

DESCRIPTION

Title of Invention

PRESSURE-SENSITIVE ADHESIVE TAPE SET AND PRESSURE-SENSITIVE

5 ADHESIVE TAPE FOR SEMICONDUCTOR ELEMENT TRANSPORT

Technical Field

[0001]

The present invention relates to a pressure-sensitive
10 adhesive tape set including a pressure-sensitive adhesive tape
for semiconductor wafer fabrication and a pressure-sensitive
adhesive tape for semiconductor element transport, and to a
pressure-sensitive adhesive tape for semiconductor element
transport.

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Background Art

[0002]

In recent years, as electronic instruments have been
improved functionally and become more widely used in mobile
20 devices, a demand for semiconductor devices that have higher
density and are more highly integrated has become strong, and
hence the capacity and density of IC packages have been
continuously increased.

[0003]

25 One of the examples of manufacturing methods of the

semiconductor devices is as below. For example, a pressure-sensitive adhesive tape (dicing tape) for semiconductor wafer fabrication described in PTL 1 is bonded to a semiconductor wafer. While the side of the outer peripheral portion of the semiconductor wafer is being fixed using a wafer ring, by using a dicing saw, the semiconductor wafer is cut and split (singulated) as individual semiconductor elements (dicing step). Thereafter, an expanding step is performed, and then a pickup step of picking up the singulated semiconductor elements is performed.

[0004]

Then, in order to mount each of the semiconductor elements obtained by singulation onto a substrate (for example, a tape substrate, an organic hard substrate, or the like), a mounting step is performed. By the mounting step, the semiconductor element picked up is mounted on the substrate, and then a void between the substrate and the semiconductor element is filled with an underfill material, thereby joining the semiconductor element to the substrate. Subsequently, the semiconductor element and the side of the top surface of the substrate are sealed with a semiconductor sealant, thereby manufacturing a semiconductor device.

[0005]

In a case where the steps from the pickup step in the manufacturing method of the semiconductor device are repeatedly

performed, a plurality of semiconductor elements are obtained from one semiconductor wafer, and accordingly, a plurality of semiconductor devices are manufactured. Furthermore, because the steps from the mounting step, in which the semiconductor elements obtained by singulation are used, are repeatedly performed, a plurality of substrates need to be prepared, and hence the steps can be complicated. For these reasons and the like, after the obtained semiconductor elements are transported, the steps from the mounting step are performed in different lines, that is, different places in some cases.

[0006]

For the purpose of more efficiently performing the steps from the mounting step and smoothly transporting the semiconductor elements to different places, the following methods are suggested. That is, a method is suggested in which the semiconductor elements picked up in the pickup step are repeatedly rearranged on a pressure-sensitive adhesive tape (shipping tape) for semiconductor element transport, and the obtained pressure-sensitive adhesive tape for semiconductor element transport on which a plurality of semiconductor elements are rearranged (bonded) is transported to different lines, in other words, different places.

[0007]

Incidentally, in recent years, due to the growth in size of the semiconductor wafer, the number of semiconductor elements

obtained from one semiconductor wafer has tended to increase. Therefore, the time (arrangement time) required for rearranging a plurality of semiconductor elements on a pressure-sensitive adhesive tape for semiconductor element transport has increased.

5 As a result, the time, for which the semiconductor elements remain bonded to a pressure-sensitive adhesive layer included in the pressure-sensitive adhesive tape for semiconductor element transport, greatly varies between the semiconductor elements that move on to the mounting step at the initial stage
10 and the semiconductor elements that move on to the mounting step at the last stage. This trend is more markedly shown in a case where the manufacturing of a semiconductor device is stopped in the middle of the process and postponed to the next day or thereafter.

15 [0008]

Accordingly, between the semiconductor elements that move on to the mounting step at the early stage and the semiconductor elements that move on to the mounting step at the last stage, there is a difference in an adhesive force by which the
20 semiconductor elements are held on the pressure-sensitive adhesive tape for semiconductor element transport through the pressure-sensitive adhesive layer. Unfortunately, due to the difference in the adhesive force, the semiconductor elements cannot be stably picked up from the pressure-sensitive adhesive
25 tape for semiconductor element transport.

Citation List

Patent Literature

[0009]

- [PTL 1] Japanese Unexamined Patent Application, First
5 Publication No. 2009-245989

Summary of Invention

Technical Problem

[0010]

10 An object of present invention (first invention) is to
provide a pressure-sensitive adhesive tape set that makes it
possible to stably pick up semiconductor elements from a
pressure-sensitive adhesive tape for semiconductor element
transport after the plurality of semiconductor elements, which
15 are obtained by singulating a semiconductor wafer bonded to a
pressure-sensitive adhesive tape for semiconductor wafer
fabrication, are rearranged on a pressure-sensitive adhesive
tape for semiconductor element transport, regardless of the
arrangement time required for arranging the semiconductor
20 elements on the pressure-sensitive adhesive tape for
semiconductor element transport.

Another object of the present invention (second invention)
is to provide a pressure-sensitive adhesive tape for
semiconductor element transport that makes it possible to stably
25 pick up semiconductor elements fixed on the pressure-sensitive

adhesive tape for semiconductor element transport in a case where the plurality of semiconductor elements, which are obtained by singulating a semiconductor wafer fixed to a pressure-sensitive adhesive tape for semiconductor wafer fabrication, are fixed to the pressure-sensitive adhesive tape for semiconductor element transport, regardless of the arrangement time required for arranging the semiconductor elements on the pressure-sensitive adhesive tape for semiconductor element transport.

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Solution to Problem

[0011]

The above objects are achieved by the present invention described in the following (1) to (13).

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(1) A pressure-sensitive adhesive tape set constituted with at least one pressure-sensitive adhesive tape for semiconductor wafer fabrication constituted with a first laminate including a sheet-shaped first base material containing a resin material and a first pressure-sensitive adhesive layer laminated on the first base material and at least one pressure-sensitive adhesive tape for semiconductor element transport constituted with a second laminate including a sheet-shaped second base material containing a resin material and a second pressure-sensitive adhesive layer laminated on the second base material, in which a contact angle of hexadecane

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with respect to the first pressure-sensitive adhesive layer is equal to or greater than 10° , and a contact angle of hexadecane with respect to the second pressure-sensitive adhesive layer is less than 10° .

5 [0012]

(2) The pressure-sensitive adhesive tape set described in (1), in which provided that the contact angle of hexadecane with respect to the first pressure-sensitive adhesive layer is $A[^\circ]$, and the contact angle of hexadecane with respect to the second pressure-sensitive adhesive layer is $B[^\circ]$, A and B satisfy a relationship of $20^\circ \leq A - B$.

[0013]

(3) The pressure-sensitive adhesive tape set described in (1) or (2), in which a contact angle of pure water with respect to the first pressure-sensitive adhesive layer is equal to or less than 90° , and a contact angle of pure water with respect to the second pressure-sensitive adhesive layer is greater than 90° .

[0014]

20 (4) The pressure-sensitive adhesive tape set described in any one of (1) to (3), in which the second pressure-sensitive adhesive layer contains a surfactant.

[0015]

(5) The pressure-sensitive adhesive tape set described in

any one of (1) to (4), in which the pressure-sensitive adhesive tape for semiconductor wafer fabrication is used for obtaining a plurality of semiconductor elements formed by singulating a semiconductor wafer bonded to the pressure-sensitive adhesive tape for semiconductor wafer fabrication, and the pressure-sensitive adhesive tape for semiconductor element transport is used for rearranging, moving and storing each of the semiconductor elements picked up from the pressure-sensitive adhesive tape for semiconductor wafer fabrication.

[0016]

(6) The pressure-sensitive adhesive tape set described in (5), in which each semiconductor element picked up from the pressure-sensitive adhesive tape for semiconductor wafer fabrication is bonded to the second pressure-sensitive adhesive layer included in the pressure-sensitive adhesive tape for semiconductor element transport, in a state where a portion of the first pressure-sensitive adhesive layer remains on the side of a surface of the semiconductor element having been in contact with the first pressure-sensitive adhesive layer.

[0017]

(7) A pressure-sensitive adhesive tape for semiconductor element transport which is used for fixing semiconductor elements and constituted with a laminate, the laminate including a sheet-shaped base material containing a resin material and

a pressure-sensitive adhesive layer laminated on the base material,

in which the semiconductor elements are fixed to the pressure-sensitive adhesive tape for semiconductor element transport through the side of a non-circuit-formed surface thereof on which no circuit is formed,

a resin material having pressure-sensitive adhesiveness, which is derived from a pressure-sensitive adhesive tape for semiconductor wafer fabrication having been used for fixing a semiconductor wafer, is attached to the non-circuit-formed surface when the semiconductor elements are obtained by singulating the semiconductor wafer, and

provided that a contact angle of hexadecane with respect to the non-circuit-formed surface, to which the resin material derived from the pressure-sensitive adhesive tape for semiconductor wafer fabrication is attached, is $H[^\circ]$ and a contact angle of hexadecane with respect to the pressure-sensitive adhesive layer included in the pressure-sensitive adhesive tape for semiconductor element transport is $B[^\circ]$, H and B satisfy a relationship of $20^\circ \leq H - B$.

[0018]

(8) The pressure-sensitive adhesive tape for semiconductor element transport described in (7), in which the contact angle H of hexadecane with respect to the

non-circuit-formed surface, to which the resin material derived from the pressure-sensitive adhesive tape for semiconductor wafer fabrication is attached, is equal to or greater than 10° .

[0019]

5 (9) The pressure-sensitive adhesive tape for semiconductor element transport described (7) or (8), in which the contact angle B of hexadecane with respect to the pressure-sensitive adhesive layer included in the pressure-sensitive adhesive tape for semiconductor element
10 transport is less than 10° .

[0020]

 (10) The pressure-sensitive adhesive tape for semiconductor element transport described in any one of (7) to (9), in which provided that a contact angle of pure water with
15 respect to the non-circuit-formed surface, to which the resin material derived from the pressure-sensitive adhesive tape for semiconductor wafer fabrication is attached, is $I[^\circ]$ and a contact angle of pure water with respect to the pressure-sensitive adhesive layer included in the
20 pressure-sensitive adhesive tape for semiconductor element transport is $D[^\circ]$, I and D satisfy a relationship of $55^\circ \leq D - I$.

[0021]

 (11) The pressure-sensitive adhesive tape for
25 semiconductor element transport described in any one of (7) to

(10), in which the contact angle θ of pure water with respect to the non-circuit-formed surface, to which the resin material derived from the pressure-sensitive adhesive tape for semiconductor wafer fabrication is attached, is equal to or less than 50° .

[0022]

(12) The pressure-sensitive adhesive tape for semiconductor element transport described in any one of (7) to (11), in which the contact angle θ of pure water with respect to the pressure-sensitive adhesive layer included in the pressure-sensitive adhesive tape for semiconductor element transport is greater than 90° .

[0023]

(13) The pressure-sensitive adhesive tape for semiconductor element transport described in any one of (7) to (12), in which the pressure-sensitive adhesive layer included in the pressure-sensitive adhesive tape for semiconductor element transport contains a surfactant.

Advantageous Effects of Invention

[0024]

According to the pressure-sensitive adhesive tape set of the present invention including the pressure-sensitive adhesive tape for semiconductor wafer fabrication and the pressure-sensitive adhesive tape for semiconductor element transport, the semiconductor elements picked up from the

pressure-sensitive adhesive tape for semiconductor wafer
fabrication are rearranged on and bonded to the second
pressure-sensitive adhesive layer included in the
pressure-sensitive adhesive tape for semiconductor element
5 transport. Presumably, at the time of rearrangement, a portion
of the first pressure-sensitive adhesive layer may be attached
to (remain on) the side of a surface, which has been in contact
with the first pressure-sensitive adhesive layer, of each of
the semiconductor elements.

10 [0025]

In the present invention, the contact angle of hexadecane
with respect to the first pressure-sensitive adhesive layer is
equal to or greater than 10° , and the contact angle of hexadecane
with respect to the second pressure-sensitive adhesive layer
15 is less than 10° . Therefore, it is possible to stably pick up
the semiconductor elements from the pressure-sensitive adhesive
tape for semiconductor wafer fabrication, regardless of the
arrangement time required for arranging the semiconductor
elements on the pressure-sensitive adhesive tape for
20 semiconductor element transport.

[0026]

Furthermore, in the present invention, the semiconductor
elements picked up from the pressure-sensitive adhesive tape
for semiconductor wafer fabrication are fixed by being bonded
25 to the pressure-sensitive adhesive layer included in the

pressure-sensitive adhesive tape for semiconductor element transport. The semiconductor elements are fixed to the pressure-sensitive adhesive tape for semiconductor wafer fabrication and the pressure-sensitive adhesive tape for semiconductor element transport, through the side of a non-circuit-formed surface thereof on which no circuit is formed. Therefore, the semiconductor elements are fixed to the pressure-sensitive adhesive tape for semiconductor element transport, in a state where the resin material having pressure-sensitive adhesiveness derived from the pressure-sensitive adhesive tape for semiconductor wafer fabrication is attached to the non-circuit-formed surface.

[0027]

In the present invention, provided that the contact angle of hexadecane with respect to the non-circuit-formed surface, to which the resin material derived from the pressure-sensitive adhesive tape for semiconductor wafer fabrication is attached, is $H[^\circ]$ and the contact angle of hexadecane with respect to the pressure-sensitive adhesive layer included in the pressure-sensitive adhesive tape for semiconductor element transport is $B[^\circ]$, H and B satisfy a relationship of $20^\circ \leq H - B$. Accordingly, it is possible to stably pick up the semiconductor elements regardless of the arrangement time required for arranging the semiconductor elements on the pressure-sensitive adhesive tape for semiconductor element

transport.

Brief Description of Drawings

[0028]

5 FIG. 1 is a vertical cross-sectional view showing an example of a semiconductor device manufactured using a pressure-sensitive adhesive tape set of the present invention (and a pressure-sensitive adhesive tape for semiconductor element transport of the present invention).

10 FIG. 2 is a vertical cross-sectional view for illustrating a method for manufacturing the semiconductor device shown in FIG. 1 by using the pressure-sensitive adhesive tape set of the present invention (and the pressure-sensitive adhesive tape for semiconductor element transport of the present invention).

15 FIG. 3 is a vertical cross-sectional view for illustrating the method for manufacturing the semiconductor device shown in FIG. 1 by using the pressure-sensitive adhesive tape set of the present invention (and the pressure-sensitive adhesive tape for semiconductor element transport of the present invention).

20 Fig. 4 is a vertical cross-sectional view for illustrating the method for manufacturing the semiconductor device shown in Fig. 1 by using the pressure-sensitive adhesive tape set of the present invention (and the pressure-sensitive adhesive tape for semiconductor element transport of the present invention).

25 Fig. 5 is a vertical cross-sectional view for illustrating

an embodiment of a pressure-sensitive adhesive tape for semiconductor wafer fabrication included in the pressure-sensitive adhesive tape set of the present invention and an example of the pressure-sensitive adhesive tape for semiconductor wafer fabrication used at the time of manufacturing the semiconductor device shown in Fig. 1 by using the pressure-sensitive adhesive tape for semiconductor element transport of the present invention.

Fig. 6 is a vertical cross-sectional view for illustrating an embodiment of the pressure-sensitive adhesive tape for transport included in the pressure-sensitive adhesive tape set of the present invention (and the pressure-sensitive adhesive tape for semiconductor element transport of the present invention).

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Description of Embodiments

[0029]

Hereinafter, a pressure-sensitive adhesive tape set of the present invention (first invention) will be specifically described. A pressure-sensitive adhesive tape for semiconductor element transport of the present invention (second invention) will be specifically described after the first invention is described.

First, before the pressure-sensitive adhesive tape set of the present invention is described, a semiconductor device

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manufactured using the pressure-sensitive adhesive tape set of the present invention will be described.

[0030]

<Semiconductor device>

5 FIG. 1 is a vertical cross-sectional view showing an example of a semiconductor device manufactured using the pressure-sensitive adhesive tape set of the present invention (and the pressure-sensitive adhesive tape for semiconductor element transport of the present invention). In the following
10 description, the upper side and the lower side in FIG. 1 will be referred to as "top" and "bottom" respectively.

[0031]

A semiconductor device 10 shown in FIG. 1 has a semiconductor chip (semiconductor element) 20, an interposer
15 (substrate) 30 supporting the semiconductor chip 20, a plurality of bumps (terminals) 70 having electric conductivity, and a mold portion (sealing portion) 17 sealing the semiconductor chip 20.

[0032]

The interposer 30 is an insulating substrate, and is
20 constituted, for example, with various resin materials such as a polyimide resin, an epoxy resin, a cyanate resin, and a bismaleimide triazine resin (BT resin). Generally, in a case where the interposer 30 is seen in a plan view, the interposer 30 is found to have a quadrangular shape such as a square shape
25 or a rectangular shape.

[0033]

The top surface (one surface) of the interposer 30 is provided, for example, with terminals 41 which are constituted with a conductive metal material such as copper and each have
5 a predetermined shape.

[0034]

Furthermore, in the interposer 30, a plurality of vias (through holes) (not shown in the drawing) penetrating the interposer 30 in the thickness direction thereof are formed.

10 [0035]

One end (top end) of each of the bumps 70 is electrically connected to a portion of the terminals 41 through each of the vias, and the other end (bottom end) thereof protrudes from the bottom surface (the other surface) of the interposer 30.

15 [0036]

The portion of each of the bumps 70 that protrudes from the interposer 30 substantially has a sphere shape (ball shape).

[0037]

The bumps 70 are constituted mainly with a brazing material
20 such as a solder, a silver solder, a copper solder, or a phosphor copper solder.

[0038]

On the interposer 30, the terminals 41 are formed. Through a connection portion 81, each of the terminals 41 is electrically
25 connected to each of terminals 21 included in the semiconductor

chip 20.

[0039]

In the present embodiment, as shown in Fig. 1, each of the terminals 21 is constituted to protrude from the side of a bottom surface (circuit-formed surface) of the semiconductor chip 20, and each of the terminals 41 is constituted to protrude from the interposer 30.

[0040]

The void between the semiconductor chip 20 and the interposer 30 is filled with an underfill material constituted with various resin materials. By curing the underfill material, a sealing layer 80 is formed. That is, the sealing layer 80 is a cured material of the underfill material. The sealing layer 80 has a function of improving the joining strength between the semiconductor chip 20 and the interposer 30 or a function of preventing a foreign substance, moisture, or the like from entering the void.

[0041]

On the upper side of the interposer 30, a mold portion 17 for covering the semiconductor chip 20 and the interposer 30 is formed. The mold portion 17 is constituted with a cured material of a semiconductor sealing material. By the mold portion 17, the semiconductor chip 20 in the semiconductor device 10 is sealed, and a foreign substance, moisture, or the like is prevented from entering the semiconductor chip 20.

[0042]

The semiconductor device 10 constituted as above is manufactured as below, for example, by a manufacturing method of a semiconductor device using the pressure-sensitive adhesive tape set of the present invention including a pressure-sensitive adhesive tape for semiconductor wafer fabrication (dicing tape) and a pressure-sensitive adhesive tape for semiconductor element transport (shipping tape).

[0043]

10 <Manufacturing method of semiconductor device>

FIG. 2 to FIG. 4 are vertical cross-sectional views for illustrating a method for manufacturing the semiconductor device shown in FIG. 1 by using the pressure-sensitive adhesive tape set of the present invention (and the pressure-sensitive adhesive tape for semiconductor element transport of the present invention). In the following description, the upper side and the lower side in FIG. 2 to Fig. 4 will be referred to as "top" and "bottom" respectively.

[0044]

20 [1A] First, a pressure-sensitive adhesive tape 100 for semiconductor wafer fabrication (hereinafter, simply referred to as "pressure-sensitive adhesive tape 100 for fabrication" as well in some cases) is prepared which is constituted with a laminate (first laminate) having a base material 4 (first base material) and a pressure-sensitive adhesive layer 2 (first

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pressure-sensitive adhesive layer) laminated on the top surface of the base material 4 (see (a) of Fig. 2). In (a) of Fig. 2, in order that the pressure-sensitive adhesive layer 2 includes an outer peripheral portion 121 and a central portion 122, a predetermined region (for example, a region having an annular shape in plan view) of the pressure-sensitive adhesive layer 2 is removed.

[0045]

The pressure-sensitive adhesive tape 100 for fabrication is included in the pressure-sensitive adhesive tape set of the present invention and used for obtaining the semiconductor chip 20. That is, in a case where a semiconductor wafer 7 is singulated in a state of being bonded (fixed) to the pressure-sensitive adhesive tape 100 for fabrication, the semiconductor chip 20 can be obtained. Details of this process will be described later.

[0046]

[2A] Then, as shown in (b) of Fig. 2, on a dicing table not shown in the drawing, the pressure-sensitive adhesive tape 100 for fabrication is installed. Furthermore, as shown in (b) of Fig. 2, in order that a surface (non-circuit-formed surface), on which no circuit is formed, of a semiconductor chip as the semiconductor wafer 7 and the central portion 122 of the pressure-sensitive adhesive layer 2 contact each other, the semiconductor wafer 7 is placed on the pressure-sensitive

adhesive layer 2 and gently pressed, thereby laminating (bonding) the semiconductor wafer 7 on the pressure-sensitive adhesive tape 100 (bonding step).

[0047]

5 The semiconductor wafer 7 may be bonded to the pressure-sensitive adhesive tape 100 for fabrication first and then installed on the dicing table.

[0048]

 Generally, the semiconductor wafer 7 has a diameter of
10 about equal to or greater than 6 inches and equal to or less than 12 inches and a thickness of about equal to or greater than 100 μm and equal to or less than 600 μm .

[0049]

 [3A] Thereafter, the outer peripheral portion 121 (edge)
15 of the pressure-sensitive adhesive layer 2 is fixed using a wafer ring 9 having a cylindrical shape. Subsequently, by using a dicing saw (blade) not shown in the drawing, the semiconductor wafer 7 is cut (diced) and singulated, thereby obtaining a plurality of semiconductor chips 20 (singulation step; step E
20 (c) of Fig. 2).

[0050]

 At this time, the pressure-sensitive adhesive tape 100 for fabrication absorbs shock and prevents cracking, chipping, or the like at the time of cutting the semiconductor wafer 7.

25 [0051]

The semiconductor wafer 7 is cut using a dicing blade such that the dicing blade reaches the middle of the base material 4 in the thickness direction thereof as shown in(c) of Fig. 2. In this way, the semiconductor wafer can be reliably singulated.

5 [0052]

At this time, for the purpose of preventing the scattering of dust generated at the time of cutting the semiconductor wafer 7 or for the purpose of inhibiting the semiconductor wafer 7 from being unnecessarily heated, usually, the semiconductor
10 wafer 7 is cut while cutting water is being supplied to the semiconductor wafer 7.

[0053]

Generally, the thickness of the wafer ring 9 is about equal to or greater than 1.0 mm and equal to or less than 1.5 mm.

15 [0054]

[4A] Next, energy is applied to the pressure-sensitive adhesive layer 2 included in the pressure-sensitive adhesive tape 100 for fabrication such that the pressure-sensitive adhesiveness of the pressure-sensitive adhesive layer 2 with
20 respect to the semiconductor wafer 7 is reduced (energy application step).

By this step, peeling occurs between the pressure-sensitive adhesive layer 2 and the semiconductor wafer 7.

25 [0055]

The method for applying energy to the pressure-sensitive adhesive layer 2 is not particularly limited, and examples thereof include a method of irradiating the pressure-sensitive adhesive layer 2 with energy rays, a method of heating the pressure-sensitive adhesive layer 2, and the like. Among these, the method of irradiating the pressure-sensitive adhesive layer 2 with energy rays is preferable, and a method of irradiating the pressure-sensitive adhesive layer 2 with energy rays from the side of the base material 4 of the pressure-sensitive adhesive tape 100 for fabrication is more preferable.

[0056]

The aforementioned method is suitably used as the method for applying energy, because this method prevents the semiconductor chip 20 from experiencing an unnecessary thermal history and can efficiently apply energy to the pressure-sensitive adhesive layer 2 in a relatively simple manner.

[0057]

Examples of the energy rays include ultraviolet rays, electron beams, particle beams such as ion beams, and the like, and a combination of two or more kinds of these energy rays can also be used. Among these, ultraviolet rays are particularly preferable. In a case where the ultraviolet rays are used, the pressure-sensitive adhesiveness of the pressure-sensitive adhesive layer 2 with respect to the semiconductor wafer 7 can

be efficiently reduced.

[0058]

[5A] Then, the pressure-sensitive adhesive tape 100 for fabrication is radially stretched using an expander not shown in the drawing such that the singulated semiconductor wafers 5 7 (semiconductor chips 20) are spaced apart at a certain interval (expanding step; see (d) of Fig. 2). By the expanding step, the semiconductor chips 20 are separated at a certain interval. Thereafter, the semiconductor chips 20 are raised up by using 10 a needle or the like, and in this state, the semiconductor chips 20 are picked up by being adsorbed onto a vacuum collet or air tweezers (pickup step; see (e) of Fig. 2).

[0059]

[6A] Subsequently, a pressure-sensitive adhesive tape 200 15 for semiconductor element transport (hereinafter, simply referred to as "pressure-sensitive adhesive tape 200 for transport" as well in some cases) is prepared which is constituted with a laminate (second laminate) having a base material 204 (second base material) and a pressure-sensitive 20 adhesive layer 202 (second pressure-sensitive adhesive layer) laminated on the top surface of the base material 204. The wafer ring 9 is fixed to the outer peripheral portion of the pressure-sensitive adhesive tape 200 for transport, and then as shown in (a) of Fig. 3, the pressure-sensitive adhesive tape 25 200 for transport is installed on a table not shown in the drawing.

Thereafter, in order that a surface (non-circuit-formed surface), on which no circuit is formed, of the semiconductor chip 20 and the pressure-sensitive adhesive layer 202 contact each other, the semiconductor chip 20 is placed on the pressure-sensitive adhesive layer 202 and gently pressed, thereby laminating (bonding) the semiconductor chip 20 on the pressure-sensitive adhesive tape 200 for transport (bonding step).

[0060]

In a case where the bonding of the semiconductor chip 20 to the pressure-sensitive adhesive tape 200 for transport is repeatedly performed plural times, a plurality of semiconductor chips 20 obtained by singulating the semiconductor wafer 7 are rearranged on the pressure-sensitive adhesive tape 200 for transport.

[0061]

At this time, the holding force (adhesive force) exerted on the semiconductor chip 20 by the pressure-sensitive adhesive layer 202 is preferably equal to or higher than 10 cN/25 mm and equal to or lower than 200 cN/25 mm, and more preferably equal to or higher than 35 cN/25 mm and equal to or lower than 100 cN/25 mm. In a case where the holding force is within the above range, it is possible to reliably inhibit or prevent the semiconductor chip 20 from being separated from the pressure-sensitive adhesive layer 202 in a closed space 255 at

the time of moving·storing the semiconductor chip 20 in the next step [7A].

[0062]

The pressure-sensitive adhesive tape 200 for transport is
5 included in the pressure-sensitive adhesive tape set of the present invention, and used for rearranging and moving·storing the semiconductor chips 20. That is, the semiconductor chips 20 picked up from the pressure-sensitive adhesive tape 100 for fabrication are moved·stored by being rearranged on the
10 pressure-sensitive adhesive tape 200 for transport. Details of this process will be described later.

[0063]

[7A] Thereafter, as shown in (b) of Fig. 3, a pressure-sensitive adhesive tape 300 for protection is bonded
15 to the top surface of the wafer ring 9 (a side of the wafer ring 9 that is opposite to the pressure-sensitive adhesive tape 200 for transport) fixed to the pressure-sensitive adhesive tape 200 for transport. In this way, the rearranged semiconductor chips 20 are stored in the formed closed space 255.

20 [0064]

While the aforementioned state is being maintained, the semiconductor chips 20 are moved to a different line which is located in a different place and in which steps from the next step [8A] will be performed. Before and after the movement, the
25 semiconductor chips 20 may be stored while this state is being

maintained.

[0065]

[8A] Subsequently, the pressure-sensitive adhesive tape 300 for protection is peeled from the wafer ring 9, and then
5 energy is applied to the pressure-sensitive adhesive layer 202 included in the pressure-sensitive adhesive tape 200 for transport, thereby reducing the pressure-sensitive adhesiveness of the pressure-sensitive adhesive layer 202 with respect to the semiconductor wafer 7 (energy application step).

10 By this step, peeling occurs between the pressure-sensitive adhesive layer 202 and the semiconductor chip 20.

[0066]

The method for applying energy to the pressure-sensitive
15 adhesive layer 202 is the same as the method for applying energy to the pressure-sensitive adhesive layer 2 described above in the step [4A].

[0067]

At this time, the holding force (adhesive force) exerted
20 on the semiconductor chip 20 by the pressure-sensitive adhesive layer 202 is preferably equal to or higher than 2 cN/25 mm and equal to or lower than 25 cN/25 mm, and more preferably equal to or higher than 5 cN/25 mm and equal to or lower than 20 cN/25 mm. In a case where the holding force is within the above range,
25 it is possible to smoothly and accurately pick up the

semiconductor chips 20 in the next step [9A].

[0068]

In a case where the adhesive force between the pressure-sensitive adhesive layer 202 and the semiconductor chip 20 is of such a magnitude that enables peeling to occur between the pressure-sensitive adhesive layer 202 and the semiconductor chip 20 even before energy is applied to the pressure-sensitive adhesive layer 202, the application of energy to the pressure-sensitive adhesive layer 202 can be skipped.

[0069]

[9A] Next, as shown in (c) of Fig. 3, the semiconductor chips 20 on the pressure-sensitive adhesive tape 200 for transport are raised up by using a needle or the like, and in this state, the semiconductor chips 20 are picked up by being adsorbed onto a vacuum collet or air tweezers (pickup step).

[0070]

[10A] Then, the semiconductor chips 20 picked up are upside down by being transported to a mounting probe or the like from the vacuum collet or the air tweezers. Thereafter, as shown in (a) of Fig. 4, the terminals 21 included in each of the semiconductor chips 20 and the terminals 41 included in the interposer 30 are made face each other across solder bumps provided on the terminals 41, and the semiconductor chip 20 is provided on top of the interposer 30. That is, a surface, which

contacted the pressure-sensitive adhesive tape 100 for fabrication, of the semiconductor chip 20 is caused to face up, and the semiconductor chip (semiconductor element) 20 is provided on top of the interposer (substrate) 30.

5 [0071]

[11A] Thereafter, as shown in (b) of Fig. 4, the solder bump 85 interposed between each of the terminals 21 and each of the terminals 41 is heated, and in this state, the interposer 30 and the semiconductor chip 20 are brought close to each other.

10 [0072]

In this way, the molten solder bump 85 contacts both the terminal 21 and terminal 41 and is cooled as it is, and consequently, a connection portion 81 is formed. As a result, through the connection portion 81, the terminal 21 and the terminal 41 are electrically connected to each other (mounting step; see (c) of Fig. 4).

[0073]

[12A] Subsequently, a void formed between the semiconductor chip 20 and the interposer 30 is filled with an underfill material (sealant) constituted with various resin materials, and then the underfill material is cured, thereby forming a sealing layer 80 constituted with a cured material of the underfill material (sealing layer forming step; see (d) of Fig. 4).

25 [0074]

[13A] Then, the mold portion 17 is formed on the upper side of the interposer 30 such that the semiconductor chip 20 and the interposer 30 are covered. By this step, the semiconductor chip 20 is sealed with the interposer 30 and the mold portion 17. Furthermore, bumps 70, which are electrically connected to a portion of the terminals 41 through vias included in the interposer 30, are formed such that the bumps 70 protrude from the lower side of the interposer 30 (see (e) of Fig. 4).

[0075]

10 The sealing with the mold portion 17 may be performed as below. For example, a molding die is prepared which includes an internal space matching with the shape of the mold portion 17 to be formed. The semiconductor chip 20 and the interposer 30 are disposed in the internal space, and the internal space 15 is filled with a semiconductor sealing material in the form of powder such that the semiconductor chip 20 and the interposer 30 are covered. In this state, the semiconductor sealing material is cured by heating, thereby forming the mold portion 17 which is a cured material of the semiconductor sealing 20 material. In this way, the sealing with the mold portion 17 is performed.

[0076]

By the manufacturing method of a semiconductor device including the steps described above, the semiconductor device 25 10 is obtained. More specifically, by performing the steps [1A]

to [13A] and then repeatedly performing the steps [9A] to [13A], a plurality of semiconductor devices 10 can be simultaneously manufactured from one semiconductor wafer 7.

[0077]

5 The pressure-sensitive adhesive tape set of the present invention used in the manufacturing method of the semiconductor device 10 includes at least one pressure-sensitive adhesive tape 100 for semiconductor wafer fabrication and at least one pressure-sensitive adhesive tape 200 for transport.

10 Hereinafter, the pressure-sensitive adhesive tapes 100 and 200 will be described.

[0078]

As shown in Fig. 5, the pressure-sensitive adhesive tape 100 for semiconductor wafer fabrication is constituted with a laminate (first laminate) including the base material 4 (first base material) and the pressure-sensitive adhesive layer 2 (first pressure-sensitive adhesive layer) laminated on the top surface (one surface) of the base material 4. As shown in Fig. 6, the pressure-sensitive adhesive tape 200 for transport is constituted with a laminate (second laminate) including the base material 204 (second base material) and the pressure-sensitive adhesive layer 202 (second pressure-sensitive adhesive layer) laminated on the top surface of the base material 204 (second base material). In order that the contact angle of hexadecane

20

25 with respect to the pressure-sensitive adhesive layer 202

becomes equal to or greater than 10° , and the contact angle of hexadecane with respect to the pressure-sensitive adhesive layer 2 becomes less than 10° , the pressure-sensitive adhesive layer 2 and the pressure-sensitive adhesive layer 202 contain
5 different constituent materials. Except for this difference, the pressure-sensitive adhesive tape 100 for fabrication and the pressure-sensitive adhesive tape 200 for transport have the same constitution. Therefore, hereinafter, the pressure-sensitive adhesive tape 100 for fabrication will be
10 representatively described except for the difference.

[0079]

<Pressure-sensitive adhesive tape for semiconductor wafer fabrication>

Fig. 5 is a vertical cross-sectional view for illustrating
15 an embodiment of a pressure-sensitive adhesive tape for semiconductor wafer fabrication and an example of the pressure-sensitive adhesive tape for semiconductor wafer fabrication used at the time of manufacturing the semiconductor device shown in Fig. 1 by using the pressure-sensitive adhesive
20 tape for semiconductor element transport of the present invention. In the following description, the upper side and the lower side in FIG. 5 will be referred to as "top" and "bottom" respectively.

[0080]

25 The pressure-sensitive adhesive tape 100 for fabrication

is constituted with a laminate including the sheet-shaped base material 4 containing a resin material and the pressure-sensitive adhesive layer 2 laminated on the top surface (one surface) of the base material 4. Hereinafter, the base material 4 and the pressure-sensitive adhesive layer 2 will be described.

[0081]

The pressure-sensitive adhesive tape 100 for fabrication has a function of reducing the pressure-sensitive adhesiveness of the pressure-sensitive adhesive layer 2 with respect to the semiconductor wafer 7 in a case where energy is applied to the pressure-sensitive adhesive layer 2. Furthermore, the pressure-sensitive adhesive tape 200 for transport has a function of reducing the pressure-sensitive adhesiveness of the pressure-sensitive adhesive layer 202 with respect to the semiconductor chip 20 in a case where energy is applied to the pressure-sensitive adhesive layer 202. As the method for applying energy to the pressure-sensitive adhesive layer 2, for example, a method of irradiating the pressure-sensitive adhesive layer 2 with energy rays, a method of heating the pressure-sensitive adhesive layer 2, and the like may be used. Among these, the method of irradiating the pressure-sensitive adhesive layer 2 with energy rays is suitably used because this method prevents the semiconductor chip 20 from experiencing an unnecessary thermal history. Accordingly, hereinafter,

regarding the pressure-sensitive adhesive layer 2, a case where the pressure-sensitive adhesiveness is reduced by the irradiation of energy rays will be representatively described.

[0082]

5 <Base material 4>

The base material 4 is mainly formed of a resin material, has a sheet shape, and has a function of supporting the pressure-sensitive adhesive layer 2 provided on the base material 4. Furthermore, the base material 4 enables the pressure-sensitive adhesive tape 100 for fabrication to be stretched in a plane direction thereof by using an expander in the step [5A].

[0083]

The resin material is not particularly limited. For example, as the resin material, polyethylene such as low-density polyethylene, linear polyethylene, medium-density polyethylene, high-density polyethylene, or ultra-low-density polyethylene, polypropylene such as random copolymer polypropylene, block copolymer polypropylene, or homopolypropylene, a polyolefin-based resin (olefin-based polymer) such as polyvinyl chloride, polybutene, polybutadiene, polymethylpentene, or polyisobutylene, an ionomer such as an ethylene-vinyl acetate copolymer, a zinc ion cross-linked substance, or a sodium ion cross-linked substance, an olefin-based copolymer such as an ethylene-(meth)acrylic acid copolymer, an

ethylene-(meth)acrylic acid ester (random or alternating) copolymer, an ethylene-propylene copolymer, an ethylene-butene copolymer, or an ethylene-hexene copolymer, a polyester-based resin (polymer of esters) such as polyethylene terephthalate, 5 polyethylene naphthalate, polybutylene terephthalate, or polybutylene naphthalate, polyurethane, polyimide, polyamide, polyether ketone such as polyether ether ketone, polyether sulfone, polystyrene, a fluoro-resin, a silicone resin, a cellulose-based resin, a thermoplastic resin such as a 10 styrene-based thermoplastic elastomer (styrene-based polymer), an olefin-based thermoplastic elastomer (olefin-based polymer) like a polypropylene-based thermoplastic elastomer, an acrylic resin, a polyester-based thermoplastic elastomer, polyvinyl isoprene, and polycarbonate (carbonate-based polymer) or a 15 mixture of these thermoplastic resins is used. Among these, the polymer of esters, the styrene-based polymer, the olefin-based polymer, the carbonate-based polymer, the ionomer, and a copolymer containing at least one kind of polymer described above is preferable.

20 [0084]

These resin materials can transmit energy rays such as light (visible rays, near infrared rays, and ultraviolet rays), X-rays, and electron beams. Therefore, these resin materials can be preferably used in a case where the energy rays are 25 transmitted through the base material 4 from the side of the

base material 4 and radiated to the pressure-sensitive adhesive layer 2. Accordingly, in a case where the energy rays are radiated to the pressure-sensitive adhesive layer 2 from the side of the base material 4, the pressure-sensitive adhesiveness of the pressure-sensitive adhesive layer 2 can be reduced, and the semiconductor chips 20 can be easily picked up.

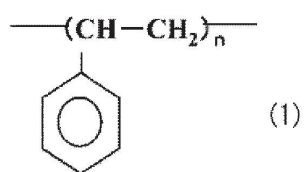
[0085]

Particularly, as the resin material, it is preferable to use a mixture of polypropylene and an elastomer or a mixture of polyethylene and an elastomer.

[0086]

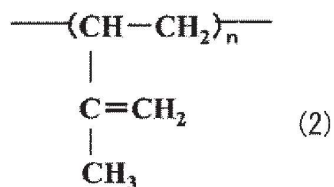
As the elastomer, a block copolymer (styrene-isoprene block copolymer: SIS) is preferable which is formed of a polystyrene segment represented by General Formula (1) and a vinyl polyisoprene segment represented by General Formula (2).

[0087]



(In General Formula (1), n represents an integer equal to or greater than 2.)

[0088]



(In General Formula (2), n represents an integer equal to or greater than 2).

[0089]

5 It is preferable that the base material 4 contains a
 conductive material having electric conductivity. In a case
 where the base material 4 contains the conductive material, by
 causing the conductive material to function as an antistatic
 agent, it is possible to reliably inhibit or prevent the
 10 occurrence of static electricity in the semiconductor chip 20
 in the singulation step [3A] and the pickup steps [5A] and [9A].

[0090]

The conductive material is not particularly limited as
 long as it has electric conductivity. Examples thereof include
 15 a surfactant, an inherently dissipative polymer (IDP), a metal
 material, a metal oxide material, a carbonaceous material, and
 the like. One kind of the above antistatic agent can be used,
 or two or more kinds of the above antistatic agents can be used
 in combination.

20 [0091]

Among these, examples of the surfactant include an anionic
 surfactant, a cationic surfactant, a nonionic surfactant, an
 amphoteric surfactant, and the like.

[0092]

As the inherently dissipative polymer (IDP), for examples, it is possible to use all IDPs such as a polyether-polyolefin block polymer-based IDP, a polyester amide-based IDP, polyester
5 amide, polyether ester amide, and a polyurethane-based IDP.

[0093]

Examples of the metal material include gold, silver, copper, silver-coated copper, nickel, and the like, and powder of these metals is preferably used.

10 [0094]

Examples of the metal oxide material include indium tin oxide (ITO), indium oxide (IO), antimony tin oxide (ATO), indium zinc oxide (IZO), tin oxide (SnO_2), zinc oxide (ZnO), and the like, and powder of these metal oxides is preferably used.

15 [0095]

Examples of the carbonaceous material include carbon black, carbon nanotubes such as single-layer carbon nanotubes and multilayer carbon nanotubes, carbon nanofiber, CN nanotubes, CN nanofiber, BCN nanotubes, BCN nanofiber, graphene, and the
20 like.

[0096]

Furthermore, the base material 4 may contain a softener such as mineral oil, a filler such as calcium carbonate, silica, talc, mica, or clay, an antioxidant, a light stabilizer, a
25 lubricant, a dispersant, a neutralizer, a colorant, and the like.

[0097]

The average thickness of the base material 4 is not particularly limited. For example, the average thickness of the base material 4 is preferably equal to or greater than 10 μm and equal to or less than 300 μm , more preferably equal to or greater than 30 μm and equal to or less than 200 μm , and even more preferably equal to or greater than 80 μm and equal to or less than 200 μm . In a case where the average thickness of the base material 4 is within the above range, the dicing of the semiconductor wafer 7 in the step [3A] can be performed with excellent workability. Furthermore, in the pressure-sensitive adhesive tape 200 for transport, in a case where the average thickness of the base material 204 is within the above range, the semiconductor chip 20 fixed through the pressure-sensitive adhesive layer 202 can be reliably supported.

[0098]

It is preferable that a functional group such as a hydroxyl group or an amino group, which is reactive with the constituent material incorporated into the pressure-sensitive adhesive layer 2, is exposed on the surface of the base material 4.

[0099]

The base material 4 may be constituted with a laminate (multilayer substance) in which a plurality of layers constituted with different resin materials are laminated. Furthermore, the base material 4 may be constituted with a blend

film obtained by dry-blending the resin materials.

[0100]

<Pressure-sensitive adhesive layer>

The pressure-sensitive adhesive layer 2 has a function of
5 supporting the semiconductor wafer 7 by allowing the
semiconductor wafer 7 to adhere thereto at the time of dicing
the semiconductor wafer 7 in the step [3A]. In a case where
energy is applied to the pressure-sensitive adhesive layer 2,
the pressure-sensitive adhesiveness of the pressure-sensitive
10 adhesive layer 2 with respect to the semiconductor wafer 7 is
reduced. As a result, peeling can easily occur between the
pressure-sensitive adhesive layer 2 and the semiconductor wafer
7. In the pressure-sensitive adhesive tape 200 for transport,
the pressure-sensitive adhesive layer 202 has a function of
15 supporting the semiconductor chip 20 at the time of
transporting·storing the semiconductor chip 20 by allowing the
semiconductor chip 20 to adhere thereto. In a case where energy
is applied to the pressure-sensitive adhesive layer 202, the
pressure-sensitive adhesiveness of the pressure-sensitive
20 adhesive layer 202 with respect to the semiconductor chip 20
is reduced. As a result, peeling can easily occur between the
pressure-sensitive adhesive layer 202 and the semiconductor
chip 20.

[0101]

25 The pressure-sensitive adhesive layer 2 having the

aforementioned function is constituted with a resin composition containing, as main materials, (1) base resin having pressure-sensitive adhesiveness and (2) curable resin curing the pressure-sensitive adhesive layer 2.

5 [0102]

Hereinafter, each of the components contained in the resin composition will be sequentially described.

(1) Base resin

The base resin has pressure-sensitive adhesiveness and is
10 incorporated into the resin composition such that the pressure-sensitive adhesiveness with respect to the semiconductor wafer 7 is imparted to the pressure-sensitive adhesive layer 2 before the pressure-sensitive adhesive layer 2 is irradiated with energy rays. In the pressure-sensitive
15 adhesive tape 200 for transport, the base resin is incorporated into the resin composition such that the pressure-sensitive adhesiveness with respect to the semiconductor chip 20 is imparted to the pressure-sensitive adhesive layer 202 before the pressure-sensitive adhesive layer 202 is irradiated with
20 energy rays.

[0103]

Examples of the base resin include known base resins used as components of a pressure-sensitive adhesive layer, such as an acrylic resin (pressure-sensitive adhesive), a
25 silicone-based resin (pressure-sensitive adhesive), a

polyester-based resin (pressure-sensitive adhesive), a
polyvinyl acetate-based resin (pressure-sensitive adhesive),
a polyvinyl ether-based resin (pressure-sensitive adhesive),
a styrene-based elastomer resin (pressure-sensitive adhesive),
5 a polyisoprene-based resin (pressure-sensitive adhesive), a
polyisobutylene-based resin (pressure-sensitive adhesive), and
a urethane-based resin (pressure-sensitive adhesive). Among
these, an acrylic resin is preferably used. The acrylic resin
has excellent heat resistance and can be relatively easily
10 obtained at low costs. Therefore, the acrylic resin is
preferably used as the base resin.

[0104]

The acrylic resin contains, as a base polymer, a polymer
(homopolymer or copolymer) containing a (meth)acrylic acid
15 ester as a main monomer component.

[0105]

The (meth)acrylic acid ester is not particularly limited,
and examples thereof include a (meth)acrylic acid alkyl ester
such as methyl (meth)acrylate, ethyl (meth)acrylate, propyl
20 (meth)acrylate, isopropyl (meth)acrylate, butyl (meth)acrylate,
isobutyl (meth)acrylate, s-butyl (meth)acrylate, t-butyl
(meth)acrylate, pentyl (meth)acrylate, hexyl (meth)acrylate,
heptyl (meth)acrylate, octyl (meth)acrylate, isooctyl
(meth)acrylate, 2-ethylhexyl (meth)acrylate, nonyl
25 (meth)acrylate, isononyl (meth)acrylate, decyl (meth)acrylate,

isodecyl (meth)acrylate, undecyl (meth)acrylate, dodecyl
(meth)acrylate, tridecyl (meth)acrylate, tetradecyl
(meth)acrylate, pentadecyl (meth)acrylate, hexadecyl
(meth)acrylate, heptadecyl (meth)acrylate, or octadecyl
5 (meth)acrylate, a (meth)acrylic acid cycloalkyl ester such as
cyclohexyl (meth)acrylate, a (meth)acrylic acid aryl ester such
as phenyl (meth)acrylate, and the like. One kind of the above
compound can be used, or two or more kinds of the above compounds
can be used in combination. Among these, a (meth)acrylic acid
10 alkyl ester such as methyl (meth)acrylate, ethyl (meth)acrylate,
butyl (meth)acrylate, and 2-ethylhexyl (meth)acrylate, or octyl
(meth)acrylate is preferable. Particularly, the (meth)acrylic
acid alkyl ester has excellent heat resistance and can be
relatively easily obtained at low costs.

15 [0106]

In the present specification, "(meth)acrylic acid ester"
means both the acrylic acid ester and methacrylic acid ester.

[0107]

The glass transition point of the acrylic resin is
20 preferably equal to or lower than 20°C. In a case where the glass
transition temperature is as above, it is possible to make the
pressure-sensitive adhesive layer 2 exhibit excellent
pressure-sensitive adhesiveness before the pressure-sensitive
adhesive layer 2 is irradiated with energy rays.

25 [0108]

For purpose of improving cohesive force, heat resistance, and the like, if necessary, the acrylic resin can contain a copolymerizable monomer as a monomer component constituting the polymer.

5 [0109]

The aforementioned copolymerizable monomer is not particularly limited, and examples thereof include a hydroxyl group-containing monomer such as 2-hydroxyethyl (meth)acrylate, 2-hydroxypropyl (meth)acrylate, 4-hydroxybutyl (meth)acrylate, 10 or 6-hydroxyhexyl (meth)acrylate, an epoxy group-containing monomer such as glycidyl (meth)acrylate, a carboxyl group-containing monomer such as (meth)acrylic acid, itaconic acid, maleic acid, fumaric acid, crotonic acid, or isocrotonic acid, an acid anhydride group-containing monomer such as maleic 15 anhydride or itaconic anhydride, an amide-based monomer such as (meth)acrylamide, N,N-dimethyl (meth)acrylamide, N-butyl (meth)acrylamide, N-methylol (meth)acrylamide, N-methylolpropane (meth)acrylamide, N-methoxymethyl (meth)acrylamide, or N-butoxymethyl (meth)acrylamide, an amino 20 group-containing monomer such as aminoethyl (meth)acrylate, N,N-dimethylaminoethyl (meth)acrylate, or t-butylaminoethyl (meth)acrylate, a cyano group-containing monomer such as (meth)acrylonitrile, an olefin-based monomer such as ethylene, propylene, isoprene, butadiene, or isobutylene, a styrene-based 25 monomer such as styrene, α -methylstyrene, or vinyl toluene, a

vinyl ester-based monomer such as vinyl acetate or vinyl propionate, a vinyl ether-based monomer such as methyl vinyl ether or ethyl vinyl ether, a halogen atom-containing monomer such as vinyl chloride or vinylidene chloride, an alkoxy group
5 group-containing monomer such as methoxyethyl (meth)acrylate or ethoxyethyl (meth)acrylate, a monomer having a nitrogen atom-containing ring such as N-vinyl-2-pyrrolidone, N-methylvinylpyrrolidone, N-vinylpyridine, N-vinylpiperidone, N-vinylpyrimidine, N-vinylpiperazine, N-vinylpirazine,
10 N-vinylpyrrole, N-vinylimidazole, N-vinyloxazole, N-vinylmorpholine, N-vinylcaprolactam, or N-(meth)acryloylmorpholine, and the like. One kind of the above monomer can be used, or two or more kinds of the above monomers can be used in combination.

15 [0110]

The content of these copolymerizable monomers with respect to all of the monomer components constituting the acrylic resin is preferably equal to or less than 40% by weight, and more preferably equal to or less than 10% by weight.

20 [0111]

In the polymer constituting the acrylic resin, the copolymerizable monomer may be contained in the terminal of a main chain, in the middle of the main chain, or in both of the terminal of the main chain and the middle of the main chain.

25 [0112]

For the purpose of cross-linking the polymers, the copolymerizable monomer may contain a polyfunctional monomer.

[0113]

Examples of the polyfunctional monomer include

5 1,6-hexanediol (meth)acrylate, (poly)ethylene glycol
di(meth)acrylate, (poly)propylene glycol di(meth)acrylate,
neopentyl glycol di(meth)acrylate, pentaerythritol
di(meth)acrylate, trimethylolpropane tri(meth)acrylate,
pentaerythritol tri(meth)acrylate, dipentaerythritol
10 hexa(meth)acrylate, glycerin di(meth)acrylate, epoxy
(meth)acrylate, polyester (meth)acrylate, urethane
(meth)acrylate, divinyl benzene, butyl di(meth)acrylate, hexyl
di(meth)acrylate, and the like. One kind of the above monomer
can be used, or two or more kinds of the above monomers can be
15 used in combination.

[0114]

Furthermore, an ethylene-vinyl acetate copolymer, a vinyl acetate polymer, and the like can be used as the copolymerizable monomer component.

20 [0115]

The aforementioned acrylic resin (polymer) can be generated by polymerizing a single monomer component or a mixture of two or more kinds of monomer components. The monomer component can be polymerized by, for example, a polymerization
25 method such as a solution polymerization method, an

emulsification polymerization method, a bulk polymerization method, or a suspension polymerization method.

[0116]

The acrylic resin obtained by polymerizing the monomer
5 component described above is preferably an acrylic resin
(referred to as a "double bond introduction-type acrylic resin"
in some cases) having a carbon-carbon double bond in a side chain,
in the middle of a main chain, or in the terminal of a main chain.
In a case where the acrylic resin is a double bond
10 introduction-type acrylic resin, even though a curable resin
which will be described later is not added, the obtained
pressure-sensitive adhesive layer 2 can function as the
pressure-sensitive adhesive layer 2 described above.

[0117]

15 The aforementioned double bond introduction-type acrylic
resin is preferably a double bond introduction-type acrylic
resin (referred to as a "double bond side chain introduction-type
acrylic resin" in some cases) in which 1/100 or more of side
chains among the side chains in the polymer constituting the
20 acrylic resin each have one carbon-carbon double bond. The
introduction of the carbon-carbon double bond into the side chain
of the acrylic resin is advantageous as well in terms of molecular
design. The double bond side chain introduction-type acrylic
resin may also have the carbon-carbon double bond in the middle
25 of a main chain or in the terminal of a main chain.

[0118]

The method for synthesizing the double bond introduction-type acrylic resin (that is, the method for introducing the carbon-carbon double bond into the acrylic resin) is not particularly limited, and examples thereof include the following method. First, an acrylic resin containing a functional group (referred to as a "functional group-containing acrylic resin" in some cases) is synthesized by copolymerizing a functional group-containing monomer as a copolymerizable monomer. Then, a functional group which can react with the functional group in the functional group-containing acrylic resin and a compound having a carbon-carbon double bond (referred to as a "carbon-carbon double bond-containing reactive compound" in some cases) are subjected to a condensation reaction or an addition reaction in a state where the carbon-carbon double bond in the functional group-containing acrylic resin is being allowed to maintain energy ray curability (energy ray polymerizing properties). In this way, a double bond introduction-type acrylic resin can be synthesized.

20 [0119]

Examples of control means at the time of introducing the carbon-carbon double bond into 1/100 or more of side chains among all of the side chains in the acrylic resin include a method of appropriately regulating the content of the carbon-carbon double bond-containing reactive compound which is a compound

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subjected to the condensation reaction or the addition reaction together with the functional group-containing acrylic resin.

[0120]

At the time of causing the condensation reaction or the addition reaction between the functional group-containing acrylic resin and the carbon-carbon double bond-containing reactive compound, by using a catalyst, the aforementioned reaction can be effectively carried out. The catalyst is not particularly limited, but a tin-based catalyst such as dibutyltin dilaurate is preferably used. The content of the tin-based catalyst is not particularly limited, but is preferably, for example, equal to or greater than 0.05 parts by weight and equal to or less than 1 part by weight with respect to 100 parts by weight of the functional group-containing acrylic resin.

[0121]

Examples of a functional group A in the functional group-containing acrylic resin and a functional group B in the carbon-carbon double bond-containing reactive compound include a carboxyl group, an acid anhydride group, a hydroxyl group, an amino group, an epoxy group, an isocyanate group, an aziridine group, and the like. Examples of a combination of the functional group A in the functional group-containing acrylic resin and the functional group B in the carbon-carbon double bond-containing reactive compound include various combinations

such as a combination of a carboxylic acid group (carboxyl group) and an epoxy group, a combination of carboxylic acid group and an aziridine group, a combination of a hydroxyl group and an isocyanate group, and a combination of a hydroxyl group and a carboxyl group. Among these, a combination of a hydroxyl group and an isocyanate group is preferable. In a case where the aforementioned combination is used, it is possible to easily track the reaction between the functional groups A and B.

[0122]

10 In the combination of the functional groups A and B, any of the functional groups may be the functional group A of the functional group-containing acrylic resin or the functional group B of the carbon-carbon double bond-containing reactive compound. For example, in a case where a combination of a hydroxyl group and an isocyanate group is used, the hydroxyl group is preferably the functional group A in the functional group-containing acrylic resin, and the isocyanate group is preferably the functional group B in the carbon-carbon double bond-containing reactive compound.

20 [0123]

In this case, examples of the monomer having the functional group A constituting the functional group-containing acrylic resin include a carboxyl group-containing monomer such as acrylic acid, methacrylic acid, carboxyethyl acrylate, carboxypentyl acrylate, itaconic acid, maleic acid, fumaric

25

acid, or crotonic acid, an acid anhydride group-containing monomer such as maleic anhydride or itaconic anhydride, a hydroxyl group-containing monomer such as 2-hydroxyethyl (meth)acrylate, 2-hydroxypropyl (meth)acrylate, 5 4-hydroxybutyl (meth)acrylate, 6-hydroxyhexyl (meth)acrylate, 8-hydroxyoctyl (meth)acrylate, 10-hydroxydecyl (meth)acrylate, 12-hydroxylauryl (meth)acrylate, (4-hydroxymethylcyclohexyl)methyl (meth)acrylate, vinyl alcohol, allyl alcohol, 2-hydroxyethyl vinyl ether, 10 2-hydroxypropyl vinyl ether, 4-hydroxybutyl vinyl ether, ethylene glycol monovinyl ether, diethylene glycol monovinyl ether, propylene glycol monovinyl ether, or dipropylene glycol monovinyl ether, an epoxy group-containing monomer such as glycidyl (meth)acrylate or allyl glycidyl ether, and the like.

15 [0124]

Examples of the carbon-carbon double bond-containing reactive compound having the functional group B include a carbon-carbon double bond-containing reactive compound having an isocyanate group such as (meth)acryloyl isocyanate, 20 (meth)acryloyloxymethyl isocyanate, 2-(meth)acryloyloxyethyl isocyanate, 2-(meth)acryloyloxypropyl isocyanate, 3-(meth)acryloyloxypropyl isocyanate, 4-(meth)acryloyloxybutyl isocyanate, m-propenyl- α,α -dimethylbenzyl isocyanate, and the like, a 25 carbon-carbon double bond-containing reactive compound having

an epoxy group such as glycidyl (meth)acrylate, and the like.

[0125]

From the viewpoint of preventing the acrylic resin from remaining on the semiconductor chip 20 at the time of picking up the semiconductor chip 20 from the pressure-sensitive adhesive layer 2, it is preferable that the content of a low-molecular weight compound in the acrylic resin is small. In this case, the weight-average molecular weight of the acrylic resin is preferably set to be 300,000 to 5,000,000, more preferably set to be 500,000 to 5,000,000, and even more preferably set to be 800,000 to 3,000,000. Depending on the type of the monomer component or the like, in a case where the weight-average molecular weight of the acrylic resin is less than the lower limit described above, the properties of preventing the contamination of the semiconductor chip 20 may deteriorate. Accordingly, at the time of picking up the semiconductor chip 20 is picked up, adhesive residues may remain.

[0126]

It is preferable that the acrylic resin has a functional group (reactive functional group) such as a hydroxyl group or a carboxyl group (particularly, a hydroxyl group) exhibiting reactivity to a cross-linking agent or a photopolymerization initiator. In a case where the acrylic resin has such a functional group, the cross-linking agent or the photopolymerization initiator is linked to the acrylic resin

which is a monomer component. Accordingly, it is possible to accurately inhibit or prevent the cross-linking agent or the photopolymerization initiator from leaking out of the pressure-sensitive adhesive layer 2. As a result, by the energy ray irradiation, the pressure-sensitive adhesiveness of the pressure-sensitive adhesive layer 2 with respect to the semiconductor chip 20 is reliably reduced.

[0127]

(2) Curable resin

The curable resin has, for example, curing properties of being cured by being irradiated with energy rays. As a result of incorporating the base resin into the cross-linked structure of the curable resin by curing, the adhesive force (pressure-sensitive adhesiveness) of the pressure-sensitive adhesive layer 2 is reduced.

[0128]

As the curable resin, for example, a low-molecular weight compound is used which has, as a functional group, a polymerizable carbon-carbon double bond being able to be three-dimensionally cross-linked by being irradiated with energy rays such as ultraviolet rays or electron beams in at least two or more molecules. Specific examples of the curable resin include an esterified substance of (meth)acrylic acid and a polyol such as trimethylolpropane tri(meth)acrylate, pentaerythritol tri(meth)acrylate, pentaerythritol

tetra(meth)acrylate, tetramethylolmethane tetra(meth)acrylate, tetraethylene glycol di(meth)acrylate, 1,6-hexanediol di(meth)acrylate, neopentyl glycol di(meth)acrylate, dipentaerythritol hexa(meth)acrylate, dipentaerythritol

5 monohydroxypenta(meth)acrylate, 1,4-butylene glycol di(meth)acrylate, polyethylene glycol di(meth)acrylate, or glycerin di(meth)acrylate, an ester acrylate oligomer, a cyanurate-based compound having a carbon-carbon double bond-containing group such as 2-propenyl-di-3-butenyl

10 cyanurate, an isocyanurate-based compound having a carbon-carbon double bond-containing group such as tris(2-acryloxyethyl)isocyanurate, tris(2-methacryloxyethyl)isocyanurate, 2-hydroxyethyl bis(2-acryloxyethyl)isocyanurate, bis(2-acryloxyethyl)

15 2-[(5-acryloxyhexyl)-oxy]ethyl isocyanurate, tris(1,3-diacryloxy-2-propyl-oxycarbonylamino-n-hexyl)isocyanurate, tris(1-acryloxyethyl-3-methacryloxy-2-propyl-oxycarbonylamino-n-hexyl)isocyanurate, or

20 tris(4-acryloxy-n-butyl)isocyanurate, commercially available oligoester acrylate, aromatic urethane acrylate, aliphatic urethane acrylate, and the like. One kind of the above resin can be used, or two or more kinds of the above resins can be used in combination. The resin composition preferably contains

25 an oligomer having 6 or more functional groups among the above,

and more preferably contains an oligomer having 15 or more functional groups. In a case where the resin composition contains the above oligomer, the curable resin can be more reliably cured by being irradiated with energy rays. The curable resin is preferably urethane acrylate. In a case where urethane acrylate is used, appropriate flexibility can be imparted to the pressure-sensitive adhesive layer 2, and as a result, an effect is obtained which makes it possible to inhibit the cracking of the adhesive at the time of pickup.

10 [0129]

The aforementioned urethane acrylate is not particularly limited. For example, the urethane acrylate is obtained by reacting hydroxyl group-containing (meth)acrylate (for example, 2-hydroxyethyl (meth)acrylate, 2-hydroxypropyl (meth)acrylate, or polyethylene glycol (meth)acrylate) with an isocyanate-terminated urethane prepolymer which is obtained by reacting a polyester-type or polyether-type polyol compound with a polyvalent isocyanate compound (for example, 2,4-tolylene diisocyanate, 2,6-tolylene diisocyanate, 1,3-xylylene diisocyanate, 1,4-xylylene diisocyanate, or diphenylmethane 4,4-diisocyanate).

[0130]

The curable resin is not particularly limited, but is preferably obtained by mixing two or more curable resins having different weight-average molecular weights. In a case where

25

such a curable resin is used, a degree of cross-linking of the resin cured by energy ray irradiation can be easily controlled, and it is easy to pick up the semiconductor chip 20 from the pressure-sensitive adhesive layer 2. As the curable resin, for
5 example, a mixture of a first curable resin and a second curable resin which has a weight-average molecular weight greater than that of the first curable resin may be used.

[0131]

The amount of the curable resin formulated with respect
10 to 100 parts by weight of the base resin is preferably equal to or greater than 5 parts by weight and equal to or less than 500 parts by weight, more preferably equal to or greater than 10 parts by weight and equal to or less than 300 parts by weight, and even more preferably equal to or greater than 20 parts by
15 weight and equal to or less than 200 parts by weight. In a case where the amount of the curable resin formulated is adjusted as described above, it is possible to easily pick up the semiconductor chip 20 from the pressure-sensitive adhesive layer 2.

20 [0132]

In a case where a double bond introduction-type acrylic resin is used as the aforementioned acrylic resin, that is, in a case where an acrylic resin having a carbon-carbon double bond in a side chain, in the middle of a main chain, or in the terminal
25 of a main chain is used, the curable resin may not be added to

the resin composition, for the following reason. This is because in a case where the acrylic resin is a double bond introduction-type acrylic resin, by the irradiation of energy rays, the pressure-sensitive adhesive layer 2 is cured due to the function of the carbon-carbon double bond included in the double bond introduction-type acrylic resin, and accordingly, the adhesive force of the pressure-sensitive adhesive layer 2 is reduced.

[0133]

10 (3) Photopolymerization initiator

By the irradiation of energy rays, the pressure-sensitive adhesiveness of the pressure-sensitive adhesive layer 2 with respect to the semiconductor wafer 7 is reduced. Furthermore, by the irradiation of energy rays, the pressure-sensitive adhesiveness of the pressure-sensitive adhesive layer 202 with respect to the semiconductor chip 20 is reduced. In a case where ultraviolet rays and the like are used as the energy rays, it is preferable that the curable resin contains a photopolymerization initiator for facilitating the initiation of the polymerization of the curable resin.

[0134]

Examples of the photopolymerization initiator include 2,2-dimethoxy-1,2-diphenylethan-1-one, 1-[4-(2-hydroxyethoxy)-phenyl]-2-hydroxy-2-methyl-1-propan-1-one,

- 2-hydroxy-1-{4-[4-(2-hydroxy-2-methyl-propionyl)-benzyl]phenyl}-2-methyl-propan-1-one, benzyl diphenyl sulfide, tetramethylthiuram monosulfide, 4-(2-hydroxyethoxy)phenyl (2-hydroxy-2-propyl) ketone,
- 5 α -hydroxy- α,α' -dimethylacetophenone, 2-methyl-2-hydroxypropiophenone, 1-hydroxycyclohexyl phenylketone, Michler's ketone, acetophenone, methoxyacetophenone, 2,2-dimethoxy-2-phenyl acetophenone, 2,2-diethoxyacetophenone,
- 10 2-methyl-1-[4-(methylthio)-phenyl]-2-morpholinopropane-1-one, benzoin methyl ether, benzoin ethyl ether, benzoin propyl ether, benzoin isopropyl ether, benzoin isobutyl ether, benzyl, benzoin, dibenzyl, α -hydroxycyclohexyl phenyl ketone, benzyl dimethyl ketal, 2-hydroxymethyl phenyl propane,
- 15 2-naphthalenesulfonyl chloride, 1-phenone-1,1-propanedione-2-(o-ethoxycarbonyl) oxime, benzophenone, benzoyl benzoate, 4,4'-dimethylaminobenzophenone, 4,4'-diethylaminobenzophenone, 4,4'-dichlorobenzophenone, 3,3'-dimethyl-4-methoxybenzophenone, o-acryloxybenzophenone,
- 20 p-acryloxybenzophenone, o-methacryloxybenzophenone, p-methacryloxybenzophenone, p-(meth)acryloxyethoxybenzophenone, a benzophenone-4-carboxylic acid ester of acrylate such as 1,4-butanediol mono(meth)acrylate, 1,2-ethanediol
- 25 mono(meth)acrylate, or 1,8-octanediol mono(meth)acrylate,

thioxanthone, 2-chlorothioxanthone, 2-methylthioxanthone,
2,4-dimethylthioxanthone, isopropylthioxanthone,
2,4-dichlorothioxanthone, 2,4-diethylthioxanthone,
2,4-diisopropylthioxanthone, azobisisobutyronitrile,
5 β -chloroanthraquinone, camphorquinone, halogenated ketone,
acylphosphine oxide, acyl phosphonate, polyvinyl benzophenone,
chlorothioxanthone, dodecyl thioxanthone, dimethyl
thioxanthone, diethyl thioxanthone, 2-ethylanthraquinone,
t-butylanthraquinone, a 2,4,5-triarylimidazole dimer, and the
10 like. One kind of the above compound can be used, or two or more
kinds of the above compounds can be used in combination.

[0135]

Among these, a benzophenone derivative and an alkylphenone
derivative are preferable. These compounds contain a hydroxyl
15 group in a molecule as a reactive functional group. Through the
reactive functional group, the compounds can be linked to the
base resin or the curable resin and can more reliably exhibit
the function thereof as a photopolymerization initiator.

[0136]

20 The amount of the photopolymerization initiator
formulated with respect to 100 parts by weight of the base resin
is preferably equal to or greater than 0.1 parts by weight and
equal to or less than 50 parts by weight, and more preferably
equal to or greater than 0.5 parts by weight and equal to or
25 less than 10 parts by weight. By adjusting the amount of the

photopolymerization initiator formulated as described above, the pickup properties of the semiconductor chip 20 become suitable.

[0137]

5 (4) Cross-linking agent

The curable resin may further contain a cross-linking agent. In a case where the curable resin contains the cross-linking agent, the curability of the curable resin can be improved.

10 [0138]

The cross-linking agent is not particularly limited, and examples thereof include an isocyanate-based cross-linking agent, an epoxy-based cross-linking agent, a urea resin-based cross-linking agent, a methanol-based cross-linking agent, a chelate-based cross-linking agent, an aziridine-based cross-linking agent, a melamine-based cross-linking agent, a polyvalent metal chelate-based cross-linking agent, an acid anhydride-based cross-linking agent, a polyamine-based cross-linking agent, a carboxyl group-containing polymer-based cross-linking agent, and the like. Among these, an isocyanate-based cross-linking agent is preferable.

[0139]

The isocyanate-based cross-linking agent is not particularly limited, and examples thereof include a polyisocyanate compound of polyvalent isocyanate, a trimer of

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a polyisocyanate compound, a trimer of an isocyanate-terminated compound obtained by reacting a polyisocyanate compound with a polyol compound, a blocked polyisocyanate compound obtained by blocking an isocyanate-terminated urethane prepolymer by
5 using phenol or oximes, and the like.

[0140]

Examples of the polyvalent isocyanate include
2,4-tolylene diisocyanate, 2,6-tolylene diisocyanate,
1,3-xylylene diisocyanate, 1,4-xylylene diisocyanate,
10 diphenylmethane-4,4'-diisocyanate,
diphenylmethane-2,4'-diisocyanate, 3-methyldiphenylmethane
diisocyanate, hexamethylene diisocyanate, isophorone
diisocyanate, dicyclohexylmethane-4,4'-diisocyanate,
dicyclohexylmethane-2,4'-diisocyanate, 4,4'-diphenylether
15 diisocyanate,
4,4'-[2,2-bis(4-phenyloxyphenyl)propane]diisocyanate,
2,2,4-trimethyl-hexamethylene diisocyanate, and the like. One
kind of the above compound can be used, or two or more kinds
of the above compounds can be used in combination. Among these,
20 at least one kind of polyvalent isocyanate is preferable which
is selected from the group consisting of 2,4-tolylene
diisocyanate, diphenylmethane-4,4'-diisocyanate, and
hexamethylene diisocyanate.

[0141]

The amount of the cross-linking agent formulated with respect to 100 parts by weight of the base resin is preferably equal to or greater than 0.01 parts by weight and equal to or less than 50 parts by weight, and more preferably equal to or greater than 5 parts by weight and equal to or less than 50 parts by weight. By adjusting the amount of the cross-linking agent formulated as described above, the properties of picking up the semiconductor chip 20 from the pressure-sensitive adhesive layer 2 (pressure-sensitive adhesive layer 202) (pickup properties of the semiconductor chip 20) become suitable.

[0142]

(5) Conductive material (antistatic agent)

It is preferable that the resin composition constituting the pressure-sensitive adhesive layer 2 contains a conductive material having electric conductivity. In a case where the resin composition contains the conductive material, by causing the conductive material to function as an antistatic agent, the occurrence of static electricity in the semiconductor chip 20 during the singulation step [3A] and the pickup steps [5A] and [9A] is reliably inhibited or prevented.

[0143]

The conductive material is not particularly limited as long as it has electric conductivity. Examples thereof include the materials described above as conductive materials incorporated into the base material 4, such as a surfactant,

an inherently dissipative polymer (IDP), a metal material, a metal oxide material, and a carbonaceous material. One kind of each of these materials may be used, or two or more kinds of these materials may be used in combination.

5 [0144]

In a case where a constitution is adopted in which the conductive material is incorporated into either the base material 4 or the pressure-sensitive adhesive layer 2, it is preferable that the conductive material is incorporated into the base material 4. In a case where this constitution is adopted, it is possible to more reliably inhibit or prevent the occurrence of static electricity in the semiconductor chip 20 without allowing the conductive material to be firmly attached to the semiconductor chip 20.

15 [0145]

(6) Other components

The resin composition constituting the pressure-sensitive adhesive layer 2 may contain, as other components used in addition to the above components (1) to (5), at least one kind among a tackifier, an anti-aging agent, a viscosity adjuster, a filler, a colorant, a flame retardant, a softener, an antioxidant, a plasticizer, and a surfactant (for example, a surfactant as a leveling agent).

[0146]

25 Among these, the tackifier is not particularly limited,

and examples thereof include a rosin resin, a terpene resin, a coumarone resin, a phenol resin, an aliphatic petroleum resin, an aromatic petroleum resin, an aliphatic-aromatic copolymer-based petroleum resin, and the like. One kind of the above resin can be used, or two or more kinds of the above resins can be used in combination.

[0147]

The average thickness of the pressure-sensitive adhesive layer 2 is not particularly limited. For example, the average thickness of the pressure-sensitive adhesive layer 2 is preferably equal to or greater than 1 μm and equal to or less than 30 μm , more preferably equal to or greater than 5 μm and equal to or less than 30 μm , and even more preferably equal to or greater than 10 μm and equal to or less than 20 μm . In a case where the average thickness of the pressure-sensitive adhesive layer 2 is within the above range, an excellent adhesive force is exhibited before energy is applied to the pressure-sensitive adhesive layer 2, and excellent peeling properties are exhibited between the pressure-sensitive adhesive layer 2 and the semiconductor wafer 7 after energy is applied to the pressure-sensitive adhesive layer 2. Furthermore, in a case where the average thickness of the pressure-sensitive adhesive layer 202 is within the above range, the pressure-sensitive adhesive layer 202 exhibits excellent adhesive force before energy is applied to the pressure-sensitive adhesive layer 202,

and after energy is applied to the pressure-sensitive adhesive layer 202, and excellent peeling properties are exhibited between the pressure-sensitive adhesive layer 202 and the semiconductor chip 20.

5 [0148]

The pressure-sensitive adhesive layer 2 may be constituted with a laminate (multilayer substance) in which a plurality of layers constituted with different resin compositions described above are laminated.

10 [0149]

In a case where the adhesive force between the pressure-sensitive adhesive layer 2 and the semiconductor chip 20 is of such a magnitude that enables peeling to occur between the pressure-sensitive adhesive layer 2 and the semiconductor chip 20 even before energy is applied to the pressure-sensitive adhesive layer 2, the addition of (2) curable resin, (3) photopolymerization initiator, and (4) cross-linking agent, which are incorporate so as to impart a function of reducing adhesive force after the application of energy to the pressure-sensitive adhesive layer 2, to the pressure-sensitive adhesive layer 2 can be skipped.

[0150]

In order that a contact angle of hexadecane with respect to the pressure-sensitive adhesive layer 2 can be equal to or greater than 10° in the pressure-sensitive adhesive tape 100 for

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fabrication constituted as above, and a contact angle of hexadecane with respect to pressure-sensitive adhesive layer 202 can be less than 10° in the pressure-sensitive adhesive tape 200 for transport constituted as above, the constituent materials incorporated into the pressure-sensitive adhesive layer 2 and the pressure-sensitive adhesive layer 202 are selected. Hereinafter, this point will be specifically described.

[0151]

10 As described above, the pressure-sensitive adhesive tape 100 for fabrication is used for obtaining the semiconductor chips 20 by singulating the semiconductor wafer 7 in a state where the semiconductor wafer 7 is bonded to the pressure-sensitive adhesive tape 100 for fabrication. Furthermore, the pressure-sensitive adhesive tape 200 for transport is used for rearranging and moving/storing the semiconductor chips 20 picked up from the pressure-sensitive adhesive tape 100 for fabrication.

[0152]

20 In the manufacturing method of a semiconductor device, the pressure-sensitive adhesive tape 100 for fabrication and the pressure-sensitive adhesive tape 200 for transport are used in the manner described above. Presumably, the semiconductor chips 20 picked up from the pressure-sensitive adhesive tape 100 for fabrication may be bonded to the pressure-sensitive

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adhesive layer 202 included in the pressure-sensitive adhesive tape 200 for transport, in a state where a portion of the pressure-sensitive adhesive layer 2 is attached to (remain on) the side of the bottom surface (non-circuit-formed surface on which no circuit is formed) which contacted the pressure-sensitive adhesive layer 2, of each of the semiconductor chips 20.

[0153]

In the manufacturing method of a semiconductor device, by repeatedly performing the steps [9A] to [13A], a plurality of semiconductor devices 10 are simultaneously manufactured. Accordingly, as in a case where the semiconductor wafer 7 having a big size such as 12 inches is used, the larger the number of semiconductor chips 20 obtained from one semiconductor wafer 7, the longer the time (arrangement time) required for rearranging the plurality of semiconductor chips 20 on the pressure-sensitive adhesive tape 200 for transport.

Consequently, the time for which the semiconductor chips 20 remain bonded to the pressure-sensitive adhesive layer 202 of the pressure-sensitive adhesive tape 200 for transport greatly varies between the semiconductor chips 20 that move on to the mounting step [10A] at the initial stage and the semiconductor chips 20 that move on to the mounting step [10A] at the last stage.

[0154]

As a result, between the semiconductor chips 20 that move on to the mounting step [10A] at the initial stage and the semiconductor chips 20 that move on to the mounting step [10A] at the last stage, there is a difference in the adhesive force (holding force) by which the semiconductor chips 20 are held on the pressure-sensitive adhesive tape 200 for transport through the pressure-sensitive adhesive layer 202. Due to the difference in the adhesive force, unfortunately, in the pickup step [9A], the semiconductor chips 20 cannot be stably picked up from the pressure-sensitive adhesive tape 200 for transport.

[0155]

Regarding this problem, an intensive examination was performed. As a result, it has been concluded that the relationship between the wettability·spreadability of hexadecane with respect to the pressure-sensitive adhesive layer 2 considered to remain on the side of bottom surface of the semiconductor chip 20 and the wettability·spreadability of hexadecane with respect to the pressure-sensitive adhesive layer 202 contacting the side of bottom surface of the semiconductor chip 20 relates to the holding force exerted on the semiconductor chip 20 by the pressure-sensitive adhesive layer 202 and the temporal stability of the holding force.

[0156]

As a result of further performing the examination, the inventors of the present invention have found that by setting

the contact angle of hexadecane with respect to the pressure-sensitive adhesive layer 2 (first pressure-sensitive adhesive layer) to be equal to or greater than 10° and setting the contact angle of hexadecane with respect to the pressure-sensitive adhesive layer 202 (second pressure-sensitive adhesive layer) to be less than 10° , a holding force can be obtained which enables the semiconductor chip 20 to be held by the pressure-sensitive adhesive layer 202 in the closed space 255 before the energy application step [8A] and to be separated from the pressure-sensitive adhesive layer 202 after the energy application step [8A], and which makes it possible to stably pick up the semiconductor chips 20 from the pressure-sensitive adhesive tape 200 for transport in the pickup step [9A] without causing a big difference between the semiconductor chips 20 that move on to the mounting step [10A] at the initial stage and the semiconductor chips 20 that move on to the mounting step [10A] at the last stage. Based on this finding, the inventors have accomplished the present invention (first invention).

[0157]

Presumably, by the following mechanism, the semiconductor chips 20 can be stably picked up from the pressure-sensitive adhesive tape 200 for transport in the pickup step [9A] without causing a big difference between the semiconductor chips 20 that move on to the mounting step [10A] at the initial stage and the

semiconductor chips 20 that move on to the mounting step [10A] at the last stage.

[0158]

That is, in a case where the contact angle of hexadecane with respect to the pressure-sensitive adhesive layer 2 is equal to or greater than 10° and the contact angle of hexadecane with respect to the pressure-sensitive adhesive layer 202 is less than 10° , it can be said that the pressure-sensitive adhesive layer 2 exhibits hydrophilicity (lipophobicity) and the pressure-sensitive adhesive layer 202 exhibits hydrophobicity (lipophilicity). In a case where the pressure-sensitive adhesive layer 2 and the pressure-sensitive adhesive layer 202 are constituted as above, the pressure-sensitive adhesive layer 2 can smoothly move to the side of the bottom surface (contact surface) of the semiconductor chip 20, an appropriate amount of a portion of the pressure-sensitive adhesive layer 2 can be attached to the bottom surface of the semiconductor chip 20, and it is possible to reliably inhibit or prevent the pressure-sensitive adhesive layer 2 remaining on the side of the bottom surface of the semiconductor chip 20 and the pressure-sensitive adhesive layer 202 contacting the side of the bottom surface of the semiconductor chip 20 from interacting with each other. Presumably, as a result, the occurrence of a temporal change in the joining strength between the pressure-sensitive adhesive layer 2 and the pressure-sensitive

adhesive layer 202 and in the holding force exerted on the semiconductor chip 20 by the pressure-sensitive adhesive layer 202 may be reliably inhibited or prevented.

[0159]

5 The contact angle of hexadecane with respect to the pressure-sensitive adhesive layer 2 may be equal to or greater than 10° , preferably equal to or greater than 30° and equal to or less than 70° , and more preferably equal to or greater than 35° and equal to or less than 55° . The contact angle of hexadecane
10 with respect to the pressure-sensitive adhesive layer 202 may be less than 10° , and preferably equal to or greater than 3° and less than 8° . In a case where the contact angle is within the above range, it is possible to set a the holding force which enables the semiconductor chips 20 to be more stably held by
15 the pressure-sensitive adhesive layer 202 in the closed space 255 before the energy application step [8A] and to be easily separated from the pressure-sensitive adhesive layer 202 after the energy application step [8A].

[0160]

20 Provided that the contact angle of hexadecane with respect to the pressure-sensitive adhesive layer 2 is $A[^\circ]$, and the contact angle of hexadecane with respect to the pressure-sensitive adhesive layer 202 is $B[^\circ]$, A and B preferably satisfy a relationship of $20^\circ \leq A - B$, and more preferably satisfy

a relationship of $35^{\circ} \leq A - B \leq 50^{\circ}$. In a case where the relationship is satisfied, it is possible to more reliably inhibit or prevent the occurrence of a temporal change in the holding force exerted on the semiconductor chip 20 by the pressure-sensitive adhesive layer 202 after the energy application step [8A].

[0161]

In addition to the contact angle of hexadecane with respect to the pressure-sensitive adhesive layers 2 and 202, a contact angle of pure water with respect to the pressure-sensitive adhesive layer 2 is preferably equal to or less than 90° , and a contact angle of pure water with respect to the pressure-sensitive adhesive layer 202 is preferably greater than 90° . The contact angle of pure water with respect to the pressure-sensitive adhesive layer 2 is more preferably equal to or greater than 60° and equal to or less than 80° , and the contact angle of pure water with respect to the pressure-sensitive adhesive layer 202 is more preferably greater than 100° and equal to or less than 120° . Furthermore, provided that the contact angle of pure water with respect to the pressure-sensitive adhesive layer 2 is $C[^{\circ}]$, and the contact angle of pure water with respect to the pressure-sensitive adhesive layer 202 is $D[^{\circ}]$, it is preferable that the absolute value of a difference between the contact angle C and the contact

angle D satisfies a relationship of $-40^{\circ} \leq C - D \leq -20^{\circ}$. In a case where the relationship is satisfied, it is possible to more reliably inhibit or prevent the occurrence of a temporal change in the holding force exerted on the semiconductor chip 20 by the pressure-sensitive adhesive layer 202 after the energy application step [8A].

[0162]

By appropriately selecting the combination of the constituent material incorporated into the pressure-sensitive adhesive layer 2 and the constituent material incorporated into the pressure-sensitive adhesive layer 202, the contact angle of hexadecane with respect to the pressure-sensitive adhesive layer 2 can be equal to or greater than 10° , and the contact angle of hexadecane with respect to the pressure-sensitive adhesive layer 202 can be less than 10° . Particularly, by determining whether or not a surfactant as a leveling agent will be added and by appropriately setting the content thereof, the contact angle can be reliably adjusted. Specifically, the contact angle of hexadecane with respect to the layer containing the surfactant can be set to be smaller than the contact angle of hexadecane with respect to the layer not containing the surfactant. Accordingly, by combining the constituent materials such that the surfactant is incorporated not into the pressure-sensitive adhesive layer 2 but into the pressure-sensitive adhesive layer 202, the contact angle B of hexadecane with respect to the

pressure-sensitive adhesive layer 202 can be set to be smaller than the contact angle A of hexadecane with respect to the pressure-sensitive adhesive layer 2. Specifically, the contact angle A can be set to be equal to or greater than 10° , and the
5 contact angle B can be set to be less than 10° .

[0163]

As a surfactant by which the contact angle of hexadecane with respect to the pressure-sensitive adhesive layer can be set to be small, any of anionic, cationic, and nonionic
10 surfactants may be used. For example, a fluorine-based surfactant (anionic surfactant) such as perfluoroalkylsulfonic acid ($\text{CF}_3(\text{CF}_2)_n\text{SO}_3\text{H}$; n represents an integer equal to or greater than 1), perfluoroalkylcarboxylic acid ($\text{CF}_3(\text{CF}_2)_n\text{COOH}$; n represents an integer equal to or greater than 1), or
15 fluoro-telomer alcohol ($\text{F}(\text{CF}_2)_n\text{CH}_2\text{CH}_2\text{OH}$; n represents an integer equal to or greater than 1) is preferably used.

[0164]

In the energy application step [8A], it is preferable that a temporal change does not occur in the holding force (adhesive
20 force) exerted on the semiconductor chip 20 by the pressure-sensitive adhesive layer 202 after the application of energy to the pressure-sensitive adhesive layer 202. Specifically, provided that a holding force of the pressure-sensitive adhesive layer 202 immediately after the
25 energy application is E [cN/25 mm], and a holding force of the

pressure-sensitive adhesive layer 202 that has been stored for 7 days at a temperature of 60°C after the energy application is F [cN/25 mm], E and F preferably satisfy a relationship of $F/E \leq 2.0$, and more preferably satisfy a relationship of $F/E \leq 1.5$.

5 In a case where the relationship is satisfied, it can be said that the holding force exerted on the semiconductor chip 20 by the pressure-sensitive adhesive layer 202 is inhibited from experiencing temporal change after the energy application step [8A]. As a result, both the semiconductor chip 20 that moves
10 on to the mounting step [10A] at the initial stage and semiconductor chip 20 that moves on to the mounting step [10A] at the final stage can be stably picked up from the pressure-sensitive adhesive tape 200 for transport in the pickup step [9A].

15 [0165]

In the energy application step [8A], it is preferable that the holding force (adhesive force) exerted on the semiconductor chip 20 by the pressure-sensitive adhesive layer 202 after the application of energy to the pressure-sensitive adhesive layer
20 202 is lower than the holding force obtained in a case where the bonding of the pressure-sensitive adhesive tape 100 for fabrication to the semiconductor wafer 7 is not performed in the step [2A] described above. Specifically, provided that a holding force of the pressure-sensitive adhesive layer 202,
25 which is measured immediately after the application of energy

(after 0 day) in a case where the bonding of the pressure-sensitive adhesive tape 100 for fabrication to the semiconductor wafer 7 is performed, is E [cN/25 mm], and a holding force of the pressure-sensitive adhesive layer 202, which is measured immediately after the application of energy (after 0 day) in a case where the bonding of the pressure-sensitive adhesive tape 100 for fabrication to the semiconductor wafer 7 is not performed, is G [cN/25 mm], E and G preferably satisfy a relationship of $E/G < 1.0$, and more preferably satisfy a relationship of $E/G \leq 0.8$. In a case where the relationship is satisfied, it can be said that the holding force exerted on the semiconductor chip 20 by the pressure-sensitive adhesive layer 202 after the energy application step [8A] is effectively reduced by the bonding of the pressure-sensitive adhesive tape 100 for fabrication to the semiconductor wafer 7. Furthermore, it is possible to reliably pick up the semiconductor chips 20 from the pressure-sensitive adhesive tape 200 for transport in the pickup step [9A].

[0166]

The pressure-sensitive adhesive tape set of the present invention is applicable to the manufacturing of the Flip-Chip-Ball-Grid-Array (FCBGA)-type semiconductor device shown in Fig. 1. For example, the pressure-sensitive adhesive tape set of the present invention is applicable to the manufacturing of memory or logic elements such as a dual in-line

package (DIP), a plastic leaded chip carrier (PLCC), a low-profile quad flat package (LQFP), a small outline package (SOP), a small outline J lead package (SOJ), a thin small outline package (TSOP), a thin quad flat package (TQFP), a tape carrier
5 package (TCP), a ball grid array (BGA), a chip size package (CSP), a matrix array package ball grid array (MAPBGA), and a chip stacked chip size package and the manufacturing of image sensors such as a Contact-Image-Sensor (CIS).

[0167]

10 Hitherto, the pressure-sensitive adhesive tape set of the present invention has been described, but the present invention is not limited thereto.

[0168]

For example, optional components which can perform the
15 same function may be added to each of the layers included in the pressure-sensitive adhesive tape for semiconductor wafer fabrication and the pressure-sensitive adhesive tape for semiconductor element transport that the pressure-sensitive adhesive tape set of the present invention has. Alternatively,
20 as described in the above embodiment, the base material may be constituted with one layer or a plurality of layers. For instance, the base material may include an antistatic layer on a surface, which is opposite to the pressure-sensitive adhesive layer, of the base material.

25 [0169]

In addition, the constitution of each of the layers included in the pressure-sensitive adhesive tape for semiconductor wafer fabrication or the pressure-sensitive adhesive tape for semiconductor element transport included in the pressure-sensitive adhesive tape set of the present invention may be substituted with any constitution which can perform the same function. Alternatively, any constitution may be added.

[0170]

Next, a pressure-sensitive adhesive tape for semiconductor element transport of the present invention (second invention) will be described. The constitution of the pressure-sensitive adhesive tape 200 for semiconductor element transport is the same as the constitution of the pressure-sensitive adhesive tape for semiconductor element transport of the present invention, except for the constitution relating to the contact angle of hexadecane with respect to the pressure-sensitive adhesive layer 202. Accordingly, in a case where the pressure-sensitive adhesive tape for semiconductor element transport of the present invention is used, the semiconductor device 10 described above can also be manufactured in the same manner. Therefore, the manufacturing method of a semiconductor device using the pressure-sensitive adhesive tape for semiconductor element transport of the present invention will not be described. At the time of manufacturing a

semiconductor device by using the pressure-sensitive adhesive tape for semiconductor element transport of the present invention, for example, the pressure-sensitive adhesive tape 100 for semiconductor wafer fabrication used in the manufacturing method of the semiconductor device 10 can be used. According to the present invention, provided that a contact angle of hexadecane with respect to a non-circuit-formed surface, to which the resin material derived from the pressure-sensitive adhesive tape 100 for fabrication is attached and on which no circuit is formed, of the semiconductor chip 20 is $H[^\circ]$, and a contact angle of hexadecane with respect to the pressure-sensitive adhesive layer 202 included in the pressure-sensitive adhesive tape 200 for transport is $B[^\circ]$, H and B satisfy a relationship of $20^\circ \leq H - B$. Hereinafter, this point will be mainly described.

[0171]

According to the present invention, provided that a contact angle of hexadecane with respect to a non-circuit-formed surface (bottom surface), to which the resin material derived from the pressure-sensitive adhesive tape 100 for fabrication is attached and on which no circuit is formed, of the semiconductor chip 20 is $H[^\circ]$, and a contact angle of hexadecane with respect to the pressure-sensitive adhesive layer 202 included in the pressure-sensitive adhesive tape 200 for transport is $B[^\circ]$, in order that H and B satisfy a relationship

of $20^\circ \leq H - B$, the constituent materials to be incorporated into the pressure-sensitive adhesive layer 202 are selected in accordance with the constituent materials to be incorporated with the pressure-sensitive adhesive layer 2. Hereinafter, the combination of the constituent materials of the pressure-sensitive adhesive layer 2 and the pressure-sensitive adhesive layer 202 will be specifically described.

[0172]

As described above, the pressure-sensitive adhesive tape 100 for fabrication is used for obtaining the semiconductor chips 20 by singulating the semiconductor wafer 7 in a state where the semiconductor wafer 7 is bonded to the pressure-sensitive adhesive tape 100 for fabrication. Furthermore, the pressure-sensitive adhesive tape 200 for transport is used for rearranging and moving/storing the semiconductor chips 20 picked up from the pressure-sensitive adhesive tape 100 for fabrication.

[0173]

The pressure-sensitive adhesive tape 100 for fabrication and the pressure-sensitive adhesive tape 200 for transport are used in this way in the manufacturing method of a semiconductor device. The semiconductor chips 20 picked up from the pressure-sensitive adhesive tape 100 for fabrication are bonded to the pressure-sensitive adhesive layer 202 included in the pressure-sensitive adhesive tape 200 for transport, in a state

where a portion of the pressure-sensitive adhesive layer 2 is attached to (remains on) the side of a non-circuit-formed surface (bottom surface) thereof, which contacted the pressure-sensitive adhesive layer 2 and on which no circuit is
5 formed.

[0174]

In the aforementioned manufacturing method of a semiconductor device, by repeatedly performing the steps [9A] to [13A], a plurality of semiconductor devices 10 are
10 simultaneously manufactured. Accordingly, as in a case where the semiconductor wafer 7 having a big size such as 12 inches is used, the larger the number of semiconductor chips 20 obtained from one semiconductor wafer 7, the longer the time (arrangement time) required for rearranging the plurality of semiconductor
15 chips 20 on the pressure-sensitive adhesive tape 200 for transport. Consequently, the time for which the semiconductor chips 20 remain bonded to the pressure-sensitive adhesive layer 202 of the pressure-sensitive adhesive tape 200 for transport greatly varies between the semiconductor chips 20 that move on
20 to the mounting step [10A] at the initial stage and the semiconductor chips 20 that move on to the mounting step [10A] at the last stage.

[0175]

As a result, between the semiconductor chips 20 that move
25 on to the mounting step [10A] at the initial stage and the

semiconductor chips 20 that move on to the mounting step [10A] at the last stage, there is a difference in the adhesive force (holding force) by which the semiconductor chips 20 are held on the pressure-sensitive adhesive tape 200 for transport
5 through the pressure-sensitive adhesive layer 202. Due to the difference in the adhesive force, unfortunately, in the pickup step [9A], the semiconductor chips 20 cannot be stably picked up from the pressure-sensitive adhesive tape 200 for transport.

[0176]

10 Regarding this problem, an intensive examination was performed. As a result, it has been concluded that the relationship between the wettability·spreadability of hexadecane with respect to the bottom surface, to which the resin material derived from the pressure-sensitive adhesive tape 100
15 for fabrication is attached, of the semiconductor chip 20 and the wettability·spreadability of hexadecane with respect to the pressure-sensitive adhesive layer 202 contacting the side of the bottom surface of the semiconductor chip 20 relates to the holding force exerted on the semiconductor chip 20 by the
20 pressure-sensitive adhesive layer 202 and the temporal stability of the holding force.

[0177]

As a result of further performing the examination, the inventors of the present invention have found that provided that
25 a contact angle of hexadecane with respect to the

non-circuit-formed surface (bottom surface), on which no circuit is formed, of the semiconductor chip 20 is not formed is $H[^\circ]$ and a contact angle of hexadecane with respect to the pressure-sensitive adhesive layer 202 (second
5 pressure-sensitive adhesive layer) is $B[^\circ]$, in a case where H and B satisfy a relationship of $20^\circ \leq H - B$, it is possible to obtain a holding force which enables the semiconductor chip 20 to be held by the pressure-sensitive adhesive layer 202 in the closed space 255 before the energy application step [8A] and
10 to be separated from the pressure-sensitive adhesive layer 202 after the energy application step [8A]. Furthermore, the inventors have found that the semiconductor chips 20 can be stably pick up from the pressure-sensitive adhesive tape 200 for transport in the pickup step [9A] without causing a big
15 difference between the semiconductor chips 20 that move on to the mounting step [10A] at the initial state and the semiconductor chips 20 that move on to the mounting step [10A] at the last stage. Based on this finding, the inventors have accomplished the present invention (second invention).

20 [0178]

Presumably, by the following mechanism, the semiconductor chips 20 can be stably picked up from the pressure-sensitive adhesive tape 200 for transport in the pickup step [9A] without causing a big difference between the semiconductor chips 20 that
25 move on to the mounting step [10A] at the initial stage and the

semiconductor chips 20 that move on to the mounting step [10A] at the last stage.

[0179]

That is, as in a case where the absolute value of a
5 difference between the contact angle H of hexadecane with respect to the non-circuit-formed surface of the semiconductor chip 20 and the contact angle B of hexadecane with respect to the pressure-sensitive adhesive layer 202 satisfies a relationship of $20^\circ \leq H - B$, in a case where both the wettability·spreadability
10 of hexadecane with respect to the pressure-sensitive adhesive layer 2 remaining on the side of the non-circuit-formed surface of the semiconductor chip 20 and wettability·spreadability of hexadecane with respect to the pressure-sensitive adhesive layer 202 contacting the side of the bottom surface of the
15 semiconductor chip 20 exhibits hydrophobicity or hydrophobicity, on the side of the non-circuit-formed surface of the semiconductor chip 20, an affinitive interaction occurs between the pressure-sensitive adhesive layer 2 and the pressure-sensitive adhesive layer 202, and hence the joining
20 strength between the pressure-sensitive adhesive layer 2 and the pressure-sensitive adhesive layer 202 is improved.
Presumably, as a result, the holding force exerted on the semiconductor chip 20 by the pressure-sensitive adhesive layer 202 may tend to be increased with the lapse of time. In contrast,
25 considering the wettability·spreadability of hexadecane with

respect to the pressure-sensitive adhesive layer 2 remaining on the side of the non-circuit-formed surface of the semiconductor chip 20 and the wettability-spreadability of hexadecane with respect to the pressure-sensitive adhesive layer 202 contacting the side of the non-circuit-formed surface of the semiconductor chip 20, in a case where the relationship of $20^\circ \leq H - B$ is satisfied, the pressure-sensitive adhesive layer 2 remaining on the side of the non-circuit-formed surface of the semiconductor chip 20 exhibits hydrophilicity (lipophobicity), and the pressure-sensitive adhesive layer 202 contacting the side of the non-circuit-formed surface of the semiconductor chip 20 exhibits hydrophobicity (lipophilicity). Consequently, it is possible to reliably inhibit or prevent the occurrence of an interaction between the pressure-sensitive adhesive layer 2 and the pressure-sensitive adhesive layer 202. Presumably, for this reason, the occurrence of a temporal change in the joining force between the pressure-sensitive adhesive layer 2 and the pressure-sensitive adhesive layer 202 and in the holding force exerted on the semiconductor chip 20 by the pressure-sensitive adhesive layer 202 may be reliably inhibited or prevented.

[0180]

The absolute value of a difference between the contact angle H of hexadecane with respect to the non-circuit-formed surface of the semiconductor chip 20 and the contact angle B

of hexadecane with respect to the pressure-sensitive adhesive layer 202 may satisfy a relationship of $20^\circ \leq H - B$, and preferably satisfies a relationship of $20^\circ \leq H - B \leq 35^\circ$. In a case where this relationship is satisfied, it is possible to set a holding
5 force which enables the semiconductor chip 20 to be more stably held by the pressure-sensitive adhesive layer 202 in the closed space 255 before the energy application step [8A] and to be easily separated from the pressure-sensitive adhesive layer 202 after the energy application step [8A].

10 [0181]

In a case where the relationship of $20^\circ \leq H - B$ is satisfied, the size of each of the contact angles H and B is not particularly limited. For example, the contact angle H is preferably equal to or greater than 10° , and the contact angle B is preferably
15 less than 10° . The contact angle H is more preferably equal to or greater than 25° and equal to or less than 35° , and the contact angle B is more preferably equal to or greater than 3° and equal to or less than 8° . In a case where each of the contact angles is within the above range, it is possible to more reliably inhibit
20 or prevent the occurrence of a temporal change in the holding force exerted on semiconductor chip 20 by the pressure-sensitive adhesive layer 202 after the energy application step [8A].

[0182]

In addition to the contact angle of hexadecane with respect

to the non-circuit-formed surface of the semiconductor chip 20 and the pressure-sensitive adhesive layer 202, provided that a contact angle of pure water with respect to the non-circuit-formed surface of the semiconductor chip 20 is $I[^\circ]$ and a contact angle of pure water with respect to the pressure-sensitive adhesive layer 202 is $D[^\circ]$, the absolute value of a difference between the contact angle I and the contact angle D preferably satisfies a relationship of $55^\circ \leq D - I$, and more preferably satisfies a relationship of $55^\circ \leq D - I \leq 65^\circ$.

The contact angle I of pure water with respect to the non-circuit-formed surface of the semiconductor chip 20 is preferably equal to or less than 50° , and the contact angle D of pure water with respect to the pressure-sensitive adhesive layer 202 is preferably greater than 90° . The contact angle I is more preferably equal to or greater than 35° and equal to or less than 50° , and the contact angle D is more preferably greater than 95° and equal to or less than 105° . In a case where each of the contact angles is within the above range, it is possible to more reliably inhibit or prevent the holding force exerted on the semiconductor chip 20 by the pressure-sensitive adhesive layer 202 from experiencing temporal change after the energy application step [8A].

[0183]

As described above, by appropriately selecting the

constituent material to be incorporated into the pressure-sensitive adhesive layer 202 in accordance with the constituent material to be incorporated into the pressure-sensitive adhesive layer 2, the absolute value of a difference between the contact angle H of hexadecane with respect to the non-circuit-formed surface of the semiconductor chip 20 and the contact angle B of hexadecane with respect to the pressure-sensitive adhesive layer 202 can satisfy a relationship of $20^{\circ} \leq H - B$. Particularly, regarding the constituent materials of the pressure-sensitive adhesive layer 2 and the pressure-sensitive adhesive layer 202, by determining whether or not a surfactant as a leveling agent or the like will be added and by appropriately setting the content thereof, the above relationship can be reliably adjusted. Specifically, the contact angle of hexadecane with respect to the layer into which the surfactant will be incorporated can be set to be lower than the contact angle of hexadecane with respect to the layer into which the surfactant will not be incorporated. Accordingly, by combining the constituent materials such that the surfactant is incorporated not into the pressure-sensitive adhesive layer 2 but into the pressure-sensitive adhesive layer 202, the contact angle B of hexadecane with respect to the pressure-sensitive adhesive layer 202 can be set to be smaller than the contact angle H of hexadecane with respect to the non-circuit-formed surface of the semiconductor chip 20. Consequently, the

relationship of $20^\circ \leq H - B$ can be reliably satisfied.

[0184]

As a surfactant, any of anionic, cationic, and nonionic surfactants may be used. For example, a fluorine-based
5 surfactant (anionic surfactant) such as perfluoroalkylsulfonic acid ($\text{CF}_3(\text{CF}_2)_n\text{SO}_3\text{H}$; n represents an integer equal to or greater than 1), perfluoroalkylcarboxylic acid ($\text{CF}_3(\text{CF}_2)_n\text{COOH}$; n represents an integer equal to or greater than 1), or
fluoro-telomer alcohol ($\text{F}(\text{CF}_2)_n\text{CH}_2\text{CH}_2\text{OH}$; n represents an integer
10 equal to or greater than 1) is preferably used.

[0185]

In the energy application step [8A], it is preferable that no temporal change occurs in the holding force (adhesive force) exerted on the semiconductor chip 20 by the pressure-sensitive
15 adhesive layer 202 after the application of energy to the pressure-sensitive adhesive layer 202. This point will not be specifically described because the same description as that in the first invention can be adopted.

[0186]

20 The pressure-sensitive adhesive tape for semiconductor element transport of the present invention is applicable to the manufacturing of the Flip·Chip·Ball·Grid·Array (FCBGA)-type semiconductor device 10 shown in Fig. 1. For example, the pressure-sensitive adhesive tape for semiconductor element
25 transport of the present invention is applicable to the

manufacturing of memory or logic elements such as a dual in-line package (DIP), a plastic leaded chip carrier (PLCC), a low-profile quad flat package (LQFP), a small outline package (SOP), a small outline J lead package (SOJ), a thin small outline package (TSOP), a thin quad flat package (TQFP), a tape carrier package (TCP), a ball grid array (BGA), a chip size package (CSP), a matrix array package ball grid array (MAPBGA), and a chip stacked chip size package and the manufacturing of image sensors such as a Contact Image Sensor (CIS).

10 [0187]

Hitherto, the pressure-sensitive adhesive tape for semiconductor element transport of the present invention has been described, but the present invention is not limited thereto.

[0188]

15 For example, optional components which can perform the same function may be added to each of the layers included in the pressure-sensitive adhesive tape for semiconductor element transport of the present invention. Alternatively, as described in the above embodiment, the base material may be constituted with one layer or a plurality of layers. For instance, the base material may include an antistatic layer on a surface, which is opposite to the pressure-sensitive adhesive layer, of the base material.

[0189]

25 In addition, the constitution of each of the layers

included in the pressure-sensitive adhesive tape for semiconductor element transport of the present invention may be substituted with any constitution which can perform the same function. Alternatively, any constitution can be added.

5 Examples

[0190]

Next, specific examples of the present invention (the first invention and the second invention) will be described.

It should be noted that the present invention is not
10 limited to the description of the examples.

[0191]

1. Preparation of pressure-sensitive adhesive tape 100 for fabrication and pressure-sensitive adhesive tape 200 for transport

15 (Pressure-sensitive adhesive tape No. 1)

On the base materials 4 and 204, pressure-sensitive adhesive tape No. 1 pressure-sensitive adhesive layer tapes 100 and 200 including the pressure-sensitive adhesive layers 2 and 202 not containing a surfactant were prepared respectively.

20 [0192]

In the pressure-sensitive adhesive tape No. 1 pressure-sensitive adhesive tapes 100 and 200, a contact angle of pure water with respect to the pressure-sensitive adhesive layers 2 and 202 was 80°, and a contact angle of hexadecane with
25 respect to the pressure-sensitive adhesive layers 2 and 202 was

42°.

[0193]

(Pressure-sensitive adhesive tape No. 2)

On the base materials 4 and 204, pressure-sensitive
5 adhesive tape No. 2 pressure-sensitive adhesive tapes 100 and
200 including the pressure-sensitive adhesive layers 2 and 202
containing a surfactant were prepared respectively.

[0194]

In the pressure-sensitive adhesive tape No. 2
10 pressure-sensitive adhesive tapes 100 and 200, a contact angle
of pure water with respect to the pressure-sensitive adhesive
layers 2 and 202 was 107°, and a contact angle of hexadecane with
respect to the pressure-sensitive adhesive layers 2 and 202 was
6°.

15 [0195]

(Pressure-sensitive adhesive tape No. 3)

On the base materials 4 and 204, pressure-sensitive
adhesive tape No. 3 pressure-sensitive adhesive tapes 100 and
200 including the pressure-sensitive adhesive layers 2 and 202
20 containing a surfactant were prepared respectively.

[0196]

In the pressure-sensitive adhesive tape No. 3
pressure-sensitive adhesive tapes 100 and 200, a contact angle
of pure water with respect to the pressure-sensitive adhesive
25 layers 2 and 202 was 102°, and a contact angle of hexadecane with

respect to the pressure-sensitive adhesive layers 2 and 202 was 5°.

[0197]

(Pressure-sensitive adhesive tape No. 4)

5 On the base materials 4 and 204, pressure-sensitive adhesive tape No. 4 pressure-sensitive adhesive tapes 100 and 200 including the pressure-sensitive adhesive layers 2 and 202 containing a surfactant were prepared respectively.

[0198]

10 In the pressure-sensitive adhesive tape No. 4 pressure-sensitive adhesive tapes 100 and 200, a contact angle of pure water with respect to the pressure-sensitive adhesive layers 2 and 202 was 106°, and a contact angle of hexadecane with respect to the pressure-sensitive adhesive layers 2 and 202 was
15 16°.

[0199]

(Pressure-sensitive adhesive tape No. 5)

On the base material 204, pressure-sensitive adhesive tape No. 5 pressure-sensitive adhesive tape 200 including the
20 pressure-sensitive adhesive layer 202 containing a surfactant was prepared respectively.

In the pressure-sensitive adhesive tape No. 5 pressure-sensitive adhesive tape 200, a contact angle of pure water with respect to the pressure-sensitive adhesive layer 202
25 was 111°, and a contact angle of hexadecane with respect to the

pressure-sensitive adhesive layer 202 was 17°.

[0200]

2. Combination of pressure-sensitive adhesive tapes 100
and 200 in tape set

5 (Example 1)

A tape set of Example 1 was constituted with the
pressure-sensitive adhesive tape No. 1 as the
pressure-sensitive adhesive tape 100 for fabrication and the
pressure-sensitive adhesive tape No. 3 as the
10 pressure-sensitive adhesive tape 200 for transport.

[0201]

(Comparative Example 1)

A tape set of Comparative Example 1 was constituted with
the pressure-sensitive adhesive tape No. 1 as the
15 pressure-sensitive adhesive tape 100 for fabrication and the
pressure-sensitive adhesive tape No. 4 as the
pressure-sensitive adhesive tape 200 for transport.

[0202]

(Comparative Example 2)

20 A tape set of Comparative Example 2 was constituted with
the pressure-sensitive adhesive tape No. 2 as the
pressure-sensitive adhesive tape 100 for fabrication and the
pressure-sensitive adhesive tape No. 1 as the
pressure-sensitive adhesive tape 200 for transport.

25 [0203]

(Comparative Example 3)

A tape set of Comparative Example 3 was constituted with the pressure-sensitive adhesive tape No. 3 as the pressure-sensitive adhesive tape 100 for fabrication and the
5 pressure-sensitive adhesive tape No. 1 as the pressure-sensitive adhesive tape 200 for transport.

[0204]

(Comparative Example 4)

A tape set of Comparative Example 4 was constituted with
10 the pressure-sensitive adhesive tape No. 4 as the pressure-sensitive adhesive tape 100 for fabrication and the pressure-sensitive adhesive tape No. 1 as the pressure-sensitive adhesive tape 200 for transport.

[0205]

15 (Comparative Example 5)

A tape set of Comparative Example 5 was constituted with the pressure-sensitive adhesive tape No. 2 as the pressure-sensitive adhesive tape 100 for fabrication and the pressure-sensitive adhesive tape No. 3 as the
20 pressure-sensitive adhesive tape 200 for transport.

[0206]

(Comparative Example 6)

A tape set of Comparative Example 6 was constituted with the pressure-sensitive adhesive tape No. 2 as the
25 pressure-sensitive adhesive tape 100 for fabrication and the

pressure-sensitive adhesive tape No. 5 as the
pressure-sensitive adhesive tape 200 for transport.

[0207]

3. Evaluation

5 <Holding force by pressure-sensitive adhesive tape 200 for
transport>

The holding force by the pressure-sensitive adhesive tape
200 for transport was evaluated as below.

[0208]

10 <<1>> First, for the pressure-sensitive adhesive tape 100
for fabrication included in the tape set of each of the example
and the comparative examples, the semiconductor wafer 7 having
a size of 8 inches was bonded to the pressure-sensitive adhesive
layer 2 of the pressure-sensitive adhesive tape 100 for
15 fabrication. Then, the pressure-sensitive adhesive layer 2 was
irradiated with ultraviolet rays such that the adhesive force
exerted on the semiconductor wafer 7 by the pressure-sensitive
adhesive layer 2 was reduced. Thereafter, the
pressure-sensitive adhesive tape 100 for fabrication was peeled
20 from the semiconductor wafer 7. At this time, each of the contact
angle I of pure water and the contact angle H of hexadecane with
respect to a surface (non-circuit-formed surface), to which the
pressure-sensitive adhesive tape 100 for fabrication was not
bonded, of the semiconductor wafer 7 was measured.

25 [0209]

<<2>> Then, in order that the surface (non-circuit-formed surface), to which the pressure-sensitive adhesive tape 100 for fabrication was not bonded, of the semiconductor wafer 7 and the pressure-sensitive adhesive layer 202 of the
5 pressure-sensitive adhesive tape 200 for transport included in the tape set of each of the example and the comparative examples contact each other, the pressure-sensitive adhesive tape 200 for transport was bonded to the semiconductor wafer 7, thereby obtaining a laminate. Subsequently, the pressure-sensitive
10 adhesive layer 202 was irradiated with ultraviolet rays such that the adhesive force exerted on the semiconductor wafer 7 by the pressure-sensitive adhesive layer 202 was reduced, and then the laminate was stored under the condition of 60°C.

[0210]

15 <<3>> Thereafter, at a point in time when the laminate had been stored for 0, 2, 4, and 7 days under the condition of 60°C, the holding force (adhesive force) at the time of peeling the pressure-sensitive adhesive tape 200 for transport from the semiconductor wafer 7 was measured.

20 [0211]

Furthermore, for the pressure-sensitive adhesive tape 200 for transport included in the tape set of each of the example and the comparative examples, the step <<2>> was performed on the semiconductor wafer 7 which had not undergone the step <<1>>,
25 and then the holding force (adhesive force) at the time of peeling

the pressure-sensitive adhesive tape 200 for transport from the semiconductor wafer 7 was measured.

[0212]

The holding force of the pressure-sensitive adhesive tape
5 200 for transport was measured based on a peel strength test
(specified in JIS-C6481). Specifically, a cut having a width
of 10 mm was made in the pressure-sensitive adhesive tape 200
for transport bonded to each of the semiconductor wafers 7. Then,
one end of the pressure-sensitive adhesive tape 200 for transport
10 was gripped, and the tape 200 was peeled off at room temperature
in a 180° direction at a speed of 300 mm/sec. The peel strength
measured as a load applied at this time was determined as the
holding force of the pressure-sensitive adhesive tape 200 for
transport.

15 The evaluation results are shown in Table 1.

[0213]

[Table 1]

		Example	Comparative Example 1	Comparative Example 2	Comparative Example 3	Comparative Example 4	Comparative Example 5	Comparative Example 6
Pressure-sensitive adhesive tape 100 for fabrication	Pressure-sensitive tape No. 1	Applied	Applied					
	Pressure-sensitive tape No. 2			Applied			Applied	Applied
	Pressure-sensitive tape No. 3				Applied			
	Pressure-sensitive tape No. 4					Applied		
Pressure-sensitive adhesive tape 200 for transport	Contact angle C of pure water with respect to pressure-sensitive adhesive layer [°]	80	80	107	102	106	107	107
	Contact angle A of hexadecane with respect to pressure-sensitive adhesive layer [°]	42	42	6	5	16	6	6
	Pressure-sensitive tape No. 1			Applied	Applied	Applied		
	Pressure-sensitive tape No. 2							
Pressure-sensitive adhesive tape 200 for transport	Pressure-sensitive tape No. 3	Applied					Applied	
	Pressure-sensitive tape No. 4		Applied					
	Pressure-sensitive tape No. 5							Applied
	Contact angle D of pure water with respect to pressure-sensitive adhesive layer [°]	102	106	80	80	80	102	111
Evaluation	Contact angle B of hexadecane with respect to pressure-sensitive adhesive layer [°]	5	16	42	42	42	5	17
	Contact angle I of pure water with respect to semiconductor wafer (semiconductor element) after peeling of pressure-sensitive adhesive tape 100 for fabrication [°]	47.2	47.2	61.4	60.5	61.4	61.4	61.4
	Contact angle H of hexadecane with respect to semiconductor wafer (semiconductor element) after peeling of pressure-sensitive adhesive tape 100 for fabrication [°]	26	26	5	4	5	5	5
	Difference between contact angle A and contact angle B A - B [°]	37	26	-36	-37	-26	1	-11
Evaluation	Difference between contact angle C and contact angle D C - D [°]	-22	-26	27	22	26	5	-4
	Difference between contact angle H and contact angle B H - B [°]	21	10	-37	-38	-37	0	-12
	Difference between contact angle I and contact angle D I - D [°]	55	59	19	20	19	41	50
	Difference between contact angle I and contact angle D I - I [°]	10	19	17	12	10	70	110
Evaluation	Holding force of semiconductor wafer after 0 day	12	25	29	20	22	80	135
	After 2 days	15	40	31	25	28	90	135
	After 4 days	15	49	50	33	36	90	140
	After 7 days (F)	15	49	50	33	36	90	140
Evaluation	7 with respect to pressure-sensitive adhesive tape 100 (bonding of pressure-sensitive adhesive tape 100 for fabrication to wafer was not performed.) (G)	18	18	8	8	8	18	100
	adhesive tape 200 for transport (cm/25 mm)							
	Adhesive force increase rate (F/E)	1.5	2.6	2.9	2.8	3.6	1.3	1.3
	Adhesive force reduction rate (ratio of adhesive force after 0 day depending on whether or not pressure-sensitive adhesive tape 100 for fabrication was bonded to wafer) (E/G)	0.6	1.1	2.1	1.5	1.3	3.9	1.1

[0214]

As shown in Table 1, the tape set of the example satisfied the condition in which the contact angle A of hexadecane with respect to the pressure-sensitive adhesive layer is equal to or greater than 10° , and the contact angle B of hexadecane with respect to the pressure-sensitive adhesive layer is less than 10° . In contrast, the tape set of each of the comparative examples did not satisfy the condition of the contact angle described above. Furthermore, while the pressure-sensitive adhesive tape for transport of the example satisfied the relationship of $20^\circ \leq H - B$, the pressure-sensitive adhesive tape for transport of each of the comparative examples did not satisfy the relationship. Accordingly, in the tape set (pressure-sensitive adhesive tape for transport) of the example, a change rate (F/E) of the holding force [cN/25 mm] of the semiconductor wafer 7 with respect to the pressure-sensitive adhesive tape 200 for transport, that is, the adhesive force increase rate was suppressed and became less than 2.0. This result shows that the temporal change of the holding force of the semiconductor wafer 7 with respect to the pressure-sensitive adhesive tape 200 for transport is inhibited, and the effects relating to the following adhesive force reduction rate are also excellent.

[0215]

Specifically, in a case where the tape sets were compared

to each other in terms of the holding force [cN/25 mm] of the semiconductor wafer 7 with respect to the pressure-sensitive adhesive tape 200 for transport based on whether or not the bonding of the pressure-sensitive adhesive tape 100 for
5 fabrication to the semiconductor wafer 7 was performed (E/G), in the tape set (pressure-sensitive adhesive tape for transport) of the example, E/G, that is, the adhesive force reduction rate was less than 1.0, which is a result showing that the holding force of the semiconductor wafer 7 with respect to the
10 pressure-sensitive adhesive tape 200 for transport was effectively reduced. In contrast, in the tape set (pressure-sensitive adhesive tape for transport) of each of the comparative examples, a result satisfying both the adhesive force increase rate and adhesive force reduction rate was not
15 obtained.

Industrial Applicability

[0216]

According to the present invention, it is possible to
20 provide a pressure-sensitive adhesive tape set and a pressure-sensitive adhesive tape for semiconductor element transport which make it possible to stably pick up semiconductor elements regardless of the arrangement time required for arranging the semiconductor elements on the pressure-sensitive
25 adhesive tape for semiconductor element transport from a

pressure-sensitive adhesive tape for semiconductor wafer fabrication. Therefore, the present invention has industrial applicability.

5 Reference Signs List

[0217]

- 2 pressure-sensitive adhesive layer
- 4 base material
- 7 semiconductor wafer
- 10 9 wafer ring
- 10 semiconductor device
- 17 mold portion
- 20 semiconductor chip
- 21 terminal
- 15 30 interposer
- 41 terminal
- 70 bump
- 80 sealing layer
- 81 connection portion
- 20 85 solder bump
- 100 pressure-sensitive adhesive tape for semiconductor wafer fabrication (pressure-sensitive adhesive tape for fabrication)
- 121 outer peripheral portion
- 25 122 central portion

- 200 pressure-sensitive adhesive tape for semiconductor
element transport (pressure-sensitive adhesive tape for
transport)
- 202 pressure-sensitive adhesive layer
- 5 204 base material
- 255 closed space
- 300 pressure-sensitive adhesive tape for protection

CLAIMS

1. A pressure-sensitive adhesive tape set comprising:

at least one pressure-sensitive adhesive tape for
semiconductor wafer fabrication constituted with a first

5 laminate including a sheet-shaped first base material
containing a resin material and a first pressure-sensitive
adhesive layer laminated on the first base material; and

at least one pressure-sensitive adhesive tape for
semiconductor element transport constituted with a second

10 laminate including a sheet-shaped second base material
containing a resin material and a second pressure-sensitive
adhesive layer laminated on the second base material,

wherein a contact angle of hexadecane with respect to the
first pressure-sensitive adhesive layer is equal to or greater

15 than 10° , and

a contact angle of hexadecane with respect to the second
pressure-sensitive adhesive layer is less than 10° .

2. The pressure-sensitive adhesive tape set according to

20 claim 1,

wherein provided that the contact angle of hexadecane with
respect to the first pressure-sensitive adhesive layer is $A[^\circ]$,
and the contact angle of hexadecane with respect to the second
pressure-sensitive adhesive layer is $B[^\circ]$, A and B satisfy a

relationship of $20^{\circ} \leq A - B$.

3. The pressure-sensitive adhesive tape set according to claim 1 or 2,

5 wherein a contact angle of pure water with respect to the first pressure-sensitive adhesive layer is equal to or less than 90° , and

 a contact angle of pure water with respect to the second pressure-sensitive adhesive layer is greater than 90° .

10

4. The pressure-sensitive adhesive tape set according to any one of claims 1 to 3,

 wherein the second pressure-sensitive adhesive layer contains a surfactant.

15

5. The pressure-sensitive adhesive tape set according to any one of claims 1 to 4,

 wherein the pressure-sensitive adhesive tape for semiconductor wafer fabrication is used for obtaining a
20 plurality of semiconductor elements formed by singulating a semiconductor wafer bonded to the pressure-sensitive adhesive tape for semiconductor wafer fabrication, and

 the pressure-sensitive adhesive tape for semiconductor element transport is used for rearranging, moving and storing
25 each of the semiconductor elements picked up from the

pressure-sensitive adhesive tape for semiconductor wafer fabrication.

6. The pressure-sensitive adhesive tape set according to
5 claim 5,

wherein each semiconductor element picked up from the pressure-sensitive adhesive tape for semiconductor wafer fabrication is bonded to the second pressure-sensitive adhesive layer included in the pressure-sensitive adhesive tape for
10 semiconductor element transport, in a state where a portion of the first pressure-sensitive adhesive layer remains on a side of a surface of the semiconductor element having been in contact with the first pressure-sensitive adhesive layer.

15 7. A pressure-sensitive adhesive tape for semiconductor element transport which is used for fixing semiconductor elements and constituted with a laminate, the laminate including a sheet-shaped base material containing a resin material and a pressure-sensitive adhesive layer laminated on the base
20 material,

wherein the semiconductor elements are fixed to the pressure-sensitive adhesive tape for semiconductor element transport through a side of a non-circuit-formed surface thereof on which no circuit is formed,

25 a resin material having pressure-sensitive adhesiveness,

which is derived from a pressure-sensitive adhesive tape for semiconductor wafer fabrication having been used for fixing a semiconductor wafer, is attached to the non-circuit-formed surface when the semiconductor elements are obtained by
5 singulating the semiconductor wafer, and

provided that a contact angle of hexadecane with respect to the non-circuit-formed surface, to which the resin material derived from the pressure-sensitive adhesive tape for semiconductor wafer fabrication is attached, is $H[^\circ]$ and a
10 contact angle of hexadecane with respect to the pressure-sensitive adhesive layer included in the pressure-sensitive adhesive tape for semiconductor element transport is $B[^\circ]$, H and B satisfy a relationship of $20^\circ \leq H - B$.

15

8. The pressure-sensitive adhesive tape for semiconductor element transport according to claim 7,

wherein the contact angle H of hexadecane with respect to the non-circuit-formed surface, to which the resin material
20 derived from the pressure-sensitive adhesive tape for semiconductor wafer fabrication is attached, is equal to or greater than 10° .

9. The pressure-sensitive adhesive tape for semiconductor
25 element transport according to claim 7 or 8,

wherein the contact angle B of hexadecane with respect to the pressure-sensitive adhesive layer included in the pressure-sensitive adhesive tape for semiconductor element transport is less than 10° .

5

10. The pressure-sensitive adhesive tape for semiconductor element transport according to any one of claims 7 to 9,

wherein provided that a contact angle of pure water with respect to the non-circuit-formed surface, to which the resin material derived from the pressure-sensitive adhesive tape for semiconductor wafer fabrication is attached, is $I[^{\circ}]$ and a contact angle of pure water with respect to the pressure-sensitive adhesive layer included in the pressure-sensitive adhesive tape for semiconductor element transport is $D[^{\circ}]$, I and D satisfy a relationship of $55^{\circ} \leq D - I$.

11. The pressure-sensitive adhesive tape for semiconductor element transport according to any one of claims 7 to 9,

wherein a contact angle I of pure water with respect to the non-circuit-formed surface, to which the resin material derived from the pressure-sensitive adhesive tape for semiconductor wafer fabrication is attached, is equal to or less

than 50°.

12. The pressure-sensitive adhesive tape for
semiconductor element transport according to any one of claims
5 7 to 9,

wherein a contact angle θ of pure water with respect to
the pressure-sensitive adhesive layer included in the
pressure-sensitive adhesive tape for semiconductor element
transport is greater than 90°.

10

13. The pressure-sensitive adhesive tape for
semiconductor element transport according to any one of claims
7 to 12,

wherein the pressure-sensitive adhesive layer included in
15 the pressure-sensitive adhesive tape for semiconductor element
transport contains a surfactant.