

DESCRIPTION

Title of Invention

DICING/DIE-BONDING INTEGRATED FILM, METHOD FOR
MANAGING QUALITY OF SAME, AND METHOD FOR
5 MANUFACTURING SEMICONDUCTOR DEVICE

Technical Field

[0001] The present disclosure relates to a dicing die-bonding integrated film and a quality management method therefor, and a method for manufacturing a semiconductor device.

10 Background Art

[0002] In the manufacture of semiconductor chips, a dicing step of singularizing a semiconductor wafer into individual semiconductor chips, a pick-up step of peeling off the singularized semiconductor chips from a pressure-sensitive adhesive layer, and a die-bonding step of
15 adhering the singularized semiconductor chips to a lead frame, a package substrate, and the like, are usually provided. In the manufacture of semiconductor chips as such, a dicing die-bonding integrated film is mainly used, which includes a base material layer, a pressure-sensitive adhesive layer (photocurable pressure-sensitive
20 adhesive layer) formed from a photocurable pressure-sensitive adhesive that is used for fixing a semiconductor wafer in a dicing step, and an adhesive layer that is used for the adhesion of a semiconductor chip and a lead frame, a package substrate, or the like. It can be said that a dicing die-bonding integrated film is a product in which a dicing film
25 including a pressure-sensitive adhesive layer and a die-bonding film including an adhesive layer are integrated.

[0003] In recent years, as an example of a method for manufacturing semiconductor chips by singularizing a thin semiconductor wafer, there has been proposed so-called stealth dicing, in which the inner part of a semiconductor wafer along scheduled cutting lines is irradiated with laser light to form a modified layer, without completely cutting the semiconductor wafer, and cleaving the semiconductor wafer by expanding the pressure-sensitive adhesive layer (for example, Patent Literature 1). In the semiconductor chips that have been singularized by stealth dicing, it is required to peel off the pressure-sensitive adhesive layer and the adhesive layer with a smaller force from the viewpoint of preventing damage in the subsequent pick-up step. Therefore, for a dicing die-bonding integrated film used for the manufacture of thin semiconductor chips, it is very important to increase the success rate of pickup with a small force.

[0004] In order to enhance the success rate of pickup, it has been suggested to improve the dicing film, particularly the pressure-sensitive adhesive layer, in the following literatures. In Patent Literature 2, an optimized composition of the pressure-sensitive adhesive layer is suggested. In Patent Literature 3, it is proposed to optimize both the base material layer and the pressure-sensitive adhesive layer. Furthermore, in the base material layer of a dicing film, it is considered that excellent uniform stretchability and the tensile stress in consideration of the work process are important in order to enhance the success rate of pickup. For example, in Patent Literature 4, it is described to the effect that the uniform expandability and restoration rate of the film are effective for an expansion step in a semiconductor

manufacturing process. Furthermore, in Patent Literature 5, it is investigated to control the gaps between chips (kerf width) and to enhance the success rate of pickup by controlling the elongation ratio and the shrinkage ratio in the dicing film.

5 [0005] On the other hand, with regard to the dicing film, it has been investigated to subject a surface of the base material layer, the surface being on the opposite side of the pressure-sensitive adhesive layer (hereinafter, optionally may be referred to as "back surface of the base material layer"), to various treatments from the viewpoint of enhancing
10 the conveyance characteristics and suppressing blocking. For example, in Patent Literature 6, it is described to adjust the arithmetic surface roughness and to subject the back surface of the base material layer to a treatment by means of a lubricating material. Furthermore, for example, in Patent Literature 7, it is described that the arithmetic
15 surface roughness of the back surface of the base material layer is adjusted to a predetermined range, from the viewpoint of suppressing blocking and enhancing visibility.

Citation List

Patent Literature

20 [0006] Patent Literature 1: JP 2003-338467
Patent Literature 2: JP 2015-126217
Patent Literature 3: JP 2013-135146
Patent Literature 4: JP 2018-065327
Patent Literature 5: JP 2017-147293
25 Patent Literature 6: JP 2007-150206
Patent Literature 7: WO 2017/150330

Summary of Invention

Technical Problem

[0007] In the manufacture of a semiconductor chip, the pressure-sensitive adhesive layer is irradiated with light from the back surface of the base material layer through the base material layer. However, according to the investigation of the inventors of the present invention, it was found that the base material layer of a dicing die-bonding integrated film may be gradually degraded due to various factors, and accordingly, the photoreactivity of the pressure-sensitive adhesive layer may also be deteriorated. Deterioration of the photoreactivity of the pressure-sensitive adhesive layer also leads to deterioration of the success rate of pickup. Therefore, it is important to control the quality of the dicing die-bonding integrated film. However, it is not possible to judge by appearance whether the quality is maintained, and it is often not known until the dicing die-bonding integrated film is actually used.

[0008] The present disclosure was achieved in view of such circumstances, and it is a main object to provide a novel quality management method for a dicing die-bonding integrated film.

Solution to Problem

[0009] The base material layer of a dicing die-bonding integrated film, particularly a dicing film, is usually stored in a state in which constant tension is applied to the winding core until immediately before use. Depending on the storage conditions at this time, a creep phenomenon may occur in the base material layer, and the unevenness of the back surface of the base material layer may be deformed. Conventionally,

in the case of a dicing film, it is known to control the back surface of the base material layer by using the arithmetic surface roughness (Ra), the arithmetic mean height (Sa), the friction coefficient, and the like as indices, from the viewpoints of conveyance characteristics, visibility enhancement, and suppression of blocking (see, for example, Patent Literatures 6 and 7). However, in the steps applied to the semiconductor manufacturing process in recent years, for example, a stealth dicing process and the like, more precise control of the pressure-sensitive adhesive force is required. In addition, it is considered that the transmissibility of light irradiated through the back surface of the base material layer is affected by the unevenness of the back surface of the base material layer, affects the photoreactivity of the pressure-sensitive adhesive layer, and consequently affects mass productivity. The inventors of the present invention conducted a thorough investigation on the state of the back surface of the base material layer, and the inventors found that the load length ratio t_p is superior as an evaluation index as compared with the conventional parameter of surface roughness, thus completing the present invention.

[0010] An aspect of the present disclosure relates to a quality management method for a dicing die-bonding integrated film. This quality management method includes a first step of preparing a dicing die-bonding integrated film that includes a base material layer having a first surface (corresponding to the above-described "back surface of the base material layer") and a second surface on the opposite side of the first surface, a pressure-sensitive adhesive layer provided on the second surface of the base material layer and formed from a photocurable

pressure-sensitive adhesive, and an adhesive layer provided on the pressure-sensitive adhesive layer, the adhesive layer being on the opposite side of the base material layer; a second step of calculating the load length ratio tp with regard to the first surface of the base material layer of the dicing die-bonding integrated film; and a third step of determining whether the quality of the dicing die-bonding integrated film is good or bad by using the load length ratio tp as an index.

[0011] The dicing die-bonding integrated film determined as such may have an excellent success rate of pickup. Therefore, such a quality management method is useful for determining whether the quality of a dicing die-bonding integrated film scheduled to be used is being maintained.

[0012] The load length ratio tp may be the load length ratio tp (50%) at a cut level of 50%. In this case, the third step may be a step of determining whether the quality is good or bad by checking whether the condition that the load length ratio tp (50%) is 15% or greater is satisfied.

[0013] Another aspect of the present disclosure relates to a method for manufacturing a semiconductor device. This method for manufacturing a semiconductor device includes a first step of preparing a dicing die-bonding integrated film that includes a base material layer having a first surface and a second surface on the opposite side of the first surface, a pressure-sensitive adhesive layer provided on the second surface of the base material layer and formed from a photocurable pressure-sensitive adhesive, and an adhesive layer provided on the pressure-sensitive adhesive layer, the adhesive layer being on the

opposite side of the base material layer; a second step of calculating the load length ratio tp for the first surface of the base material layer of the dicing die-bonding integrated film; a third step of determining whether the quality of the dicing die-bonding integrated film is good or bad by using the load length ratio tp as an index; and a fourth step of manufacturing a semiconductor device by using a dicing die-bonding integrated film that has been determined to be good in the third step.

[0014] The load length ratio tp may be the load length ratio tp (50%) at a cut level of 50%. In this case, the third step may be a step of determining whether the quality is good or bad by checking whether the load length ratio tp (50%) satisfies 15% or greater.

[0015] Another aspect of the present disclosure relates to a dicing die-bonding integrated film. This dicing die-bonding integrated film includes a base material layer having a first surface and a second surface on the opposite side of the first surface; a pressure-sensitive adhesive layer provided on the second surface of the base material layer and formed from a photocurable pressure-sensitive adhesive; and an adhesive layer provided on the pressure-sensitive adhesive layer, the adhesive layer being on the opposite side of the base material layer, and in the first surface of the base material layer, the load length ratio tp (50%) at a cut level of 50% is 15% or greater.

Advantageous Effects of Invention

[0016] According to the present disclosure, provision of a novel quality management method for a dicing die-bonding integrated film is provided. Furthermore, according to the present disclosure, a dicing die-bonding integrated film whose quality is determined to be good by

such a method, and a method for manufacturing a semiconductor device by using such a dicing die-bonding integrated film are provided.

Brief Description of Drawings

5 [0017] FIG. 1 is a schematic cross-sectional view illustrating an embodiment of a dicing die-bonding integrated film.

FIG. 2 is an explanatory diagram for explaining the load length ratio t_p .

10 FIG. 3 is schematic cross-sectional views for explaining an embodiment of a method for manufacturing a semiconductor device, and FIG. 3(a), FIG. 3(b), FIG. 3(c), FIG. 3(d), and FIG. 3(e) are schematic cross-sectional views each illustrating a step.

15 FIG. 4 is schematic cross-sectional views for explaining an embodiment of the method for manufacturing a semiconductor device, and FIG. 4(f), FIG. 4(g), FIG. 4(h), and FIG. 4(i) are schematic cross-sectional views each illustrating a step.

FIG. 5 is a schematic cross-sectional view illustrating an embodiment of a semiconductor device.

Description of Embodiments

20 [0018] Hereinafter, embodiments of the present disclosure will be described with appropriate reference to the drawings. However, the present disclosure is not intended to be limited to the following embodiments. In the following embodiments, the constituent elements thereof (including steps and the like) are not essential unless particularly stated otherwise. The sizes of the constituent elements in each
25 drawing are only conceptual, and the relative size relationships between the constituent elements are not limited to those shown in each drawing.

[0019] The same also applies to the numerical values and ranges thereof in the present specification, and the present disclosure is not intended thereby. A numerical value range expressed using the term "to" in the present specification represents a range including the numerical values described before and after the term "to" as the minimum value and the maximum value, respectively. With regard to numerical value ranges described stepwise in the present specification, the upper limit value or lower limit value described in one numerical value range may be replaced with the upper limit value or lower limit value of another numerical value range described stepwise. Furthermore, with regard to a numerical value range described in the present specification, the upper limit value or the lower limit value of the numerical value range may be replaced with a value shown in the Examples.

[0020] According to the present specification, the term (meth)acrylate means acrylate or methacrylate corresponding thereto. The same also applies to other similar expressions such as a (meth)acryloyl group and a (meth)acrylic copolymer.

[0021] [Quality management method for dicing die-bonding integrated film]

A quality management method for a dicing die-bonding integrated film according to an embodiment includes a first step of preparing a dicing die-bonding integrated film that includes a base material layer having a first surface and a second surface on the opposite side of the first surface, a pressure-sensitive adhesive layer provided on the second surface of the base material layer and formed

from a photocurable pressure-sensitive adhesive, and an adhesive layer provided on the pressure-sensitive adhesive layer, the adhesive layer being on the opposite side of the base material layer; a second step of calculating the load length ratio tp for the first surface of the base material layer of the dicing die-bonding integrated film; and a third step of determining whether the quality of the dicing die-bonding integrated film is good or bad by using the load length ratio tp as an index.

[0022] <First step>

The present step is a step of preparing a dicing die-bonding integrated film, which is an object to be managed. FIG. 1 is a schematic cross-sectional view illustrating an embodiment of the dicing die-bonding integrated film. The dicing die-bonding integrated film 1 includes a base material layer 10 having a first surface 10A and a second surface 10B on the opposite side of the first surface 10A; a pressure-sensitive adhesive layer 20 provided on the second surface 10B of the base material layer 10 and formed from a photocurable pressure-sensitive adhesive; and an adhesive layer 30 provided on the pressure-sensitive adhesive layer 20, the adhesive layer 30 being on the opposite side of the base material layer 10.

[0023] (Base material layer)

Regarding the base material layer 10, a known polymer sheet or film can be used, and there is no particular limitation as long as the base material layer 10 is composed of a material that can be expanded in a die-bonding step. Examples of such a material include polyolefins such as crystalline polypropylene, amorphous polypropylene, high-density polyethylene, medium-density polyethylene, low-density

polyethylene, ultralow-density polyethylene, low-density linear polyethylene, polybutene, and polymethylpentene; an ethylene-vinyl acetate copolymer; an ionomer resin; an ethylene-(meth)acrylic acid copolymer; an ethylene-(meth)acrylic acid ester (random, alternating) copolymer; an ethylene-propylene copolymer; an ethylene-butene copolymer; an ethylene-hexene copolymer; polyurethane; polyesters such as polyethylene terephthalate and polyethylene naphthalate; polycarbonate; polyimide; polyether ether ketone; polyimide; polyetherimide; polyamide; all aromatic polyamide; polyphenyl sulfide; aramid (paper); glass; glass cloth; a fluororesin; polyvinyl chloride; polyvinylidene chloride; a cellulose-based resin; and a silicone resin. These materials may be materials mixed with a plasticizer, silica, an anti-blocking material, a slipping agent, an antistatic agent, and the like. [0024] Among these, from the viewpoints of characteristics such as Young's modulus, stress relaxation properties, and melting point, as well as the price, recycling of waste materials after use, and the like, the base material layer 10 may have a surface containing at least one material selected from polyethylene, polypropylene, a polyethylene-polypropylene random copolymer, and a polyethylene-polypropylene block copolymer as a main component, the surface adjoining the pressure-sensitive adhesive layer 20. The base material layer 10 may be a single layer or may be a multilayer having two or more layers formed from different materials. From the viewpoint of controlling the adhesiveness to the pressure-sensitive adhesive layer 20 that will be described below, the base material layer 10 may be subjected to a surface roughening treatment such as a corona

discharge treatment or a matting treatment as necessary.

5 [0025] The thickness of the base material layer 10 may be 50 to 200 μm , 60 to 150 μm , or 70 to 120 μm . When the thickness of the base material layer 10 is 50 μm or more, there is a tendency that the damage caused by expansion can be further suppressed. When the thickness of the base material layer 10 is 200 μm or less, stress during pickup is likely to reach the adhesive layer, and the pickup properties tend to be superior.

[0026] (Pressure-sensitive adhesive layer)

10 The pressure-sensitive adhesive layer 20 is a layer formed from a photocurable pressure-sensitive adhesive. The photocurable pressure-sensitive adhesive is not particularly limited as long as it is a pressure-sensitive adhesive that is curable by light, and a pressure-sensitive adhesive that is used in the field of dicing films can be used. The photocurable pressure-sensitive adhesive may be an ultraviolet-curable type photocurable pressure-sensitive adhesive that is cured by ultraviolet radiation.

20 [0027] The pressure-sensitive adhesive layer 20 is formed on the base material layer 10. Examples of a method of forming the pressure-sensitive adhesive layer 20 on the base material layer 10 include a method of preparing a varnish for forming a pressure-sensitive adhesive layer, applying the varnish on the base material layer 10, subsequently removing volatile components of the varnish, and forming the pressure-sensitive adhesive layer 20; and a method of applying the varnish on a release-treated film, removing volatile components of the varnish to form the pressure-sensitive adhesive layer 20, and

transferring the obtained pressure-sensitive adhesive layer 20 to the base material layer 10.

5 [0028] The varnish for forming a pressure-sensitive adhesive layer contains, for example, a photocurable pressure-sensitive adhesive and an organic solvent. The organic solvent may be one that can dissolve the contained components and is volatilized by heating. Examples of such an organic solvent include aromatic hydrocarbons such as toluene and xylene; cyclic ethers such as tetrahydrofuran and 1,4-dioxane; 10 alcohols such as methanol, ethanol, ethylene glycol, and propylene glycol; ketones such as acetone, methyl ethyl ketone, methyl isobutyl ketone, and cyclohexanone; esters such as methyl acetate, ethyl acetate, and γ -butyrolactone; carbonic acid esters such as ethylene carbonate and propylene carbonate; polyhydric alcohol alkyl ethers such as ethylene glycol monomethyl ether, ethylene glycol dimethyl ether, propylene glycol monomethyl ether, propylene glycol monoethyl ether, and 15 propylene glycol dimethyl ether; polyhydric alcohol alkyl ether acetates such as ethylene glycol monomethyl ether acetate and ethylene glycol monoethyl ether acetate; and amides such as N,N-dimethylformamide, N,N-dimethylacetamide, and N-methyl-2-pyrrolidone. These may be used singly or in combination of two or more kinds thereof. The solid 20 content concentration of the varnish may be 10% to 60% by mass based on the total mass of the varnish.

[0029] The thickness of the pressure-sensitive adhesive layer 20 may be, for example, 1 to 200 μm , 3 to 50 μm , or 5 to 30 μm .

25 [0030] (Adhesive layer)

The adhesive layer 30 is a layer formed from an adhesive.

Regarding the adhesive, an adhesive that is used in the field of die-bonding films can be used. In the following description, an adhesive containing an epoxy resin, an epoxy resin curing agent, and a (meth)acrylic copolymer having an epoxy group will be described as an embodiment. According to an adhesive layer 30 formed from such an adhesive, the adhesiveness between a chip and a substrate and between a chip and another chip is excellent, electrode embedding properties, wire embedding properties, and the like can be imparted, and adhesion can be achieved at a low temperature in the die-bonding step.

10 [0031] · Epoxy resin

Examples of the epoxy resin include a bisphenol A type epoxy resin, a bisphenol F type epoxy resin, a bisphenol S type epoxy resin, a phenol novolac type epoxy resin, a cresol novolac type epoxy resin, a bisphenol A novolac type epoxy resin, a bisphenol F novolac type epoxy resin, a dicyclopentadiene skeleton-containing epoxy resin, a stilbene type epoxy resin, a triazine skeleton-containing epoxy resin, a fluorene skeleton-containing epoxy resin, a triphenol phenol methane type epoxy resin, a biphenyl type epoxy resin, a xylylene type epoxy resin, a biphenylaralkyl type epoxy resin, a naphthalene type epoxy resin, a polyfunctional phenol, and a diglycidyl ether compound of a polycyclic aromatic compound such as anthracene. These may be used singly or in combination of two or more kinds thereof.

[0032] · Epoxy resin curing agent

25 The epoxy resin curing agent may be, for example, a phenol resin. Regarding the phenol resin, any phenol resin having a phenolic hydroxy group in the molecule can be used without particular

limitations. Examples of the phenol resin include a novolac type phenol resin obtainable by condensing or co-condensing a phenol such as phenol, cresol, resorcin, catechol, bisphenol A, bisphenol F, phenylphenol, or aminophenol, and/or a naphthol such as α -naphthol, β -naphthol, or dihydroxynaphthalene, with a compound having an aldehyde group, such as formaldehyde, in the presence of an acidic catalyst; a phenol aralkyl resin synthesized from a phenol and/or a naphthol, such as allylated bisphenol A, allylated bisphenol F, allylated naphthalenediol, phenol novolac, or phenol, and dimethoxy-para-xylene or bis(methoxymethyl)biphenyl; and a naphthol aralkyl resin. These may be used singly or in combination of two or more kinds thereof.

[0033] · (Meth)acrylic copolymer having epoxy group

The (meth)acrylic copolymer having an epoxy group may be a copolymer in which the amount of glycidyl (meth)acrylate as a raw material is adjusted to 0.5% to 6% by mass with respect to the resulting copolymer. When this amount is 0.5% by mass or more, there is a tendency that high adhesive force is likely to be obtained, and when the amount is 6% by mass or less, there is a tendency that gelation can be suppressed. The balance of glycidyl (meth)acrylate may be a mixture of an alkyl (meth)acrylate having an alkyl group having 1 to 8 carbon atoms, such as methyl (meth)acrylate, as well as styrene, acrylonitrile, and the like. The alkyl (meth)acrylate may include ethyl (meth)acrylate and/or butyl (meth)acrylate. The mixing ratio of each component can be adjusted in consideration of the T_g (glass transition point) of the obtained (meth)acrylic copolymer having an epoxy group. When the T_g is -10°C or higher, tackiness of the adhesive layer 30 in a

B stage state tends to be satisfactory, and handleability tends to be excellent. The upper limit value of the Tg of the (meth)acrylic copolymer having an epoxy group may be, for example, 30°C.

5 [0034] The weight average molecular weight of the (meth)acrylic copolymer having an epoxy group may be 100000 or more and may be 300000 to 3000000 or 500000 to 2000000. When the weight average molecular weight is 3000000 or less, there is a tendency that lowering of the filling property between a semiconductor chip and a support substrate can be controlled. The weight average molecular weight is a
10 polystyrene-equivalent value obtained by a gel permeation chromatography method (GPC) by using a calibration curve based on polystyrene standards.

[0035] The adhesive may further contain a curing accelerator such as a tertiary amine, an imidazole, or a quaternary ammonium salt, as
15 necessary. Examples of the curing accelerator include 2-methylimidazole, 2-ethyl-4-methylimidazole, 1-cyanoethyl-2-phenylimidazole, 1-cyanoethyl-2-phenylimidazolium trimellitate. These may be used singly or in combination of two or more kinds thereof.

20 [0036] The adhesive may further contain an inorganic filler as necessary. Examples of the inorganic filler include aluminum hydroxide, magnesium hydroxide, calcium carbonate, magnesium carbonate, calcium silicate, magnesium silicate, calcium oxide, magnesium oxide, aluminum oxide, aluminum nitride, aluminum borate
25 whiskers, boron nitride, crystalline silica, and amorphous silica. These may be used singly or in combination of two or more kinds thereof.

[0037] The adhesive layer 30 is formed on the pressure-sensitive adhesive layer 20. Regarding a method of forming the adhesive layer 30 on the pressure-sensitive adhesive layer 20, for example, a method of preparing a varnish for forming an adhesive layer, applying the varnish on a release-treated film to form an adhesive layer 30, and transferring the obtained adhesive layer 30 onto the pressure-sensitive adhesive layer 20 may be mentioned. The varnish for forming an adhesive layer contains the components to be contained (for example, an epoxy resin, an epoxy resin curing agent, and a (meth)acrylic copolymer having an epoxy group) and an organic solvent. The organic solvent may be similar to those mentioned as examples as the organic solvent used in the varnish for forming a pressure-sensitive adhesive layer.

[0038] The thickness of the adhesive layer 30 may be, for example, 1 to 300 μm , 5 to 150 μm , or 10 to 100 μm .

[0039] <Second step>

The present step is a step of calculating the load length ratio t_p for the first surface of the base material layer of the dicing die-bonding integrated film, which is an object to be managed. Here, the load length ratio t_p is a value measured according to JIS B0601:1994. FIG. 2 is an explanatory diagram for explaining the load length ratio t_p . As shown in FIG. 2, the load length ratio t_p (C%) is the percentage with respect to the reference length l at the cut level C and is a parameter represented by the following formula. The reference length l is a value determined by surface roughness, periodicity of the surface, and the like. The maximum height R_y is the distance between the highest peak and the bottom of the deepest valley of the roughness curve. The cut

level C is such that the highest peak of the roughness curve is taken as 0%, and the deepest valley bottom is taken as 100%. The load length ratio tp (0%) at the time of a maximum cut level of 0% is 0%, and the load length ratio tp (100%) at the time of a cut level of 100% is 100%.

5 [0040]

$$tp(C\%)[\%] = 100/l \times \sum_{i=1}^n M(C)_i$$

[0041] There are various parameters for the surface roughness. For example, the arithmetic mean roughness Ra defined in JIS B0601:1994 or the like is a parameter in the height direction of roughness. On the other hand, the load length ratio tp is a parameter representing the complexity of surface unevenness, including the width of the peaks (valley width) of the roughness curve and the information on the height direction of roughness. With regard to light transmissibility, the complexity of the unevenness of the surface through which light is transmitted greatly affects light scattering, reflection, and the like. Therefore, in the dicing die-bonding integrated film where light transmissibility is important, the load length ratio tp of the surface of the base material layer can serve as a more effective evaluation index.

[0042] The load length ratio tp can be measured by, for example, the method described in the Examples. That is, a sample measuring 10 mm on each side is prepared, and the load length ratio tp can be calculated by making measurement randomly at 10 to 30 points, and preferably 20 to 30 points with a laser microscope. Incidentally, with regard to the load length ratio tp, the median value is optimal as data

compared with the average value of a predetermined number of samples. Here, the median value means a value located at the center when a finite number of data are arranged in an ascending order, and when the number of data is an even number, the median value means an average value of values close to the center. The inventors of the present invention consider that in the case of an average value, since the data is local, the difference between a piece of data and another piece of data may have a large value so that when the absolute value of the data is too large, the average value may be greatly affected, and since there is no guarantee that the data distribution is a normal distribution, it is optimal to use the median value of the set of data for the load length ratio t_p .

[0043] <Third step>

The present step is a step of determining whether the quality of the dicing die-bonding integrated film is good or bad by using the load length ratio t_p as an index. The cut level C% for the load length ratio t_p is not particularly limited and can be arbitrarily set; however, since the load length ratio t_p may be the load length ratio t_p (50%) with the cut level set to 50%, because the load curve shows a gentle curve. In this case, the third step may be a step of determining whether the quality is good or bad by checking whether the condition that the load length ratio t_p (50%) is 15% or greater is satisfied. When the load length ratio t_p (50%) is 15% or greater, the first surface of the base material layer has many protrusions, the surface is said to be more complicated, and light is likely to be scattered, refracted, or reflected so that light is not concentrated locally and there is a tendency that light

transmissibility is likely to be uniform. The load length ratio t_p (50%), which is the reference of determining whether the quality is good or bad, can be appropriately set with the combination of the base material layer and the pressure-sensitive adhesive layer, and the load length ratio t_p (50%) may be set to, for example, 16% or greater, 18% or greater, 20% or greater, 22% or greater, or 25% or greater and may be set to 70% or less, 60% or less, or 50% or less.

[0044] The dicing die-bonding integrated film determined as such may have an excellent success rate of pickup. Furthermore, the dicing die-bonding integrated film determined as such can be expected to be able to suppress sticking during transportation, a decrease in the detection rate of inspection equipment, and the like. As described above, the quality management method of the present disclosure is useful for determining whether the quality of a dicing die-bonding integrated film scheduled to be used is being maintained.

[0045] [Dicing die-bonding integrated film]

The dicing die-bonding integrated film according to an embodiment includes a base material layer having a first surface and a second surface on the opposite side of the first surface; a pressure-sensitive adhesive layer provided on the second surface of the base material layer and formed from a photocurable pressure-sensitive adhesive; and an adhesive layer provided on the pressure-sensitive adhesive layer, the adhesive layer being on the opposite side of the base material layer. The dicing die-bonding integrated film is such that in the first surface of the base material layer, the load length ratio t_p (50%) at a cut level of 50% is 15% or greater. The base material layer, the

pressure-sensitive adhesive layer, and the adhesive layer are similar to those mentioned as examples with regard to the above-described quality management method for the dicing die-bonding integrated film. Therefore, any overlapping explanations will not be repeated.

5 [0046] Examples of a method of adjusting the load length ratio t_p (50%) at a cut level of 50% in the first surface of the base material layer include a method of heating the first surface of the base material layer, and a method of applying a constant temperature and a constant pressure to a roll with controlled surface unevenness. In a case where
10 the first surface of the base material layer is heated, when the first surface is heated to a temperature higher than or equal to the softening point of the base material layer, there is a tendency that the load length ratio t_p (50%) does not satisfy a predetermined range.

[0047] [Method for manufacturing semiconductor device
15 (semiconductor package)]

FIG. 3 and FIG. 4 are schematic cross-sectional views for explaining an embodiment of a method for manufacturing a semiconductor device. The method for manufacturing a semiconductor device includes a first step of preparing a dicing
20 die-bonding integrated film that includes a base material layer having a first surface and a second surface on the opposite side of the first surface, a pressure-sensitive adhesive layer provided on the second surface of the base material layer and formed from a photocurable pressure-sensitive adhesive, and an adhesive layer provided on the
25 pressure-sensitive adhesive layer, the adhesive layer being provided on the opposite side of the base material layer; a second step of calculating

the load length ratio t_p for the first surface of the base material layer of the dicing die-bonding integrated film; a third step of determining whether the quality of the dicing die-bonding integrated film is good or bad by using the load length ratio t_p as an index; and a fourth step of producing a semiconductor device by using a dicing die-bonding integrated film that has been determined to be good in the third step. Incidentally, the first step, the second step, and the third step are similar to the first step, the second step, and the third step of the above-described quality management method for the dicing die-bonding integrated film. Therefore, any overlapping explanation will not be repeated.

[0048] <Fourth step>

The fourth step is a step of producing a semiconductor device by using a dicing die-bonding integrated film that has been determined to be good in the third step. More specifically, the fourth step in the method for producing a semiconductor device includes a step of sticking the adhesive layer 30 of the dicing die-bonding integrated film 1 to a semiconductor wafer W2 (wafer lamination step); a step of singularizing the semiconductor wafer W2, the adhesive layer 30, and the pressure-sensitive adhesive layer 20 (dicing step); a step of irradiating the pressure-sensitive adhesive layer 20 with ultraviolet radiation (ultraviolet irradiation step); a step of picking up a semiconductor chip having the adhesive layer 30a stuck thereon from the base material layer 10 (adhesive layer-attached semiconductor chip 50) (pickup step); and a step of adhering the adhesive layer-attached semiconductor chip 50 to a support substrate 60, with the adhesive layer 30a interposed

therebetween (semiconductor chip adhesion step).

[0049] Dicing in the dicing step is not particularly limited, and examples thereof include blade dicing, laser dicing, and stealth dicing. When the thickness of the semiconductor wafer W2 is set to 60 μm or less, dicing may be performed by applying stealth dicing. In the following description, an embodiment of mainly using stealth dicing as the dicing will be described in detail.

[0050] (Modified layer forming step)

When dicing is performed by applying stealth dicing, the method for manufacturing a semiconductor device may include a modified layer forming step before the wafer lamination step.

[0051] First, a semiconductor wafer W1 having a thickness of H1 is prepared. The thickness H1 of the semiconductor wafer W1 in which a modified layer is formed may be more than 60 μm . Subsequently, a protective film 2 is stuck onto one principal surface of the semiconductor wafer W1 (see FIG. 3(a)). The surface to which the protective film 2 is stuck is preferably a circuit surface of the semiconductor wafer W1. The protective film 2 may be a back grinding tape used for back face grinding (back grinding) of the semiconductor wafer. Subsequently, the inner part of the semiconductor wafer W1 is irradiated with laser light to form a modified layer 4 (see FIG. 3(b)), and the opposite side (back face side) of the surface of the semiconductor wafer W1 where the protective film 2 is stuck, is subjected to back grinding (back face grinding) and polishing (abrasion) so as to produce a semiconductor wafer W2 having a modified layer 4 (see FIG. 3(c)). The thickness H2 of the obtained

semiconductor wafer W2 may be 60 μm or less.

[0052] (Wafer lamination step)

5 Next, the adhesive layer 30 of the dicing die-bonding integrated film 1 is disposed on a predetermined apparatus. Subsequently, the dicing die-bonding integrated film 1 is stuck to a principal surface Ws of the semiconductor wafer W2, with the adhesive layer 30 interposed therebetween (see FIG. 3(d)), and the protective film 2 of the semiconductor wafer W2 is peeled off (see FIG. 3(e)).

[0053] (Dicing step)

10 Next, at least the semiconductor wafer W2 and the adhesive layer 30 are singularized by dicing (see FIG. 4(f)). When the dicing is performed by applying stealth dicing, singularization can be achieved by performing cool expansion and heat shrinking.

[0054] (Ultraviolet irradiation step)

15 Next, the pressure-sensitive adhesive layer 20 is cured by irradiating the pressure-sensitive adhesive layer 20 with ultraviolet radiation, and a cured pressure-sensitive adhesive layer including a cured product of the photocurable pressure-sensitive adhesive is formed (see FIG. 4(g)). As a result, the pressure-sensitive adhesive force
20 between the pressure-sensitive adhesive layer 20 and the adhesive layer 30 can be decreased. With regard to ultraviolet irradiation, it is preferable to use ultraviolet radiation having a wavelength of 200 to 400 nm. It is preferable that the ultraviolet irradiation conditions are adjusted so as to have an amount of irradiation of 200 to 500 mJ/cm^2 at
25 an illuminance of 30 to 240 mW/cm^2 .

[0055] (Pickup step)

Next, while the diced adhesive layer-attached semiconductor chips 50 are separated apart from each other by expanding the base material layer 10, an adhesive layer-attached semiconductor chip 50 that has been pushed up with a needle 42 from the base material layer 10 side is picked up from the cured pressure-sensitive adhesive layer 20ac by suctioning with a suction collet 44 (see FIG. 4(h)). Incidentally, the adhesive layer-attached semiconductor chip 50 has a semiconductor chip Wa and the adhesive layer 30a. The semiconductor chip Wa is obtained by splitting the semiconductor wafer W2 by dicing, and the adhesive layer 30a is obtained by splitting the adhesive layer 30 by dicing. The cured pressure-sensitive adhesive layer 20ac is obtained by splitting the cured pressure-sensitive adhesive layer including a cured product of the photocurable pressure-sensitive adhesive by dicing. The cured pressure-sensitive adhesive layer 20ac may remain on the base material layer 10 when picking up the adhesive layer-attached semiconductor chip 50. In the pickup step, it is not necessarily essential to expand; however, the pickup properties can be further enhanced by expanding.

[0056] The push-up quantity by the needle 42 can be appropriately set. Furthermore, from the viewpoint of securing sufficient pickup properties even for an extremely thin wafer, for example, pickup in two stages or three stages may be performed. Furthermore, pickup of the adhesive layer-attached semiconductor chip 50 may also be carried out by a method other than the method of using a suction collet 44.

[0057] (Semiconductor chip adhesion step)

After the adhesive layer-attached semiconductor chip 50 is

picked up, the adhesive layer-attached semiconductor chip 50 is adhered to a support substrate 60 by thermal compression, with the adhesive layer 30a interposed therebetween (see FIG. 4(i)). A plurality of adhesive layer-attached semiconductor chips 50 may be adhered to the support substrate 60.

[0058] FIG. 5 is a cross-sectional view schematically illustrating an embodiment of a semiconductor device. The semiconductor device 100 shown in FIG. 5 includes a semiconductor chip Wa, a support substrate 60 for mounting the semiconductor chip Wa, and an adhesive layer 30a provided between the semiconductor chip Wa and the support substrate 60 for adhering the semiconductor chip Wa and the support substrate 60. The adhesive layer 30a may be a cured product of an adhesive (die-bonding film). In the semiconductor device 100, the semiconductor chip Wa and the support substrate 60 may be electrically connected by wire bonding 70. In the semiconductor device 100, the semiconductor chip Wa may be resin-encapsulated on the surface 60a of the support substrate 60 by means of a resin encapsulant 80. In the semiconductor device 100, solder balls 90 may be formed on a surface of the support substrate 60, the surface being on the opposite side of the surface 60a, for electrical connection to an external substrate (main board).

[0059] The semiconductor device 100 shown in FIG. 5 can be manufactured by a manufacturing method further including, in addition to the above-described steps, a step of electrically connecting the semiconductor chip Wa and the support substrate 60 by wire bonding 70, and a step of resin-encapsulating the semiconductor chip Wa on the

surface 60a of the support substrate 60 by using a resin encapsulant 80.

Examples

[0060] Hereinafter, the present disclosure will be more specifically described by way of Examples; however, the present disclosure is not intended to be limited to these Examples. Incidentally, unless particularly stated otherwise, commercially available reagents were used for the compounds.

[0061] [Preparation of dicing die-bonding integrated film]

<Production Example 1>

(Production of die-bonding film)

A thermosetting epoxy resin-containing adhesive (trade name "FH-D2-10", manufactured by Hitachi Chemical Co., Ltd.) was applied on a release base material (polyethylene terephthalate film, thickness 38 μm), an adhesive layer having a thickness of 10 μm was formed, and a die-bonding film including an adhesive layer was produced.

[0062] (Production of dicing film)

An ultraviolet-curable photocurable pressure-sensitive adhesive was applied on a base material film (ionomer-based single-layer film, trade name "HM-1855", thickness 100 μm , softening point 56°C, manufactured by Dow-Mitsui Polychemicals Co., Ltd.) as a base material layer, a pressure-sensitive adhesive layer having a thickness of 10 μm was formed, and a dicing film including a pressure-sensitive adhesive layer was produced. The softening temperature is a value measured according to JIS K6760.

[0063] (Production of dicing die-bonding integrated film)

The adhesive layer of the die-bonding film produced as

described above and the pressure-sensitive adhesive layer of the dicing film produced as described above were stuck together. Sticking was carried out using a lamination machine at a temperature of 23°C and a lamination speed of 12.5 mm/s.

5 [0064] <Production Example 2>

A dicing die-bonding integrated film of Production Example 2 was produced in the same manner as in Production Example 1, except that the base material film in the produced dicing film was brought into contact with a roller set to 40°C, which is equal to or lower than the softening point of the base material film, for 1 second.

[0065] <Production Example 3>

A dicing die-bonding integrated film of Production Example 3 was produced in the same manner as in Production Example 1, except that the base material film of the produced dicing film was brought into contact with a hot plate set to 70°C, which is higher than or equal to the softening point of the base material film, for 1 second, and then heat was immediately dissipated.

[0066] <Production Example 4>

A dicing die-bonding integrated film of Production Example 4 was produced in the same manner as in Production Example 1, except that the base material layer of the produced dicing film was brought into contact with a hot plate at 70°C, which is higher than or equal to the softening point of the base material film, for 3 seconds, and then heat was immediately dissipated.

25 [0067] [Calculation of arithmetic mean roughness Ra, 10-point mean roughness Rz, and load length ratio tp (50%)]

The base material layer of each of the obtained dicing die-bonding integrated films of Production Examples 1 to 4 was cut into a size of 10 mm on each side. The first surface of the cut base material layer was observed using a laser microscope, and the arithmetic mean roughness Ra, the 10-point mean roughness Rz, and the load length ratio tp (50%) were calculated. Incidentally, the reference length l was set to 800 μm from the calculated arithmetic mean roughness Ra based on JIS B0601:1994. The results are presented in Table 1.

[0068] Apparatus: Shape measurement laser microscope VK-X100 (manufactured by Keyence Corporation.)

Visual field: 20-magnification lens used

Pitch: 0.75 μm

Condition: Room temperature (23°C)

Analysis technique: Based on JIS B0601:1994

Observation application: VK-H1V2 (manufactured by Keyence Corporation.)

Monitor: Arithmetic mean roughness Ra, 10-point mean roughness Rz, load length ratio tp (50%)

N number: 20 to 30

[0069] [Evaluation of success rate of pickup]

For the obtained dicing die-bonding integrated films of Production Examples 1 to 4, the success rate of pickup was evaluated.

[0070] <Production of evaluation sample>

(Formation of modified layer)

A back grinding tape was stuck to one surface of a semiconductor wafer (silicon wafer (thickness 750 μm , outer diameter

12 inches)), and a back grinding tape-attached semiconductor wafer was obtained. The surface of the semiconductor wafer on the opposite side of the side where the back grinding tape was stuck was irradiated with laser light to form a modified layer in the inner part of the semiconductor wafer. The laser irradiation conditions are as follows.

[0071] Laser oscillator type: Semiconductor laser excitation Q-switch solid-state laser

Wavelength: 1342 nm

Oscillation type: Pulse

Frequency: 90 kHz

Power output: 1.7 W

Movement speed of semiconductor wafer mounting table: 700 mm/sec

[0072] Next, the surface of the semiconductor wafer on the opposite side of the side where the back grinding tape was stuck, was subjected to back grinding and polishing to obtain a semiconductor wafer having a thickness of 30 μm .

[0073] (Wafer lamination)

The PET film of the dicing die-bonding integrated film was peeled off, and the adhesive layer was stuck to the surface of the semiconductor wafer on the opposite side of the side where the back grinding tape was stuck.

[0074] (Dicing)

Next, the dicing die-bonding integrated film-attached semiconductor wafer having a modified layer was fixed on an expanding apparatus. Next, the dicing film was expanded under the

following conditions, and the semiconductor wafer, the adhesive layer, and the pressure-sensitive adhesive layer were singularized.

[0075] Apparatus: Manufactured by DISCO Corporation, trade name "DDS2300 Fully Automatic Die Separator"

5 Cool expansion conditions:

Temperature: -15°C, height: 9 mm, cooling time: 90 seconds, speed: 300 mm/sec, waiting time: 0 seconds

Heat shrinkage conditions:

10 Temperature: 220°C, height: 7 mm, retention time: 15 seconds, speed: 30 mm/sec, heater speed: 7°C/sec

[0076] (Ultraviolet irradiation)

The pressure-sensitive adhesive layer of the singularized semiconductor wafer was irradiated with ultraviolet radiation having a center wavelength of 365 nm at an irradiation intensity of 70 mW/cm² and an accumulated light amount of 150 mJ/cm², and a cured pressure-sensitive adhesive layer including a cured product of a photocurable pressure-sensitive adhesive was formed to obtain an evaluation sample for the pickup properties that will be described below.

[0077] <Evaluation of pickup properties>

20 A pickup test was performed, with the number of pins being 9, by using a die bonder DB-830P (manufactured by Fasford Technology Co., Ltd. (manufactured by formerly Hitachi High-Tech Corporation). For the collet for pickup, RUBBER TIP 13-087E-33 (manufactured by Micro-Mechanics, Inc., trade name, size: 10 × 10 mm) was used. For
25 the push-up pin, EJECTOR NEEDLE SEN2-83-05 (manufactured by Micro-Mechanics, Inc., trade name, diameter: 0.7 mm, tip shape:

semicircle having a diameter of 350 μm) was used. Nine push-up pins were disposed at equal intervals from the pin center.

[0078] (Success rate of pickup)

5 In the above-described pickup test, the case where the success rate of pickup was 99.5% or higher was rated as "A"; and the case where the success rate of pickup was lower than 99.5% was rated as "B". The results are presented in Table 1.

[0079] Table 1

	Prod. Exam. 1	Prod. Exam. 2	Prod. Exam. 3	Prod. Exam. 4
Ra (average value) (μm)	1.39	1.31	1.36	1.27
Rz (average value) (μm)	22.11	23.62	24.22	20.23
tp (50%) (median value) (%)	16.0	25.6	14.8	12.0
Success rate of pickup	A	A	B	B

10 [0080] As shown in Table 1, the dicing die-bonding integrated films of Production Example 1 to 4 had the same degrees of arithmetic mean roughness Ra and 10-point mean roughness Rz. Among these, the dicing die-bonding integrated films of Production Examples 1 and 2 satisfied the condition that the load length ratio tp (50%) is 15% or greater, and it was found that the dicing die-bonding integrated films were highly excellent in the evaluation of the success rate of pickup.

15 In contrast, regarding the dicing die-bonding integrated films of Production Examples 3 and 4 having a load length ratio tp (50%) of less than 15%, it was found that the success rate of pickup was insufficient.

20 From these results, it was verified that the quality management method

of the present disclosure is useful for determining whether the quality of a dicing die-bonding integrated film scheduled to be used is being maintained.

Reference Signs List

- 5 [0081] 1: dicing die-bonding integrated film, 2: protective film, 4: modified layer, 10: base material layer, 10A: first surface, 10B: second surface, 20: pressure-sensitive adhesive layer, 20ac: cured pressure-sensitive adhesive layer, 30, 30a: adhesive layer, 42: needle, 44: suction collet, 50: adhesive layer-attached semiconductor chip, 60: support substrate, 70: wire bonding, 80: resin encapsulant, 90: solder ball, W1, W2: semiconductor wafer, H1: thickness of semiconductor wafer W1, H2: thickness of semiconductor wafer W2, 100: semiconductor device.

CLAIMS

1. A quality management method for a dicing die-bonding integrated film, the method comprising:

5 preparing a dicing die-bonding integrated film that includes a base material layer having a first surface and a second surface on the opposite side of the first surface, a pressure-sensitive adhesive layer provided on the second surface of the base material layer and formed from a photocurable pressure-sensitive adhesive, and an adhesive layer provided on the pressure-sensitive adhesive layer, the adhesive layer
10 being on the opposite side of the base material layer;

calculating a load length ratio tp for the first surface of the base material layer of the dicing die-bonding integrated film; and

determining whether quality of the dicing die-bonding integrated film is good or bad by using the load length ratio tp as an index.

15 2. The quality management method for a dicing die-bonding integrated film according to claim 1,

wherein the load length ratio tp is the load length ratio tp (50%) at a cut level of 50%.

20 3. The quality management method for a dicing die-bonding integrated film according to claim 2,

wherein determining the quality is determining whether the quality is good or bad by checking whether a condition that the load length ratio tp (50%) is 15% or greater is satisfied.

25 4. A method for manufacturing a semiconductor device, the method comprising:

preparing a dicing die-bonding integrated film that includes a

base material layer having a first surface and a second surface on the opposite side of the first surface, a pressure-sensitive adhesive layer provided on the second surface of the base material layer and formed from a photocurable pressure-sensitive adhesive, and an adhesive layer provided on the pressure-sensitive adhesive layer, the adhesive layer being on the opposite side of the base material layer;

calculating a load length ratio t_p for the first surface of the base material layer of the dicing die-bonding integrated film;

determining whether quality of the dicing die-bonding integrated film is good or bad by using the load length ratio t_p as an index; and

manufacturing a semiconductor device by using a dicing die-bonding integrated film that has been determined to be good in determining the quality .

5. The method for manufacturing a semiconductor device according to claim 4,

wherein the load length ratio t_p is the load length ratio t_p (50%) at a cut level of 50%.

6. The method for manufacturing a semiconductor device according to claim 5,

wherein determining the quality is determining whether the quality is good or bad by checking whether a condition that the load length ratio t_p (50%) is 15% or greater is satisfied.

7. A dicing die-bonding integrated film comprising:

a base material layer having a first surface and a second surface on the opposite side of the first surface;

a pressure-sensitive adhesive layer provided on the second

surface of the base material layer and formed from a photocurable pressure-sensitive adhesive; and

5 an adhesive layer provided on the pressure-sensitive adhesive layer, the adhesive layer being on the opposite side of the base material layer,

 wherein in the first surface of the base material layer, a load length ratio t_p (50%) at a cut level of 50% is 15% or greater.