

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. 2018-022641, filed on
February 12, 2018, 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) has increased in response to the
demand for miniaturization, thinning, and multifunctionalization of IT devices such as
20 mobile 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 be 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 that there be 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 oxidative degradation with respect to the polymer material of copper which is the transition metal, and the adhesive is easily oxidatively degraded due to heat hysteresis accompanying assembling of the QFN
25 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 do not sufficiently satisfy a practical level that can be used for a lead frame formed from a copper alloy.

5 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 such an adhesive sheet, there are problems in that the acrylonitrile - butadiene copolymer is easily deteriorated due to the heat applied in the die-attach curing
10 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.

PRIOR ART LITERATURE

15 Patent Documents

[0006]

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

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

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

DISCLOSURE OF INVENTION

25 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, 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 heat hysteresis accompanying 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 to provide a method of producing a semiconductor device using the same.

10

Solution to Problem

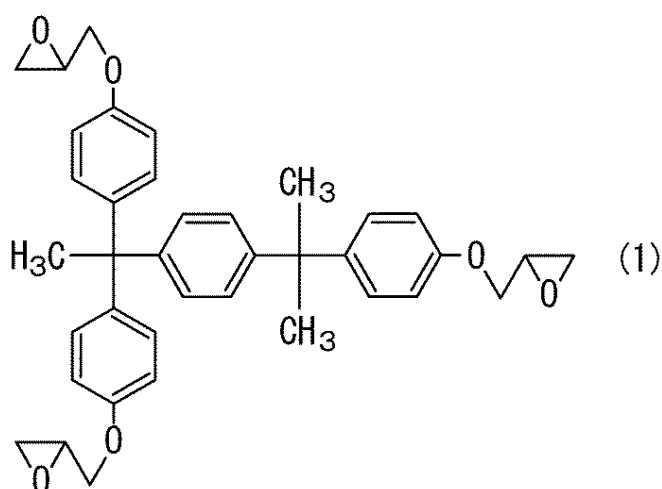
[0008]

An adhesive sheet for producing a semiconductor device of the present 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 formula (1), and (c) a compound having two or more maleimide groups, and in the adhesive layer, a residual amount of unreacted maleimide ranges from 0.02 to 0.13.

20

[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) and the component (c) mentioned above range from 20 to 300 parts by mass with respect to 100 parts by mass of the component (a).

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,

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

5 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]

10 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 heat hysteresis accompanying 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
15 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]

20 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.

25 EMBODIMENTS OF THE INVENTION

[0014]

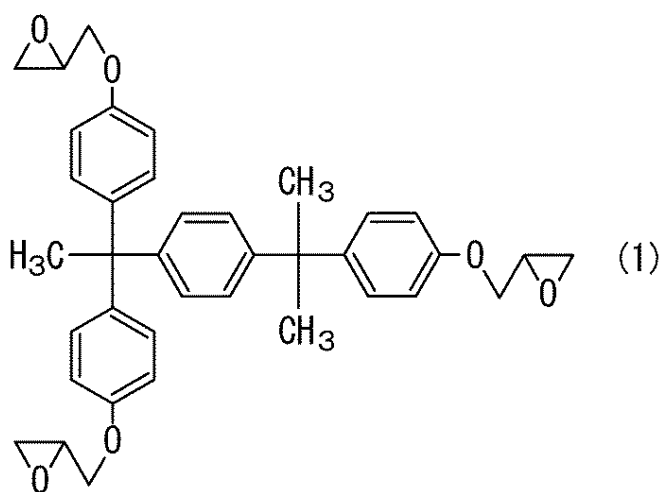
Hereinafter, the present invention is described in detail.

[Adhesive Sheet for Producing a Semiconductor Device]

5 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
10 copolymer (a), an epoxy resin (b) having a structural formula (1) described below, and a compound (c) containing two or more maleimide groups, and in the adhesive layer, the residual amount of unreacted maleimide ranges from 0.02 to 0.13. The adhesive sheet is used as a masking tape at the time of assembling a semiconductor device according to the QFN method.

15 [0015]

[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) being 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 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.

5 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:

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

10 [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, superior thermal stability is exhibited. In addition, an adhesive layer which can be easily released and does not cause adhesive
15 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
20 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.

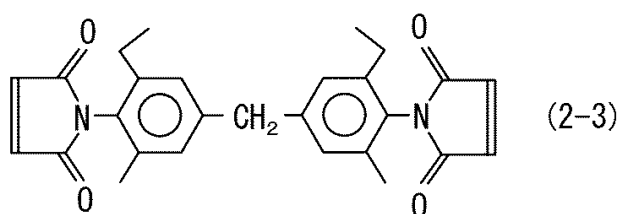
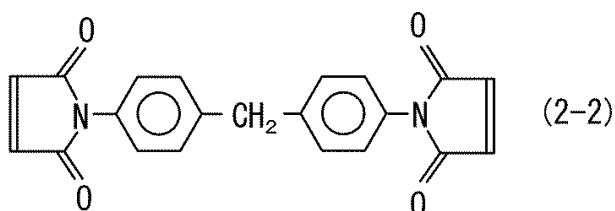
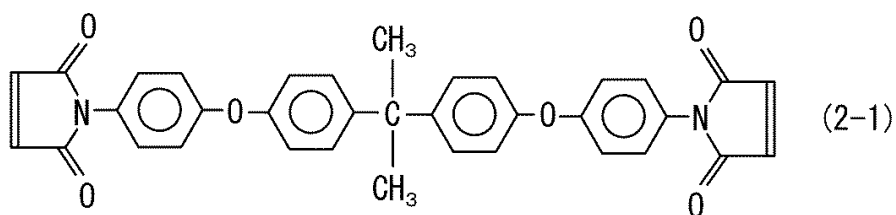
 As a specific example of the compound (c) containing two or more maleimide
25 groups, a compound constituting a bismaleimide resin is preferably used, and those

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]

5

[Chem. 3]



[0021]

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

[0022]

The adhesive layer in the adhesive sheet for use in producing the semiconductor device of the present invention has to have a residual amount of unreacted maleimide

which ranges from 0.02 to 0.13. In particular, the residual amount of unreacted maleimide preferably ranges from 0.02 to 0.10. If the residual amount of unreacted maleimide is below 0.02, the initial adhesive strength to the lead frame is low, and problems such as occurrences of non-adhered parts during laminate processing, and the like occur. On the other hand, if the residual amount of unreacted maleimide exceeds 0.13, the initial adhesive strength to the lead frame becomes high, and as a result, the detaping property after package assembling is impaired (high peeling strength, and adhesive residue / tape fracture easily occur). The residual amount of unreacted maleimide ranging from 0.02 to 0.13 can be obtained by appropriately controlling the curing in the drying step during the preparation of the adhesive layer.

The residual amount of unreacted maleimide can be obtained by analyzing the results of the measurement of the adhesive layer by means of a FT-IR spectroscopy (Fourier transformed infrared spectroscopy). The residual amount of unreacted maleimide can be calculated by a ratio (S_{1148}/S_{1500}) of an integrated value of a peak (1148 cm^{-1}) of maleimide to an integrated value of a peak (1500 cm^{-1}) of an aromatic ring of maleimide in the FT-IR. The method for analyzing the residual amount of unreacted maleimide is described in detail in the evaluation results of the Examples.

[0023]

With respect to a ratio of the components mentioned above, the total of component (b) and component (c) with respect to 100 parts by mass of component (a) preferably ranges from 20 to 300 parts by mass, and more preferably ranges from 20 to 200 parts by mass. If the total of component (b) and component (c) is below the range mentioned above, the reactivity of the adhesive layer is decreased, non-solubilization – non-melting hardly proceeds even in the case of heating, and therefore, adhesion power tends to become strong due to decreasing of thermal stability. On the other hand, if the

total of component (b) and component (c) exceeds the range mentioned above, the melting viscosity of the adhesive layer at the initial period of heating becomes insufficient. Therefore, in the adhesive sheet using such an adhesive layer, the adhesive layer may flow out or foam in the die-attach curing treatment after a taping step, or the
5 like.

[0024]

In addition, a mass ratio ((c)/(b)) of component (c) to component (b) preferably ranges from 0.1 to 10. If the mass ratio is below the range mentioned above, in the adhesive layer obtained, the curing reaction at room temperature may tend to easily
10 proceed and poor storage stability may be exhibited. Or an adhesive power becomes extremely strong, and an adhesive sheet using the same cannot be peeled or may be broken during a peeling step. On the other hand, if the mass ratio exceeds the range mentioned above, an adhesive property between such an adhesive layer and a substrate formed from a thermal resistance film may be degraded during the preparation of an
15 adhesive sheet. Or an adhesive layer may foam, or in an adhesive sheet obtained, the adhesive tends to remain.

[0025]

In the adhesive layer in the adhesive sheet for producing a semiconductor device of the present invention, a reactive siloxane compound may be contained. The reactive
20 siloxane compound is used for enhancing the compatibility of 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 highly compatible with each other, and a uniform adhesive layer can be formed without the disadvantages such as separation and precipitation of the
25 components. As a result, the adhesive strength of the adhesive layer 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, a siloxane compound in which the reactivity is provided by the reactive group such as amino modification, epoxy modification,

5 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, it is preferable to

10 use one having such 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 terminal or a silane coupling agent having a reactive group at one terminal and a non-reactive group at another terminal can also be used.

[0026]

15 In the adhesive layer in the adhesive sheet for producing a semiconductor device of the present invention, the ratio of the number of reactive groups of reactive siloxane compound 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,

20 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

25 reduced.

[0027]

In addition to the respective essential components (a) to (c), 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
5 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
10 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.

[0028]

In the adhesive sheet of the present invention, the adhesive layer mentioned
15 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, and compound (c) containing at least two maleimide groups, and the reactive siloxane
20 compound if necessary, 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
25 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.

[0029]

5 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.

10 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
15 assembling QFN tends to be difficult.

[0030]

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
20 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.

[0031]

25 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.

[0032]

5 [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
10 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.

15 [0033]

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
20 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.

[0034]

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
25 (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 are provided on the surface of the copper alloy plate.

[0035]

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 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 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.

[0036]

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 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 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 mounting portion 21 (die-attach agent curing treatment: hereinabove, die-attaching step). At this
5 time, the adhesive sheet 10 is adhered to the lead frame by curing the adhesive layer.

[0037]

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, yield drop is likely to occur due to the poor bonding of the wires in the wire-bonding step. Therefore, after
10 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
15 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.

[0038]

20 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
25 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.

[0039]

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).

[0040]

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).

[0041]

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.

[0042]

The adhesive layer in the adhesive sheet of the present invention can have a low glass transition temperature (-30°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
5 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 at room temperature (5°C to 35°C) to 150°C . Therefore, superior productivity can be exhibited.

[0043]

10 In addition, the adhesive layer having a low glass transition temperature (-30°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 have
15 been 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, processing with a higher load is required to prepare a stable shape than a conventional gold wire.

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
20 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 in that the adhesive layer is broken from the deformed adhesive layer portion and the adhesive remains on the surface
25 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 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.

[0044]

In addition, the adhesive layer in the adhesive sheet of the present invention contains the compound (c) containing two or more maleimide groups, and the residual amount of the unreacted maleimide resin is controlled to a specific range. Thereby, the adhesive layer can be in a high B-stage state. For this reason, increasing of the adhesion strength to the lead frame can be 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

[0045]

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

[Examples 1 to 4 and Comparative Examples 1 to 3]

(Composition of Adhesive Coating Composition)

An adhesive coating composition was prepared by mixing the components (a) to (c), 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., 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 based on the drying conditions shown in Table 1 to obtain an adhesive sheet.

5 The details of each component used are as follows.

[0046]

- Carboxyl group-containing acrylonitrile-butadiene copolymer: carboxyl group equivalent amount: 1500, calculated from number-average molecular weight, and 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

15 - 1,3-Bis (3-aminopropyl) tetramethyldisiloxane: molecular weight: 248, functional group equivalent amount: 62 g/eq

[0047]

[Table 1]

Table 1

		Example 1	Example 2	Example 3	Example 4	Comparative Example 1	Comparative Example 2	Comparative Example 3
Component (a)	Carboxyl group-containing acrylonitrile – butadiene copolymer	100	100	100	100	100	100	100
Component (b)	Epoxy resin having structural formula (1)	12	12	12	12	12	12	12
Component (c)	Bisphenol A diphenyl ether bismaleimide	24	24	24	72	24	72	72
	1,3-Bis(3-aminopropyl) tetramethyl disiloxane	1	1	1	3	1	3	3
	2-Ethyl-4-methylimidazole	1	1	1	1	1	1	1
	Hindered phenol-based antioxidant (manufactured by BASF, under the trade name of IRGANOX 1010)	5	5	5	5	5	5	5
	Fluorine-based additive (manufactured by DIC Corporation, under the trade name of MEGAFAC F-553)	-	2.5	2.5	2.5	-	2.5	2.5
Drying condition (heating temperature / heating period)		180°C/3 min	180°C/3 min	100°C/3 min	180°C/3 min	260°C/6 min	220°C/3 min	100°C/3 min

[0048]

With respect to the adhesive sheet of each example obtained as mentioned above, the measurements and evaluation described below were carried out. The results thereof are shown in Table 2.

5 (1) Residual amount of unreacted maleimide

A residual amount of unreacted maleimide of an adhesive sheet was measured by means of an ATR (Attenuated Total Reflection) method using FT-IR (Spectrum 100, manufactured by PerkinElmer Co., Ltd.). A method for calculating the residual amount of the unreacted maleimide of the adhesive sheet is described below.

10 (i) Measurement: After the ATR correction and absorbance conversion, the peak areas at wavelengths S1 and S2 described below were calculated.

S1 = Integrated value of a peak (1148 cm^{-1}) of maleimide

S2 = Integrated value of a peak (1500 cm^{-1}) of an aromatic ring of maleimide

(ii) A ratio of S1/S2 was set to a residual amount of unreacted maleimide.

15 [0049]

(1) Peeling strength to Cu plate

Body to be adhered: Copper plate (manufactured by Furukawa Co., Ltd., 125 μm , 7025 type)

Adhesive sheet size: Width of 10 mm $\times$ length of 50 mm

20 Processing: A sheet obtained in each of the examples was adhered to the body to be adhered, by 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.

Measurement: With respect to the test body mentioned above, the 90° peeling

strength of the test body was measured at room temperature using a universal tensile tester. The measurement was carried out by fixing the copper plate and pulling the adhesive sheet in the perpendicular direction. The tensile speed was 50 mm/min.

Evaluation: With respect to the peeling strength, 5 gf/cm or more corresponds to the peeling strength without problems in view of practical use. Therefore, the case of 5 gf/cm or more was evaluated as O, while the case of less than 5 gf/cm was evaluated as X.

[0050]

(3) Thermal properties after the die-attaching step

Processing: 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 and 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.

Measurement: 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.

Evaluation: The product in which the tensile storage modulus at 200°C when assuming the wire -step was 10 MPa or more was evaluated as O.

[0051]

(4) Peeling strength to the test body after the resin-sealing step and the presence

or absence of the adhesive residue after releasing the tape

Method of processing / measurement:

(i) Preparation of test body and heat treatment

The adhesive sheet obtained in each example was cut into a width of 50 mm × length of 60 mm, and subsequently subjected to the following treatments (a) to (d), successively, by assuming heat hysteresis and the like accompanying actual assembling of the QFN.

(a) The adhesive sheet obtained in each example was cut into a piece having a width of 50 mm × 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 × 53.5 mm of 50 mm × 100 mm (surface strike plating, 8 × 8 matrix array, package size of 5 mm × 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 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 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.

[0052]

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

For the test body after the resin-sealing step mentioned above, 90° peeling strength was measured at room temperature 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 tape was confirmed using an optical microscope (digital microscope VHX-500, manufactured by Keyence Corporation) at a magnification of 100 times.

Evaluation:

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

- Δ: Peeling strength was 1,000 gf/50 mm or more, the released adhesive sheet was not broken, and the adhesive did not remain on the surface of the lead frame material and the surface of the sealing resin.

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

[0053]

- (5) Presence or absence of leakage of the resin

With respect to the test body after the resin-sealing step mentioned above, the presence or absence of 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.

- 5 O: The sealing resin did 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.

[0054]

[Table 2]

Table 2

	Example 1	Example 2	Example 3	Example 4	Comparative Example 1	Comparative Example 2	Comparative Example 3
Residual amount of unreacted maleimide	0.029	0.026	0.10	0.068	0	0.017	0.14
Peeling strength to the Cu plate (gf/cm)	20	15	400	6	2	2	450
	O	O	O	O	X	X	O
Thermal properties after die-attaching step (MPa)	10	10	10	20	10	20	20
	O	O	O	O	O	O	O
Peeling strength to the test body after resin-sealing step (gf/50 mm)	530	400	830	1060	The adhesive tape could not be adhered.	The adhesive tape could not be adhered.	The adhesive tape was broken.
Presence or absence of adhesive residue after releasing the tape	O	O	O	Δ	-	-	-
Presence or absence of leakage of the resin	O	O	O	O	-	-	-

[0055]

As is apparent from Table 2 described above, the adhesive sheets of Examples 1 to 4 exhibited results without problems in terms of practical use with respect to the evaluation in all the categories of the peeling strength to the Cu plate, the thermal properties after die-attaching step, the peeling strength to the test body after resin-sealing step, the presence or absence of the adhesive residue after releasing the tape, and the presence or absence of leakage of the resin.

On the other hand, the adhesive sheets of Comparative Example 1 and Comparative Example 2 had problems in that the adhesive sheet could not be adhered to the lead frame for use in test made of a copper alloy in the evaluation of the peeling strength to the test body after the resin-sealing step. In addition, the adhesive sheet of Comparative Example 3 had problems in that the adhesive sheet was strongly adhered to the lead frame for use in test, made of a copper alloy, and for this reason, the adhesive sheet was broken in the evaluation of the peeling strength to the test body after the resin-sealing step.

DESCRIPTION OF SYMBOLS

[0056]

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

What is claimed is:

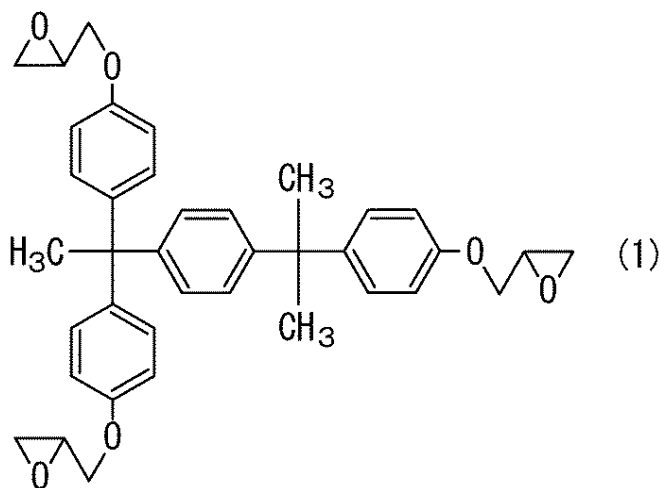
[Claim 1]

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), and
 (c) a compound having two or more maleimide groups, wherein a residual amount of
 unreacted maleimide ranges from 0.02 to 0.13.

[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) and said component (c) is present in a range of from 20 to 300 parts by mass with respect to 100 parts by mass of said component (a).

10 [Claim 4]

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 device to a lead frame or a wiring substrate,

15 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,

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

20 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.