Next, as shown in FIG. 3A, the adhesive sheet 10 of the present invention is strippably adhered to one surface of the lead frame 20, so that the adhesive layer 12 side comes to the lead frame 20 side (adhesive sheet adhering step) . As the method of adhering the adhesive sheet 10 to the lead frame 20, a heat laminating method, a heat pressing method, etc., are suitable.

As shown in FIGS.3A and 3B, in this step of the present invention, a part of the adhesive layer 12 can be made to enter into the gap formed on the lead frame 20 in a depth of not less than 2 micrometers (i.e., the gaps between the adjacent two leads 22, and between the semiconductor element mounting portion 21 and the lead 22).

Next, as shown in FIG. 3B, the semiconductor elements 30, such as an IC chip, are mounted to the semiconductor element mounting portion 21 of the lead frame 20 using a die-attach agent (not shown) from the side on which the adhesive sheet 10 is not adhered

"die-attach process".

Plasma cleaning is performed on the lead frame 20 on which the semiconductor element 30 is mounted, if needed.

Plasma cleaning is performed prior to the wire-bonding process, in order to prevent an outgas component from depositing on the surface of the lead frame 20. That is, the out gas component is generated from the adhesive sheet 10 and the die-attach agent, etc., through the heat history the lead frame suffers after mounting the semiconductor

element and just before the wire-bonding process. If the outgas component is deposited on the surface of the lead frame 20, a poor electrical connection may occur in the wire-bonding process, such that the yield will decrease.

Next, as shown in FIG. 3C, the semiconductor element 30 and the lead 22 of the lead frame 20 are electrically connected to each other through the bonding wires 31 made of a gold wire, (wire-bonding process). Furthermore, as shown in FIG. 3D, the lead frame 20 and the semiconductor element 30 are sealed with the molding resin 40 by laying the QFN in the middle of the manufacture shown in FIG. 3C in a resin molding die, and carrying out a transfer molding (die-molding) using the molding resin (molding material). (resin molding process).

Next, as shown in FIG. 3E, the adhesive sheet 10 is stripped from the molding resin 40 and the lead frame 20 (adhesive sheet stripping process) to obtain the QFN unit in which a plurality of the QFNs 50 are arranged.

Finally as shown in FIG. 3F, the QFN unit is diced along each periphery of the QFNs 50 (dicing process) to produce a plurality of the QFNs 50. Since the QFN50 is manufactured using the above adhesive sheet 10 of the present invention according to the above manufacturing method, there is no possibility that poor wire-bonding, mold flash, and the adhesive residue may occur.

Moreover, in the adhesive sheet adhering step, since a part of the adhesive layer 12 can be made to enter into the gap of the lead frame 20, as shown in FIG. 3F, the QFN50 of which the tip end of the lead 22 as the external connecting terminal is projected by not less than 2 micrometers from the molding resin 40 bottom is obtained. The B-B' cross section (the B-B' line is shown in FIG. 2) of the QFN50 is shown in FIG. 4A.

This figure shows that the leads are arranged in a predetermined pitch.

If the solder ball 60 is attached to the QFN50 shown in FIG. 4A, as shown in FIG. 4B, the solder ball 60 can be adhered in three dimension fashion so that the lead 22 may be wrapped with the solder ball 60 ranging over the side from the bottom of the lead 22 which is the external connecting terminal.

Therefore, the solder ball 60 will be adhered to the lead 22 which is an external connecting terminal more firmly as compared with the conventional QFN, and the mounting strength upon mounting in the wiring board, etc., can be remarkably improved. As a result, mounting reliability, such as the bending strength of the wiring board, can be

remarkably improved.

In addition, since a part of the lead 22 is projected from the molding resin 40 bottom, the space between the lead frame 20 (the molding resin 40) bottom and the wiring board 70 can be wider compared with the traditional one. Therefore, as shown in FIG. 4C, even if foreign matter 71 (for example, adhering matter, such as dust, and a part where wiring, etc., buckled parting in response to mechanical damage) is present on the wiring board 70, since the height of the foreign matter 71 is compensated by the projected portion of the lead 22 and the height of the solder ball 60, the solder ball 60 can be in good contact with the wiring board 70.

Therefore, the poor electrical connection and the stripping of the solder ball 60 from the wiring board 70 resulting from the existence of the foreign matter 71 can be remarkably inhibited.

As explained above, according to the present invention, an adhesive sheet for manufacturing a semiconductor device which has, in manufacturing the QFN, no poor wire-bonding, no mold flash, no fear of the adhesive residue remaining, capability of increasing the mounting strength to the wiring board of QFN and the mounting reliability can be provided.

Moreover, a QFN and the manufacturing method thereof, which has a high mounting strength to the wiring board, etc., and an excellent mounting reliability can be provided.

It should be noted that, although the above embodiment is explained as the example of application to a manufacture of QFN using the lead frame, the present invention can be applied to any semiconductor device of any structure, as long as it has the semiconductor elements mounted to its semiconductor element mounting portions formed on the lead frame or the wiring board and which is sealed with the molding resin.

Next, although the present invention will be explained further by a working example and a comparative example, these do not limit the present invention at all.

"Working Examples 1-5"

The components shown in Table 1 were mixed at the mass ratio shown in Table 1 under a tetrahydrofuran solvent to prepare the adhesive composition. It should be noted that, in Table 1, the mass ratio (((a) + (c)) /(b)) of the resin component total amount (total amount of the thermosetting resin (a) and the thermoplastic resin (c)) and the strippability imparting component (b) and the mass ratio ((a) /(c)) of (the thermosetting

resin(a)) / the thermoplastic resin (c) are also indicated (the same may be said in the comparative example).

Next, after applying the above adhesive composition, using a polyimide resin film (trade name: KAPTON 100EN, which is produced by Du Pont-Toray Co., Ltd., the thickness of 25 micrometers, the glass transition temperature of not less than 300°C, coefficient of thermal expansion of 16 ppm/°C) as the heat-resistant base material, so that the thickness after drying thereon may be 10 micrometers, the resultant film was dried for 5 minutes at 120°C to obtain an adhesive sheet of the present invention.

"Comparative Example 1"

The components shown in Table 1 were mixed at the mass ratio shown in Table 1 under a tetrahydrofuran solvent to prepare an adhesive composition. Then an adhesive sheet for comparison was formed by the same process as in the working examples excepting that, in forming the adhesive layer, the adhesive composition was applied to the film, so that the thickness after drying would be 5 micrometers.

"Comparative Example 2"

The components shown in Table 1 were mixed at the mass ratio shown in Table 1, in the toluene solvent to prepare the adhesive composition.

Next, the adhesive composition was applied to the same heat-resistant base material as in the working examples so that the thickness after drying would be 5 micrometers, then the resultant sheet was dried for 5 minutes at 160°C to obtain an adhesive sheet for comparison.

"Comparative Example 3"

An adhesive sheet was obtained by the same process as in the Comparative Example 1 excepting that the components shown in Table 1 were mixed at the mass ratios shown in Table 1 under a tetrahydrofuran solvent to prepare an adhesive composition.

It should be noted that, the symbols in Table 1 indicate the following components.

(A1): An epoxy resin (trade name "AT-501" produced by DAICEL CHEMICAL INDUSTRIES CO., LTD., weight average molecular weight 120,000),

(A2) : An epoxy resin (trade name "EPKOTE 828" produced by JAPAN EPOXY RESINS CO., LTD.),

(A3): An epoxy resin (trade name "EPKOTE 604" produced by JAPAN EPOXY

RESINS CO., LTD.),

(A4): An epoxy resin (trade name "HP-7200" produced by DAINIPPON INK AND CHEMICALS, INC.),

(A5): A phenol resin (trade name "TPM" produced by NIPPON KAYAKU CO., LTD.),

(A6): A phenol resin (trade name "CKM-2400" produced by SHOWA HIGH POLYMER CO., LTD.),

(B1): Denaturated silicone oil trade name "XC-96-A4464" produced by GE Toshiba Silicones Co., Ltd.,

(B2): A denaturated silicone oil (trade name "KF-105" produced by Shin-Etsu Chemical Co., Ltd.),

(B3): A denaturated silicone oil (trade name "KF-861" produced by Shin-Etsu Chemical Co., Ltd.),

(C1): An acrylonitrile butadiene rubber (trade name "Nipol 1001" produced by Nippon Zeon Co., Ltd., weight average molecular weight 30,000),

(C2) : A polyamide resin (trade name "Macro Melt 6238" produced by Henkel Japan Co., Ltd.),

(C3): A styrene-butadiene-styrene resin (trade name "Tuftec M1911" produced by Asahi Kasei Co., Ltd., weight average molecular weight 110,000),

(C4): A polyimide resin (produced by Tomoegawa Paper Co., Ltd., siloxane containing aromatic group polyimide, weight average molecular weight 50,000),

(C5): A polyalkenyl siloxane/poly alkyl hydrogen siloxane mixture solution (trade name "X40-3103" produced by Shin-Etsu Chemical Co., Ltd.),

(D1): A hardening accelerator (produced by Shikoku Chemicals Corporation 2-ethyl 4-methyl imidazole),

(D2): A platinum catalyst solution (trade name "PL 50T" produced by Shin-Etsu Chemical Co., Ltd.).

(evaluation)

Evaluation criteria and an evaluation method were as follows.

<Storage modulus>

After applying the adhesive composition or sticky composition prepared in each example on a mold releasing film to form a sheet, the resultant sheet was dried under the same condition as in manufacturing the above adhesive sheet or the above sticky sheet, thereafter the resultant sheet was heat-treated under the same conditions as in the

die-attach process, i.e., at 175°C for 2 hours, to prepare a mold releasing film with an adhesive layer or a sticky layer. It should be noted that, after-drying thickness of the mold releasing film having an adhesive layer or a sticky layer was set to be 0.1 mm.

The obtained mold releasing film having an adhesive layer or a sticky layer was cut into 5 mm x 30 mm, the frequency was set to be 11Hz, the heating rate was set to be 3°C /min, and the storage modulus within the limits of 150-250°C was measured, using an elastic-modulus measurement apparatus (trade name "LEOVIBRON DDV-II" produced by ORIENTECH CO., LTD.). The minimum storage modulus of this temperature within the limits was obtained.

"Poor wire-bonding"

The adhesion sheet or sticky sheet obtained in each example was adhered to a lead frame having an outer size 200 mm x 60 mm for QFN (an Au-Pd-nickel plating Cu lead frame, 4x16 matrix arrangement (a total of 64 pieces), package size 10 mm x 10 mm, 84 pins) through a laminating method. Subsequently, after mounting a dummy chip (6 mm x 6mm, thickness of 0.4mm) on which an aluminium was vapor-deposited to the semiconductor element mounting portion of the lead frame using an epoxy type die-attach agent, the dummy chip and the lead were electrically connected to each other through a gold wire, using a wire-bonder (trade name "UTC-470BI" manufactured by SHINKAWA CO., LTD.), in the condition that load was used to be 0.59N, processing time was used as 10 msec / pin for the heating temperature of 210°C, and US POWER was 30.

Thereafter, 64 pieces of obtained packages were inspected and the number of packages having poor lead side connection was detected as the generating number of the poor wire-bonding.

"Mold flash"

Mold flash was evaluated using the lead frame after the wire-bonding evaluation was finished. Using an epoxy type molding resin (a biphenyl epoxy type, filler 85% content), 180°C and a pressure were set to be10 MPa, processing time was set for heating temperature for 3 minutes, and the dummy chip was sealed with the molding resin through a transfer molding (die-molding process). Thereafter, 64 pieces of packages after the sealing with the molding resin were inspected and the package number of which molding resin is leaked to the portion for lead terminal external connection (surface at the side of the adhesive sheet or the sticky sheet of the lead), and adhered to it was detected

as the generating number of mold flash.

"Adhesive residue"

From the lead frame sealed with the molding resin of which mold flash is evaluated, the adhesive sheet or the sticky sheet was stripped off on condition of stripping rate of 500 mm/min.

64 pieces of packages after the adhesive sheet or sticky sheet was stripped therefrom were inspected, and the number of the packages on which the stripped side surface the adhesive remained (the portion for lead terminal external connection, a resin molded side, etc.) was determined as the number of the adhesive residue remaining.

"Amount of projection of the tip end of the lead"

The amount of projection of the tip end of the lead from the molding resin bottom was measured using the lead frame used for evaluating the adhesive residue. That is, using a surface coarseness meter (the trade name of "SURFCOM 110B" manufactured by Tokyo Seimitsu Co., Ltd.), about 64 pieces of packages after stripping the adhesive sheet or sticky sheet therefrom, the vertical difference between the external connection side tip end of the lead and the bottom of the molding resin was measured, and the average was calculated.

Moreover, although the thickness of the adhesive layer was 10 micrometers and thicker than a traditional one, the adhesive residue did not remain at all. Furthermore, the amount of projection of the tip end of the lead which is the external connecting terminal from the molding resin bottom was not less than 2 micrometers, so that a high reliability in mounting is established, that is, in mounting the obtained semiconductor element to the wiring board, etc., the solder can be made to adhered in a 3 dimensional fashion so as to cover the lead extending from the bottom to the side surface of the lead.

In contrast, in the Comparative Examples 1 and 3 in which the adhesive composition was not compounded in the strippability imparting component (b), although the storage modulus of the adhesive layer was good, and poor wire-bonding and mold flash did not occur in manufacturing a semiconductor device, despite the thickness of the adhesive layer being 5 micrometers, which is thinner than working examples, large amount of adhesive residue remained. In the Comparative Example 2 in which the adhesive composition was prepared without compounding the thermosetting resin (a) and the strippability imparting component (b), the storage modulus of the adhesive layer was

remarkably low, much poor wire-bonding and mold flash occurred in manufacturing the semiconductor device, and also much adhesive residue remained. Moreover, each semiconductor device obtained by comparative examples 1-3 did not have the projections of the tip end of the lead from the molding resin bottom, and their mounting reliabilities were low.

Table 1

		WORKING EXAMPLE 1	WORKING EXAMPLE 2	WORKING EXAMPLE 3	WORKING EXAMPLE 4	WORKING EXAMPLE 5	COMPARATIVE EXAMPLE 1	COMPARATIVE EXAMPLE 2	COMPARATIVE EXAMPLE 3
THERMOSETTING RESIN (a)	A1	40							
	A2		30				30		
	A3				20	30			
	A4			40					40
	A5	60	30						20
	A6			20	40	30	30		
STRIPPABILITY IMPARTING COMPONENT (b)	B1	4							
	B2		3.5			4			
	B3			3.5	3.5				
THERMOPLASTIC RESIN (c)	C1		40			40	40		
	C2			40					
	C3				40				
	C4								40
	C5							100	
OTHERS	D1	1	1	1	1	1	1		1
	D2							2	
((a)+(c))/(b)		25	28.57	28.57	28.57	25			
(a)/(c)			1.5	1.5	1.5	1.5	1.5		1.5

Table 2

	MINIMUM STORAGE MODULUS (MPa)	POOR WIRE-BONDING (PIECES)	RESIN LEAKAGE (PIECES)	ADHESIVE RESIDUE (PIECES)	AMOUNT OF PROJECTION OF THE LEAD TIP END (μm)
WORKING EXAMPLE 1	20	0	0	0	6
WORKING EXAMPLE 2	40	0	0	0	4
WORKING EXAMPLE 3	50	0	0	0	3
WORKING EXAMPLE 4	45	0	0	0	4
WORKING EXAMPLE 5	40	0	0	0	2
COMPARATIVE EXAMPLE 1	30	0	0	12	0
COMPARATIVE EXAMPLE 2	0.05	30	12	64	0
COMPARATIVE EXAMPLE 3	20	0	0	11	0

The adhesive sheet for manufacturing a semiconductor device of the present invention is applicable for manufacturing a semiconductor device of a QFN, etc. The semiconductor device of the present invention and the manufacturing method thereof are preferably applicable to the semiconductor device of a QFN, etc.

While preferred embodiments of the invention have been described and illustrated above and it should be understood that these are exemplary of the invention and are not to be considered as limiting. Additions, omissions and substitutions, and other modifications can be made without departing from the spirit or scope of the present invention. Accordingly the invention is not to be considered as being limited by the foregoing description, and is only limited by the scope of the appended claims.

What is claimed is:

1. An adhesive sheet strippably adhered to a lead frame or a wiring board, for manufacturing a semiconductor device, comprising:

an adhesive layer on one surface thereof and a heat-resistant base material,

wherein the adhesive layer contains a thermosetting resin (a) and a strippability imparting component (b).

2. An adhesive sheet for manufacturing a semiconductor device as set forth in claim 1, wherein the adhesive layer further contains a thermoplastic resin (c).

3. An adhesive sheet for manufacturing a semiconductor device as set forth in claim 1, wherein the strippability imparting component (b) is a silicone oil.

4. An adhesive sheet for manufacturing a semiconductor device as set forth in claim 1, wherein the adhesive layer contains the strippability imparting component (b) which is chemically bonded with the thermosetting resin (a) or both the thermosetting resin (a) and the thermoplastic resin (c).

5. An adhesive sheet for manufacturing a semiconductor device as set forth in claim 1, wherein the adhesive layer has a minimum storage modulus at 150-250°C after heat curing of not less than 1 MPa.

6. An adhesive sheet for manufacturing a semiconductor device as set forth in claim 1, wherein the heat-resistant base material is a heat-resistant resin film having a glass transition temperature of not less than 150°C and a coefficient of thermal expansion of 5-50 ppm/°C.

7. An adhesive sheet for manufacturing a semiconductor device as set forth in claim 1, wherein the heat-resistant base material is a metallic foil having a coefficient of thermal expansion of 5-50 ppm/°C.

8. An adhesive sheet for manufacturing a semiconductor device as set forth in claim 1,

wherein the adhesive layer has a protecting film on the surface opposite to the surface facing the heat-resistant base material.

9. An adhesive sheet strippably adhered to a lead frame or a wiring board, for manufacturing a semiconductor device, comprising:

an adhesive layer on one surface thereof and a heat-resistant base material,

wherein a part of the adhesive layer enters into gaps formed on the lead frame and/or the wiring board upon being adhered to the lead frame or the wiring board.

10. An adhesive sheet for manufacturing a semiconductor device as set forth in claim 9, wherein the adhesive layer has a thickness of not less than 6 micrometers and the adhesive layer enters into gaps formed on the lead frame or wiring board in depth of not less than 2 micrometers upon being adhered to the lead frame or the wiring board.

11. A semiconductor device comprising:

a lead frame or a wiring board having semiconductor element mounting portions and external connecting terminals, and

at least one semiconductor element mounted on the semiconductor element mounting portions and sealed with a molding resin,

wherein the external connecting terminals are projected from the molding resin bottom.

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

adhering strippably the adhesive sheet for manufacturing a semiconductor device as set forth in claim 1 to a lead frame or a wiring board having semiconductor mounting portions such that a part of an adhesive layer enters into gaps formed on the lead frame or the wiring board;

mounting semiconductor elements on the semiconductor mounting portions to electrically connect the semiconductor elements with external connecting terminals of the lead frame or the wiring board;

sealing the lead frame or the wiring board and the semiconductors with a molding resin; and

stripping the adhesive sheet for manufacturing a semiconductor device from the lead frame or the wiring board.