SEMICONDUCTOR MANUFACTURING DEVICE, MANUFACTURING METHOD OF SEMICONDUCTOR CHIP, CIRCUIT SUBSTRATE, AND ELECTRONIC APPARATUS

CROSS-REFERENCE TO RELATED APPLICATIONS

This application is based on and claims priority under 35 USC 119 from Japanese Patent Application No. 2015-074755 filed on April 01, 2015.

BACKGROUND

(i) Technical Field

[0001]

The present invention relates to a semiconductor manufacturing device, a manufacturing method of a semiconductor chip, a circuit substrate, an electronic apparatus.

(ii) Related Art

[0002]

[0003]

SUMMARY

[0004]

[0005]

[0006]

[0007]

BRIEF DESCRIPTION OF THE DRAWINGS

Exemplary embodiments of the present invention will be described in detail based on the following figures, wherein:

[0008]

Fig. 1A is a schematic perspective view of a pickup unit according to an embodiment of the present invention, and Fig. 1B is a schematic sectional view of Fig. 1A;

Fig. 2A is a schematic planar view of a semiconductor substrate, and Fig. 2B is a schematic perspective view illustrating an example of a semiconductor chip;

Fig. 3 is a diagram illustrating push-up of an adhesive tape which is performed by a push-up device;

Fig. 4 is a block diagram illustrating an electrical configuration of a pickup unit according to an embodiment of the present invention;

Fig. 5 is a diagram schematically illustrating an adhesive state and a peeled state of a rear surface of the semiconductor chip when viewed from the rear surface of the semiconductor substrate;

Fig. 6 is a block diagram illustrating a functional configuration of a pickup control program according to the embodiment of the present invention;

Figs. 7A to 7D are diagrams illustrating a phenomenon in which a failure occurs in a pickup step;

Fig. 8 is a flowchart illustrating a first method of changing pickup conditions of a pickup unit according to a first embodiment of the present invention;

Fig. 9 is a diagram illustrating pickup when the amount of push-up of a needle is adjusted;

Fig. 10 is a diagram illustrating pickup when an adsorption force of the push-up device is adjusted;

Figs. 11A to 11C are diagrams illustrating pickup when a time interval is adjusted;

Fig. 12 is a flowchart illustrating a second method of changing the pickup conditions of the pickup unit according to the first embodiment of the present invention;

Figs. 13A and 13B are diagrams illustrating a third method of detecting an adhesive state in a substrate unit according to the first embodiment of the present invention;

Figs. 14A and 14B are diagrams illustrating a fourth method of detecting the adhesive state of an area unit according to the first embodiment of the present invention;

Fig. 15 is a schematic planar view of a front surface of a semiconductor substrate after an expanding step;

Fig. 16 is a graph illustrating a relationship between an adhesive width of an adhesive area of a rear surface of the semiconductor chip, and an interval between the semiconductor chips on a front surface side;

Fig. 17 is a schematic perspective view of the pickup unit according to the embodiment of the present invention; and

Fig. 18 is a flowchart in which pickup conditions of a pickup unit according to a second embodiment of the present invention is changed.

DETAILED DESCRIPTION

[0009]

Steps of manufacturing a semiconductor chip include, for example, a step of forming elements on a surface of a semiconductor substrate or a semiconductor wafer (hereinafter, referred to as a semiconductor substrate or a substrate), a step of attaching a dicing tape to the semiconductor substrate, a step of dicing the semiconductor substrate into semiconductor chips, a step of expanding the dicing tape, a step of picking-up the semiconductor chip from the dicing tape, and a step of mounting the picked semiconductor chip on a circuit substrate or the like. A semiconductor device according to the present invention relates to a pickup unit which is used for the picking-up step after the expanding step. The pickup unit peels off the semiconductor chip which is retained on an adhesive tape such as a dicing tape or an expanding tape from the adhesive tape, and picks up the picked semiconductor chip from an adsorption member such as a collet. The pickup unit may be combined with a device which performs the expanding step which is a preceding step, or a device which performs a die-mounting step which is a subsequent step, and alternatively, may configure a part of the device. The pickup unit may be separate from the device.

[0010]

Elements which are formed on the semiconductor chip are not limited particularly, and may include a light emitting element, a light receiving element, an active element, a passive element, or the like. The light emitting element may be, for example, a surface light emitting type semiconductor laser, a light emitting diode, a light emitting thyristor, or an array in which multiple elements are formed. The passive elements may be a contact image sensor or a line sensor. Furthermore, one semiconductor chip may also include a drive circuit or the like which drives elements. In addition, the semiconductor substrate may be configured by, for example, silicon, SiC, a compound semiconductor, a sapphire, or the like, but is not limited to these, and may be a substrate configured by other materials if the substrate contains at least semiconductor. For example, the light receiving element such as a contact image sensor is formed in a silicon substrate, and, for example, a light emitting element such as a surface light emitting type semiconductor laser or a light emitting diode is formed in a compound semiconductor substrate of a group III-V such as GaAs.

[0011]

A semiconductor chip which is picked up by a pickup unit is mounted on a circuit substrate or the like. The circuit substrate on which a semiconductor chip in which a light emitting element is formed is mounted configures a light source of an image forming device or a light transmission device.

[0012]

Hereinafter, a pickup unit will be described in detail with reference to the accompanying drawings, as an example of a semiconductor manufacturing device according to the present invention. The scale, shape, or the like of the drawing is emphasized such that the characteristics of the invention can be easily understood, and it should be noted that the scale, or the shape, is not the same as that of an actual device.

Embodiments

[0013]

Fig. 1A is a schematic perspective view which schematically illustrates a pickup unit according to an embodiment of the present invention, Fig. 1B is a schematic sectional view thereof, Fig. 2A is a schematic top view of a semiconductor substrate on which elements are formed, and Fig. 2B is a schematic perspective view of one semiconductor chip.

[0014]

As illustrated in Fig. 2A, multiple semiconductor chips 10 are formed on a front surface of a semiconductor substrate W in an array shape and a matrix. Here, as an example, the semiconductor chip 10 of a rectangular shape in which a vertical and horizontal aspect ratio is great is illustrated, and the respective semiconductor chips 10 are separated in a grid pattern by cutting areas 20 which are defined by scribed lines with an interval S. In general, one semiconductor chip has a rectangular shape with a length L in a depth direction, a width W, and a height H, but the width W is much greater than the length L, and the height H is greater than the length L, as illustrated in Fig. 2B. For example, multiple light emitting elements are formed in a semiconductor chip with a great aspect ratio, in the width W direction. However, a configuration of the semiconductor chip illustrated in Figs. 2A and 2B is an example, and the semiconductor chip may have a rectangular shape with a great aspect ratio, or may have a square shape in which the length L is approximately the same as the width W.

[0015]

For example, an ultraviolet curable adhesive tape is attached to the rear surface of the semiconductor substrate W, the semiconductor substrate W is diced along the cutting areas 20 by a dicing device or the like, and divided into individual semiconductor chips. Thereafter, the adhesive tape is irradiated with ultraviolet, an adhesive layer is cured, and then the adhesive tape is expanded. In an expanding step, for example, the adhesive tape is mounted on a heated stage, the adhesive tape is expanded by pulling the adhesive tape in a two-dimensional direction, and thus, the interval S of the semiconductor chip 10 is expanded.

[0016]

The adhesive tape in an expanded state is held by a holding member of a ring shape, and set to a stage of a pickup deice. A pickup unit 100 according to the preset embodiment includes a stage 110 on which an adhesive tape 30 to which the rear surface of the semiconductor chip 10 is attached is fixed by a holding member which holds the adhesive tape 30, a push-up device 120 which is positioned under the stage 110 and pushes the semiconductor chip upward through the adhesive tape, a collet 130 which is positioned over the stage 110 and adsorbs the front surface of the semiconductor chip that is pushed up, an upper imaging camera 140 which images a front surface side of the semiconductor chip from an upper side of the stage 110, and a lower imaging camera 150 which images a rear surface side of the semiconductor chip from a lower side of the stage 110, as illustrated in Fig. 1A.

[0017]

The push-up device 120 is fixed in an X and Y plane, and the semiconductor chip 10 to be picked up is positioned on the push-up device 120 by moving the stage 110 in an X or Y direction. After the stage 110 is positioned, the push-up device 120 moves a push-up member, such as a needle, upward (in the Z direction), and lifts the adhesive tape 30 and the semiconductor chip 10. By doing so, a part of the rear surface of the semiconductor chip 10 is peeled off from the adhesive tape 30. Meanwhile, the collet 130 is positioned immediately above the semiconductor chip 10, adsorbs the rear surface of the semiconductor chip 10, and is moved in the Z direction. Accordingly, the semiconductor chip 10 is picked up in the Z direction with the collet 130, and the semiconductor chip 10 is completely peeled off from the adhesive tape 30. The semiconductor chip adsorbed by the collet 130 is transported to a circuit substrate or a different position.

[0018]

The push-up device 120 includes a cylindrical needle cap 160 having a flat front surface, and a via-hole 162 of a ring shape which extends in an axis direction is formed in approximately the center of the needle cap 160, as illustrated in Fig. 1B. A needle 164 is contained in the via-hole 162, and the needle 164 is moved up and down by a push-up drive device 166 in the Z direction. That is, when the semiconductor chip is picked up, the push-up drive device 166 raises the needle 164 such that the needle 164 protrudes from the front surface of the needle cap 160, and if pickup is completed, the push-up drive device 166 drops the needle 164 such that the needle 164 does not protrude from the front surface of the needle cap 160. In addition, multiple adsorbing holes 168 are formed around the via-hole 162. The adsorbing hole 168 is coupled to an adsorbing device 170 which generates negative pressure, and adsorbs the rear surface of the adhesive tape 30 positioned on the needle cap 160. Here, four adsorbing holes of a ring shape are illustrated, but the shape and the number of the adsorbing holes are not particularly limited.

[0019]

Fig. 3 is a diagram illustrating an operation of the push-up device 120. If the semiconductor chip to be picked up is positioned on the push-up device 120, the rear surface of the adhesive tape 30 is adsorbed to the front surface of the needle cap 160 through the adsorbing hole 168, as illustrated in Fig. 1B. Subsequently, if the needle 164 is raised by the push-up drive device 166, the needle 164 makes the adhesive tape 30 and the semiconductor chip 10 thereon protrude, as illustrated in Fig. 3. By doing so, the adhesive tape 30 is deformed in a convex manner around the needle 164, and the adhesive tape 30 is peeled off from the rear surface of the semiconductor chip 10 at a portion R from which slope starts. When the rear surface of the semiconductor chip 10 is peeled off from the adhesive tape 30, a distance in a width direction is referred to as the amount of peeling D.

[0020]

Fig. 4 is a block diagram illustrating an electrical configuration of the pickup unit 100 according to the present embodiment. The pickup unit 100 receives image data from the upper imaging camera 140 and the lower imaging camera 150, and is configured to include an image processing unit 210 which performs image processing of the received image data, a storage unit 220 which stores data such as parameters for controlling an operation relevant to pickup, a stage drive unit 230 which moves the stage 110 in the X direction or the Y direction, a collet drive unit 240 which moves the collet 130 in the X direction, the Y direction, and the Z direction and controls adsorption of the collet 130, an adsorbing force adjustment unit 250 which adjusts adsorbing force of the adsorbing device 170 of the push-up device 120, a push-up amount adjustment unit 260 which adjusts the amount of push-up of the push-up drive device 166 of the push-up device 120, and a control unit 270 which controls each unit.

[0021]

The image processing unit 210 recognizes the semiconductor chip 10 by interpreting the image data from the upper imaging camera 140. For example, as illustrated in Fig. 2B, when the semiconductor chip 10 is imaged from an upper portion approximately and immediately above the semiconductor chip, the image processing unit 210 detects the contour of the semiconductor chip, that is, the contour of width W´length L, using an edge detection filter. The detected result is provided to the control unit 270, and the control unit 270 controls movement of the stage 110 on the basis of the detected result.

[0022]

Furthermore, the image processing unit 210 interprets an adhesive state of the rear surface of the semiconductor chip 10 and the adhesive tape 30 by interpreting image data from the lower imaging camera 150. The rear surface of the semiconductor chip is held by the adhesive tape 30 through a sticking layer or an adhesive layer, but an adhesive state of the rear surface of the semiconductor chip depends upon the respective semiconductor chips. As described above, if an expanding step in which the interval S of the semiconductor chip 10 is expanded before a pickup step, the adhesive tape is expanded in the X and Y directions, and as a result, a part of the rear surface of the semiconductor chip 10 is peeled off from the adhesive tape 30. It is preferable that all the semiconductor chips are uniformly peeled off, but peeled states, that is, adhesive states of the semiconductor chips, differ from each other. In the present embodiment, the lower imaging camera 150 images the rear surface side of the semiconductor substrate W, and the adhesive state of the semiconductor chip is detected from the imaged data.

[0023]

Fig. 5 schematically illustrates an adhesive state of the rear surface of the semiconductor chip 10 after the expanding step. If the rear surface of the semiconductor chip across the adhesive tape is viewed from the rear surface side of the semiconductor substrate W, there is a difference of darkness and lightness, or a difference of color tone between an adhesive area P to which the rear surface of the semiconductor chip 10 adheres by means of the adhesive tape 30, and a peeled area Q which is peeled off from the adhesive tape 30. The adhesive tape 30 includes an adhesive layer and a light-transmissive base material, has a dark color if the rear surface of the semiconductor chip adheres to the adhesive tape by means of the adhesive layer, and had a light color if the rear surface of the semiconductor chip is peeled off from the adhesive tape. If the adhesive tape 30 is expanded, the semiconductor chip 10 is in a state in which both end portions of the rear surface thereof are peeled off and the central portion between both end portions adheres to the adhesive tape, but an adhesive width Wp of the adhesive area P may not be uniform depending on the semiconductor chips.

[0024]

The image processing unit 210 interprets image data from the lower imaging camera 150, and provides the interpreted result to the control unit 270. The control unit 270 detects an adhesive state of the semiconductor chip on the basis of the interpreted result, and controls the pickup operation on the basis of the detected result, as will be described below.

[0025]

The storage unit 220 stores parameters for controlling the pickup operation of the semiconductor chip. As an example, corresponding relationships between adhesive states of the semiconductor chips and optimal parameters are confirmed in advance by experiment or simulation, and the relationships are stored in the storage unit 220. The relationships between the adhesive states and the optimal parameters which are stored in the storage unit 220 are referred to as optimal parameter information for the sake of convenience. In the present embodiment, the amount of push-up of the needle, adsorbing force of the adsorbing device 170, and a time interval up to the pickup of the next semiconductor chip are used as the parameters for controlling the pickup of the semiconductor chip.

[0026]

An example of the optimal parameter information will be described. Here, an adhesive area is used as an adhesive state of the semiconductor chip, but the adhesive state may be referred to as index other than this, and for example, may be the adhesive width Wp illustrated in Fig. 5. The adhesive area is approximately a size (adhesive width Wp ´ length L) of the adhesive area P. An example in which parameters for control are set to the amount of push-up of the needle will be described. The larger the adhesive area is, the greater the amount of push-up of the needle 164 is, and the smaller the adhesive area is, the less the amount of push-up of the needle 164 is. If the adhesive area is large, adhesive strength increases, and thus, it is difficult for the rear surface of the semiconductor chip to be peeled off from the adhesive tape. For this reason, the amount of push-up of the needle increases.

[0027]

An example in which the parameters for control are set to the adsorbing force of the adsorbing device 170 will be described. The larger the adhesive area is, the greater the adsorbing force is, and the smaller the adhesive area is, the less the adsorbing force is. If the adhesive area is large, it is difficult for the rear surface of the semiconductor chip to be peeled off from the adhesive tape. For this reason, the adsorbing force of the adhesive tape 30 is increased by the adsorbing device 170, and thus, peeling is expedited.

[0028]

An example in which the parameters for control are set to the time interval up to the pickup of the next semiconductor chip will be described. The larger the adhesive area is, the shorter time interval is, and the smaller the adhesive area is, the longer the time interval is. If the adhesive area is large, the adhesive force increases, and the time when a next adjacent semiconductor chip returns to an original posture thereof after the semiconductor chip is picked up is shortened. In contrast to this, if the adhesive area is small, the time when a subsequent adjacent semiconductor chip returns to an original posture thereof is lengthened. If the posture of the semiconductor chip becomes bad, image recognition of the upper imaging camera 140 may not be performed normally, and thus, a control of the optimal time interval according to the adhesive state is required. A relationship between the adhesive state and the parameters will be described below.

[0029]

The stage drive unit 230 moves the stage 110 in the X direction and Y direction such that the semiconductor chip to be picked up next is positioned to the push-up device 120, on the basis of the image interpretation result of the image data of the upper imaging camera 140.

[0030]

When the semiconductor chip is picked up, the collet drive unit 240 positions the collet 130 in an immediately upward direction of the push-up device 120, and adsorbs the front surface of the semiconductor chip through an adsorbing hole 132 of the collet 130. In addition, the collet drive unit 240 moves the collet 130 which adsorbs the semiconductor chip to a positioned place, and releases the semiconductor chip by stopping the adsorption.

[0031]

The adsorbing force adjustment unit 250 adjusts adsorbing force of the adsorbing device 170. The adsorbing device 170 adsorbs the rear surface of the adhesive tape 30 using a constant adsorbing force which is created by negative pressure set in advance and is transferred through the adsorbing hole 168. In addition, the adsorbing force adjustment unit 250 varies the adsorbing force of the adsorbing device 170 according to parameters which are determined by the control unit 270.

[0032]

The push-up amount adjustment unit 260 adjusts the amount of push-up of the needle which is performed by the push-up drive device 166. The push-up drive device 166 pushes up the needle 164 by the amount of push-up set in advance, thereby peeling off a part of the rear surface of the semiconductor chip from the adhesive tape 30. In addition, the push-up amount adjustment unit 260 varies the amount of push-up of the push-up drive device 166 according to the parameters determined by the control unit 270.

[0033]

The control unit 270 controls an operation of each unit of the pickup unit 100. The control unit 270 includes, for example, a microcontroller, a microprocessor, or a ROM/RAM, and controls the pickup unit by executing, for example, a program stored in the ROM/RAM. In the present embodiment, the control unit 270 includes a pickup control program for controlling each unit of the pickup unit. Fig. 6 illustrates a functional block diagram of the pickup control program. As illustrated in Fig. 6, a pickup control program 280 includes a semiconductor chip recognition unit 282, an adhesive state detection unit 284, and a parameter determination unit 286.

[0034]

The semiconductor chip recognition unit 282 recognizes a semiconductor chip to be picked up next on the basis of the contour information of the semiconductor chip which is the interpreted result of the image data of the upper imaging camera 140 that is processed by the image processing unit 210. The semiconductor chip recognition unit 282 controls the stage drive unit 230 on the basis of the recognized result, and moves the stage 110 in the X direction and the Y direction, such that a semiconductor chip to be picked up next is positioned in the push-up device 120.

[0035]

The adhesive state detection unit 284 detects the adhesive state of the semiconductor chip on the basis of the interpreted result of the image data of the lower imaging camera 150 which is processed by the image processing unit 210. The adhesive state of the rear surface of the semiconductor chip is, for example, an adhesive state of the adhesive area P illustrated in Fig. 5, and here, an adhesive area Sp or the adhesive width Wp is detected as an index indicating the adhesive state. Edge detection filtering is performed as an example of a method of detecting the adhesive area Sp or the adhesive width Wp, thereby extracting the contour of the rear surface of the semiconductor chip from the image data. For example, when one image is configured by n bits, one piece of image data is represented by gradation data of 2n pieces. As illustrated in Fig. 5, a difference between darkness and lightness is represented in the adhesive area P and the peeled area Q, and thus, image data is compared with a threshold which defines constant darkness, the number of pixels with a value higher than or equal to the threshold, that is, the number of dark pixels which are included in the image data is counted, and the sum of the counted pixels is referred to as the adhesive area Sp. At this time, the sum of pixels in consecutive areas in which the pixels with a value higher than or equal to the threshold are more than or equal to the number of predetermined pixels, may be determined to be the adhesive area Sp.

[0036]

In addition, if the adhesive width Wp is detected, for example, the number of consecutive pixels in a width direction may be detected as the adhesive width Wp on the basis of the position information of a pixel group which is detected as the adhesive area Sp. In this case, the adhesive width Wp may be a width of an angle of any one of a lateral direction, a vertical direction, and an oblique direction, with respect to the adhesive area P, and in addition, it is not necessary for a an adhesive width to be determined to be as a maximum width. That is, in an angle at which a relationship between a magnitude of adhesive force and the size of the adhesive area Sp is established, a width of an arbitrary angle may be determined to be the adhesive width Wp.

[0037]

The parameter determination unit 286 determines optimal parameters for controlling pickup of the semiconductor chip on the basis of the detected result of the adhesive state detection unit 284. In the present embodiment, the parameters for controlling the pickup are the adsorbing force of the adsorbing device 170, the amount of push-up of the needle of the push-up drive device 166, and the time interval up to the image processing of the next semiconductor chip which is performed by the upper imaging camera 140. The adjustment of the time interval may be performed at any timing, and for example, start time of the image processing of the image processing unit 210, moving time of the stage 110 of the stage drive unit 230, or the like may be managed by a timer. The parameter determination unit 286 reads the optimal parameter information from the storage unit 220 in response to the detected result of adhesive state performed by the adhesive state detection unit 284, compares the detected adhesive state with the optimal parameter information, and determines optimal parameters according to the detected adhesive state. The parameters determined by the parameter determination unit 286 are provided to the adsorbing force adjustment unit 250 and the push-up amount adjustment unit 260. The adsorbing force adjustment unit 250 varies the adsorbing force according to the determined parameters. The push-up amount adjustment unit 260 varies the amount of push-up according to the determined parameters.

[0038]

Next, an operation of the pickup unit according to the present embodiment will be described. Failure in the pickup step is generated by a phenomenon in which the semiconductor chip may not be recognized in the image data of the upper imaging camera 140 due to the tilted posture of the semiconductor chip, a phenomenon in which two semiconductor chips are taken, or the like. A mechanism which is the cause of occurrence of the phenomenon results from the amount of peeling D (refer to Fig. 3) of the semiconductor chip from the adhesive tape, or the posture of the semiconductor chip. If the amount of peeling D is great, the posture of the semiconductor chip is collapsed and not detected or may not be recognized by the image data, and two semiconductor chips adjacent to each other are drawn and taken by the collet. In contrast to this, if the amount of peeling D is small, the rear surface of the semiconductor chip is not peeled off from the adhesive tape, and pickup failure occurs.

[0039]

Fig. 7A illustrates an example in which the semiconductor chip is not taken by the collet 130, in a case in which the amount of peeling D of the semiconductor chip is small. If the amount of peeling D is small, the adhesive area increases, adhesive strength between the rear surface of a semiconductor chip 10A and the adsorbing force of the adhesive tape 30 is greater than the adsorbing force of the collet 130, and thereby pickup failure of the semiconductor chip 10A occurs. Fig. 7B illustrates an example in which a semiconductor chip 10B is not taken by the collet 130, in a case in which the amount of peeling D of the semiconductor chip 10B is great. Since the amount of peeling D is great, the adhesive strength decreases. If the posture of the semiconductor chip 10B is tilted due to this reason, the front surface of the semiconductor chip 10B may not be adsorbed by the collet 130, and thus, pickup failure occurs. Fig. 7C illustrates an example in which two semiconductor chips are taken by the collet 130. If the amount of peeling D of a semiconductor chip 10C-2 is great and the posture thereof is slightly tilted toward a semiconductor chip 10C-1, the two semiconductor chips 10C-1 and 10C-2 are simultaneously picked up by the collet 130. Fig. 7D illustrates an example in which, when the amount of peeling D of a semiconductor chip 10D is great, the posture of the semiconductor chip 10D is tilted, and thereby the semiconductor chip 10D may not be recognized in the image data of the upper imaging camera 140. Particularly, the tilt of the posture of the semiconductor chip 10D easily occurs when the semiconductor chips adjacent to each other are picked up, that is, when the semiconductor chips adjacent to each other and the adhesive tape are pushed up by the needle. In addition, the failure easily occurs when the aspect ratio of the semiconductor chip is great as illustrated in Fig. 2B, compared to a case in which the aspect ratio of the semiconductor chip is small.

[0040]

The semiconductor chip which is determined to undergo to pickup failure in the pickup step has to be wasted, and thus, the yield is inevitably reduced. For this reason, in order to increase the yield, it is very important to reduce the failure rate of the pickup step.

[0041]

The failure rate of the pickup step of the related art depends upon wafers, and depends upon the semiconductor chips of the wafer. One of the reasons for this is that even though the adhesive states of the rear surfaces of the semiconductor chips are different from each other depending upon the wafers, and are different even within the wafer surface, the pickup is performed with the same pickup condition in both situations. That is, pickup conditions do not correspond to variations of the adhesive states of the wafers or within the wafer. Meanwhile, even if the pickup conditions correspond to the variations of the adhesive states, the number of steps increases in order to adjust the pickup conditions, and thus, changing the pickup conditions is very complicated, and at the same time, adjustment thereof depends upon the experience of an operator. According to the above-described situation, as optimal pickup conditions are automatically applied to the semiconductor chips having different adhesive states from each other, the yield increases, and the number of adjustment steps for a change of pickup conditions and influence of the difference in skill level between operators are reduced. Hence, in the pickup unit according to the present embodiment, parameters for adjusting the pickup conditions are automatically changed in accordance with the adhesive state of the semiconductor chip.

[0042]

Fig. 8 is a flowchart illustrating a first method of automatically changing the pickup conditions of the pickup unit according to the present embodiment. If the expanding step which is a preceding step is completed (S100), an adhesive tape that is adhered to by the semiconductor substrate in which the intervals between the semiconductor chips are expanded is held by a holding member of a ring shape, the holding member is set on the stage 110 of the pickup unit 100 (S102), and the pickup operation starts under a control of the control unit 270.

[0043]

If the holding member including the semiconductor substrate is set on the stage 110, imaging of the semiconductor substrate is performed by the upper imaging camera 140 and the lower imaging camera 150 from a lower side and an upper side of the stage 110, respectively, and image processing of the image data is performed by the image processing unit 210. The semiconductor chip recognition unit 282 recognizes a semiconductor chip to be picked up next on the basis of the interpreted result of the image processing unit 210, the stage 110 moves in accordance with the recognized result, and the semiconductor chip is positioned in the push-up device 120. In addition, the adhesive state detection unit 284 detects an adhesive state between the rear surface of the semiconductor chip and the adhesive tape on the basis of the interpreted result of the image processing unit 210 (S104). Here, the adhesive state detection unit 284 detects the adhesive state of the semiconductor chip to be picked up after being recognized by the semiconductor chip recognition unit 282. The parameter determination unit 286 compares the adhesive state detected by the adhesive state detection unit 284 with the optimal parameter information read from the storage unit 220 (S106), and determines optimal parameters according to the detected adhesive state (S108). For example, in a case in which the amount of push-up is adjusted as the parameter, the parameter determination unit 286 selects an adhesive area which coincides with and is nearest to the detected adhesive area Wp from the optimal parameter information, and determines the amount of push-up corresponding to the selected adhesive area. Alternatively, in a case in which adsorbing force is adjusted as the parameter, the parameter determination unit 286 determines the adsorbing force corresponding to the adhesive area which coincides with and is nearest to the detected adhesive area Wp. Alternatively, in a case in which a time interval is adjusted as the parameter, the parameter determination unit 286 determines the time interval corresponding to the adhesive area which coincides with and is nearest to the detected adhesive area Wp. The parameter determination unit 286 may determine not only one parameter, but also two or three parameters simultaneously. That is, each parameter between the amount of push-up and the adsorbing force may be determined, each parameter between the amount of push-up and the time interval may be determined, each parameter between the adsorbing force and the time interval may be determined, or three parameters between the amount of push-up, the adsorbing force, and the time interval may be determined simultaneously.

[0044]

If the parameters are determined by the parameter determination unit 286, the pickup of the semiconductor chip is performed by the amount of push-up, the adsorbing force, or the time interval which are adjusted in accordance with the parameters (S110). Subsequently, it is determined whether or not the pickup of all the semiconductor chips in the semiconductor substrate is completed (S112). If there is the semiconductor chip which is not picked up, the operation in step S104 is repeated, and when the pickup of all the semiconductor chips in the semiconductor substrate is completed, the flow is terminated.

[0045]

Next, each parameter will be described. Fig. 9 is a diagram illustrating pickup when the amount of push-up of the needle is adjusted. As illustrated in Fig. 9, the push-up drive device 166 varies the amount of push-up V of the needle 164 which protrudes from the front surface of the needle cap 160 in accordance with the parameter determined by the parameter determination unit 286. That is, when the adhesive area of the rear surface of the semiconductor chip is great, the amount of push-up V increases, and in contrast to this, when the adhesive area is small, the amount of push-up V decreases. Accordingly, the amount of peeling D is controlled in accordance with the adhesive area. As a result, the failure illustrated in Figs. 7A to 7D is reduced.

[0046]

Fig. 10 is a diagram illustrating pickup when the adsorbing force of the push-up device is adjusted. As illustrated in Fig. 10, the adsorbing device 170 varies the adsorbing force which adsorbs the rear surface of the adhesive tape 30 from the adsorbing groove 168 in accordance with the parameter determined by the parameter determination unit 286. That is, when the adhesive area of the rear surface of the semiconductor chip is great, the adsorbing force increases, and in contrast to this, when the adhesive area is small, the adsorbing force decreases. Accordingly, the adsorbing force which pulls the adhesive tape 30 in a direction of peeling is varied, and the amount of peeling D is controlled in accordance with the adhesive area.

[0047]

Figs. 11A to 11C are diagrams illustrating pickup when the time interval is adjusted. First, in Fig. 1A, when the semiconductor chip 10A is picked up, the semiconductor chip 10A and the adhesive tape 30 are pushed up by the needle 164. At this time, the adhesive tape 30 is formed in a convex shape, and thus, the semiconductor chip 10B adjacent to the semiconductor chip 10A is tilted. Immediately after the pickup of the semiconductor chip 10A is completed, the adhesive tape 30 starts to return to an original state as illustrated in Fig. 11B, and when a predetermined amount of time passes, the adhesive tape completely returns to the original state, as illustrated in Fig. 11C. When the adhesive area of the semiconductor chip 10B is small, the adhesive strength is weakened, and time is taken until the posture of the semiconductor chip 10B returns to the original state. However, if the adhesive area of the semiconductor chip 10B is large, the time which is taken until the posture of the semiconductor chip 10B returns to the original state is shortened. If the posture of the semiconductor chip 10B is bad, the semiconductor chip 10B may not be correctly recognized by the upper imaging camera 140, or the semiconductor chip 10B may not be correctly positioned, and thereby, there is a possibility that the semiconductor chip 10B may not be adsorbed by the collet 130. For this reason, the time interval is adjusted in accordance with the adhesive area of the semiconductor chip. The time interval is a period from a time when the semiconductor chip 10A of the semiconductor chip is pushed up to a time when image recognition of the semiconductor chip 10B is performed, and the time may be adjusted at any section of the period. In addition, in a case in which the parameter of the time interval is determined, it is necessary to detect the adhesive state of the semiconductor chip 10B adjacent to the semiconductor chip 10A. Hence, the adhesive state detection unit 284 detects simultaneously the adhesive state of the semiconductor chip 10A to be picked up, and the adhesive state of the next semiconductor chip 10B adjacent to the semiconductor chip 10A, but may regard the adhesive state of the semiconductor chip 10A as the adhesive state of the semiconductor chip 10B.

[0048]

The adhesive states of each semiconductor chip are detected by using the above-described method, the parameters are changed in accordance with the detected adhesive states, and thus, if the number of semiconductor chips within the semiconductor substrate is great, time is taken until the pickup is completed. In contrast to this, even if variation exists in the adhesive state of the semiconductor chip within the semiconductor substrate, the pickup operation corresponding to each adhesive state is performed, and thus, the failure of the pickup step is reduced.

[0049]

Fig. 12 illustrates a second method of automatically changing the pickup conditions according to the present embodiment. An example in which, while the adhesive state of the semiconductor chip which is picked up, the parameters are changed is detected as the first method. However, in the second method, the adhesive state of the semiconductor chip is detected, and thereafter, when the semiconductor chip is picked up, the parameters are changed in accordance with the adhesive state of the semiconductor chip. If the expanding step is completed (S200), the holding member which holds the semiconductor substrate and the adhesive tape is set in the stage of the pickup unit (S202). Subsequently, the control unit 270 detects the adhesive states of all the semiconductor chips within the semiconductor substrate, as preprocessing of the pickup. First, the lower imaging camera 150 images the entire rear surface of the semiconductor substrate from the lower side of the stage 110, and the image data is interpreted by the image processing unit 210. The adhesive state detection unit 284 detects the adhesive states of all the semiconductor chips within the semiconductor substrate on the basis of the interpreted result from the image processing unit 210 (S204). The detected adhesive states are stored in the storage unit 220 in association with each semiconductor chip (S206). Subsequently, the pickup of the semiconductor chip starts, if the preprocessing is completed by doing so. If the semiconductor chip which is picked up by the semiconductor chip recognition unit 282 is recognized, the adhesive state detection unit 284 reads the adhesive state corresponding to the recognized semiconductor chip from the storage unit 220 (S208), compares the adhesive state with the optimal parameter information (S210), and then the parameters according to the adhesive state are determined (S212) and the pickup of the semiconductor chip is performed in accordance with the parameters (S214). Thereafter, processing from step S208 to step S214 is repeated until the pickup of all the semiconductor chips within the semiconductor substrate is completed.

[0050]

In this way, according to the second method, the adhesive states of each semiconductor chip on the semiconductor substrate are detected in advance as the preprocessing, and thus, the time required for the pickup operation is shortened. In the same manner as in the second method, if the adhesive state of the semiconductor chip is detected in advance, step S204 may be performed earlier than step S202. That is, before the holding member which holds the semiconductor substrate and the adhesive tape is set in the pickup unit, the rear surface side of the semiconductor substrate is observed by the imaging camera, and the adhesive states of each semiconductor chip may be detected.

[0051]

Next, a third method will be described. According to the first and second methods, the adhesive states of each semiconductor chip are detected, and the parameters of each semiconductor chip are changed, but according to the third method, the adhesive states of the semiconductor chips are detected by a semiconductor substrate unit, and the parameters are changed by a semiconductor substrate unit. If the adhesive state of the semiconductor chip is detected by a semiconductor substrate unit, a representative one semiconductor substrate or multiple semiconductor chips are selected, and the adhesive state of the selected semiconductor chip is set to the adhesive state of the semiconductor substrate. In the same manner as in the second method, even in the third method, the adhesive state is detected in advance by a semiconductor substrate unit for being stored in the storage unit 220, and the adhesive state of the corresponding substrate may be read from the storage unit 220, when the pickup of a substrate which is a target is performed.

[0052]

Next, a method of detecting the adhesive state by a substrate unit will be described. In Fig. 13A, the adhesive state of the semiconductor chip which is positioned in a radial direction of the semiconductor substrate is set to the adhesive state in a substrate unit. For example, the adhesive state of a semiconductor chip 10a which is positioned in an approximately central point ra in a radial direction is detected, and the detected adhesive state is set to the adhesive state of the substrate. The reason is that, when the adhesive tape is expanded in the expanding step, stretching of the adhesive tape is not necessarily uniform, and a peripheral portion may be stretched more greatly than a central portion. As a result, the adhesive area of the semiconductor chip in the peripheral portion easily becomes smaller that in the central portion. Accordingly, by detecting the adhesive state of the semiconductor chip 10a of the central point ra in the radial direction, it is possible to detect an average adhesive state of the central portion and the peripheral portion.

[0053]

In addition, the adhesive states of multiple semiconductor chips within the substrate are detected, and the adhesive state of a substrate unit may be obtained from the detected result. For example, the adhesive states of multiple semiconductor chips which are positioned in one radial direction are detected, the adhesive states of the multiple semiconductor chips which are positioned in multiple radial directions are detected, or the adhesive states of semiconductor chips which are positioned in random multiple places on the substrate are detected, and an average adhesive state of the detected result is calculated. In Fig. 13B, adhesive states of semiconductor chips 10a, 10b, and 10c of three points ra, rb, and rc in a radial direction are detected, and an adhesive state of a substrate unit is calculated from the detected result. The “average” of the present specification may be not only a simple arithmetic average of the detected adhesive state, but also values included in a third of the center of values which are obtained by trisecting a range between a maximum value and a minimum value of the detected value, and may be other detected values except for the maximum value and the minimum value among the detected values.

[0054]

According to the third method, when there is a difference between adhesive states of semiconductor chips on semiconductor substrates, parameters are changed in a semiconductor substrate unit in accordance with an adhesive state, and thus, failure of pickup is reduced in a substrate unit. In addition, a change of the parameters is performed only once per one semiconductor substrate unlike the first and second methods, and thus, time required for pickup of one semiconductor substrate is shortened.

[0055]

Next, a fourth method will be described. In the third method, an adhesive state is detected in a semiconductor substrate unit, and parameters are changed, but in the fourth method, an adhesive state is detected in multiple semiconductor chips of a semiconductor substrate, in other words, an adhesive state is detected in area units of a semiconductor substrate, and parameters are changed. In Fig. 14A, a semiconductor substrate is divided into multiple concentric areas, an average adhesive state is calculated from the adhesive states of one or multiple semiconductor chips included in each area, and the calculated average adhesive state is set to an adhesive state of an area unit. In addition, In Fig. 14B, a semiconductor substrate is divided into multiple rectangular areas, an average adhesive state is calculated from the adhesive states of one or multiple semiconductor chips included in each area, and the calculated average adhesive state is set to an adhesive state of an area unit. In the same manner as in the second method, also in the fourth method, adhesive states of the area units of a semiconductor substrate are stored in the storage unit 220, and when the pickup of a semiconductor chip in the corresponding area is performed, an adhesive state of the area is read, and parameters for each area are changed.

[0056]

According to the fourth method, even if there is a difference of an adhesive state between the areas of a semiconductor substrate, parameters are changed in accordance with the adhesive states of the areas, and thus, a pickup control is performed with less failure than in a method of changing parameters in a substrate unit. In addition, time required for pickup is shortened more than in the first and second methods.

[0057]

Next, a second embodiment of the present invention will be described. In the first embodiment, an adhesive state of a semiconductor chip is detected by observing a rear surface of the semiconductor chip across an adhesive tape from imaging data which is obtained by imaging the rear surface side of the semiconductor substrate, but in the second embodiment, an adhesive state of a semiconductor chip is detected from a front surface side of a semiconductor substrate. Fig. 15 illustrates a planar view of a semiconductor chip on a front surface of a semiconductor substrate after an expanding step. Each of the semiconductor chips 10 is separated from each other by the interval S as illustrated in Figs. 2A and 2B, but the interval S is expanded to an interval Se by the expanding step. The interval Se has a constant correlation with an adhesive state of a rear surface of a semiconductor chip. Fig. 16 is a graph illustrating a relationship between the adhesion width Wp of the adhesive area P of the semiconductor chip illustrated in Fig. 5, and the interval Se of a semiconductor chip on a front surface side of a substrate. As is apparent from Fig. 16, it can be seen that there is correlation between the adhesive width Wp and the interval Se. That is, the smaller the adhesive width Wp of a rear surface of a semiconductor chip is, the wider the interval Se is, and the greater the adhesive width Wp is, the narrower the interval Se is. If the adhesive width Wp of the rear surface of the semiconductor chip becomes smaller, adhesive force decreases, and thus, the interval Se becomes wider. If the adhesive width Wp becomes greater, the adhesive force increases, and thus, the interval Se becomes narrower. In this way, an inverse proportional relationship is established between the adhesive width Wp and the interval Se, and thus, an adhesive state of a rear surface of a semiconductor chip is detected by imaging a front surface side of a semiconductor substrate, without observing the rear surface side of the semiconductor substrate using an imaging camera.

[0058]

Fig. 17 is a schematic perspective view of the pickup unit according to the second embodiment. The same reference numerals will be attached to the same configuration as in Figs. 1A and 1B. A pickup unit 100A according to the second embodiment has substantially the same configuration as the pickup unit according to the first embodiment, except for the lower imaging camera 150.

[0059]

Fig. 18 illustrates a flowchart in which pickup conditions according to the second embodiment are automatically changed. The flowchart corresponds to the first method (Fig. 8) according to the first embodiment. After the expanding step (S300), a holding device which holds an adhesive tape including a semiconductor device is set over the stage 110 of the pickup unit 100A (S302), and a pickup operation starts. The upper imaging camera 140 images a front surface side of a semiconductor substrate (S304), the imaged data is interpreted by the image processing unit 210, and the interpreted results are provided to the semiconductor chip recognition unit 282 and the adhesive state detection unit 284. The semiconductor chip recognition unit 282 recognizes a semiconductor chip to be picked up next (S306), and the stage drive unit 230 moves the stage 110 in the X and Y directions on the basis of the recognized results for positioning the semiconductor chip in the push-up device 120. In parallel with this, the adhesive state detection unit 284 detects the interval Se of the semiconductor chip (S306). For example, edge detection is performed with respect to the imaged data and thereby an appearance of each semiconductor chip is detected, and the number of pixels between the detected appearances is set to the interval Se. Furthermore, the adhesive state detection unit 284 detects the adhesive width Wp or an adhesive area of a rear surface of a semiconductor chip by using the correlation illustrated in Fig. 16 (S308). The steps from step S310 to step S316 thereafter are the same as those of the first embodiment. In addition, the second embodiment may also be applied to any of the second method to the fourth method, which are described in the first embodiment.

[0060]

According to the second embodiment, an adhesive state of a rear surface of a semiconductor chip is detected by using the image data which is obtained by the upper imaging camera 140, and thus, it is possible to achieve miniaturization and low costs of the pickup unit 100A.

[0061]

In the present specification, “adhesive state” may be replaced with “magnitude of adhesive force” or “state that correlates with adhesive force”. Furthermore, “adhesive state”, “magnitude of adhesive force”, or “state that correlates with adhesive force” may be replaced with “size of an adhesive area”, “size of an adhesive width”, or “size of an interval between semiconductor chips”.

[0062]

Furthermore, in the above-described embodiments, an adhesive state of a semiconductor chip is detected by using image data of a imaging camera, but an operator may confirm an adhesive state with the naked eye, the operator sets an operation relevant to pickup in a pickup unit on the basis of the confirmed results, and the pickup unit may be operated on the basis of the setting.

[0063]

Furthermore, in the above embodiments, a tape for dicing or a tape for expanding is described as an adhesive tape which is attached to a rear surface of a semiconductor substrate, but the adhesive tape may be a tape having the same function as that, and furthermore, may be a base material with flexibility or a member which is obtained by forming a sticking layer, an adhesive layer, or the like on the base material, for example. In addition, a name of the sticking tape is not limited to a tape, and may be a holding member of a sheet shape, for example, a resin, a film, or the like. Furthermore, a sticking layer or an adhesive layer which comes into close contact with a substrate may be a material such as an ultraviolet-curable type material, an ultraviolet-curable type material, an epoxy resin, or the like.

What is claimed is:

1. A semiconductor manufacturing device comprising:

a detection unit which detects an adhesive state between a semiconductor chip and a holding member, in a state in which the holding member having an adhesive layer on which a substrate in a state of being into diced int a plurality of semiconductor chips is held is expanded by pulling stress; and

a pickup unit which picks up the semiconductor chip by changing an operation relevant to pickup of the semiconductor chip on the basis of the detected adhesive state.

2. The semiconductor manufacturing device according to Claim 1, wherein the detection unit detects an adhesive area or an adhesive width between the semiconductor chip and the holding member in a state in which the holding member is expanded as the adhesive state.

3. The semiconductor manufacturing device according to Claim 1, wherein the detection unit detects the size of an interval between the semiconductor chips in a state in which the holding member is expanded as the adhesive state.

4. The semiconductor manufacturing device according to Claim 1, wherein the detection unit detects the size of an interval between the semiconductor chips in a state in which the holding member is expanded as the adhesive state.

5. The semiconductor manufacturing device according to Claim 2, wherein the detection unit includes an imaging unit which images the substrate, and detects the adhesive state on the basis of density of an image that is captured by the imaging unit.

6. The semiconductor manufacturing device according to Claim 1,

wherein the pickup unit includes a push-up unit which pushes up the holding member and the semiconductor chip from the side of a surface of the substrate to which the holding member adheres, and

wherein the push-up unit changes the amount of push-up of the semiconductor chip on the basis of the detected adhesive state.

7. The semiconductor manufacturing device according to Claim 2,

wherein the pickup unit includes a push-up unit which pushes up the holding member and the semiconductor chip from the side of a surface of the substrate to which the holding member adheres, and

wherein the push-up unit increases the amount of push-up of the semiconductor chip as the adhesive area or the adhesive width is large.

8. The semiconductor manufacturing device according to Claim 3,

wherein the pickup unit includes a push-up unit which pushes up the holding member and the semiconductor chip from the side of a surface of the substrate to which the holding member adheres, and

wherein the push-up unit decreases the amount of push-up of the semiconductor chip as the interval is large.

9. The semiconductor manufacturing device according to Claim 1,

wherein the pickup unit includes an adsorbing unit which adsorbs a holding member to which the substrate adheres, and

wherein the adsorbing unit changes adsorbing force on the basis of the detected adhesive state.

10. The semiconductor manufacturing device according to Claim 2,

wherein the pickup unit includes an adsorbing unit which adsorbs a holding member to which the substrate adheres, and

wherein the adsorbing unit increases adsorbing force as the adhesive area or the adhesive width is large.

11. The semiconductor manufacturing device according to Claim 3,

wherein the pickup unit includes an adsorbing unit which adsorbs a holding member to which the substrate adheres, and

wherein the adsorbing unit decreases adsorbing force as the interval is large.

12. The semiconductor manufacturing device according to Claim 1, wherein the pickup unit changes a time interval at which the semiconductor chip is picked up in response to the detected adhesive state.

13. The semiconductor manufacturing device according to Claim 2, wherein the pickup unit decreases a time interval at which the semiconductor chip is picked up as the adhesive area or the adhesive width is large.

14. The semiconductor manufacturing device according to Claim 3, wherein the pickup unit increases a time interval at which the semiconductor chip is picked up as the time interval is large.

15. The semiconductor manufacturing device according to Claim 1,

wherein the detection unit detects the adhesive state of a central area of the substrate in a radial direction or detects an average adhesive state in the radial direction, and

wherein the pickup unit changes an operation relevant to the pickup in a substrate unit, on the basis of the detected adhesive state.

16. The semiconductor manufacturing device according to Claim 1, wherein the pickup unit changes an operation relevant to the pickup for each of the plurality of semiconductor chips.

17. The semiconductor manufacturing device according to Claim 1,

wherein the detection unit detects the adhesive state for each of the plurality of semiconductor chips, and

wherein the pickup unit changes an operation relevant to the pickup for each of the plurality of semiconductor chips, on the basis of the detected adhesive state.

18. A manufacturing method of a semiconductor chip comprising:

expanding a holding member having an adhesive layer on which a substrate in a state of being diced into a plurality of semiconductor chips is held, using pulling stress; and

picking up the semiconductor chip by changing an operation relevant to pickup of the semiconductor chip, on the basis of an adhesive state between the semiconductor chip and the holding member in a state in which the holding member is expanded.

19. A circuit substrate comprising:

at least one of the semiconductor chips which are manufactured by the semiconductor manufacturing device according to Claim 1.

20. An electronic apparatus comprising:

The circuit substrate according to Claim 19.

ABSTRACT