

DESCRIPTION

Title of the Invention

ADHESIVE SHEET FOR PRODUCING SEMICONDUCTOR DEVICE AND
5 PRODUCTION METHOD FOR SEMICONDUCTOR DEVICE USING THE SAME

TECHNICAL FIELD

[0001]

The present invention relates to an adhesive sheet suitably used as a masking
10 tape at the time of assembling a semiconductor device by a QFN (Quad Flat Non-lead)
method, and a method of producing a semiconductor device using the same.

Priority is claimed on Japanese Patent Application No. 2017-017490, filed on
February 2, 2017 in Japan, the content of which is incorporated herein by reference.

15 BACKGROUND ART

[0002]

In recent years, the need for further high-density mounting technology in
semiconductor devices (semiconductor packages) is increasing in response to the demand
for miniaturization, thinning, and multifunctionalization of IT devices such as mobile
20 phones.

As a CSP (Chip Size Package) technology that meets the requirement mentioned
above, the QFN method has attracted attention (see Patent Document 1 and Patent
Document 2), and is widely adopted particularly in a lesser pin type of 100 pins or less.

[0003]

25 Here, as a general method of assembling a QFN package by means of the QFN

method, the following method is generally known. First, an adhesive sheet is adhered to one surface of a lead frame in an adhering step, and subsequently, in a die-attaching step, a semiconductor element such as an IC chip is mounted on each of semiconductor element-mounting portions (die pad portions) formed in a plurality on the lead frame.

5 Next, in a wire bonding step, the plurality of leads disposed along the outer periphery of each semiconductor element-mounting portion of the lead frame and the semiconductor elements are electrically connected by means of bonding wires. Next, in a sealing step, the semiconductor elements mounted on the lead frame are sealed with a sealing resin.

Thereafter, in a releasing step, the adhesive sheet is released from the lead
10 frame, and thereby, a QFN unit in which a plurality of QFN packages are arranged can be formed. Finally, a plurality of QFN packages can be manufactured by dicing this QFN unit along the outer periphery of each QFN package in a dicing process.

[0004]

In the adhesive sheet used for such applications, it is required that the adhesive
15 sheet is sufficiently and stably adhered to the back surface of the lead frame and the back surface of the sealing resin without peeling off therefrom before the releasing step, and can be easily released in the releasing step, and there is no disadvantage such as adhesive residue in which the adhesive remains on the back surface of the lead frame and the back surface of the sealing resin, and breakage of the adhesive sheet.

20 Particularly in recent years, lead frames formed from a copper alloy have come to be used in order to reduce the cost of semiconductor devices. The lead frame formed from such a copper alloy also has a catalytic action of the oxidative degradation with respect to the polymer material of copper which is the transition metal, and the adhesive is easily oxidatively degraded due to the heat hysteresis in accompany with assembling
25 of the QFN packages after the taping step. In addition, at the time of releasing the

sheet, heavy peeling and adhesive residue likely occur.

[0005]

However, the adhesive sheets conventionally used were not sufficiently satisfying the practical level that can be used for a lead frame formed from a copper alloy.

For example, a conventional adhesive sheet may be in the form in which an adhesive layer containing an acrylonitrile-butadiene copolymer and a bismaleimide resin is laminated on a substrate formed from a heat resistant film (see Patent Document 3).

In the case of using this adhesive sheet, there are problems that the acrylonitrile -

butadiene copolymer was easily deteriorated due to the heat applied in the die-attach curing treatment after the taping step, in the wire bonding step, and in the resin sealing step, and thereby, during the releasing step, the adhesive sheet may be hardly released, the adhesive sheet may be broken or an adhesive residue may be exhibited.

15 PRIOR ART LITERATURE

Patent Documents

[0006]

[Patent Document 1] Japanese Unexamined Patent Application, First Publication No. 2003-165961

[Patent Document 2] Japanese Unexamined Patent Application, First Publication No. 2005-142401

[Patent Document 3] Japanese Unexamined Patent Application, First Publication No. 2008-095014

25 DISCLOSURE OF INVENTION

Technical Problem

[0007]

The present invention has been completed in view of the circumstances mentioned above. An objective of the present invention is to provide an adhesive sheet,
5 which sufficiently and stably adheres to the back surface of a lead frame and the back surface of a sealing resin without peeling off therefrom, before the releasing step, even under the heat hysteresis in accompany with assembling of the QFN, which does not exhibit leakage of the sealing resin, which can be easily released in the releasing step, and which does not cause an adhesive residue or breakage, and also provide a method of
10 producing a semiconductor device using the same.

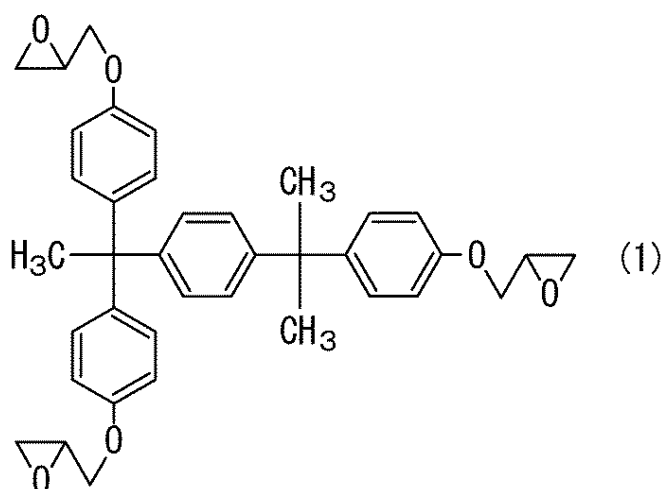
Solution to Problem

[0008]

An adhesive sheet for producing a semiconductor device of the present
15 invention, which includes a substrate, and a thermo-setting type adhesive layer provided on one surface of the substrate mentioned above, and which is to be releasably adhered to a wiring substrate or a lead frame of the semiconductor device, is characterized in that the adhesive layer mentioned above contains (a) a carboxyl group-containing acrylonitrile – butadiene copolymer, (b) an epoxy resin having the following structural
20 formula (1), (c) a compound having two or more maleimide groups, and (d) a reactive siloxane compound.

[0009]

[Chem. 1]



[0010]

In addition, the aforementioned component (a) is preferably a carboxyl group-containing acrylonitrile-butadiene copolymer having an acrylonitrile content of from 5 to 50% by mass and a carboxyl group equivalent amount calculated from the number average molecular weight of from 100 to 20,000.

[0011]

It is preferable that the total of the component (b), the component (c) and the component (d) mentioned above range from 30 to 300 parts by mass with respect to 100 parts by mass of the component (a).

In addition, the mass ratio of the component (c) to the component (b) ((c) / (b)) is preferably in the range of from 0.1 to 10.

In addition, the ratio of the number of reactive groups of the component (d) to the total number of epoxy groups of the component (b) and the number of maleimide groups of the component (c) preferably ranges from 0.05 to 1.2.

In addition, a method for producing a semiconductor device according to the present invention is a method for producing a semiconductor device using the adhesive sheet for producing a semiconductor device described above, wherein the production

method is characterized by including:

an adhering step of adhering the adhesive sheet for producing a semiconductor device to a lead frame or a wiring substrate,

5 a die attaching step of mounting a semiconductor element on the lead frame or the wiring substrate,

a wire bonding step of electrically connecting said semiconductor element to an external connection terminal,

a sealing step of sealing the semiconductor element mentioned above with a sealing resin, and

10 a releasing step of releasing the adhesive sheet for producing a semiconductor device from the lead frame or the wiring substrate after the sealing step.

Advantageous Effects of the Invention

[0012]

15 According to the present invention, an adhesive sheet can be provided, which sufficiently and stably adheres to the back surface of a lead frame and the back surface of a sealing resin without separating therefrom, before the releasing step, even under the heat hysteresis in accompany with assembling of the QFN, which does not exhibit leakage of the sealing resin, which can be easily released in the releasing step, and which
20 does not cause an adhesive residue or breakage. According to the present invention, a method for producing a semiconductor device using the same can be provided.

BRIEF DESCRIPTION OF DRAWINGS

[0013]

25 Fig. 1 is a plan view which shows an example of a lead frame for use in a

method for producing a semiconductor device of the present invention.

Fig. 2 is a step drawing which shows a method for producing a semiconductor device of the present invention.

5 EMBODIMENTS OF THE INVENTION

[0014]

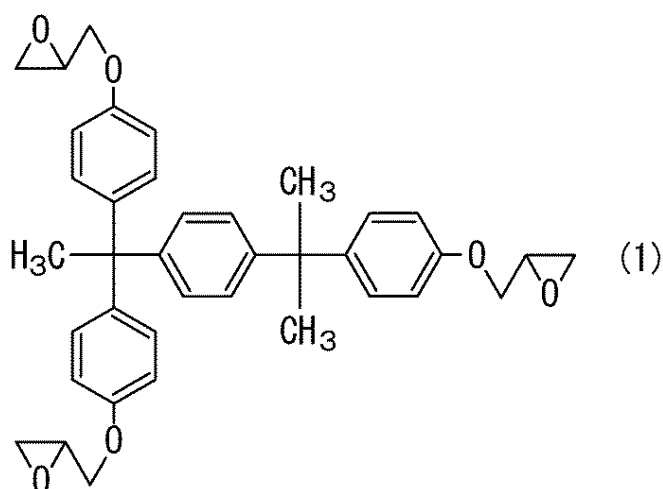
Hereinafter, the present invention is described in detail.

[Adhesive Sheet for Producing a Semiconductor Device]

10 The adhesive sheet for producing a semiconductor device of the present invention (hereinafter referred to as an adhesive sheet) is provided with a substrate and a thermosetting adhesive layer provided on one side of the substrate, and is releasably adhered to a lead frame or a wiring substrate of a semiconductor device. In the adhesive sheet, the adhesive layer has a carboxyl group-containing acrylonitrile-butadiene
15 copolymer (a), an epoxy resin (b) having a structural formula (1) described below, a compound (c) containing two or more maleimide groups, and a reactive siloxane compound (d). The adhesive sheet is used as a masking tape at the time of assembling a semiconductor device according to the QFN method.

[0015]

20 [Chem. 2]



[0016]

The carboxyl group-containing acrylonitrile-butadiene copolymer (a) plays a role of appropriately maintaining the melt viscosity of the adhesive layer at the initial stage of heating, and at the same time, imparts good flexibility and adhesiveness to the cured adhesive layer. Due to the copolymer (a) included, it is possible to form an adhesive layer having good adhesion to a substrate made of a heat resistant film or the like and having no cracks. As the carboxyl group-containing acrylonitrile-butadiene copolymer (a), any known one can be used without limitation, one having an acrylonitrile content of from 5 to 50% by mass is preferable, and one having an acrylonitrile content of from 10 to 40% by mass is more preferable. If the acrylonitrile content is below the range mentioned above, the solubility in a solvent and the compatibility with other components are reduced, and for this reason, the uniformity of the obtained adhesive layer tends to be reduced. On the other hand, if the acrylonitrile content exceeds the range mentioned above, the adhesive layer obtained has an excessive adhesion to the lead frame or the sealing resin, and in the case of using this for the adhesive sheet, releasing in the releasing step becomes difficult, or the adhesive sheet may be broken.

[0017]

The carboxyl group equivalent amount calculated from the number average molecular weight of the carboxyl group-containing acrylonitrile-butadiene copolymer is preferably in the range of from 100 to 20,000, and more preferably in the range of from 200 to 10,000. If the carboxyl group equivalent amount is below the range mentioned above, the reactivity with other components becomes too high, and the storage stability of the resulting adhesive layer tends to be reduced. On the other hand, if the carboxyl group equivalent amount exceeds the range mentioned above, the reactivity with other components is insufficient, and for this reason, the obtained adhesive layer is likely to have a low B-stage. As a result, in the case of using this copolymer in an adhesive sheet, the viscosity of the adhesive layer is lowered when the adhesive sheet is heated in the initial stage of heating, that is, in the adhering step of the adhesive sheet, the die-attach curing treatment, and the like. Thereby, the adhesive layer tends to foam or flow out, and the thermal stability tends to be reduced.

The carboxyl group equivalent amount calculated from the number average molecular weight is a value obtained by dividing the number average molecular weight (Mn) by the number of carboxyl groups (the number of functional groups) per molecule, and is represented by the following equation:

$$\text{Carboxyl group equivalent amount} = \text{Mn} / \text{number of functional groups}$$

[0018]

The epoxy resin (b) and the compound (c) containing two or more maleimide groups are responsible for the thermosetting property of the adhesive layer. By means of using these components in combination, the superior thermal stability is exhibited. In addition, an adhesive layer, which can be easily released and does not cause adhesive residue or breakage, can be formed. In particular, the epoxy resin (b) imparts toughness

to the adhesive layer, and by means of containing this resin, it is possible to suppress the adhesive residue caused by cracking of the adhesive layer in the releasing step.

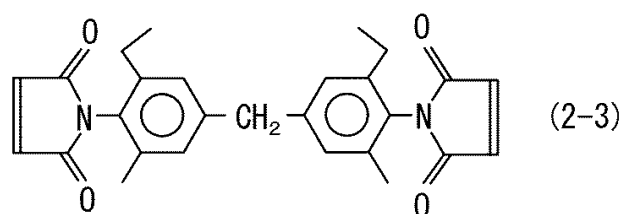
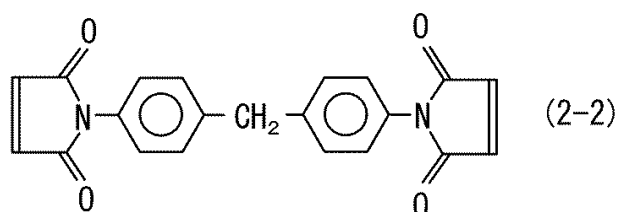
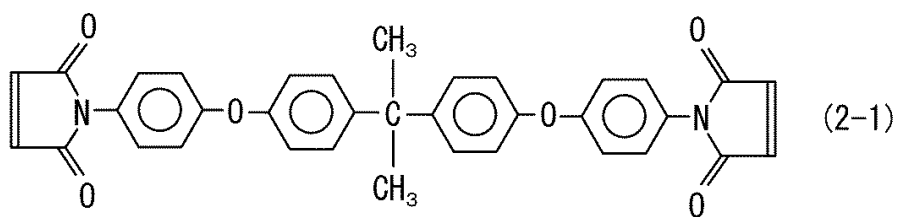
[0019]

The compound (c) containing two or more maleimide groups imparts thermal
5 stability to the adhesive layer and, at the same time, exhibits functions to adjust the adhesiveness of the adhesive layer. By means of including this compound, the adhesiveness can be appropriately controlled. Thereby, an adhesive layer that can be easily released in the releasing step can be formed.

As a specific example of the compound (c) containing two or more maleimide
10 groups, a compound constituting a bismaleimide resin is preferably used, and those represented by the following formulae (2-1) to (2-3) can be mentioned. Among these, the compound represented by the following formula (2-1) or (2-3) is particularly useful in view of solubility in a solvent.

[0020]

15 [Chem. 3]



[0021]

The reactive siloxane compound (d) is used for enhancing the compatibility of
 5 each component constituting the adhesive layer, and at the same time for improving the
 releasability of the adhesive layer from the sealing resin. By means of containing this
 compound, the respective components are well compatible with each other, and a
 uniform adhesive layer can be formed without the disadvantages such as separation and
 precipitation of the components. As a result, the adhesive strength of the adhesive layer
 10 becomes uniform, and thereby, it is possible to suppress the problems such as the
 decrease in releasability and the adhesive residue which are caused due to the partially
 high adhesive strength.

As the reactive siloxane compound (d), a siloxane compound in which the
 reactivity is provided by the reactive group such as amino modification, epoxy

modification, carboxyl modification, or mercapto modification, can be used without restriction. Among these, 1,3-bis (3-aminopropyl) tetramethyldisiloxane, aminopropyl-terminated dimethylsiloxane tetramer or octamer, bis (3-aminophenoxymethyl) tetramethyldisiloxane is preferable since the reaction with the component (b) and the component (c) proceeds rapidly. As the reactive siloxane compound (d), it is preferable to use one having such the reactive groups bonded to both terminals of the siloxane structure as described above from the viewpoint of reactivity, but a silane coupling agent having one end or a silane coupling agent having a reactive group at one terminal and a non-reactive group at another terminal can also be used.

10 [0022]

In addition, as each component of the components (a) to (d) mentioned above, one comprised from one type of compound may be used, or a mixture of 2 or more types of compounds may be used.

[0023]

15 With respect to the ratio of the components, the total amount of the component (b), the component (c) and the component (d) preferably ranges from 30 to 300 parts by mass, and more preferably ranges from 30 to 200 parts by mass, with respect to 100 parts by mass of the component (a). If the total amount of the components (b), (c) and (d) is below the range mentioned above, the reactivity of the adhesive layer is lowered, and even if it is heated, the insolubilization does not proceed easily, and the heat stability is reduced. Thereby, there is a tendency for the adhesive strength to be increased. On the other hand, if the total amount of the components (b), (c), and (d) exceeds the range mentioned above, the melt viscosity of the adhesive layer in the initial stage of heating is insufficient, and in an adhesive sheet using this adhesive layer, the adhesive layer may
20
25 flow out or foam during the die-attach curing treatment after the taping step.

[0024]

Furthermore, the mass ratio of the component (c) to the component (b) ((c) / (b)) is preferably in the range of from 0.1 to 10, and more preferably in the range of from 1 to 7. If the mass ratio is below the range mentioned above, in the adhesive layer to be obtained, a curing reaction at ordinary temperature tends to easily proceed, and storage stability becomes poor, or the adhesive strength becomes too strong, and the adhesive sheet using this cannot be released in the releasing step, or may be broken. On the other hand, if the mass ratio exceeds the range mentioned above, the adhesion between the adhesive layer and the substrate formed from the heat-resistant film may be reduced during the production of the adhesive sheet, or the adhesive layer may be foamed, or in the adhesive sheet obtained, adhesive residue tends to be exhibited.

[0025]

In addition, the ratio of the number of reactive groups of component (d) to the total of the number of epoxy groups of component (b) and the number of maleimide groups of component (c) preferably ranges from 0.05 to 1.2, and more preferably ranges from 0.1 to 0.8. If the amount is below the range mentioned above, the reactivity of the adhesive layer as a whole is decreased, and it is difficult for a curing reaction to proceed in a die-attach curing treatment or the like. As a result, the adhesive strength may be too strong. On the other hand, if the ratio exceeds the range mentioned above, the reaction proceeds excessively, and problems such as gelation easily occur during the preparation of the adhesive layer, and the adhesive strength tends to be reduced.

[0026]

In addition to the respective essential components (a) to (d), reaction promoters such as triphenylphosphine, organic peroxides, and imidazoles may be added to the adhesive layer. By means of the addition of these components, it is also possible to

control the state of the adhesive layer at room temperature to a good B-stage.

Furthermore, a filler having an average particle size of 1 μm or less may be added for the purpose of control of melt viscosity, improvement of thermal conductivity, imparting of flame retardancy, and the like. As examples of the filler, mention may be made of inorganic fillers such as silica, alumina, magnesia, aluminum nitride, boron nitride, titanium oxide, calcium carbonate and aluminum hydroxide, and organic fillers such as a silicone resin and a fluorine resin. In the case of using a filler, the amount thereof preferably ranges from 1 to 40% by mass in the adhesive layer.

[0027]

In the adhesive sheet of the present invention, the adhesive layer mentioned above is formed on one surface of a heat resistant film as a substrate.

In the case of producing such an adhesive sheet, first, an adhesive coating composition formed from at least the carboxyl group-containing acrylonitrile-butadiene copolymer (a), the epoxy resin (b) having the structural formula (1) mentioned above, the compound (c) containing at least two maleimide groups, and the reactive siloxane compound (d), as well as a solvent, is prepared. Subsequently, the coating composition may be applied to one surface of the heat-resistant film so that the thickness of the adhesive layer after drying is preferably in the range of from 1 to 50 μm , and more preferably in the range of from 3 to 20 μm , and then dried. In addition, in order to protect the adhesive layer, it is preferable to further provide a releasable protective film on the formed adhesive layer. In this case, an adhesive sheet may be produced by means of a method in which the coating composition is applied on the protective film, and dried to form an adhesive layer, and a heat resistant film is provided thereon. The protective film is released at the time of use of the adhesive sheet.

[0028]

As examples of heat resistant films, mention may be made of heat resistant plastic films made of polyimide, polyphenylene sulfide, polyether sulfone, polyether ether ketone, liquid crystal polymer, polyethylene terephthalate, polyethylene naphthalate, or the like, and composite heat resistant films such as an epoxy resin - glass cloth or the like. In particular, a polyimide film is preferable.

The thickness of the polyimide film preferably ranges from 12.5 to 125 μm , and more preferably ranges from 25 to 50 μm . If the thickness is below the range mentioned above, the rigidity of the adhesive sheet tends to be insufficient and handling thereof becomes difficult. On the other hand, if the thickness exceeds the range mentioned above, the operation in the taping step and the releasing step at the time of assembling QFN tends to be difficult.

[0029]

As the solvent used for the adhesive coating composition, one or more types of organic solvents such as hydrocarbons, alcohols, ketones, and ethers (such as tetrahydrofuran), water and the like can be preferably used. The amount of the solvent used may be adjusted suitably so that the viscosity becomes an appropriate viscosity for the coating composition. In addition, the properties of the coating composition may be any of a solution, an emulsion, and a suspension, and may be appropriately selected according to the coating apparatus to be used, environmental conditions, and the like.

20 [0030]

As examples of the releasable protective film, mention may be made of plastic films of polyethylene, polypropylene, vinyl chloride, fluorocarbon resin, silicone and the like, polyethylene terephthalate, polyethylene naphthalate, paper and the like to which releasability is imparted by silicone coating or the like.

25 [0031]

[Method for Producing a Semiconductor Device]

A method for producing a semiconductor device using the adhesive sheet of the present invention includes: an adhering step of adhering the adhesive sheet for producing a semiconductor device to a lead frame or a wiring substrate; a die-attaching step of mounting a semiconductor element on the lead frame or wiring substrate; a wire bonding step of electrically connecting the semiconductor element mentioned above to the external connection terminal; a sealing step of sealing the semiconductor element mentioned above with a sealing resin; and a releasing step of releasing the adhesive sheet for producing a semiconductor device from the lead frame or the wiring substrate after the sealing step.

[0032]

Hereinafter, an example of a method for producing a semiconductor device using the adhesive sheet of the present invention is described with reference to Figs. 1 and 2. Fig. 1 is a plan view of a lead frame viewed from the side on which a semiconductor element is mounted, and Fig. 2 (a) to (f) is a step view showing a method for producing a QFN package using the lead frame shown in Fig. 1, and is a cross-sectional view taken along line A – A' of the lead frame of Fig. 1.

[0033]

First, a lead frame 20 having a schematic configuration shown in Fig. 1 is prepared. In the lead frame 20, a plurality of semiconductor element mounting parts (die pad parts) 21 for mounting semiconductor elements such as IC chips are formed in a matrix, and a large number of leads 22 (external connection terminals) are provided along the outer periphery of each semiconductor element mounting part 21.

As examples of the material of the lead frame 20, mention may be made of conventionally known materials, such as a copper plate and a copper alloy plate, one

provided with strike plating thereon, or one in which a nickel plated layer, a palladium plated layer, and a gold plated layer in this order provided on the surface of the copper alloy plate.

[0034]

5 As shown in Fig. 2 (a), an adhesive sheet 10 is adhered to one surface (lower surface) of the lead frame 20 so that an adhesive layer (not shown) abuts on the lead frame 20 (adhesion step). As a method of adhering the adhesive sheet 10 to the lead frame 20, there are a laminating method, a pressing method and the like, but from the viewpoint of productivity, a laminating method in which a taping step can be
10 continuously carried out is preferable. The temperature of the adhesive sheet 10 in this step ranges, for example, from normal temperature (5 to 35°C) to 150°C, and more preferably ranges from 60 to 120°C. When adhering is carried out at a temperature higher than 150°C, the lead frame tends to be warped.

 If the lead frame 20 is warped in this step, positioning in the die attaching step
15 or the wire bonding step becomes difficult, or transferring to the heating furnace becomes difficult. Thereby, the productivity of the QFN package may be reduced.

[0035]

 As shown in Fig. 2 (b), on the side of the semiconductor element mounting portion 21 of the lead frame 20 to which the adhesive sheet 10 is not adhered, a
20 semiconductor element 30 such as an IC chip is placed via a die attach agent (not shown). At this time, the lead frame 20 can be easily positioned since the warping is suppressed. In addition, the semiconductor element 30 is accurately placed at a predetermined position. Thereafter, the die attach agent is cured by heating to about 100 to 200°C, and the semiconductor element 30 is fixed and mounted on the semiconductor element
25 mounting portion 21 (Die attach agent curing treatment. Hereinabove, die attaching

step). At this time, the adhesive sheet 10 is adhered to the lead frame by curing the adhesive layer.

[0036]

If the outgas component generated from the adhesive sheet 10 or the die attach agent adheres to the lead frame 20 or the semiconductor element 30, the yield drop is likely to occur due to the poor bonding of the wires in the wire bonding step. Therefore, after the die attaching step, the lead frame 20 and the semiconductor element 30 are subjected to plasma treatment (plasma cleaning step) before the wire bonding step. As an example of the plasma treatment, mention may be made of, for example, a method in which the lead frame 20 (hereinafter, sometimes referred to as a work-in-process) on which the adhesive sheet 10 is adhered and the semiconductor element 30 is mounted is subjected to plasma irradiation in an atmosphere of an argon gas or a mixed gas of an argon gas and a hydrogen gas. The irradiation power of plasma in the plasma treatment is set to, for example, 150 to 600 W. In addition, the period of the plasma treatment is set to, for example, 0.1 to 15 minutes.

[0037]

As shown in Fig. 2 (c), the semiconductor element 30 and the leads 22 (external connection terminals) of the lead frame 20 are electrically connected by means of bonding wires 31 such as a gold wire, a copper wire, or a copper wire coated with palladium (wire bonding step). This step is carried out while heating the work-in-process to about 150 to 250°C on the heater block. The heating period in this step is set to, for example, 5 to 60 minutes.

After the work-in-process is heated in the wire bonding step, in the case of containing a fluorine additive in the adhesive layer, the fluorine additive is transferred to the surface of the adhesive layer. For this reason, the adhesive sheet 10 is easily

released from the lead frame 20 and the sealing resin 40 in a releasing step described below.

[0038]

As shown in Fig. 2 (d), the work-in-process shown in Fig. 2 (c) is placed in a mold, and a sealing resin (mold material) is injected and filled into the mold. After filling an arbitrary amount thereof in the mold, the semiconductor element 30 is sealed with the sealing resin 40 by maintaining the inside of the mold at an arbitrary pressure (sealing step). As the sealing resin, a conventionally well-known resin is used. For example, a mixture of an epoxy resin, an inorganic filler, and the like may be mentioned.

As shown in Fig. 2 (e), the adhesive sheet 10 is released from the sealing resin 40 and the lead frame 20, and thereby, a QFN unit 60 can be obtained, in which a plurality of QFN packages 50 are arranged (releasing step).

[0039]

As shown in Fig. 2 (f), a plurality of QFN packages 50 are obtained by dicing the QFN unit 60 along the outer periphery of each QFN package 50 (dicing step).

[0040]

In the embodiment mentioned above, the method for producing the QFN package using the lead frame is described as an example. However, the present invention is not limited thereto. The present invention can also be applied to a method for producing a semiconductor device other than the QFN package using the lead frame, and a method for producing a semiconductor device using a wiring substrate.

[0041]

The adhesive layer in the adhesive sheet of the present invention can have a low glass transition temperature (10°C to 50°C) by crosslinking the carboxyl group of the carboxyl group-containing acrylonitrile-butadiene copolymer (a) and the glycidyl group

of the epoxy resin (b) to take a B-stage state (semi-cured state). An adhesive sheet having an adhesive layer having a low glass transition temperature can be continuously subjected to a taping step by means of a roll laminator or the like under the heating conditions of a relatively low temperature, and specifically ranging from 60 to 150°C.

5 Therefore, superior productivity can be exhibited.

[0042]

In addition, the adhesive layer having a low glass transition temperature (10°C to 50°C) of the adhesive sheet of the present invention can exhibit a property of high elastic modulus at the time of heating. In recent years, in order to reduce the cost in the wire bonding step, products in which bonding is carried out by means of a low-cost copper wire or palladium-coated copper wire, instead of the conventional gold wire are widely used. The copper wire or the palladium-coated copper wire is a metal with higher elasticity than that of gold, and for this reason, the processing with a higher load is required to prepare a stable shape than a conventional gold wire.

15 When such a large load is applied to the lead frame, and when the adhesive layer in the adhesive sheet adhered to the lower portion of the lead frame has a low elastic modulus, the adhesive layer mentioned above is deformed and the deformed adhesive layer is subjected to resin-sealing in such a deformed state. Thereby, the sealing resin may leak from the deformed adhesive layer portion. In addition, when the adhesive sheet is released from the lead frame, there is also a problem that the adhesive layer is broken from the deformed adhesive layer portion and the adhesive remains on the surface of the lead frame. In addition, when the adhesive has a low elastic modulus at the time of wire bonding, the adhesive is deformed. Thereby, it may be difficult for the wire load to be transmitted, and a wire bonding failure is likely to occur. The adhesive layer
20
25 in the adhesive sheet of the present invention has the characteristics of high elastic

modulus as described above. For this reason, even if wire bonding is carried out using a copper wire or a palladium-coated copper wire, problems of wire bonding failure, leakage of the sealing resin, and adhesive layer residue hardly occur.

[0043]

5 In addition, the adhesive layer in the adhesive sheet of the present invention has the compound (c) containing two or more maleimide groups, and for this reason, the curing of the adhesive layer is appropriately controlled in the drying step during the production of the adhesive sheet, and the adhesive layer can be in a high B-stage state. For this reason, the increasing of the adhesion strength to the lead frame can be
10 suppressed. As a result, the leakage of the sealing resin, remaining of the adhesive in the lead frame, and the fracture of the adhesive layer at the time of releasing can be suppressed.

EXAMPLES

15 [0044]

Hereinafter, the present invention is described in detail with reference to the Examples.

[Examples 1 to 6 and Comparative Examples 1 to 4]

(Composition of Adhesive Coating Composition)

20 An adhesive coating composition was prepared by mixing the components (a) to (d), and other components, as well as tetrahydrofuran (THF) as a solvent, in the mass ratio shown in Table 1.

Subsequently, this adhesive coating composition was applied to one surface of a polyimide film with a thickness of 25 μm (manufactured by DuPont – Toray Co., Ltd.,
25 under the trade name of Kapton 100 EN) so that the thickness of the adhesive layer after

drying was 5 μm . The resultant product was dried in a hot air circulating oven set at 180°C to obtain an adhesive sheet.

The details of each component used are as follows.

[0045]

5 - Carboxyl group-containing acrylonitrile-butadiene copolymer: carboxyl group equivalent amount: 1500, calculated from number average molecular weight, and acrylonitrile content: 27% by mass

 - Acrylonitrile-butadiene copolymer: acrylonitrile content: 27% by mass

10 - Epoxy resin having structural formula (1): molecular weight: 630, functional group equivalent amount: 210 g/eq

 - Bisphenol A diphenyl ether bismaleimide: molecular weight: 570, functional group equivalent amount: 285 g/eq

 - 1,3-Bis (3-aminopropyl) tetramethyldisiloxane: molecular weight: 248, functional group equivalent amount: 62 g/eq

15 [0046]

[Table 1]

		Example 1	Example 2	Example 3	Example 4	Example 5	Example 6	Comparative Example 1	Comparative Example 2	Comparative Example 3	Comparative Example 4
Component (a)	Carboxyl group-containing acrylonitrile – butadiene copolymer	100	100	100	100	100	100	100	100	100	-
Component (b)	Epoxy resin having structural formula (1)	12	12	12	12	12	12	12	-	-	12
Component (c)	Bisphenol A diphenyl ether bismaleimide	24	24	24	72	24	24	-	24	72	24
Component (d)	1,3-Bis(3-aminopropyl) tetramethyl disiloxane	1	1	1	3	1	1	-	1	3	1
	Acrylonitrile - butadiene copolymer	-	-	-	-	-	-	-	-	-	100
	2-Ethyl-4-methylimidazole	1	1	1	1	-	1	-	-	1	1
	Triphenylphosphine	1	1	-	1	-	1	1	-	-	-
	Hindered phenol-based antioxidant (manufactured by BASF, under the trade name of IRGANOX 1010)	5	5	5	5	-	-	5	-	-	-
	Fluorine-based additive (manufactured by DIC Corporation, under the trade name of MEGAFAC F-477)	-	2.5	2.5	2.5	-	-	-	-	-	-

[0047]

With respect to the adhesive sheet of each example obtained as mentioned above, (1) the peeling strength to the lead frame material, (2) the thermal properties after the die-attach step, (3) the peeling strength to the sealing resin material and the presence or absence of the adhesive residue after releasing the sheet, and (4) the presence or absence of leakage of the sealing resin of the test body after the resin sealing step were measured or confirmed.

[0048]

(1) Peeling strength to lead frame material

(i) Preparation of test body

The adhesive sheet obtained in each example was cut into a piece having a size of width of 50 mm $\times$ length of 60 mm, and this piece was adhered to a lead frame for test made of copper alloy having an outer size of 57.5 mm $\times$ 53.5 mm (surface strike plating, 8 $\times$ 8 matrix array, package size: 5 mm $\times$ 5 mm, 32 pins), using a roll laminator.

Thereby, a test body was prepared. The lamination conditions at that time were set to a temperature of 80°C, a pressure of 4 N/cm, and a pressure bonding speed of 1 m/min.

(ii) Measurement of peeling strength

With respect to the test body mentioned above, the 90° peeling strength was measured using a universal tensile tester. The measurement was carried out by fixing the lead frame and pulling the adhesive sheet in the perpendicular direction. The tensile speed was 50 mm/min. The results are shown in Table 2.

[0049]

(2) Thermal properties after the die attaching step

In the adhesive sheet obtained in each example, a polyimide film having a

thickness of 25 μm was formed into a polyethylene terephthalate film (PET film) having a thickness of 38 μm subjected to a mold-release treatment, and heating was carried out for 1 hour at 175°C using a ventilated oven, by assuming a die-attach curing treatment.

The adhesive layer in the adhesive sheet after heating was released from the PET film, and the tensile storage modulus was measured using a DMA (Dynamic Mechanical Analyzer). The measurement was carried out at a frequency of 11 Hz, a temperature rising rate of 10°C/min, and a load of 1.0 gf, using a Vibron measuring device (manufactured by ORIENTEC Co., Ltd., RHEOVIBRON DDV-II-EP) as the DMA.

The temperature and the result of the tensile storage modulus at 180°C when assuming the wire bonding step are shown in Table 2.

[0050]

(3) Peeling strength to the test body after the resin sealing step and the presence or absence of the adhesive residue after releasing the sheet

(i) Preparation of test body and heat treatment

The adhesive sheet obtained in each example was subjected to the following treatments (a) to (d), by assuming a heat hysteresis and the like in accompany with actually assembling of the QFN.

(a) The adhesive sheet obtained in each example was cut into a piece having a size of width of 50 mm $\times$ length of 60 mm, and this piece was adhered to a lead frame for test made of a copper alloy having an outer size of 57.5 mm $\times$ 53.5 mm (surface strike plating, 8 $\times$ 8 matrix array, package size of 5 mm $\times$ 5 mm, 32 pins) by using a roll laminator. The lamination conditions at that time were a temperature of 80°C, a pressure of 4 N/cm, and a pressure bonding speed of 1 m/min.

(b) The lead frame for test made of copper alloy to which the adhesive sheet had

been adhered was heated in a ventilated oven at 175°C for 1 hour. This was a treatment based on assuming of a die attach curing treatment.

(c) Plasma irradiation treatment: A treatment was carried out at 450 W for 60 seconds using Ar as a gas type by means of 1000 P manufactured by Yield Engineering, Co., Ltd.

(d) Heating for 30 minutes at 200°C: This treatment corresponded to a treatment based on assuming of a wire bonding step, and heating was carried out using a hot plate.

Subsequently, the sealing resin was laminated on the copper material-exposed surface which was the surface opposite to the surface to which the adhesive sheet to be adhered after the heat treatments (a) to (d) had been applied, using a mold press, under the conditions of 175°C/3 minutes (resin sealing step). As the sealing resin, an epoxy mold resin (EME-G 631 BQ) manufactured by Sumitomo Bakelite Co., Ltd., was used.

[0051]

(ii) Measurement of peeling strength and the presence or absence of adhesive residue after sheet releasing

For the test body after the resin sealing step mentioned above, 90° peeling strength was measured using a universal tensile tester. In addition, the measurement was carried out by fixing the test body, and pulling the corner part of the adhesive sheet in the perpendicular direction. The tensile speed was set to 300 mm/min. In addition, the presence or absence of the adhesive residue after releasing of the sheet was confirmed using an optical microscope (digital microscope VHX-500, manufactured by Keyence Corporation) at a magnification of 100 times. The results are shown in Table 2.

(4) Presence or absence of leakage of the sealing resin of the test body after the resin sealing step

With respect to the test body after the resin sealing step mentioned above, the presence or absence of the leakage of the sealing resin was confirmed by means of an optical microscope (digital microscope VHX-500, manufactured by Keyence Corporation) at a magnification of 100 times. The results are shown in Table 2.

5 [0052]

The symbols in the column of judgment in Table 2 indicate the following contents:

(1) Measurement of peeling strength to lead frame material

O: Peeling strength is 10 gf/50 mm or more.

10 Δ: Peeling strength is 5 gf/50 mm or more and less than 10 gf/50 mm.

X: Peeling strength is less than 5 gf/50 mm.

[0053]

(2) Thermal properties after the die attaching step

O: The tensile storage modulus at 180°C is 10 MPa or more

15 Δ: The tensile storage modulus at 180°C is 1 MPa or more and less than 10 MPa

X: The tensile storage modulus at 180°C is less than 1 MPa

[0054]

(3) Peeling strength to the test body after resin sealing step and the presence or absence of adhesive residue after releasing the sheet

20 O: Peeling strength is less than 1,000 gf/50 mm, the released adhesive sheet is not broken, and the adhesive does not remain on the surface of the lead frame material and on the surface of the sealing resin.

Δ: Peeling strength is 1,000 gf/50 mm or more, the released adhesive sheet is not broken, and the adhesive does not remain on the surface of the lead frame material and

the surface of the sealing resin.

X: At least one of the observation of breakage of the adhesive sheet and the observation of the adhesive residue on the surface of the lead frame material and on the surface of the sealing resin.

- 5 (4) Presence or absence of leakage of the sealing resin of the test body after the resin sealing step

O: The sealing resin does not leak out on the surface of the lead frame material for test in which the resin sealing had been carried out after releasing of the adhesive sheet.

- 10 X: The sealing resin leaks out on the surface of the lead frame material for test in which the resin sealing had been carried out after releasing of the adhesive sheet.

[0055]

[Table 2]

[illegible]

[0056]

As is apparent from Table 2 described above, the adhesive sheets of Examples 1 to 6 had superior adhesion to the lead frame material with the peeling strength of 5 gf/50 mm or more to the lead frame for test made of copper alloy. In addition, it was confirmed that the adhesive sheets of Examples 1 to 6 had properties such that the tensile storage elastic modulus at 180°C was 10 MPa or more and that the adhesive sheets exhibited sufficient resistance to deformation of the adhesive layer caused by the load in the wire bonding step. In addition, the adhesive sheets of Examples 1 to 6 had superior properties such that there was no leakage of the sealing resin, the substrate of the adhesive sheet and the adhesive layer were not broken, and the adhesive did not remain on the surface of the lead frame material and the surface of the sealing resin.

On the other hand, it was confirmed that the adhesive sheets of Comparative Example 1, Comparative Example 2 and Comparative Example 4 had a tensile storage elastic modulus at 180°C of less than 10 MPa, and were difficult to withstand the deformation of the adhesive layer caused by the load in the wire bonding step. In addition, in the adhesive sheets of Comparative Examples 1 to 4, the adhesive sheet was broken at the time of releasing from the sealing resin material, and the adhesive remained on the surface of the lead frame material and on the surface of the sealing resin even in the places where the sheet releasing was possible.

INDUSTRIAL APPLICABILITY

[0057]

The adhesive sheet according to the present invention is suitably used as a masking tape at the time of assembling a semiconductor device by a QFN (Quad Flat Non-lead) method. According to the adhesive sheet of the present invention, even

before the releasing step, even if it receives the heat hysteresis in accompany with assembling of the QFN, the adhesive sheet is sufficiently and stably adhered to the back surface of the lead frame and the back surface of the sealing resin without releasing. There is no leakage of the sealing resin. In addition, it can be easily released in the releasing step, and adhesive residue that causes the adhesive remaining does not occur or breakages are not exhibited. In addition, the adhesive sheet according to the present invention can be applied to the manufacture of a semiconductor device.

DESCRIPTION OF SYMBOLS

10	[0058]
	10 Adhesive sheet for producing a semiconductor device
	20 Lead frame
	30 Semiconductor element
	31 Bonding wire
15	40 Sealing resin
	50 QFN package

What is claimed is:

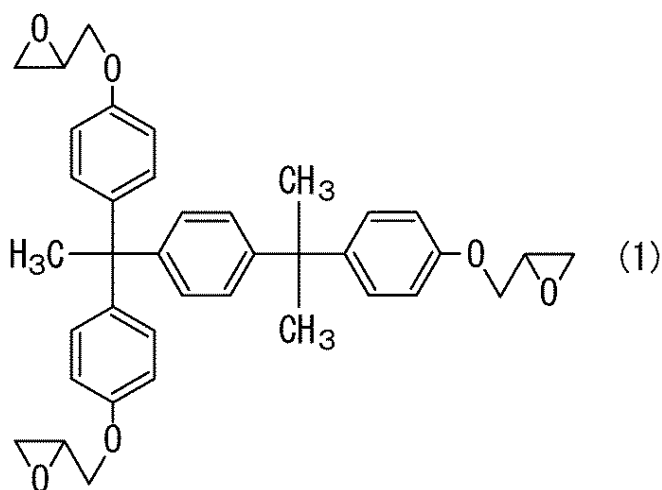
[Claim 1]

An adhesive sheet for producing a semiconductor device which comprises a
 5 substrate, and a thermo-setting type adhesive layer provided on one surface of said
 substrate, and is releasably adhered to a wiring substrate or a lead frame of the
 semiconductor device,

characterized in that

said adhesive layer comprises (a) a carboxyl group-containing acrylonitrile –
 10 butadiene copolymer, (b) an epoxy resin having the following structural formula (1), (c) a
 compound having two or more maleimide groups, and (d) a reactive siloxane compound.

[Chem. 1]



15

[Claim 2]

The adhesive sheet for producing a semiconductor device according to Claim 1,
 wherein said component (a) is a carboxyl group-containing acrylonitrile-butadiene

copolymer having an acrylonitrile content of from 5 to 50% by mass and a carboxyl group equivalent amount calculated from the number average molecular weight of from 100 to 20,000.

5 [Claim 3]

The adhesive sheet for producing a semiconductor device according to Claim 1, wherein a total of said component (b), said component (c) and said component (d) ranges from 30 to 300 parts by mass with respect to 100 parts by mass of said component (a).

10 [Claim 4]

The adhesive sheet for producing a semiconductor device according to Claim 1, wherein a mass ratio of said component (c) to said component (b) ((c) / (b)) is in the range of from 0.1 to 10.

15 [Claim 5]

The adhesive sheet for producing a semiconductor device according to Claim 1, wherein a ratio of the number of reactive groups of said component (d) to a total of the number of epoxy groups of said component (b) and the number of maleimide groups of said component (c) ranges from 0.05 to 1.2.

20

[Claim 6]

A method for producing a semiconductor device as recited in Claim 1, characterized by comprising:

an adhering step of adhering an adhesive sheet for producing a semiconductor
25 device to a lead frame or a wiring substrate,

a die attaching step of mounting a semiconductor element on said lead frame or said wiring substrate,

a wire bonding step of electrically connecting said semiconductor element to an external connection terminal,

5 a sealing step of sealing said semiconductor element with a sealing resin, and

a releasing step of releasing said adhesive sheet for producing a semiconductor device from said lead frame or said wiring substrate after said sealing step.