

[DESCRIPTION]

[TITLE OF THE INVENTION]

FILM FOR A SPACER AND METHOD OF FORMING SPACER USING THE
SAME

5

[BACKGROUND OF THE INVENTION]

1. Field of the Invention

The present invention relates to a film for a spacer
applied to a multi-chip package and a method of forming a spacer
10 using the same.

2. Description of the Related Art

With the development of semiconductor device
manufacturing technologies, many studies have been performed on
15 reduction in the size and multifunctional properties of
electronic devices. Multi-chip package (MCP) technology is one
of packaging solutions of semiconductor chips, and is a
technology for implementing the same type of semiconductor chips
or different types of semiconductor chips into a single package.
20 The multi-chip package technology allows to implement high-
speed transmission in a narrow package area, thereby having
advantages in that the size and weight can be reduced compared
to the case of implementing the respective semiconductor chips
as a separate package.

In order to obtain an effect of size reduction in the multi-chip package, it is necessary to stack a plurality of semiconductor chips and arrange the stacked body in one package. In this case, a component used for such the process is a spacer.

5 For example, in a package in which two semiconductor chips are stacked, one semiconductor chip is directly attached to a package substrate, whereas the other semiconductor chip is not directly attached to the package substrate. A component serves to support the semiconductor chip which is not directly attached
10 to the package substrate is the spacer.

The spacer is generally made of metal, a polymer, a photosensitive resist and the like. When the spacer is made of the metal or photosensitive resist, a method, in which the metal or photosensitive resist is deposited or coated on the package
15 substrate, then a portion other than the spacer is removed by etching, may be used. When the spacer is made of the metal or polymer, a method, in which a spacer is manufactured in a predetermined shape and the spacer is bonded on the package substrate, may be used.

20 The method of forming a spacer by depositing or coating the metal or photosensitive resist then removing the portion other than the spacer by etching not only requires a complicated process such as photolithography, but also has a problem such as waste of materials. The method of manufacturing a spacer
25 having a predetermined size and bonding the spacer on the

package substrate has problems in that it is not easy to accurately manufacture the spacer having the required size, as well as it is difficult to accurately attach the spacer on the package substrate.

5 Further, there is a method of manufacturing a spacer by using a dummy wafer and bonding the spacer on the package substrate. In the case of this method, there is a problem of wasting the dummy wafer.

10 Meanwhile, a method of using a polymer film including a component such as polyimide instead of the dummy wafer as a spacer may be considered. However, a phenomenon, in which the film is bent at an edge portion of the chip due to a low elastic modulus of the polymer film after dicing, occurs, and thereby resulting in a failure in recognizing the die and a reduction
15 in pickup ability.

[SUMMARY OF THE INVENTION]

20 An object of the present invention is to provide a film for a spacer that enables a dicing process without using a dummy wafer, while suppressing die recognition failure and having improved pickup ability.

25 In addition, another object of the present invention is to provide a method of forming a spacer, which is capable of performing a dicing process with excellent efficiency without using a dummy wafer.

Further, another object of the present invention is to provide a multi-chip package which does not use a dummy wafer.

The technical problem to be achieved by the present invention is not limited to the problems described above, and other problems not described above will be clearly understood by those skilled in the art from the following descriptions.

To achieve the above objects, according to an aspect of the present invention, there is provided a film for a spacer including a first film; and an adhesive layer disposed on a lower portion of the first film, wherein the film for a spacer satisfies Equation 1 below:

[Equation 1]

$$10 \text{ GPa} \cdot \text{mm} \leq (\text{Storage modulus} \times \text{Amount of curl}) \leq 200 \text{ GPa} \cdot \text{mm}$$

(In Equation 1, the storage modulus is a storage modulus of the film for a spacer at 25°C, and the amount of curl is an amount of curl measured by cutting a portion where the first film and the adhesive layer are stacked into a rectangle with a width of 50 mm and a length of 15 mm, and placing the cut portion on a horizontal surface so that the adhesive layer faces downward).

In some embodiments, the storage modulus may be 2 GPa to 10 GPa.

In some embodiments, the amount of curl may be 5 mm to 20 mm.

In some embodiments, the first film may include at least one of polyimide, polyetheretherketone, polyamideimide, polyphenylene sulfide, polyphthalamide, polysulfone, polyethersulfone, and polyetherimide.

5 In some embodiments, the first film may include a coating layer formed on a lower portion thereof.

In some embodiments, the coating layer may include at least one of a compound containing a polyimide functional group, a compound containing a polyamideimide functional group, a
10 compound containing an epoxy functional group, and a compound containing a urethane acrylate functional group.

In some embodiments, the coating layer may have a thickness of 2 to 9 μm .

In some embodiments, the adhesive layer may include at
15 least one of an acrylic compound and an epoxy resin.

In some embodiments, the film for a spacer may further include a first pressure sensitive adhesive layer disposed on a lower portion of the adhesive layer.

In some embodiments, the first pressure sensitive adhesive
20 layer may include an acrylic compound.

In some embodiments, an edge of an upper surface of the first pressure sensitive adhesive layer may be exposed.

In some embodiments, an adhesive force between the first pressure sensitive adhesive layer and the adhesive layer may be
25 20 to 200 N/m before UV curing of the first pressure sensitive

adhesive layer, and 15 N/m or less after UV curing of the first pressure sensitive adhesive layer.

In some embodiments, the film for a spacer may further include a second film disposed on a lower portion of the first pressure sensitive adhesive layer.

In some embodiments, the second film may include a polyolefin resin.

In some embodiments, the film for a spacer may further include: a second pressure sensitive adhesive layer disposed on an upper portion of the first film; and a cover film disposed on the second pressure sensitive adhesive layer.

In addition, according to another aspect of the present invention, there is provided a method of forming a spacer including a fixation step of fixing the film for a spacer according to the embodiments to a frame; a dicing step of dicing the film for a spacer to individualize the same; a pickup step of picking up the spacer including a first film and an adhesive layer from the resulting individualized product; and an attachment step of attaching the picked up spacer onto a package substrate.

In some embodiments, the film for a spacer further may include a first pressure sensitive adhesive layer disposed on a lower portion of the adhesive layer, wherein an edge of an upper surface of the first pressure sensitive adhesive layer

may be exposed, and a frame may be disposed on the edge of the upper surface of the first pressure sensitive adhesive layer.

Further, according to another aspect of the present invention, there is provided a multi-chip package including a package substrate; a spacer comprising the film for a spacer according to the embodiments disposed on the package substrate; a first semiconductor chip unit disposed on the package substrate; a second semiconductor chip unit stacked on the spacer and the first semiconductor chip unit; a wire configured to electrically connect a chip pad of the first semiconductor chip unit and a first substrate pad corresponding thereto; a wire configured to electrically connect the chip pad of the second semiconductor chip unit and a second substrate pad corresponding thereto; and a package body configured to seal the first semiconductor chip unit, the second semiconductor chip unit, the wire and the spacer.

The film for a spacer according to the present invention includes the first film instead of a dummy wafer, wherein the product of a storage modulus and an amount of curl is 10 GPa•mm to 200 GPa•mm. Accordingly, it is possible to suppress die recognition failure occurring in the dicing process and improve pickup ability.

In addition, it is possible to easily manufacture individualized spacers having desired sizes from the film for

a spacer according to the present invention through a dicing process.

Further, in accordance with the method of forming a spacer according to the present invention, it is possible to easily
5 attach the individualized spacers to the package substrate through the pickup process and the attachment process.

Furthermore, the present invention may provide a multi-chip package which does not use a dummy wafer by using the film for a spacer.

10 [BRIEF DESCRIPTION OF THE DRAWINGS]

The above and other objects, features and other advantages of the present invention will be more clearly understood from the following detailed description taken in
15 conjunction with the accompanying drawings, in which:

FIG. 1 is a cross-sectional view schematically illustrating an example of a multi-chip package including a spacer according to an embodiment of the present invention;

FIG. 2 is a cross-sectional view schematically
20 illustrating a multi-chip package including a spacer according to another embodiment of the present invention;

FIG. 3 is a cross-sectional view schematically illustrating a multi-chip package including a spacer according to another embodiment of the present invention;

FIG. 4 is a cross-sectional view schematically illustrating a multi-chip package including a spacer according to another embodiment of the present invention;

FIG. 5 is a cross-sectional view schematically illustrating a film for a spacer according to an embodiment of the present invention;

FIG. 6 is a cross-sectional view schematically illustrating a film for a spacer according to another embodiment of the present invention;

FIG. 7(a) to (e) is cross-sectional views schematically illustrating a method of forming a spacer using a dicing process according to the present invention;

FIG. 7(a) is a cross-sectional view schematically illustrating a step of preparing a film for a spacer by removing a second pressure sensitive adhesive layer and a cover film;

FIG. 7(b) is a cross-sectional view schematically illustrating a step of fixing a film for a spacer using a frame;

FIG. 7(c) is a cross-sectional view schematically illustrating a step of dicing a film for a spacer to individualize a film;

FIG. 7(d) is a cross-sectional view schematically illustrating a step of picking up a spacer from a resulting individualized product by using a pushing means and an adsorption means;

FIG. 7(e) is a cross-sectional view schematically illustrating a step of attaching a spacer to a package substrate;

FIG. 8(a) is plan views corresponding to FIG. 7(a);

5 FIG. 8(b) is plan views corresponding to FIG. 7(b); and

FIG. 8(c) is plan views corresponding to FIG. 7(c).

[DETAILED DESCRIPTION OF THE INVENTION]

10 In descriptions of the embodiments of the present invention, publicly known techniques that are judged to be able to make the purport of the present invention unnecessarily obscure will not be described in detail. Referring to the drawings, wherein like reference characters designate like or corresponding parts throughout the several views. In addition,

15 the terms as used herein are defined by taking functions of the present invention into account and can be changed according to the custom or intention of users or operators. Therefore, definition of the terms should be made according to the overall disclosure set forth herein.

20 It should be understood that the technical spirit and scope of the present invention are defined by the appended claims, and the following embodiments are only made to efficiently describe the present invention to persons having common knowledge in the technical field to which the present

25 invention pertains.

Hereinafter, specific embodiments of the present invention will be described with reference to the accompanying drawings. However, these are merely illustrative examples and the present invention is not limited thereto.

5 FIG. 1 is a cross-sectional view schematically illustrating an example of a multi-chip package including a spacer.

Referring to FIG. 1, a first semiconductor chip unit 120 is disposed on a package substrate 110. The first semiconductor
10 chip unit 120 may include a first adhesive layer 121 and a first semiconductor chip 122. The first adhesive layer 121 serves to attach the first semiconductor chip 122 to the package substrate 110. Herein, a chip pad and a first substrate pad corresponding thereto are connected with each other through a wire 125, such
15 that the first semiconductor chip unit 120 may be electrically connected to the package substrate 110.

A spacer 130 is disposed around the first semiconductor chip unit 120. The spacer 130 includes an adhesive layer 131 and a support 132. The adhesive layer 131 serves to attach the
20 support 132 to the package substrate.

A second semiconductor chip unit 140 is disposed on the spacer 130. The second semiconductor chip unit 140 may include a second adhesive layer 141 and a second semiconductor chip 142. The second adhesive layer 141 serves to attach the second
25 semiconductor chip 142 to the support 132 of the spacer 130.

Herein, a chip pad and a second substrate pad corresponding thereto are connected with each other through a wire 145, such that the second semiconductor chip unit 140 may be electrically connected to the package substrate 110. As another example,
5 the second semiconductor chip 142 may be electrically connected to the package substrate 110 through a via hole passing through the spacer 130.

The first semiconductor chip unit 120, the spacer 130, and the second semiconductor chip unit 140 are disposed on the
10 package substrate 110, and a wire bonding process is performed thereon, then a package body 150 for sealing these components is formed. The package body 150 may be made of a sealing material such as an epoxy resin.

As shown in FIG. 1, the spacer 130 may have a higher
15 height than the height of the first semiconductor chip unit 120. Thereby, the second semiconductor chip units 140 may be stacked using the spacer 130 as a support. As another example, the spacer 130 may have the same height as the height of the first semiconductor chip unit 120. In addition, due to the fact that
20 the spacer 130 has the same height as the height of the first semiconductor chip unit 120, an effect of burying the first semiconductor chip unit 120 by the spacer 130 and the second semiconductor chip unit 140 may be obtained.

FIGS. 2 to 4 are cross-sectional views schematically illustrating other examples of the multi-chip package including a spacer.

Similar to the example shown in FIG. 1, the second semiconductor chip units (140-1 to 140-4 in FIG. 2, 140-1 to 140-5 in FIG. 3, and 140-1 to 140-7 in FIG. 4) in FIGS. 2 to 4 may be electrically connected to another second semiconductor chip unit or the package substrate 110 through a wire (not illustrated) or a via hole (not illustrated), respectively.

Even in the case of the multi-chip packages shown in FIGS. 2 to 4, the semiconductor chip units may be stacked through the spacer 130 disposed on the package substrate 110, respectively.

FIG. 5 is a cross-sectional view schematically illustrating a film for a spacer according to an embodiment of the present invention.

Referring to FIG. 5, the film for a spacer illustrated includes a first film 510 and an adhesive layer 520, and may further include a first pressure sensitive adhesive layer 535 disposed on a lower portion of the adhesive layer 520. The film for a spacer according to an embodiment of the present invention satisfies Equation 1 below.

[Equation 1]

$$10 \text{ GPa} \cdot \text{mm} \leq (\text{Storage modulus} \times \text{Amount of curl}) \leq 200 \text{ GPa} \cdot \text{mm}$$

In Equation 1, the storage modulus is a storage modulus of the film for a spacer at 25°C, and the amount of curl is a value measured by cutting a portion where the first film and the adhesive layer are stacked into a rectangle with a width of 50 mm and a length of 15 mm, and placing the cut portion on a horizontal surface so that the adhesive layer faces downward.

In Equation 1, the value of storage modulus $\times$ amount of curl is preferably 10 GPa $\cdot$ mm to 200 GPa $\cdot$ mm. Within the range of the above value, it is possible to suppress an occurrence of die recognition failure due to warpage during expanding, and the pickup process by a needle pin may be performed well. As the storage modulus is increased, the hardness of the film is increased, such that warpage of the film during expanding may be suppressed even when the amount of curl is reduced. Conversely, even if the storage modulus is decreased, it is possible to suppress die recognition failure and improve pickup property by increasing the amount of curl.

The storage modulus E' may be a value obtained by cutting a portion where the first film and the adhesive layer were stacked from the film for a spacer into 5 mm $\times$ 20 mm, and heating the cut portion at a heating rate of 10°C/min from a temperature range of -30°C, followed by measuring a storage modulus at 25°C using a dynamic mechanical analyzer (DMA, manufacturer: TA, model name: DMA850) equipment. The storage modulus is preferably 2 GPa to 10 GPa. If the storage modulus is less than

2 GPa, die recognition and pickup failures due to warpage occur during expanding, and if the storage modulus exceeds 10 GPa, hardness of the film may be excessively increased, such that commercialization in a form of a roll may not be achieved.

5 The amount of curl means a relative difference between heights of a central portion and an outer periphery of a specimen, and has a positive (+) value when the central portion is higher than the outer periphery, and a negative (-) value when the central portion is lower than the outer periphery.

10 If the amount of curl is less than 5 mm, a smile-shaped warpage occurs during expanding, thereby resulting in vision recognition failure of pickup equipment. If the amount of curl exceeds 20 mm, the first film 510 and the adhesive layer 520 are not closed to each other well, such that the manufacturing
15 process cannot be performed or chip flying occurs due to self-peeling when used in the pick-up process.

First film

20 The first film 510 is a portion which will be the support 132 of the spacer 130 shown in FIGS. 1 to 4. The spacer 130 is required to have heat resistance in a process of manufacturing a semiconductor chip package and use of the semiconductor chip package.

25 Therefore, the first film 510 preferably has heat resistance. Accordingly, as the first film 510, the present

invention exemplifies a film whose weight reduction rate was limited to 2% or less at 200°C and linear expansion coefficient was limited 50 ppm/°C or less at 100°C or lower. If the weight reduction rate at 200°C exceeds 2% or the linear expansion coefficient at 100°C or lower exceeds 50 ppm/°C, it may be seen that the heat resistance is not good.

The first film 510 having the above-described heat resistance may include at least one of polyimide, polyetheretherketone, polyamideimide, polyphenylene sulfide, polyphthalamide, polysulfone, polyethersulfone, and polyetherimide. Among them, it is preferable to use polyimide or polyether ether ketone which is more excellent in heat resistance as a material of the first film.

The first film 510 may have a single layer structure. As another example, the first film 510 may have a multi-layered structure.

The first film 510 may include a coating layer on a lower portion thereof. The coating layer may have a higher elastic modulus or shrinkage rate than the first film 510. When including the coating layer, by forming the elastic modulus or shrinkage rates in the lower portion and upper portion of the first film 510 different from each other, it is possible to provide curl to the film for a spacer in an easier manner.

The coating layer may include at least one of a compound containing a polyimide functional group, a compound containing

a polyamideimide functional group, a compound containing an epoxy functional group, and a compound containing a urethane acrylate functional group. The compound may be included in the form of a cured product.

5 The coating layer may have a thickness of 2 to 9 μm . If the thickness of the coating layer is less than 2 μm , it is difficult to provide an appropriate amount of curl to achieve effects of the present invention to the film for a spacer, and if it exceeds 9 μm , rolls occur, thereby making it difficult to
10 manufacture the film for a spacer or flying may occur during the pickup process.

 The thickness of the first film layer may be determined according to the thickness of a target spacer support (132 in FIG. 1), and may be 3 μm to 100 μm in consideration of formation
15 of curl, but it is not particularly limited thereto.

Adhesive layer

 The adhesive layer 520 is a portion which will be the adhesive layer 131 of the spacer 130 shown in FIGS. 1 to 4.

20 The adhesive layer 520 is disposed on the lower portion of the first film 510. The adhesive layer 520 may have a thickness of about 3 to 60 μm , but it is not limited thereto.

 In the present invention, the adhesive layer 520 may include an acrylic compound. In addition, the adhesive layer
25 520 may include an epoxy resin for curing. As the epoxy resin,

at least one of bisphenol-A type, bisphenol-F type, bisphenol-S type, bisphenol-AF type, biphenyl type, naphthalene type, fluorene type, phenol novolak type, orthocresol novolak type, and glycidylamine type epoxy resins, etc. may be used.

5 In addition, the adhesive layer 520 may further include at least one additive. As the additive, a curing agent (phenolic resin, amines, etc.), inorganic particles (silica, aluminum hydroxide, alumina, titanium dioxide, calcium carbonate, etc.), a curing enhancer, and a silane coupling
10 agent, etc. may be presented, but it is not limited thereto.

 The acrylic compound usable for the adhesive layer 520 and a first pressure sensitive adhesive layer 535 and a second pressure sensitive adhesive layer 545, which will be described below, preferably includes a monomer derived from (meth)acrylic
15 acid ester.

 As the monomer, (meth)acrylic acid ester, (meth)acrylic acid alkyl ester, (meth)acrylic acid cycloalkyl ester, (meth)acrylic acid aryl ester, etc., may be presented.

 The acrylic compound may further include a carboxyl group-
20 containing monomer, an acid anhydride monomer, a hydroxyl group-containing monomer, a glycidyl group-containing monomer, a sulfonic acid group-containing monomer, a phosphoric acid group-containing monomer, an acrylonitrile-containing monomer and the like.

In addition, the acrylic compound may further include one or more polyfunctional monomers. As the polyfunctional monomer, hexanediol di(meth)acrylate, (poly)ethylene glycol di(meth)acrylate, (poly)propylene glycol di(meth)acrylate, 5 neopentyl glycol di(meth)acrylate, pentaerythritol di(meth)acrylate, trimethylolpropane tri(meth)acrylate, pentaerythritol tri(meth)acrylate, dipentaerythritol hexa(meth)acrylate, epoxy(meth)acrylate (i.e., polyglycidyl(meth)acrylate), polyester(meth)acrylate, 10 urethane(meth)acrylate, etc. may be presented.

Second film

The film for a spacer according to an exemplary embodiment of the present invention may further include a second film 530 15 disposed on a lower portion of the adhesive layer 520.

The first pressure sensitive adhesive layer 535 may be disposed between the second film 530 and the adhesive layer 520. The first pressure sensitive adhesive layer 535 may be formed by directly casting coating on the second film 530 followed by 20 drying, or may be formed by laminating on the second film 530.

The second film 530 may serve as a support in a dicing process. The thickness of the second film 530 may be controlled to 40 μm or more in order to secure expanding and pickup abilities. Meanwhile, even when the thickness of the second 25 film 530 exceeds 300 μm to be too thick, there is a possibility

that an expanding failure and a pickup failure may occur. Therefore, the second film 530 preferably has a thickness of 300 μm or less. The second film 530 may have a thickness in a range of 40 to 300 μm , preferably 50 to 250 μm , more preferably 60 to 200 μm , and most preferably 70 to 150 μm .

The second film 530 may use a polyolefin resin. Specifically, the second film 530 may be made of a material including at least one of a low-density polyethylene, medium-density polyethylene, high-density polyethylene, ultra-low-density polyethylene, random copolymer polypropylene, block copolymer polypropylene, homo polypropylene, polybutene, polymethylpentene, ethylene-vinyl acetate copolymer, ionomer resin, ethylene-(meth)acrylic acid copolymer, ethylene-(meth)acrylic acid ester copolymer, ethylene-butene copolymer, and ethylene-hexene copolymer.

The second film 530 may have a single layer structure, or as another example, may have a multi-layered structure.

The first pressure sensitive adhesive layer 535 may be formed in a thickness of about 5 to 30 μm , but it is not limited thereto. The first pressure sensitive adhesive layer 535 may include an acrylic compound. However, unlike the adhesive layer 520, the first pressure sensitive adhesive layer 535 may not include an epoxy resin.

In addition, the first pressure sensitive adhesive layer 535 may further include at least one additive. As the additive,

a thermal curing agent such as an isocyanate curing agent or a photo-initiator such as benzophenone may be presented, but it is not limited thereto.

The first pressure sensitive adhesive layer 535 may exist
5 in a B-stage state until UV curing in the dicing process.

Meanwhile, an adhesive force between the first pressure sensitive adhesive layer 535 and the adhesive layer 520 may exhibit 20 to 200 N/m before UV curing of the first pressure sensitive adhesive layer, and may be 15 N/m or less after UV
10 curing. This is intended so that only the first film 510 and the adhesive layer 520 individualized in a pickup process after dicing are picked up. The control of the adhesive force of the first pressure sensitive adhesive layer 535 may be performed, for example, by controlling components of the pressure sensitive
15 adhesive. For example, the acrylic compound of the first pressure sensitive adhesive layer 535 may include a copolymer obtained by copolymerizing 10 to 40 parts by weight of acrylic acid-2-hydroxyethyl and 10 to 45 parts by weight of 2-methacryloyloxyethyl isocyanate, based on 100 parts by weight
20 of acrylic acid-2-ethylhexyl.

Meanwhile, referring to FIG. 5, an edge of an upper surface of the first pressure sensitive adhesive layer 535 may be exposed. This is intended to facilitate the fixation of the film for a spacer to a ring frame in the dicing process, which
25 will be described below with reference to FIG. 7.

FIG. 6 is a cross-sectional view schematically illustrating a film for a spacer according to another embodiment of the present invention.

Similar to the film for a spacer shown in FIG. 5, the film for a spacer shown in FIG. 6 includes a first film 510, an adhesive layer 520, a second film 530, and a first pressure sensitive adhesive layer 535. The first film 510, the adhesive layer 520, the second film 530, and the first pressure sensitive adhesive layer 535 in the film for a spacer shown in FIG. 6 are the same as those described in FIG. 5, and therefore will not be described in detail.

Meanwhile, the film for a spacer shown in FIG. 6 further includes a cover film 540 and a second pressure sensitive adhesive layer 545.

Cover film

The cover film 540 serves as a protective film for protecting the first film 510 before the dicing process. The cover film 540 is previously removed in the dicing process. The cover film 540 may be made of a material such as polyethylene terephthalate, polyethylene, polypropylene, polyvinyl chloride, polycarbonate, polyimide, etc., but it is not limited thereto.

The second pressure sensitive adhesive layer 545 may be disposed between the cover film 540 and the first film 510.

The second pressure sensitive adhesive layer 545 may be formed in a thickness of about 3 to 30 μm , but it is not limited thereto. Similar to the first pressure sensitive adhesive layer 535, the second pressure sensitive adhesive layer 545 may include an acrylic compound but may not include an epoxy resin. The second pressure sensitive adhesive layer 545 may further include at least one additive such as a curing agent, for example, a phenol resin and amine, or a silane coupling agent, etc.

Meanwhile, referring to FIG. 6, an edge of a lower surface of the second pressure sensitive adhesive layer 545 may be exposed. This is intended to facilitate the removal of the cover film 540 and the second pressure sensitive adhesive layer 545 immediately before the dicing process.

Method of forming a spacer

FIG. 7 is cross-sectional views schematically illustrating a method of forming a spacer using a dicing process according to the present invention. FIG. 8 is plan views corresponding to FIG. 7(a), (b) and (c), which will be referred to when describing the method of FIG. 7.

Referring to FIG. 7, the method of forming a spacer according to the present invention includes a fixation step, a dicing step, a pickup step and an attachment step.

First, as in the example shown in FIG. 7(a), a film for a spacer including the first film 510, the adhesive layer 520, the first pressure sensitive adhesive layer 535 and the second film 530 from the top is prepared. For example, by removing
5 the second pressure sensitive adhesive layer 545 and the cover film 540 from the film for a spacer shown in FIG. 6, the film for a spacer as the example shown in FIG. 7(a) may be prepared.

Then, as in the example shown in FIG. 7(b) and FIG. 8(b), the film for a spacer is fixed. A frame 610 such as a ring
10 frame may be used to fix the film for a spacer. Meanwhile, when the edge of the upper surface of the first pressure sensitive adhesive layer 535 is exposed in the film for a spacer, the frame 610 may be easily disposed on the edge of the upper surface of the first pressure sensitive adhesive layer 535.

Thereafter, as in the example shown in FIG. 7(c), the
15 film for a spacer is diced along predetermined cutting lines SL using a dicing saw 601 or a laser beam to individualize the film. As described above, since the curls are pre-provided to the film for a spacer according to the present invention, it is
20 possible to prevent the film for a spacer from being bent upward at an edge of the chip during expanding, thereby suppressing the expanding failure and pickup failure.

Subsequently, as in the example shown in FIG. 7(d), the spacer including the first film 510 and the adhesive layer 520

is picked up from the resulting individualized product using a pushing means 620 and an adsorption means 630.

Thereafter, as in the example shown in FIG. 7(e), the spacer including the first film 510 and the adhesive layer 520 is attached to the package substrate 110.

<Example>

Hereinafter, preferred examples are presented to help the understanding of the present invention. However, the following examples are only provided to more easily understand the present invention, and the contents of the present invention are not limited by the following examples.

Preparation of adhesive film for a spacer

Films for a spacer, which include a first film (polyimide), an acrylic-epoxy adhesive layer, an acrylic pressure sensitive adhesive layer, and a second film (polyethylene film) from the top, were prepared (see FIG. 7(a)). As the first film, films with or without a coating layer formed on the lower portion thereof were used, respectively.

The storage modulus was obtained by heating a specimen, which was fabricated by cutting the prepared film for a spacer to 5 mm × 20 mm, according to the method of the condition at a heating rate of 10°C/min, and measured at 25°C using the DMA equipment.

The amount of curl was measured by cutting a portion where the first film and the adhesive layer are stacked from the manufactured adhesive film for a spacer into a rectangle with a width of 50 mm and a length of 15 mm, and placing the cut portion on a horizontal surface so that the adhesive layer faces downward to measure a height difference between the central portion and the outermost periphery of the specimen using a measuring device

The storage modulus and amounts of curl measured on the respective specimens are shown in Table 1 below.

[TABLE 1]

Section	First film (thickness, mm)	Coating layer (thickness, mm)	Adhesive layer (thickness, μm)	Storage modulus (Gpa)	Amount of curl (mm)
Example 1	50	Polyimide, 4	16	2.0	19.9
Example 2	50	Polyimide, 4	16	5.4	19.8
Example 3	50	Polyimide, 3	17	9.9	20.0
Example 4	50	Polyimide, 7	13	2.1	5.0
Example 5	50	Polyimide, 7	13	5.4	5.0
Example 6	50	Polyimide, 7	13	9.8	5.1
Example 7	50	Polyimide, 3	17	2.1	19.9
Example 8	50	Polyimide, 4	16	2.4	19.7
Example 9	50	Polyimide, 9	11	2.9	18.5
Example 10	50	Polyimide, 5	15	8.7	12.7

Example 11	50	Polyimide , 6	14	9.0	13.7
Example 12	50	Polyimide , 9	11	9.7	15.5
Comparative Example 1	50	X, 0 mm	20	0.9	0
Comparative Example 2	50	X, 0 mm	20	10.2	0
Comparative Example 3	50	X, 0 mm	20	2.0	0
Comparative Example 4	50	Polyimide , 1 μ m	19	0.9	10.0
Comparative Example 5	50	Polyimide , 1 μ m	19	10.1	20.3
Comparative Example 6	50	Polyimide , 7 μ m	13	2.2	4.5
Comparative Example 7	50	Polyimide , 10 μ m	10	0.8	10.2
Comparative Example 8	50	Polyimide , 10 μ m	10	10.2	20.2
Comparative Example 9	50	Polyimide , 10 μ m	10	2.1	4.7

Evaluation of adhesive film for a spacer

Thereafter, a ring frame was bonded to an upper edge of the acrylic pressure sensitive adhesive layer to fix the film for a spacer, and then, a process, in which each specimen is divided into individual spacers having a size of 9 mm $\times$ 12 mm, has been performed using a dicing device DFD-6361 (manufactured by Disco). Then, individual spacers were expanded and picked up using a pickup equipment SPA-300 (manufactured by Shinkawa).

The following evaluations were performed, and results thereof are shown in Table 2 below.

Evaluation of chip recognition: After dicing, an expanding process for expanding the second film was performed

to facilitate classification between chips and pickup in pickup equipment, such that a chip recognition rate at a height of 3 mm of an expanding ring was measured. When the chip recognition rate was 95% or more, it was evaluated as good (O), and if the rate was less than 95%, it was evaluated as failure (X).

Evaluation pickup ability: The spacers were picked up at needle pin heights of 0.35 mm and 0.45 mm of pickup equipment, and when a pickup success rate was 95% or more, it was evaluated as good (O), and if the rate was less than 95%, it was evaluated as failure (X).

[TABLE 2]

Section	Storage modulus (Gpa) × Amount of curl (Gpa• mm)	Chip recognition	Pickup property	
			0.35 mm	0.45 mm
Example 1	19.9	O	O	O
Example 2	106.9	O	O	O
Example 3	198.0	O	O	O
Example 4	10.5	O	O	O
Example 5	27.0	O	O	O
Example 6	49.98	O	O	O
Example 7	47.8	O	O	O
Example 8	47.3	O	O	O
Example 9	53.7	O	O	O
Example 10	110.5	O	O	O
Example 11	123.3	O	O	O
Example 12	150.4	O	O	O
Comparative Example 1	-	X	X	X
Comparative Example 2	-	X	X	X
Comparative Example 3	-	X	X	X
Comparative Example 4	9.0	X	X	X
Comparative Example 5	205.0	O	X (chip flying)	X (chip flying)

Comparative Example 6	9.9	X	X	X
Comparative Example 7	8.2	X	X	X
Comparative Example 8	206.0	O	X (chip flying)	X (chip flying)
Comparative Example 9	9.9	X	X	X

Referring to Table 2, in the case of Examples 1 to 12 in which the product of the storage modulus and the amount of curl of the film for a spacer was 10 GPa•mm to 200 GPa•mm, any failure was not shown in the expanding process and the pickup process. On the other hand, in the case of Comparative Examples 1 to 9, pickup failure was confirmed at a needle pin height of 0.45 mm of the pickup device.

Therefore, it can be seen that providing curl to the film for a spacer is effective to improve the pickup property, and it can be seen that the product of the storage modulus and the amount of curl is preferably 10 GPa•mm to 200 GPa•mm.

Although the present invention has been described above, the present invention is not limited by the embodiments disclosed herein, and it will be apparent by those skilled in the art that various modifications can be made within the scope of the technical spirit of the present invention. In addition, although the effects according to the configuration of the present invention have not been explicitly described while describing the embodiments of the present invention, it will be

apparent that the effects predictable by the corresponding configuration should also be admitted.

[Description of Reference Numerals]

- 110: Package substrate
- 5 120: First semiconductor chip unit
- 130: Spacer
- 131: Adhesive layer
- 132: Support
- 140: Second semiconductor chip unit
- 10 150: Package body
- 510: First film
- 520: Adhesive layer
- 530: Second film
- 535: First pressure sensitive adhesive layer
- 15 540: Cover film
- 545: Second pressure sensitive adhesive layer
- 601: Dicing saw
- 610: Frame
- 620: Pushing means
- 20 630: Adsorption means

WHAT IS CLAIMED IS:

1. A film for a spacer comprising:
a first film; and
an adhesive layer disposed on a lower portion of the first film,

wherein the film for a spacer satisfies Equation 1 below:

[Equation 1]

$$10 \text{ GPa}\cdot\text{mm} \leq (\text{Storage modulus} \times \text{Amount of curl}) \leq 200 \text{ GPa}\cdot\text{mm}$$

(In Equation 1, the storage modulus is a storage modulus of the film for a spacer at 25°C, and the amount of curl is an amount of curl measured by cutting a portion where the first film and the adhesive layer are stacked into a rectangle with a width of 50 mm and a length of 15 mm, and placing the cut portion on a horizontal surface so that the adhesive layer faces downward).

2. The film for a spacer according to claim 1, wherein the storage modulus is 2 GPa to 10 GPa.

3. The film for a spacer according to claim 1, wherein the amount of curl is 5 mm to 20 mm.

4. The film for a spacer according to claim 1, wherein the first film comprises at least one of polyimide,

polyetheretherketone, polyamideimide, polyphenylene sulfide, polyphthalamide, polysulfone, polyethersulfone, and polyetherimide.

5. The film for a spacer according to claim 1, wherein the first film comprises a coating layer formed on a lower portion thereof.

6. The film for a spacer according to claim 5, wherein the coating layer comprises at least one of a compound containing a polyimide functional group, a compound containing a polyamideimide functional group, a compound containing an epoxy functional group, and a compound containing a urethane acrylate functional group.

7. The film for a spacer according to claim 5, wherein the coating layer has a thickness of 2 to 9 μm .

8. The film for a spacer according to claim 1, wherein the adhesive layer comprises at least one of an acrylic compound and an epoxy resin.

9. The film for a spacer according to claim 1, further comprising a first pressure sensitive adhesive layer disposed on a lower portion of the adhesive layer.

10. The film for a spacer according to claim 9, wherein the first pressure sensitive adhesive layer comprises an acrylic compound.

11. The film for a spacer according to claim 9, wherein an edge of an upper surface of the first pressure sensitive adhesive layer is exposed.

12. The film for a spacer according to claim 9, wherein an adhesive force between the first pressure sensitive adhesive layer and the adhesive layer is 20 to 200 N/m before UV curing of the first pressure sensitive adhesive layer, and 15 N/m or less after UV curing of the first pressure sensitive adhesive layer.

13. The film for a spacer according to claim 9, further comprising a second film disposed on a lower portion of the first pressure sensitive adhesive layer.

14. The film for a spacer according to claim 13, wherein the second film comprises a polyolefin resin.

15. The film for a spacer according to claim 9, further comprising:

a second pressure sensitive adhesive layer disposed on an upper portion of the first film; and

a cover film disposed on the second pressure sensitive adhesive layer.

16. A method of forming a spacer comprising:

a fixation step of fixing the film for a spacer according to claim 1 to a frame;

a dicing step of dicing the film for a spacer to individualize the same;

a pickup step of picking up the spacer including a first film and an adhesive layer from the resulting individualized product; and

an attachment step of attaching the picked up spacer onto a package substrate.

17. The method of forming a spacer according to claim 16, wherein the film for a spacer further comprises a first pressure sensitive adhesive layer disposed on a lower portion of the adhesive layer,

wherein an edge of an upper surface of the first pressure sensitive adhesive layer is exposed, and

a frame is disposed on the edge of the upper surface of the first pressure sensitive adhesive layer.

18. A multi-chip package comprising:

- a package substrate;
- a spacer comprising the film for a spacer according to claim 1 disposed on the package substrate;
- a first semiconductor chip unit disposed on the package substrate;
- a second semiconductor chip unit stacked on the spacer and the first semiconductor chip unit;
- a wire configured to electrically connect a chip pad of the first semiconductor chip unit and a first substrate pad corresponding thereto;
- a wire configured to electrically connect a chip pad of the second semiconductor chip unit and a second substrate pad corresponding thereto; and
- a package body configured to seal the first semiconductor chip unit, the second semiconductor chip unit, the wire and the spacer.