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DESCRIPTION

MASK SHEET FOR ASSEMBLING SEMICONDUCTOR DEVICE AND METHOD FOR ASSEMBLING SEMICONDUCTOR DEVIC E

TECHNICAL FIELD

The present invention relates to a mask sheet for assembly of semiconductor devices used in masking a metallic lead frame from a molding resin upon assembly of semiconductor devices (semiconductor packages) such as QFN by mounting semiconductor chips on the lead frame and sealing them with the resin, and a method of assembling semiconductor devices making use of such a mask sheet.

BACKGROUND ART

In these days the spread of mobile computers and handy phones is advanced, electronic instruments are required to be more miniaturized and thinned and have higher multi-functionality. In order to realize this requirement, the miniaturization and high integration of electronic parts are essential, and high- density packaging techniques for the electronic parts are further required. Thus, a surface mounting called CSP (Chip Size Package) is spotlighted as an IC package capable of packaging at high density in place of the conventional peripheral mounting such as QFP (Quad Flat Package) and SOP (Small Outline Package). Among others, a type called QFN (Quad Flat Non-

lead) is particularly used in fabrication of a small-terminal package of 100 pins or less because it can be fabricated by the conventional techniques and apparatus such as lead frame, wire bonding and resin seal (mold).

The QFN has heretofore been fabricated in the following manner. Namely, a mask sheet composed of a adhesive sheet is first stuck on one surface of a lead frame to mask it in a adhesive sheet sticking step, and semiconductor elements such as semiconductor chips are then respectively mounted on a plurality of semiconductor element mounting parts (die pads) formed on the opposite surface of the lead frame in a die attaching step. A plurality of leads is then respectively electrically connected to the semiconductor elements through bonding wires such as gold wires in a wire bonding step. The semiconductor elements mounted on the lead frame are then sealed with a molding resin in a resin-sealing step, and the mask sheet is released from the lead frame, thereby forming a QFN unit with a plurality of QFNs arranged there. Finally, the unit is diced into individual QFNs, thereby separating them from one another.

As the adhesive sheet used in the above-described process, is used an adhesive sheet with an acrylic adhesive or a rubber adhesive composed mainly of rubber such as natural rubber or SBR applied to a heat-resistance film. However, when a mask sheet having an adhesive layer formed of the acrylic adhesive is used, there has been a

possibility that the adhesive may begin to decompose due to heat in the die attaching step in which the semiconductor chips are bonded to the lead frame, and the decomposed products may contaminate the lead frame, resulting in a failure of bonding with gold wires. In addition, there has been a problem that in the resin-sealing (molding) step, the adhesion to the lead frame becomes weak, and so "mold flash" which is a phenomenon that the molding resin oozes to an external connection lead portion occurs.

When a mask sheet having an adhesive layer formed of the rubber adhesive is used on the other hand, the adhesion to the molding resin and/or lead frame begins too strong to release the mask sheet from the package, and so there have been problems that "adhesive transfer" which is a phenomenon that the rubber adhesive is left on the lead frame occurs, and that the lead frame is deformed.

The present invention has been made with the object of solving such problems as described above in the prior art. More specifically, an object of the present invention is to provide a mask sheet which does not cause the failure of bonding of gold wires (failure of wire bonding) and which can prevent the oozing of a resin sealant and the adhesive transfer of the adhesive upon fabrication of semiconductor devices to stably produce semiconductor packages such as QFNs. Another object of the present invention is to provide a method of efficiently assembling semiconductor devices using such a mask sheet.

DISCLOSURE OF THE INVENTION

A mask sheet is released from a lead frame after exposed to an environment of 150 to 180°C for 1 to 6 hours in a die attaching step and a resin-sealing step in steps of fabricating QFN packages. Accordingly, heat resistance under the above environment is the most important property thereof. The present inventors have carried out an extensive investigation. As a result, it has been found that a mask sheet is produced by using a specific heat-resistant film and a silicone adhesive, thereby providing a mask sheet withstanding the above environment, thus leading to completion of the present invention.

According to the present invention, there is thus provided a mask sheet (adhesive sheet) for assembly of semiconductor devices releasably stuck to a lead frame, which comprises a heat-resistant base material and an adhesive layer provided on one surface of the base material and, wherein a heat-resistant film having a glass transition temperature of at least 150°C and a coefficient of thermal expansion of 10 to 50 ppm/°C at 150 to 200°C is used as the heat-resistant base material, and the adhesive layer is formed with a silicone adhesive. It is preferred in the present invention that the adhesive layer has a percent loss on weight of at most 5% when heated at 180°C for 1 hour.

In the mask sheet according to the present invention, the adhesive layer may preferably be formed with a silicone

adhesive comprising polyorganosiloxane having an average molecular weight of 10,000 to 1,500,000 and have a dynamic modulus of elasticity of at least 1.0×10^4 Pa at 150 to 200°C. The silicone adhesive may preferably be an adhesive comprising polydimethylsilxane as a main component or an adhesive comprising polyalkylalkenylsiloxane and polyalkylhydrogensiloxane as main components.

According to the present invention, there is also provided a method of assembling semiconductor devices, comprising bonding a mask sheet to a lead frame under pressure, mounting semiconductor elements on the lead frame to which the mask sheet has been bonded, connecting the semiconductor elements to the lead frame through gold wires, performing resin sealing with a resin sealant in a mold and then releasing the mask sheet, wherein the mask sheet described above is used.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a typical cross-sectional view of a mask sheet for assembly of semiconductor devices according to the present invention.

FIG. 2 is a schematic plan view illustrating an example of a lead frame used in fabricating QFNs using the mask sheet for assembly of semiconductor devices according to the present invention.

FIGs. 3(a) to 3(f) are process drawings illustrating an example of a process of assembling QFNs using the mask

sheet for assembly of semiconductor devices according to the present invention.

BEST MODE FOR CARRYING OUT THE INVENTION

As illustrated in FIG. 1, a mask sheet 10 for assembly of semiconductor devices according to the present invention has an adhesive layer 12 formed with a silicone adhesive on one surface of a heat-resistant film 11.

The heat-resistant film 11 preferably has flexibility because of easy handling upon sticking or releasing of the mask sheet 10 to or from a lead frame. In the present invention, as the heat-resistant film, is used a heat-resistant film having a glass transition temperature (Tg) of at least 150°C and a coefficient of thermal expansion of 10 to 50 ppm/°C at 150 to 200°C. The mask sheet is exposed to an environment of 150 to 180°C in a die attaching step, a wire bonding step and a resin-sealing step upon fabrication of semiconductor devices such as QFN. At this time, the coefficient of thermal expansion of the heat-resistant film rapidly increases when heated to its glass transition temperature Tg or higher, and so its difference in thermal expansion with the lead frame becomes great. In such a case, warpage occurs due to the difference in thermal expansion between the heat-resistant film and the lead frame when they are cooled back to room temperature, and it forms the cause that warpage occurs after the die attaching step, which causes a problem that the lead frame

cannot be set to locating pins in a mold in the subsequent resin-sealing step to cause a failure due to misregistration. Accordingly, the Tg of the heat-resistant film must be at least 150°C, with at least 180°C being preferred. The coefficient of thermal expansion of the heat-resistant film at 150 to 200°C is preferably 10 to 50 ppm/°C, particularly 15 to 40 ppm/°C. Examples of heat-resistant films satisfying these conditions as to heat resistance include films of polyimide, polyamide, poly(ether sulfone), poly(phenylene sulfide), poly(ether ketone), poly(ether ether ketone), triacetyl cellulose and polyether-imide.

The coefficient of thermal expansion of the heat-resistant film in the present invention can be determined in the following manner. Namely, the heat-resistant film is heated at 200°C for 1 hour, the heat-resistant film heated is then cut into pieces 5 x 25 mm in size, and a sample thus obtained is installed in TMA (Thermal Mechanical Analyzer, manufactured by Shinku Riko K.K.; TM9300). The elongation of the sample at the time it has been heated at a heating rate of 3°C/min from 150°C tO 200°C under a load of 1 g is measured to determine the coefficient of thermal expansion in accordance with the following equation:

$$\text{Coefficient of thermal expansion} = \Delta L/L \cdot \Delta t$$

wherein

ΔL: elongation of the sample (length at 200°C -

length at 150°C);

L: Original length of the sample;

Δt: Temperature difference in measurement (200°C - 150°C, i.e., 50°C)

The adhesive layer in the mask sheet according to the present invention requires to scarcely undergo changes such as decomposition and deterioration against heat history in the die attaching step, wire bonding step and resin-sealing step like the heat-resistant film and have stable adhesive force. In order to make the mask sheet releasable from the lead frame, the adhesive strength of the adhesive layer to the heat-resistant film in the mask sheet must be higher than its adhesive strength to the resin sealant and lead frame. A silicone adhesive permits forming an adhesive layer satisfying such requirements and withstanding the above-described environment.

Accordingly, the adhesive layer is formed with the silicone adhesive, and the adhesive layer requires having a percent loss on weight of at most 5% and preferably at most 3% when heated at 180°C for 1 hour. If the percent loss on weight exceeds 5%, the lead frame is contaminated by decomposed products of the adhesive layer in the die attaching step in particular, which causes a problem that a failure of bonding of gold wires occurs.

The silicone adhesives are classified in view of the form of curing reaction into an organic peroxide-curing type, which uses peroxide, and an addition reaction type,

which uses a platinum catalyst. However, since the organic peroxide has a possibility that a low-molecular organic substance, which is a radical residue, may be generated in the course of its reaction to contaminate the lead frame, a silicone adhesive of the addition reaction type is preferably used in the present invention. Specific preferable examples of the silicone adhesive include those comprising polydimethylsilxane or polymethylphenylsiloxane as a main component and those comprising polyalkylalkenylsiloxane and polyalkylhydrogensiloxane as main components. In addition, as examples thereof, may be mentioned those obtained by bonding silicone raw rubber composed mainly of polyorganosiloxane to a silicone resin composed mainly of trimethylsiloxysilicic acid.

More specifically, when polydimethylsiloxane or polymethylphenylsiloxane is used as the polyorganosiloxane, a peroxide is added as a curing agent to use the resulting adhesive as a silicone adhesive of the organic peroxide-curing type because it has no unsaturated bond, and so no addition reaction progresses. When polyalkylalkenyl-siloxane is used as the polyorganosiloxane on the other hand, polyalkylhydrogensiloxane or the like having an active hydrogen radical reacting with a vinyl group is used as a curing agent because the polyalkylalkenylsiloxane has a vinyl group having an unsaturated bond, and a platinum catalyst is added, thereby using the resulting adhesive as a silicone adhesive of the addition reaction type. The

silicone adhesive of the addition reaction type is cured by heating it at 100 to 140°C for several minutes.

In the present invention, the adhesive layer is preferably formed with a silicone adhesive comprising polyorganosiloxane having an average molecular weight of 10,000 to 1,500,000 and has a dynamic modulus of elasticity of at least 1.0×10^4 Pa at 150 to 200°C. A more preferable average molecular weight is within a range of 100,000 to 1,000,000. The average molecular weight of the polyorganosiloxane is set within the above range, whereby releasability of the adhesive layer after curing can be improved to successfully release the mask sheet from the lead frame. Accordingly, the adhesive transfer after releasing the mask sheet can be prevented. The content of the polyorganosiloxane is within a range of at least 10% by weight, preferably at least 50% by weight, more preferably at least 90% by weight. A failure of wire bonding, mold flash and adhesive transfer can be thereby prevented.

If the average molecular weight of the polyorganosiloxane is lower than 10,000, there is a possibility that cohesion after the resulting adhesive layer is cured may becomes low to cause the adhesive transfer upon releasing of the mask sheet from the lead frame. If the average molecular weight of the polyorganosiloxane exceeds 1,500,000 on the other hand, there is a possibility that the solubility of the polyorganosiloxane in organic solvents may be too low to

provide a uniform adhesive, and so it is difficult to form an even adhesive layer on the heat-resistant base material. If the film thickness or the like of the adhesive layer becomes uneven, the adhesion of the mask sheet to the lead frame is partially lowered, so that the mold flash is easy to occur in the resin-sealing step. Such an uneven adhesive layer is hence not preferred.

When the adhesive of the addition reaction type comprising polyalkylalkenylsiloxane and polyalkylhydrogensiloxane is used as the silicone adhesive, the average molecular weight of the polyalkylhydrogensiloxane is preferably 500 to 10,000. If the average molecular weight of the polyalkylhydrogensiloxane is lower than 500, its reactivity when it is mixed with the polyalkylalkenylsiloxane as a main component becomes too high, and so there is a possibility that the curing reaction may progress before the resulting adhesive is applied to the heat-resistant base material to encounter with difficulties on formation of an even adhesive layer. If the average molecular weight of the polyalkylhydrogensiloxane exceeds 10,000 on the other hand, the reactivity with the polyalkylalkenylsiloxane becomes too low, and so there is a possibility that cohesion after the resulting adhesive layer is cured may become low to cause the adhesive transfer upon releasing of the mask sheet from the lead frame.

When the polyorganosiloxane having the above-

described average molecular weight is used, the dynamic modulus of elasticity of the resulting adhesive layer at 150 to 200°C must be at least 1.0×10^4 Pa. It is thereby hard for the adhesive layer to absorb ultrasonic waves in a wire bonding step upon fabrication of semiconductor devices such as QFNs, and consequently the vibration of the lead frame coming into contact with the adhesive layer can be lowered to prevent a failure of wire bonding. If the dynamic modulus of elasticity of the adhesive layer at 150 to 200°C is lower than 1.0×10^4 Pa, there is a possibility that the adhesive layer may absorb ultrasonic waves in the wire bonding step to vibrate the lead frame, thereby causing a failure of wire bonding.

The adhesive layer has the above-described constitution, whereby sufficient adhesive force can be developed in the adhesive layer of the mask sheet even at 150 to 200°C, the release of the lead frame from the mask sheet in the resin-sealing step upon fabrication of semiconductor devices such as QFNs can be controlled, and the mold flash can be prevented.

In the present invention, an inorganic or organic filler may be contained in the silicone adhesive for the purpose of adjusting the coefficient of thermal expansion and thermal conductivity of the adhesive or controlling the surface tack and adhesion property thereof. Examples of the inorganic filler include ground silica, fused silica, alumina, titanium oxide, beryllium oxide, magnesium oxide,

calcium carbonate, titanium nitride, silicon nitride, boron nitride, titanium boride, tungsten boride, silicon carbide, titanium carbide, zirconium carbide, molybdenum carbide, mica, zinc oxide, carbon black, aluminum hydroxide, calcium hydroxide, magnesium hydroxide, antimony trioxide and those obtained by treating these compounds with a trimethylsiloxyl group or the like. Examples of the organic filler include polyimide, polyamide-imide, poly(ether ether ketone), polyether-imide, polyester-imide, nylon and silicone. The amount of these fillers incorporated is within a range of 1 to 500 parts by weight, preferably 3 to 200 parts by weight, more preferably 5 to 100 parts by weight per 100 parts by weight of the silicone resin making up the adhesive layer.

As a method for laminating the adhesive layer on the heat-resistant film, is used a casting method in which a solution of the silicone adhesive is directly coated on the heat-resistant film and dried, or a lamination method in which a solution of the silicone adhesive is coated once on a release film and dried, and the adhesive layer formed is transferred to the heat-resistant film. The film thickness of the adhesive layer is generally set within a range of 1 to 30 μm.

A protective film may be provided on the adhesive layer as needed. Any film may be used as the protective film so far as it has releasability. Examples of usable films include films of polyester, polyethylene,

polypropylene and polyethylene terephthalate, and those obtained by subjecting such films to a releasing treatment with a silicone resin or fluorine compound. The protective film is released just before fabrication of semiconductor devices.

The method of fabricating semiconductor devices according to the present invention will now be described with reference to the accompanying drawings taking fabrication of QFNs as the semiconductor devices as an example. FIG. 2 is a schematic plan view of a lead frame viewed from a side where the semiconductor devices are mounted, and FIGs. 3(a) to 3(f) are process drawings illustrating a process of fabricating QFNs from the lead frame shown in FIG. 2 and are schematic cross-sectional views taken along line A-A' as to the lead frame in FIG. 2.

The lead frame 20 shown in FIG. 2 is first provided. The lead frame 20 has a plurality of semiconductor element mounting parts (die pads) 21 like islands, on which semiconductor elements such as IC chips are respectively mounted. A number of leads 22 are arranged along an outer periphery of each semiconductor element mounting part 21.

As illustrated in FIG. 3(a), the mask sheet 10 according to the present invention is then stuck on one surface of the lead frame 20 with the adhesive layer side opposed to the lead frame in a mask sheet sticking step. The sticking is preferably performed by a lamination method or the like. For example, both mask sheet and the lead

frame are heated and brought into contact under pressure with each other to bond the heat-resistant film to the lead frame through the adhesive layer formed by curing the silicone adhesive.

As illustrated in FIG. 3(b), semiconductor elements 30 such as IC chips are mounted on the semiconductor element mounting parts 21 of the lead frame 20 with a die attaching agent (not illustrated) from the side where no mask sheet 10 is stuck in a die attaching step.

As illustrated in FIG. 3(c), the semiconductor elements 30 are then respectively electrically connected to leads 22 of the lead frame 20 through bonding wires 31 such as gold wires in a wire bonding step.

As illustrated in FIG. 3(d), the semiconductor devices (FIG. 3(c)) in the course of fabrication are placed in a mold in a resin-sealing step to seal the semiconductor elements 30 with a molding resin (molding material) 40 by, for example, transfer molding.

As illustrated in FIG. 3(e), the mask sheet 10 is then released from the lead frame 20, whereby a QFN unit 60 with a plurality of QFNs 50 arranged there can be formed.

As illustrated in FIG. 3(f), the QFN unit is finally diced into individual QFNs, whereby a plurality of QFN can be fabricated.

EXAMPLES

The present invention will hereafter be described

more specifically by the following examples. However, the present invention is not limited to these examples.

Example 1:

(Preparation of coating formulation for forming adhesive layer)

A mixed solution (X40-3103, product of Shin-Etsu Chemical Co., Ltd.) of polyalkylalkenylsiloxane and polyalkylhydrogensiloxane and a solution of a platinum catalyst (PL50T, product of Shin-Etsu Chemical Co., Ltd.) were mixed at a ratio of 100:1 by weight.

(Production of mask sheet)

A polyimide film (thickness: 25 μm) having a Tg of 490°C and a coefficient of thermal expansion of 12 ppm/°C at 150 to 200°C was used as a support, and the coating formulation for forming an adhesive layer was coated thereon so as to give a dry coating thickness of 8 μm and dried at 160°C for 15 minutes to obtain a mask sheet.

Example 2:

(Preparation of coating formulation for forming adhesive layer)

Polydimethylsiloxane (KR120, product of Shin-Etsu Chemical Co., Ltd.) and benzyl peroxide (Nyber B, product of Nippon Oil & Fats Co., Ltd.) were mixed at a ratio of 100:1 by weight.

(Production of mask sheet)

A polyimide film (thickness: 25 μm) having a Tg of 490°C and a coefficient of thermal expansion of 12 ppm/°C

at 150 to 200°C was used as a support, and the coating formulation for forming an adhesive layer was coated thereon so as to give a dry coating thickness of 8 μm and dried at 160°C for 15 minutes to obtain a mask sheet.

Comparative Example 1:

(Preparation of coating formulation for forming adhesive layer)

An acrylic copolymer (SK Dine 1131B, product of Soken Chemical and Engineering Co., Ltd.) and isocyanate (Coronate L-40, product of Nippon Polyurethane Industry Co., Ltd.) were mixed at a ratio of 100:1 by weight.

(Production of mask sheet)

A polyimide film (thickness: 25 μm) having a Tg of 490°C and a coefficient of thermal expansion of 12 ppm/°C at 150 to 200°C was used as a support, and the coating formulation for forming an adhesive layer was coated thereon so as to give a dry coating thickness of 8 μm, dried at 100°C for 5 minutes and left to stand for 7 days at 30°C to obtain a mask sheet.

Comparative Example 2:

(Preparation of coating formulation for forming adhesive layer)

An epoxy resin (Epikote 828, product of Yuka Shell Epoxy K. K.), an epoxy curing agent (Resitop PSM 4261, product of Gun-ei Chemical Industry Co., Ltd.) and an acrylonitrile-butadiene copolymer (Nipol 1001, product of Nippon Zeon Co., Ltd.) were mixed at a ratio of 40:30:30 by

weight.

(Production of mask sheet)

A polyimide film (thickness: 25 μm) having a Tg of 490°C and a coefficient of thermal expansion of 12 ppm/°C at 150 to 200°C was used as a support, and the coating formulation for forming an adhesive layer was coated thereon so as to give a dry coating thickness of 8 μm and dried at 130°C for 5 minutes to obtain a mask sheet.

Comparative Example 3:

(Preparation of coating formulation for forming adhesive layer)

A mixed solution (X40-3103, product of Shin-Etsu Chemical Co., Ltd.) of polyalkylalkenylsiloxane and polyalkylhydrogensiloxane and a solution of a platinum catalyst (PL50T, product of Shin-Etsu Chemical Co., Ltd.) were mixed at a ratio of 100:1 by weight.

(Production of mask sheet)

A polyethylene terephthalate film (thickness: 25 μm) having a Tg of 73°C and a coefficient of thermal expansion of 60 ppm/°C at 150 to 200°C was used as a support, and the coating formulation for forming an adhesive layer was coated thereon so as to give a dry coating thickness of 8 μm and dried at 130°C for 5 minutes to obtain a mask sheet.

<Evaluation items and evaluation methods>

(Percent loss on weight)

The percent loss on weight of the adhesive layer in each of the mask sheets produced in Examples 1 and 2 and

Comparative Examples 1 to 3 was determined in the following manner.

After the coating formulation for forming an adhesive layer used in each of the above-described Examples 1 and 2 and Comparative Examples 1 to 3 was coated on a Teflon (trademark) sheet having a flat surface so as to give a dry coating thickness of 1 mm to form an adhesive layer, and the adhesive layer was dried or cured under the same conditions as in its corresponding Example or Comparative Example to produce a Teflon (trademark) sheet having an adhesive layer. The resultant adhesive layer was released from the Teflon sheet to measure a percent loss on weight when the adhesive layer alone was heated at 180°C for 1 hour in a differential thermobalance (TG/DTA320, manufactured by Seiko Instruments Co., Ltd.).

(Resistance to warpage)

Each of the mask sheets produced in Examples 1 and 2 and Comparative Examples 1 to 3 was laminated on a lead frame (Au-Pd-Ni plated Cu lead frame, a matrix arrangement of 8 x 32, package size: 5 x 5 mm, resin-sealing area: 180 x 40 mm) for QFN having an outer size of 200 x 60 mm, and cut into the same size as the lead frame for QFN to produce a film laminate. The resultant film laminate was used as a sample for evaluating the resistance to warpage.

This sample for evaluation was placed on a horizontal table so that the mask sheet surface was exposed as a top, and a height of warpage at its end portion was then

measured by z-axis coordinate measurement by means of a digital measuring microscope (STM-UM, manufactured by OLYMPUS OPTICAL CO., LTD.). The results are shown in Table 1.

(Wire bonding property)

Each of the mask sheets produced in Examples 1 and 2 and Comparative Examples 1 to 3 was laminated on a lead frame (Au-Pd-Ni plated Cu lead frame, a matrix arrangement of 8 x 32, package size: 5 x 5 mm, resin-sealing area: 180 x 40 mm) for QFN having an outer size of 200 x 60 mm. Aluminum-deposited dummy chips (3 x 3 cm, thickness: 0.4 mm) were then respectively bonded to die pads of the lead frame with an epoxy die-attaching material, and tips of lead pins were electrically connected to the dummy chips through gold wires by means of a wire bonder (FB131, manufactured by KAIJO CORPORATION) under conditions of a temperature of 180°C, a frequency of 60 kHz, a load of 150 gf and treatment speed of 10 ms/pin. The thus-obtained 256 packages were inspected, and the number of packages which underwent a failure of bonding on the lead side was detected as the number of packages which underwent a failure of wire bonding.

(Mold flash)

The lead frame subjected to the wire bonding was resin-sealed with an epoxy molding resin (o-cresol novolak epoxy type, filler content: 85% by weight) by transfer molding under conditions of a heating temperature of 180°C,

a pressure of 10 MPa and treatment time of 3 minutes. Thereafter, the mask sheet was released from the resin-sealed product to observe the mask sheet-covered surface of the resin-sealed product, thereby confirming the number of packages in which the molding resin leaked and adhered to areas of the lead pins. The number of packages which underwent a failure due to the leakage of the molding resin in the 256 packages was detected as the number of mold flash.

(Adhesive transfer)

After the dummy chips were sealed with the molding resin in the same manner as in the evaluation of the mold flash, the mask sheet was released from the lead frame at a releasing rate of 500 mm/min. The 256 packages after releasing the mask sheet from the lead frame were inspected, and the number of packages in which the adhesive adhered to external connection portions of the leads (surfaces of leads on the side where the mask sheet was stuck) was detected as the number of packages which underwent adhesive transfer.

<Evaluation results>

The evaluation results obtained in Examples 1 and 2 and Comparative Examples 1 to 3 are shown in Table 1.

Table 1

	Percent loss on weight (%)	Warpage (mm)	Number of packages which underwent a failure of wire bonding (packages)	Number of packages which underwent mold flash (packages)	Number of packages which underwent adhesive transfer (packages)
Ex. 1	0.8	0.3	0	0	0
Ex. 2	1.2	0.4	0	1	0
Comp. Ex. 1	5.6	0.4	154	216	189
Comp. Ex. 2	3.8	1.3	32	10	210
Comp. Ex. 3	0.8	3.2	0	0	- *1)

*1) Not evaluated.

Example 3:

A solution (TSR-1512, solid concentration: 60%, product of GE Toshiba Silicone Co., Ltd.) containing polyalkylalkenylsiloxane having an average molecular weight of 500,000 and a platinum catalyst and polyalkylhydrogen-siloxane (CR-51, average molecular weight: 1,300, product of GE Toshiba Silicone Co., Ltd.) were mixed at a ratio of 100:1 by weight to prepare a coating formulation for forming an adhesive layer containing a silicone adhesive of the addition reaction type.

The coating formulation for forming an adhesive layer was coated on the same polyimide film as that used in Example 1 so as to give a dry coating thickness of 8 μm, thereby forming an adhesive layer, and the adhesive layer was then dried and cured by heating at 160°C for 15 minutes

to obtain a mask sheet according to the present invention.

Example 4:

A solution (TSR-1516, solid concentration: 60%, product of GE Toshiba Silicone Co., Ltd.) containing polyalkylalkenylsiloxane having an average molecular weight of 400,000 and a platinum catalyst and polyalkylhydrogen-siloxane (CR-50, average molecular weight: 2,000, product of GE Toshiba Silicone Co., Ltd.) were mixed at a ratio of 100:1 by weight to prepare a coating formulation for forming an adhesive layer containing a silicone adhesive of the addition reaction type.

The coating formulation for forming an adhesive layer was coated on the same polyimide film as that used in Example 1 so as to give a dry coating thickness of 8 μm, thereby forming an adhesive layer, and the adhesive layer was then dried and cured by heating at 160°C for 15 minutes to obtain a mask sheet according to the present invention.

Example 5:

Polydimethylsiloxane (KR-101-10, average molecular weight: 240,000, product of Shin-Etsu Chemical Co., Ltd.) and benzyl peroxide (Nyber B, product of Nippon Oil & Fats Co., Ltd.) were mixed at a ratio of 100:1 by weight to prepare a coating formulation for forming an adhesive layer containing a silicone adhesive of the organic peroxide-curing type.

The coating formulation for forming an adhesive layer was coated on the same polyimide film as that used in

Example 1 so as to give a dry coating thickness of 8 μm, thereby forming an adhesive layer, and the adhesive layer was then dried and cured by heating at 160°C for 15 minutes to obtain a mask sheet according to the present invention.

The average molecular weight of the silicone resin in each of the coating formulations for forming an adhesive layer in Examples 3 to 5 was measured in the following manner. Namely, tetrahydrofuran was used as a solvent to prepare a 0.2% by weight solution of the silicone resin. The measurement was performed by using a GPC (gel permeation chromatograph) device and arranging 2 KF-806L columns (product of Showa Denko K.K.) as columns for resin separation in series, thereby determining the average molecular weight.

<Evaluation items and evaluation methods>

(Dynamic modulus of elasticity)

Each of the adhesives obtained in Examples 3 to 5 and Comparative Examples 1 and 2 was coated on a Teflon (trademark) sheet having a flat surface so as to give a dry coating thickness of 1 mm to form an adhesive layer, and the adhesive layer was dried or cured under the same conditions as in the production of the mask sheet in its corresponding Examples or Comparative Example to produce a Teflon (trademark) sheet having an adhesive layer.

The thus-obtained sample was cut into a disk having a diameter of 7 mm to measure the dynamic modulus of elasticity of the adhesive layer by using an elastic

modulus meter (Rheostress, manufactured by Haake Co.) and setting a frequency, heating rate, temperature range and load to 1 Hz, 3°C/min, 150 to 200°C and 3 N, respectively.

(Percent loss on weight)

Evaluation was made in the same manner as in Table 1.

(Wire bonding property)

Evaluation was made in the same manner as in Table 1.

(Mold flash)

Evaluation was made in the same manner as in Table 1.

(Adhesive transfer)

Evaluation was made in the same manner as in Table 1.

<Evaluation results>

The evaluation results obtained in Examples 3 to 5 and Comparative Examples 1 and 2 are shown in Table 2. In Table 2, the dynamic modulus of elasticity is expressed by the smallest value of the dynamic moduli of elasticity of the adhesive layer when measured at 150 to 200°C.

Table 2

	Dynamic modulus of elasticity (Pa)	Percent loss on weight (%)	Number of packages which underwent a failure of wire bonding (packages)	Number of packages which underwent mold flash (packages)	Number of packages which underwent adhesive transfer (packages)
Ex. 3	8.0×10^4	0.8	0	0	0
Ex. 4	5.5×10^4	1.2	0	0	5
Ex. 5	2.1×10^4	3.2	4	1	3
Comp. Ex. 1	2.3×10^3	5.6	154	216	189
Comp. Ex. 2	3.8×10^6	3.8	32	10	210

As shown in Table 2, the percent loss on weight of the adhesive layers obtained in Examples 3 to 5 in which each of the adhesive layers was formed with the silicone adhesive containing polyorganosiloxane having an average molecular weight of 10,000 to 1,500,000 to produce the mask sheet the dynamic modulus of elasticity of the adhesive layer of which was at least 1.0×10^4 Pa at 150 to 200°C was as small as 0.8 to 3.2%. As a result that the resultant mask sheets were used to make the evaluation, the failure of wire bonding, mold flash and adhesive transfer did not occur at all, or the number of packages which underwent such problems was extremely little if occurred.

On the other hand, in Comparative Example 1 in which the adhesive layer was formed with the acrylic adhesive to produce the mask sheet the dynamic modulus of elasticity of

the adhesive layer of which was lower than 1.0×10^4 Pa at 150 to 200°C, the percent loss on weight of the adhesive layer was as high as 5.6%. As a result that the resultant mask sheet was used to make the evaluation, the failure of wire bonding, mold flash and adhesive transfer occurred at high probability.

In Comparative Example 2 in which the adhesive layer was formed with the rubber adhesive to produce the mask sheet the dynamic modulus of elasticity of the adhesive layer of which was at least 1.0×10^4 Pa at 150 to 200°C, the percent loss on weight of the adhesive layer was as low as 3.8%. As a result that the resultant mask sheet was used to make the evaluation, the number of packages which underwent the failure of wire bonding could be decreased, but the adhesive transfer occurred at high probability.

CAPABILITY OF EXPLOITATION IN INDUSTRY

Since the mask sheets according to the present invention have the above-described constitution, they are excellent in heat resistance, little in the amount of decomposed products vaporized even in heat history upon curing of a die-attaching material and free from contamination of a lead frame, and so high reliability on the connection of semiconductor chips to the lead frame can be achieved. Since warpage of the lead frame is little, misregistration is hard to occur. In addition, "mold flash" that a molding resin leaks from the mask sheet can

also be prevented, and the adhesive transfer of the adhesive is inhibited, and so semiconductor packages such as QFNs can be stably produced. Accordingly, the use of the mask sheet according to the present invention permits efficiently assembling semiconductor devices.

CLAIMS:

1. A mask sheet for assembly of semiconductor devices releasably stuck to a lead frame, which comprises a heat-resistant film having a glass transition temperature of at least 150°C and a coefficient of thermal expansion of 10 to 50 ppm/°C at 150 to 200°C and an adhesive layer comprising a silicone adhesive provided on one surface of the heat-resistant film.

2. The mask sheet for assembly of semiconductor devices according to claim 1, wherein the adhesive layer has a percent loss on weight of at most 5% when heated at 180°C for 1 hour.

3. The mask sheet for assembly of semiconductor devices according to claim 1, wherein the silicone adhesive comprises polydimethylsilxane as a main component.

4. The mask sheet for assembly of semiconductor devices according to claim 1, wherein the silicone adhesive comprises polyalkylalkenylsiloxane and polyalkylhydrogensiloxane as main components.

5. The mask sheet for assembly of semiconductor devices according to claim 1, wherein the adhesive layer is formed with a silicone adhesive comprising polyorganosiloxane having an average molecular weight of 10,000 to 1,500,000 and has a dynamic modulus of elasticity of at least 1.0×10^4 Pa at 150 to 200°C.

6. The mask sheet for assembly of semiconductor devices according to claim 5, wherein the

polyorganosiloxane is polydimethylsiloxane.

7. The mask sheet for assembly of semiconductor devices according to claim 5, wherein the polyorganosiloxane is polyalkylalkenylsiloxane.

8. The mask sheet for assembly of semiconductor devices according to claim 5, wherein the silicone adhesive contains polyalkylhydrogensiloxane.

9. A method of assembling semiconductor devices, comprising bonding a mask sheet to a lead frame under pressure, mounting semiconductor elements on the lead frame to which the mask sheet has been bonded, connecting the semiconductor elements to the lead frame through gold wires, performing resin sealing with a resin sealant in a mold and then releasing the mask sheet, wherein the mask sheet according to claim 1 is used as the mask sheet.