

DESCRIPTION

SHEET DETACHMENT METHOD AND SHEET DETACHMENT DEVICE, AND DIVIDING METHOD AND DIVIDING DEVICE

5 TECHNICAL FIELD

[0001]

The present invention relates to a sheet peeling method and sheet peeling apparatus, and a splitting method and splitting apparatus.

10 BACKGROUND ART

[0002]

Sheet peeling methods for peeling an adhesive sheet attached to an adherend from the adherend have been known (see, for instance, Patent Literature 1).

15

CITATION LIST

PATENT LITERATURE(S)

[0003]

Patent Literature 1: JP 2012-222308 A

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SUMMARY OF THE INVENTION

PROBLEM(S) TO BE SOLVED BY THE INVENTION

[0004]

25 According to the sheet peeling method disclosed in Patent Literature 1, when a tension, which is applied on the adhesive sheet in order to peel an adhesive sheet S1 (adhesive sheet) from a semiconductor wafer W (adherend), is not appropriate, unexpected excessive tension is applied on the adhesive sheet, possibly causing damage on the adherend.

[0005]

30 An object of the invention is to provide a sheet peeling method and a sheet peeling apparatus capable of preventing damage on an adherend when an adhesive sheet attached on the adherend is peeled from the adherend.

Another object of the invention is to provide a splitting method and a splitting apparatus capable of preventing damage on a thinned adherend(s) when an adherend attached on an adhesive sheet is split into a plurality of the thinned adherends.

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MEANS FOR SOLVING THE PROBLEM(S)

[0006]

In some aspects of the invention, the arrangements described in claims are used.

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[0007]

A sheet peeling method and a sheet peeling apparatus according to some aspects of the invention, where an adhesive sheet is peeled from an adherend while a sheet tension applied on the adhesive sheet is kept at a desired tension, do not apply unexpected excessive tension on the adhesive sheet, so that the adherend is kept from being damaged when the adhesive sheet attached on the adherend is peeled.

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Further, by reducing the sheet tension in accordance with decrease in an area of an adhesion surface between the adherend and the adhesive sheet during the peeling step, the damage on the adherend is more likely to be prevented.

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By keeping a ratio of a magnitude of the sheet tension to a length of an outer edge or an area of an adhesion surface at a constant level when the adhesive sheet is peeled from the adherend in the peeling step, the sheet tension can be controlled in accordance with a bonding state between the adhesive sheet and the adherend, thereby being more likely to prevent the damage on the adherend.

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By controlling a peeling status in the peeling step, the adhesive sheet can be prevented from being rapidly peeled, thereby reducing deformation of the adhesive sheet and residual adhesive on the adherend.

[0008]

A splitting method and a splitting apparatus according to some aspects of the invention, where the adherend is split into a plurality of thinned adherends while the sheet tension applied on the adhesive sheet attached with the adherend is kept at a desired tension, do not apply unexpected excessive tension on the adhesive sheet,

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so that the second thinned adherend is kept from being damaged when the adherend attached on the adhesive sheet is split into the plurality of thinned adherends.

Further, by splitting the first thinned adherend into a plurality of chip pieces when the adherend is split into the first thinned adherend and the second thinned adherend, the first thinned adherend can be split into the plurality of chip pieces
5 without performing any subdivision step (e.g. dicing step and cutting step).

BRIEF EXPLANATION OF DRAWINGS

[0009]

10 Fig. 1A is an illustration showing a sheet peeling apparatus according to an exemplary embodiment of the invention.

Fig. 1B is an illustration showing a peeling status of an adhesive sheet.

Fig. 1C is another illustration showing the peeling status of the adhesive sheet.

15 Fig. 2A is an illustration showing how the sheet peeling apparatus is operated.

Fig. 2B is another illustration showing how the sheet peeling apparatus is operated.

Fig. 2C is still another illustration showing how the sheet peeling apparatus is operated.

20 Fig. 3A is an illustration showing how a splitting apparatus according to an exemplary embodiment of the invention is operated.

Fig. 3B is another illustration showing how the splitting apparatus according to the exemplary embodiment of the invention is operated.

Fig. 3C is still another illustration showing how the splitting apparatus
25 according to the exemplary embodiment of the invention is operated.

DESCRIPTION OF EMBODIMENT(S)

[0010]

30 An exemplary embodiment of the invention will be described below with reference to the attached drawings.

It should be noted that X axis, Y axis, and Z axis in the present exemplary embodiment are orthogonal to each other, where X axis and Y axis are in a

predetermined plane and Z axis is orthogonal to the predetermined plane. Further, directions in the present exemplary embodiment are defined with reference to a viewpoint at a near side in Fig. 1A or Fig. 3A viewed parallel to the Y axis, where "upper" is a direction pointed by an arrow of the Z axis and "lower" is a direction reverse to the "upper" direction, "left" is a direction pointed by an arrow of the X axis and "right" is a direction reverse to the "left" direction, and "front" is a direction pointed by an arrow of the Y axis and "back" is a direction reverse to the "front" direction.

[0011]

First Exemplary Embodiment

As shown in Fig. 1A, a sheet peeling apparatus EA1, which is configured to peel a first adhesive sheet AS1 (adhesive sheet) attached to an adherend WK1 from the adherend WK1, includes a sheet holder 10 configured to hold the first adhesive sheet AS1, an adherend holder 20 configured to hold the adherend WK1, a peeling unit 30A configured to apply a tension to the first adhesive sheet AS1 held by the sheet holder 10 to peel the first adhesive sheet AS1 from the adherend WK1, and a tension detector 40 configured to detect a sheet tension applied on the first adhesive sheet AS1 when the first adhesive sheet AS1 is peeled from the adherend WK1 by the peeling unit 30A.

It should be noted that the first adhesive sheet AS1 is bonded to the adherend WK1 and a first ring frame RF1 (frame member) via an adhesive layer AD1 layered on one side of the adhesive sheet AS1.

[0012]

The sheet holder 10, which includes a linear movement motor 12 (drive device) supported by a base plate 11 and a holding member 14 supported by an output shaft 13 of the linear movement motor 12, is provided in pair so that the first ring frame RF1 is supported at right and left sides.

[0013]

The adherend holder 20 includes a table 21 having a support surface 21A that is configured to suck and hold an object with a non-illustrated decompressor (e.g. a decompressor pump and a vacuum ejector). It should be noted that the adherend holder 20 of the present exemplary embodiment is configured to hold the adherend WK1 through a second adhesive sheet AS2 whose adhesive layer AD2 is attached

to a second ring frame RF2 (frame member).

[0014]

The peeling unit 30A, which includes a plurality of drive units 31 configured to raise and lower the sheet holder 10, a peel status controller 32 configured to control
5 a peeling status of the first adhesive sheet AS1 to be peeled from the adherend WK1, and a rotator 33 configured to rotate the sheet holder 10, the drive units 31, and the peel status controller 32, is configured to peel the first adhesive sheet AS1 from the adherend WK1 while keeping the sheet tension at a desired tension based on the detection results of the tension detector 40.

10 The drive units 31 each include a linear movement motor 31A (drive device) whose output shaft 31B supports the sheet holder 10.

The peel status controller 32 includes a linear movement motor 32A (drive device) and an abutment unit 32C (pressing unit) supported by an output shaft 32B of the linear movement motor 32A. The abutment unit 32C includes a support
15 member 32D and an elastic member 32E supported by the support member 32D. The elastic member 32E has elasticity and is slightly larger in plan than the adherend WK1.

The rotator 33 includes a rotary motor 33A (drive device) and a support plate 33C supported by an output shaft 33B of the rotary motor 32A to support the linear
20 movement motors 31A, 32A.

[0015]

The tension detector 40 includes a contact or non-contact type tension sensor 41 capable of detecting the sheet tension between the first ring frame RF1 and the adherend WK1, a controller 42 (e.g. a sequencer and personal computer)
25 capable of controlling an operation of an entirety of the sheet peeling apparatus EA1, and an image pickup 43 (e.g. a camera and projector) capable of measuring an attachment length DT1 (i.e. a length in right-left direction of an area of the first adhesive sheet AS1 bonded to the adherend WK1 shown in Figs. 1B and 1C).

[0016]

30 An operation of the above-described sheet peeling apparatus EA1 will be described below.

Initially, a user of the sheet peeling apparatus EA1 (simply referred to as

"user" hereinafter) inputs a signal for starting an automatic operation via a non-illustrated operation unit (e.g. a control panel and personal computer) on the sheet peeling apparatus EA1 whose components are set at respective initial positions (shown in solid lines in Fig. 1A). Subsequently, the second adhesive sheet AS2 attached on the second ring frame RF2 is placed on the table 21 by a user or a non-illustrated transfer unit (e.g. a multijoint robot and belt conveyor). Then, the adherend holder 20 drives the non-illustrated decompressor to start sucking and holding the second adhesive sheet AS2 on the support surface 21A. Then, after the first ring frame RF1 supporting the adherend WK1 via the first adhesive sheet AS1 is placed on the holding member 14 by the user or the non-illustrated transfer unit, the sheet holder 10 drives the linear movement motors 12 to raise the holding member 14, so that the first ring frame RF1 is held between the holding member 14 and the base plate 11 to hold the first adhesive sheet AS1 (sheet holding step).

[0017]

Subsequently, the peeling unit 30A drives the linear movement motors 31A, 32A to lower the base plate 11 and the abutment unit 32C as shown in Fig. 2A, thereby bringing the holding member 14 close to the second ring frame RF2 and pressing and attaching the adherend WK1 against the second adhesive sheet AS2 (adherend holding step). Then, the peeling unit 30A drives the linear movement motors 31A to raise the sheet holder 10 to peel the first adhesive sheet AS1 from the adherend WK1 as shown in Figs. 2B and 2C (peeling step). It should be noted that the sheet tension is reduced in accordance with decrease in the area of an adhesion surface (i.e. an area of the adherend WK1 to be bonded with the first adhesive sheet AS1) to peel the first adhesive sheet AS1 from the adherend WK1 during the peeling step of the present exemplary embodiment. Specifically, during the peeling step, the tension detector 40 drives the tension sensor 41, the controller 42, and the image pickup 43, where the sheet tension is detected by the tension sensor 41, the attachment length DT1 is measured by the image pickup 43, and the measurement data by the tension sensor 41 and the image pickup 43 are sent to the controller 42 (tension detection step). The controller 42, which has received the measurement data, calculates a length of an outer edge AE of the adhesion surface and the area of the adhesion surface based on the attachment length DT1. Then, the controller 42 drives

the linear movement motors 31A so that the first adhesive sheet AS1 is peeled from the adherend WK1 while a ratio of the magnitude of the sheet tension to the length of the outer edge AE of the adhesion surface (referred to as a "tension/length ratio" hereinafter) or a ratio of the magnitude of the sheet tension to the area of the adhesion surface (referred to as a "tension/area ratio" hereinafter) is kept constant.

[0018]

During the peeling step, in accordance with progress in peeling of the first adhesive sheet AS1 from the adherend WK1, the elastic member 32E pressed against the first adhesive sheet AS1 is elastically deformed as shown in Figs. 2B, 2C, thereby preventing the first adhesive sheet AS1 from being rapidly peeled from the adherend WK1 and reducing deformation of the first adhesive sheet AS1 and residual adhesive on the adherend WK1 (peeling status control step). At this time, the peeling unit 30A optionally drives the linear movement motor 32A to raise or lower the abutment unit 32C so that the tension/length ratio or the tension/area ratio becomes constant. Further, the peeling unit 30A optionally drives the rotary motor 33A to reciprocally rotate the support plate 33C by a predetermined angle around the Z axis. With the above arrangement, a predetermined tension is applied in a surface direction of the first adhesive sheet AS1, so that the tension in the surface direction is applied on the first adhesive sheet AS1 in addition to an upward peeling force, thereby promoting the peeling of the first adhesive sheet AS1 from the adherend WK1.

[0019]

Subsequently, when the sheet holder 10 is further raised to peel the entirety of the first adhesive sheet AS1 off from the adherend WK1, the sheet holder 10 and the peeling unit 30A drive the linear movement motors 12, 31A, 32A to return the holding member 14, the base plate 11, and the abutment unit 32C to their initial positions. Then, the adherend holder 20 stops driving the non-illustrated decompressor to release the second adhesive sheet AS2 from being sucked and held on the support surface 21A. Next, after the adherend WK1 supported on the second ring frame RF2 via the second adhesive sheet AS2 is transferred to a next step by the user or the non-illustrated transfer unit, the first adhesive sheet AS1 attached with the first ring frame RF1, from which the adherend WK1 has been

peeled, is removed from the holding member 14 by the user or the transfer unit. The same operations as described above are repeatedly performed.

[0020]

According to the above-described present exemplary embodiment, where the first adhesive sheet AS1 is peeled from the adherend WK1 while the sheet tension applied on the first adhesive sheet AS1 is kept at a desired tension, unexpected excessive tension is not applied on the first adhesive sheet AS1, so that the adherend WK1 is kept from being damaged when the first adhesive sheet AS1 attached on the adherend WK1 is peeled.

[0021]

Second Exemplary Embodiment

Description of a splitting apparatus EA2 according to the present exemplary embodiment, whose components are substantially the same as those of the sheet peeling apparatus EA1 of the first exemplary embodiment, will be mainly focused on differences from the first exemplary embodiment and the same components as those in the first exemplary embodiment will be denoted by the same reference numeral to omit or simplify the description thereof.

As shown in Fig. 3A, a splitting apparatus EA2 is an apparatus configured to split the adherend WK2, which is provided with a first modified portion DP1 and attached to the first adhesive sheet AS1 (adhesive sheet) at the first modified portion DP1, into a first thinned adherend WT1 located near the first adhesive sheet AS1 and a second thinned adherend WT2 located opposite the first thinned adherend WT1 across the first modified portion DP1. The splitting apparatus EA2 includes the sheet holder 10 configured to hold the first adhesive sheet AS1, the adherend holder 20 configured to hold the adherend WK2 from the side to be the second thinned adherend WT2, a splitting unit 30B configured to apply a tension to the first adhesive sheet AS1 held by the sheet holder 10 to split the adherend WK2 into the first thinned adherend WT1 and the second thinned adherend WT2, and the tension detector 40 configured to detect the tension applied on the first adhesive sheet AS1 when the adherend is split into the first thinned adherend WT1 and the second thinned adherend WT2 by the splitting unit 30B.

[0022]

The adherend WK2 is provided with the first modified portion DP1 and a plurality of second modified portions DP2, the first modified portion DP1 being located within a first splitting plane (a plane parallel to the XY plane in the state shown in Fig. 3A), the second modified portions DP2 extending in directions parallel to second splitting planes (the YZ plane and XZ plane in the state shown in Fig. 3A) intersecting the first splitting plane. The first and second modified portions DP1, DP2 are embrittled or softened parts of the adherend WK2 created by changing properties and/or strength of the adherend WK2. The first modified portion DP1 is a layer, at which the adherend WK2 can be split into the first thinned adherend WT1 and the second thinned adherend WT2. The second modified portions DP2 are layers, at which the first thinned adherend WT1 can be split into a plurality of chip pieces CP.

[0023]

The splitting unit 30B, whose components are substantially the same as those of the peeling unit 30A of the first exemplary embodiment, is configured to split the adherend WK2 into the first thinned adherend WT1 and the second thinned adherend WT2 while keeping the sheet tension applied on the first adhesive sheet AS1 at a desired tension based on the detection results of the tension detector 40. In the present exemplary embodiment, the splitting unit 30B is configured to split the first thinned adherend WT1, along the second modified portions DP2, into the plurality of chip pieces CP when the adherend WK2 is split into the first thinned adherend WT1 and the second thinned adherend WT2.

[0024]

The tension detector 40 is configured in the same manner as in the first exemplary embodiment except that the image pickup 43 is configured to measure a modified portion length DT2, which is a length in the right-left direction of the first modified portion DP1 before being split into the first thinned adherend WT1 and the second thinned adherend WT2.

[0025]

The operation of the above-described splitting apparatus EA2 is different from that of the sheet peeling apparatus EA1 of the first exemplary embodiment in terms of the presence of a splitting step in place of the peeling step and details of the tension detection step.

Specifically, after the splitting unit 30B drives the linear movement motors 31A, 32A to press and attach the adherend WK2 against the second adhesive sheet AS2 as shown in Fig. 3A, the sheet holder 10 is raised as shown in Figs. 3B and 3C. Then, the adherend WK2 is split into the first thinned adherend WT1 and the second
5 thinned adherend WT2 at the first modified portion DP1. Simultaneously, the first thinned adherend WT1 is split into the plurality of chip pieces CP at the second modified portions DP2 (splitting step). In the splitting step, the sheet tension is decreased in splitting the adherend WK2 in accordance with decrease in an area of the first modified surface (i.e. the first modified portion DP1 before being split into the
10 first thinned adherend WT1 and the second thinned adherend WT2). Specifically, the tension detector 40 drives the tension sensor 41, the controller 42, and the image pickup 43, where the sheet tension is detected by the tension sensor 41, the modified portion length DT2 is measured by the image pickup 43, and the data measured by the tension sensor 41 and the image pickup 43 are sent to the controller 42 (tension
15 detection step). It should be noted that the controller 42 in the present exemplary embodiment is configured to drive the linear movement motors 31A to perform an operation, where the "attachment length DT1" and the "adhesion surface" in the exemplary operation described in the first exemplary embodiment are read to be the "modified portion length DT2" and the "first modified surface," respectively.

20 [0026]

According to the above-described present exemplary embodiment, where the adherend WK2 is split into the first and second thinned adherends WT1, WT2 while the sheet tension applied on the first adhesive sheet AS1 attached on the adherend WK2 is kept at the desired tension, unexpected excessive tension is not applied on
25 the first adhesive sheet AS1, so that the second thinned adherend WT2 is kept from being damaged when the adherend WK2 attached on the first adhesive sheet AS1 is split into the first and second thinned adherends WT1, WT2.

Further, the first thinned adherend WT1 can be split into a plurality of chip pieces CP without performing an additional subdivision step.

30 [0027]

The best arrangement, process and the like for implementing the invention have been described above. However, the scope of the invention is not limited to the

above exemplary embodiments. In other words, the invention, which has been specifically illustrated and described with reference to specific exemplary embodiment(s), also encompasses various modifications made to the above-described exemplary embodiment(s) by those skilled in the art in terms of shape, material, number, and details as long as such modifications are compatible with technical idea and objective of the invention. Further, the above disclosure specifying the shape, material and the like, which is exemplarily described for assisting the understanding on the invention, does not limit the scope of the invention. Accordingly, the components described by names omitting a part or entirety of the limitation regarding the shape, material and the like are encompassed by the scope of the invention.

[0028]

The sheet holder 10 is optionally configured to hold the first adhesive sheet AS1 using a holder unit such as a mechanical chuck and a chuck cylinder, Coulomb's force, an adhesive, a sticky agent, magnetic force, Bernoulli adsorption, suction, a drive device or the like. The number of the holder units, which is optionally one or three or more, is optionally the same as or different from the number of the drive units 31. For instance, a plurality of the sheet holders 10 connected by a connector are optionally driven by a single drive unit 31. Further, the first adhesive sheet AS1 is optionally directly held without interposing the first ring frame RF1.

[0029]

The adherend holder 20 is optionally configured to hold the second adhesive sheet AS2 using a holder unit such as a mechanical chuck and a chuck cylinder, Coulomb's force, an adhesive, a sticky agent, magnetic force, Bernoulli adsorption, suction, a drive device or the like. The adherend holder 20 is optionally configured to hold the second adhesive sheet AS2 that is not attached to the second ring frame RF2 or directly hold the adherends WK1, WK2 without interposing the second adhesive sheet AS2 or the second ring frame RF2. Further, the adherend holder 20 optionally does not include the non-illustrated decompressor but includes, for instance, L-shaped or key-shaped hook member that hooks the adherends WK1, WK2, the second adhesive sheet AS2, or the second ring frame RF2 to resist a force applied when the first adhesive sheet AS1 is peeled from the adherend WK1 or the

first thinned adherend WT1 is separated from the second thinned adherend WT2.

[0030]

The peeling unit 30A and the splitting unit 30B are optionally configured to move the adherend holder 20, while moving or not moving the sheet holder 10, to peel the first adhesive sheet AS1 from the adherend WK1, or split the adherend WK2 into the first thinned adherend WT1 and the second thinned adherend WT2. The number of the drive units 31 is optionally one or three or more. The sheet holder 10 is optionally relatively moved in one of right and left directions and the adherend holder 20 is optionally moved in the opposite direction. During the relative movement, the sheet holder 10 and the adherend holder 20 are optionally moved while the elastic member 32E keeps in contact with the first adhesive sheet AS1. Further, during the relative movement, the elastic member 32E alternatively optionally does not continuously press the first adhesive sheet AS1 and the adherends WK1, WK2. Alternatively, after the abutment unit 32C is separated from the first adhesive sheet AS1 to temporarily stop the pressing operation by the elastic member 32E, the sheet holder 10 is raised to again press the first adhesive sheet AS1 and the adherends WK1, WK2 by the elastic member 32E. Further alternatively, the abutment unit 32C and the sheet holder 10 are optionally simultaneously raised to keep the first adhesive sheet AS1 and the adherends WK1, WK2 being continuously pressed by the elastic member 32E.

The peeling unit 30A is optionally configured to move the sheet holder 10 from a first end of the outer edge AE of the adhesion surface to a second end thereof to peel the first adhesive sheet AS1 from the adherend WK1.

The splitting unit 30B is optionally configured to move the sheet holder 10 from a first end of the outer edge AE of the first modified surface to a second end thereof to split the adherend WK2 into the first thinned adherend WT1 and the second thinned adherend WT2. The adherend WK2 is optionally not provided with the second modified portion DP2 and the first thinned adherend WT1 is optionally not split into a plurality of chip pieces CP.

The peel status controller 32, which is optionally provided by a component such as a roller that rolls on the first adhesive sheet AS1 and an extendable antenna that is displaceable in stages or is provided with the elastic member 32E such as

rubber, sponge, resin and spring, is optionally provided or not provided in the sheet peeling apparatus EA1 or the splitting apparatus EA2 of the invention.

The plan shape of the support member 32D and the elastic member 32E of the abutment unit 32C is optionally circular, elliptical, polygonal (e.g. triangular and rectangular), or the like. Additionally, air and/or liquid is optionally encapsulated between the support member 32D and the elastic member 32E, where the shape, hardness, and/or the like of the elastic member 32E is optionally variable as desired by controlling the pressure of the air and/or liquid. The abutment member 32C is optionally configured to be stopped at a position remote from the first adhesive sheet AS1, where the area to be pressed is optionally controlled by regulating the amount of the air and/or liquid filled within the abutment unit 32C. Additionally, the elasticity of the elastic member 32E is optionally continuously changed (controlled) when the adherends WK1, WK2 are bonded to the second adhesive sheet AS2 and/or when the first adhesive sheet AS1 is peeled from the adherend WK1.

The rotator 33 is optionally configured to rotate the adherend holder 20 while the sheet holder 10, the drive unit 31, and the peel status controller 32 are rotated or not rotated. Further, the rotator 33 is optionally configured not to rotate the peel status controller 32. Still further, the rotator 33 is optionally provided or not provided in the sheet peeling apparatus EA1 and the splitting apparatus EA2 of the invention.

[0031]

The tension detector 40 is optionally not provided with the image pickup 43. In this case, it is only required that a desired tension is applied on the first adhesive sheet AS1 irrespective of the area of the adhesion surface or the length of the outer edge AE of the adhesion surface. It should be noted that the desired tension is optionally preset or stored in the sheet peeling apparatus EA1 or the splitting apparatus EA2 or set as required by a user or the like. The value of the desired tension is not limited or specified to a specific value or the like.

The tension detector 40 is located at any point for detecting the sheet tension applied on the first adhesive sheet AS1 except for, for instance, the area for the first adhesive sheet AS1 to be attached on the first ring frame RF1, the area for the first adhesive sheet AS1 to be held by the sheet holder 10, and the area of the first adhesive sheet AS1 attached with the adherend WK1, the first thinned adherend

WT1, and the chip pieces CP. Further, the tension detector 40 is additionally configured to detect the sheet tension at a single point or two or more points. When the sheet tension is detected at two or more points, it is only required that the desired tension as a target for keeping the sheet tension is determined based on, for instance, the minimum one, maximum one, an average, or a relative value (e.g. difference or ratio of tension values at two opposite points) of the plurality of detected tension values.

The controller 42 is optionally not configured to calculate the area of the adhesion surface and/or the first modified surface or the length of the outer edge AE of the adhesion surface and/or the first modified surface, which is optionally set or determined as desired by an operator based on detection results of the tension displayed on a display unit (e.g. monitor display) and printing unit (e.g. printer) so that the drive force of the drive device of the peeling unit 30A and/or the splitting unit 30B becomes a predetermined value.

[0032]

The sheet peeling apparatus EA1 or the splitting apparatus EA2 is optionally provided with a grinder for grinding the adherends WK1, WK2 or the first and second thinned adherends WT1, WT2. Alternatively or additionally, the sheet peeling apparatus EA1 or the splitting apparatus EA2 is optionally provided with an integration unit, which is configured to integrate the adherends WK1, WK2 or the first and second thinned adherends WT1, WT2 with the frame member via another adhesive sheet (e.g. a dicing tape, expand tape, and back grind tape).

The sheet peeling apparatus EA1 is optionally configured to peel the first and second adhesive sheets AS1, AS2 from the first and second thinned adherends WT1, WT2.

The first adhesive sheet AS1 is optionally not attached on the first ring frame RF1.

The frame member is optionally annular, non-annular (i.e. with discontinuous outer circumference), circular, elliptical, polygonal having three or more corners, or shaped otherwise.

[0033]

When the adhesion force of the first adhesive sheet AS1 is smaller than the

adhesion force of the second adhesive sheet AS2, the first adhesive sheet AS1 can be efficiently peeled from the adherend WK1. However, the first and second adhesive sheets AS1, AS2 are not necessarily provided with such adhesion forces.

The first and second adhesive sheets AS1, AS2 are optionally configured such that the adhesion force of the adhesive sheets AS1, AS2 is lowered by being irradiated with an energy ray (e.g. ultraviolet ray and X-ray). Alternatively or additionally, the first and second adhesive sheets AS1, AS2 are also configured to serve as a dicing tape, expand tape, back grind tape, or the like.

The first and second modified portions DP1, DP2 are optionally formed, for instance, according to a process disclosed in WO 2019/044588 or by applying to the adherend WK2, in addition to laser ray, electromagnetic waves, vibration, heat, chemical agent(s), chemical substance(s), and/or the like to alter the properties, characteristics, nature, material, composition, structure, dimension and/or the like of the adherend WK2 to embrittle, crush, liquefy, or cavitate the adherend WK2.

[0034]

The units and processes in the invention, which are not limited as long as the operations, functions, and steps described for the units and processes are achievable, are by no means limited to the components and processes described merely in the above-described exemplary embodiments. For instance, the sheet holding step, which may follow any procedures as long as the adhesive sheet can be held, is by no means limited in any manner as long as being within the scope of technical idea of those skilled in the art at the time of filing the present application (the same applies to other units and processes).

[0035]

The material, type, shape and the like of the first and second adhesive sheets AS1, AS2, the adherends WK1, WK2, the first and second thinned adherends WT1, WT2, and the chip pieces CP are not specifically limited. For instance, the shape of the first and second adhesive sheets AS1, AS2, the adherends WK1, WK2, the first and second thinned adherends WT1, WT2, and the chip pieces CP is optionally circular, elliptical, polygonal (e.g. triangular and quadrangular), and other shape. The first and second adhesive sheets AS1, AS2 are optionally pressure-sensitive adhesive, heat-sensitive adhesive, or the like. Further, the first and second adhesive

5 sheets AS1, AS2 are optionally provided by, for instance, a single adhesive layer, a combination of a base material, the adhesive layer, and an intermediate layer between the base material and the adhesive layer, three or more layers (e.g. additionally provided with a cover layer on the upper side of the base material), or a so-called double-sided adhesive sheet capable of peeling the base material from the adhesive layer. The double-sided adhesive sheet is optionally provided with a single core material layer or plural core material layers, or provided by a single layer or plural layers without any intermediate layer. The adherends WK1, WK2, the first and second thinned adherends WT1, WT2, and the chip pieces CP, which are not necessarily plate-shaped components but optionally are, for instance, a single component such as a food, resin container, semiconductor wafer (e.g. silicon semiconductor wafer and compound semiconductor wafer), circuit board, information-recording medium such as an optical disk, glass plate, steel plate, pottery, wood plate, or resin, or a composite component made of two or more of the above single components, are optionally provided by any form of component(s) or article(s). It should be noted that in terms of function and usage, the first and second adhesive sheets AS1, AS2 may be, for instance, any sheet, film, tape or the like such as an information indication label, decoration label, protection tape, processing tape, dicing tape, die-attach film, die-bonding tape, and recording-layer formation resin sheet.

20 [0036]

The drive device in the above-described exemplary embodiments is optionally an electrically powered device such as a rotary motor, linear movement motor, linear motor, uniaxial robot, and multijoint robot having two axes or three or more axes, an actuator such as an air cylinder, hydraulic cylinder, rodless cylinder, and rotary cylinder, or a device provided by directly or indirectly combining the above devices.

30 When a rotary component such as a roller is used in the above-described exemplary embodiments, a drive device for rotating the rotary component is optionally provided. A surface of the rotary component or the rotary component itself is optionally made of a deformable material (e.g. rubber and resin) or a non-deformable material. Alternatively, other component(s) such as a rotatable or non-rotatable shaft or blade is optionally provided in place of a roller. When a press

unit/component (e.g. press roller and press head) for pressing an object is provided, in addition to or in place of the above-described examples, a component such as a roller, round bar, blade member, rubber, sponge, resin, or the like or a unit for pressing by spraying gaseous body (e.g. air and gas) is optionally used. The press unit/component is optionally provided by a deformable member (e.g. rubber and resin) or, alternatively, non-deformable member. When a support (holding) unit/component for supporting (holding) a to-be-supported member (to-be-held member) is provided, the to-be-supported member is optionally supported (held) using a holder unit (e.g. a mechanical chuck and chuck cylinder), Coulomb's force, an adhesive (adhesive sheet, adhesive tape), a sticky agent (sticky sheet, sticky tape), magnetic force, Bernoulli adsorption, suction, a drive device, or the like.

EXPLANATION OF CODES

[0037]

15	EA1...sheet peeling apparatus
	EA2...splitting apparatus
	10...sheet holder
	20...adherend holder
	30A...peeling unit
20	30B...splitting unit
	40...tension detector
	AS1...first adhesive sheet (adhesive sheet)
	AE...outer edge
	CP...chip piece
25	DP1...first modified portion
	DP2...second modified portion
	WK1...adherend
	WK2...adherend
	WT1...first thinned adherend
30	WT2...second thinned adherend

CLAIM(S)

1. A sheet peeling method for peeling an adhesive sheet attached on an adherend from the adherend, the method comprising:

holding the adhesive sheet;

5 holding the adherend;

peeling the adhesive sheet from the adherend by applying a tension on the adhesive sheet held in the holding of the sheet; and

detecting a sheet tension applied on the adhesive sheet when the adhesive sheet is peeled from the adherend in the peeling of the adhesive sheet, wherein

10 in the peeling of the adhesive sheet, the adhesive sheet is peeled from the adherend while the sheet tension is kept at a desired tension based on detection results in the detecting of the sheet tension.

2. The sheet peeling method according to claim 1, wherein

15 in the peeling of the adhesive sheet, the sheet tension is decreased in accordance with decrease in an adhesion surface, at which the adherend is bonded with the adhesive sheet, when the adhesive sheet is peeled from the adherend.

3. The sheet peeling method according to claim 2, wherein

20 in the peeling of the adhesive sheet, the adhesive sheet is peeled from the adherend while a ratio of a magnitude of the sheet tension to a length of an outer edge or an area of the adhesion surface is kept constant.

4. The sheet peeling method according to any one of claims 1 to 3, wherein

in the peeling of the adhesive sheet, a peeling status of the adhesive sheet to be peeled from the adherend is controlled.

5. A sheet peeling apparatus for peeling an adhesive sheet attached on an adherend from the adherend, the apparatus comprising:

a sheet holder configured to hold the adhesive sheet;

an adherend holder configured to hold the adherend;

a peeling unit configured to apply a tension on the adhesive sheet held by the sheet holder to peel the adhesive sheet from the adherend; and

30 a tension detector configured to detect a sheet tension applied on the adhesive sheet when the adhesive sheet is peeled from the adherend by the peeling unit, wherein

the peeling unit is configured to peel the adhesive sheet from the adherend while keeping the sheet tension at a desired tension based on detection results of the tension detector.

6. A splitting method for splitting an adherend, which is provided with a first modified portion and attached on an adhesive sheet, into a first thinned adherend located near the adhesive sheet with respect to the first modified portion and a second thinned adherend located opposite the first thinned adherend across the first modified portion, the method comprising:

holding the adhesive sheet;

10 holding the adherend from a side to be the second thinned adherend;

splitting the adherend into the first thinned adherend and the second thinned adherend by applying a tension on the adhesive sheet held in the holding of the adhesive sheet; and

15 detecting a sheet tension applied on the adhesive sheet when the adherend is split into the first thinned adherend and the second thinned adherend in the splitting of the adherend, wherein

in the splitting of the adherend, the adherend is split into the first thinned adherend and the second thinned adherend while the sheet tension is kept at a desired tension based on detection results in the detecting of the sheet tension.

20 7. The splitting method according to claim 6, wherein

the adherend comprises a plurality of second modified portions extending in a direction parallel to a second splitting plane intersecting a first splitting plane, within which the first modified portion is provided, and

25 in the splitting of the adherend, when the adherend is split into the first thinned adherend and the second thinned adherend, the first thinned adherend is split into a plurality of chip pieces along the second splitting plane.

8. A splitting apparatus for splitting an adherend, which is provided with a first modified portion and attached on an adhesive sheet, into a first thinned adherend located near the adhesive sheet with respect to the first modified portion and a second thinned adherend located opposite the first thinned adherend across the first modified portion, the apparatus comprising:

a sheet holder configured to hold the adhesive sheet;

an adherend holder configured to hold the adherend from a side to be the second thinned adherend;

a splitting unit configured to apply a tension on the adhesive sheet held by the sheet holder to split the adherend into the first thinned adherend and the second
5 thinned adherend; and

a tension detector configured to detect a sheet tension applied on the adhesive sheet when the adherend is split into the first thinned adherend and the second thinned adherend by the splitting unit, wherein

the splitting unit is configured to keep the sheet tension at a desired tension
10 based on detection results of the tension detector when the adherend is split into the first thinned adherend and the second thinned adherend.