

Description

Title of Invention: SEMICONDUCTOR MANUFACTURING DEVICE AND
METHOD FOR MANUFACTURING SEMICONDUCTOR DEVICE

5

Technical Field

[0001]

The present disclosure relates to a semiconductor
manufacturing device and is applicable, for example, to a
10 die bonder which handles dice or substrates having position
recognition marks.

Background Art

[0002]

As one step in a manufacturing process of a
15 semiconductor device, a die divided from a wafer is picked
up, and the picked-up die is bonded onto a substrate. For
example, a die or a substrate may be photographed with a
camera to capture an image, and the die or the substrate may
be positioned based on the image.

20 Citation List

Patent Literature

[0003]

PTL 1: Japanese Unexamined Patent Application

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25 Summary of Invention

Technical Problem

[0004]

For example, in the above-described positioning, the edge of a position recognition mark formed on the substrate or die may be used as a reference position. In this case, it may be difficult to obtain the edge position (reference position) with high accuracy.

[0005]

An object of the present disclosure is to provide a technique capable of improving positioning accuracy. Objects and novel features other than the above will be apparent from the description of the present specification and accompanied drawings.

Solution to Problem

15 [0006]

Among this disclosure, a typical one of summary is briefly described as follows.

That is, a semiconductor manufacturing device includes: an imaging device that includes a first camera which photographs a substrate having a tab area on which a die is placed and a reference mark, a second camera which photographs the reference mark, and a lens unit; and a coaxial lighting device. The lens unit includes: a first lens which functions an objective lens of the first camera; 20 a second lens which functions as an objective lens of the

second camera; and a beam splitter which splits reflected light from a subject into the first lens and the second lens.

Advantageous Effects of Invention

[0007]

5 According to the present disclosure, it is possible to improve positioning accuracy.

Brief Description of Drawings

[0008]

FIG. 1 is a schematic top view illustrating a
10 configuration example of a die bonder according to an embodiment.

FIG. 2 is a view describing a schematic configuration as viewed from the direction of an arrow A in FIG. 1.

FIG. 3 is a block diagram illustrating a schematic
15 configuration of a control system of the die bonder illustrated in FIG. 1.

FIG. 4 is a flowchart illustrating a method of manufacturing a semiconductor device using the die bonder illustrated in FIG. 1.

20 FIG. 5 is a view illustrating an example of an optical system of a bonding section.

FIG. 6 is a view illustrating a position recognition mark and a bonding center provided on a substrate.

FIG. 7 is a view illustrating a cross-section of a
25 substrate having leads.

FIG. 8 is a view illustrating the relationship between the leads and lighting device illustrated in FIG. 7.

FIG. 9 is a view describing a lighting device in the embodiment.

5 FIG. 10 is a view describing a teaching operation.

FIG. 11 is a view describing a production operation.

FIG. 12 is a view illustrating the arrangement of an optical system in a bonding section in a first modification.

10 FIG. 13 is a view illustrating the arrangement of an optical system in a bonding section in a second modification.

FIG. 14 is a view illustrating the arrangement of an optical system in a bonding section in a third modification.

FIG. 15 is a view illustrating the arrangement of an optical system in a bonding section in a fourth modification.

15 FIG. 16 is a view illustrating the arrangement of an optical system in a bonding section in a fifth modification.

Description of Embodiments

[0009]

Hereinafter, embodiments and modifications will be
20 described with reference to the drawings. However, in the following description, the same components are given the same reference numerals, and thus their repeated description may be omitted. Incidentally, in order to more clarify the description, the drawings may show the width, thickness,
25 shape, etc. of each part more diagrammatically than in an

actual embodiment. Further, the dimensional relationships, ratios, etc. of elements do not necessarily match between a plurality of drawings.

[0010]

5 The configuration of a die bonder which is an embodiment of a mounting device will be described with reference to FIGS. 1 and 2. FIG. 1 is a schematic top view illustrating a configuration example of a die bonder according to an embodiment. FIG. 2 is a view describing a
10 schematic configuration when viewed from the direction of an arrow A in FIG. 1.

[0011]

 The die bonder 1 roughly includes a wafer supply section 10, a pick-up section 20, an intermediate stage
15 section 30, a bonding section 40, a transport section 50, a substrate supply section 60, a substrate delivery section 70, and a controller (control device) 80. A Y2-Y1 direction is the front-rear direction of the die bonder 1, an X2-X1 direction is the left-right direction, and a Z1-Z2 direction
20 is the up-down direction. The wafer supply section 10 is arranged on the front side of the die bonder 1, and the bonding section 40 is arranged on the rear side thereof.

[0012]

The wafer supply section 10 includes a wafer cassette lifter 11, a wafer holding table 12, a peeling unit 13, and a wafer recognition camera 14.

[0013]

5 The wafer cassette lifter 11 moves a wafer cassette (not illustrated) in which a plurality of wafer rings WR are stored, up and down to a wafer transport height. A wafer correction chute (not illustrated) aligns the wafer ring WR supplied from the wafer cassette lifter 11. A wafer
10 extractor (not illustrated) extracts the wafer ring WR from the wafer cassette and supplies it to the wafer holding table 12, or extracts the same from the wafer holding table 12 and stores it in the wafer cassette.

[0014]

15 A wafer W is adhered (attached) onto a dicing tape DT, and the wafer W is divided into a plurality of dice D. The dicing tape DT is held by the wafer ring WR. A wafer W is, for example, a semiconductor wafer or a glass wafer, and a die D is a semiconductor chip or a glass chip. A film-like
20 adhesive material DF called a die attach film (DAF) may be attached between the wafer W and a dicing tape DT. The adhesive material DF hardens when heated.

[0015]

 A wafer holding table 12 is moved in the X1-X2 and Y1-
25 Y2 directions by an unillustrated drive unit, and moves the

die D to be picked up to the position of a peeling unit 13. Further, the wafer holding table 12 rotates the wafer ring WR within an XY plane by the unillustrated drive section. The peeling unit 13 is moved up and down by the
5 unillustrated drive section. The peeling unit 13 peels off the die D from the dicing tape DT.

[0016]

A wafer recognition camera 14 recognizes the pick-up position of the die D to be picked up from the wafer W and
10 inspects the surface of the die D.

[0017]

The pick-up section 20 includes a pick-up head 21 and a pick-up head table 23. The pick-up head 21 is provided with a collet unit 22 which sucks and holds the peeled die D
15 at its tip. The pick-up head 21 picks up the die D from the wafer supply section 10 and places it on an intermediate stage 31. The pick-up head table 23 moves the pick-up head 21 in the Z1-Z2 direction, the Y1-Y2 direction, and the X1-X2 direction. Incidentally, the pick-up head table 23 may
20 rotate the pick-up head 21.

[0018]

The intermediate stage section 30 includes an intermediate stage 31 on which the die D is placed, and a stage recognition camera 34 for recognizing the die D on the
25 intermediate stage 31. The intermediate stage 31 has a

suction hole which adsorbs the placed die D. The placed die D is temporarily held on the intermediate stage 31. The intermediate stage 31 is a placement stage on which the die D is placed, and also a pick-up stage on which the die D is
5 picked up.

[0019]

The bonding section 40 includes a bond head 41, a bond head table 43, a substrate recognition camera 44, and a bond stage 46. The bond head 41 is provided with a collet unit
10 42 which absorbs and holds the die D at its tip. The bond head table moves the bond head 41 in the Z1-Z2 direction, the Y1-Y2 direction and the X1-X2 direction. Incidentally, the bond head table 43 may rotate the bond head 41. The substrate recognition camera 44 captures an image of a
15 substrate S and recognizes a bond position. Here, the substrate S is, for example, a wiring substrate, a lead frame, a glass substrate, or the like. A plurality of product areas (hereinafter referred to as package areas P) which will ultimately become one package are formed in the
20 substrate S. Further, a position recognition mark (not illustrated) for the package area P is formed in the substrate S. When the die D is placed on the substrate S, the bond stage 46 is raised and supports the substrate S from below. The bond stage 46 has a suction port (not
25 illustrated) for vacuum-adsorbing the substrate S, and is

capable of fixing the substrate S. The bond stage 46 has a heating portion (not illustrated) for heating the substrate S.

[0020]

5 With this configuration, the bond head 41 corrects the pick-up position and posture, based on the imaged data of the stage recognition camera 34 and picks up the die D from the intermediate stage 31. Then, the bond head 41 bonds on the package area P of the substrate S based on the imaged
10 data of the substrate recognition camera 44, or bonds in a stacked form on the die already bonded on the package area P of the substrate S.

[0021]

 The transport section 50 includes transport claws 51
15 which grip and transport the substrate S, and a transport lane 52 along which the substrate S moves. The substrate S is moved in the X1 direction by driving an unillustrated nut of the transport claw 51 provided on the transport lane 52 by an unillustrated ball screw provided along the transport
20 lane 52. With this configuration, the substrate S moves from the substrate supply section 60 to the bond position along the transport lane 52, and after bonding, moves to the substrate delivery section 70 and passes the substrate S to the substrate delivery section 70.

25 [0022]

The substrate supply section 60 removes the substrate S which has been stored in a transport jig and carried in, from the transport jig and supplies it to the transport section 50. The substrate delivery section 70 stores the
5 substrate S transported by the transport section 50 in a transport jig.

[0023]

Next, the controller 80 will be described with reference to FIG. 3. FIG. 3 is a block diagram illustrating
10 a schematic configuration of the control system of the die bonder illustrated in FIG. 1.

[0024]

A control system 8 includes the controller (control device) 80, a drive unit 86, a signal unit 87, and an
15 optical system 88. The controller 80 is configured as a computer including, broadly, a control/arithmetic device 81 mainly comprised of a CPU (Central Processing Unit), a storage device 82, an input/output device 83, a bus line 84, and a power supply unit 85. The storage device 82 has a
20 main storage device 82a and an auxiliary storage device 82b. The main storage device 82a is comprised of a RAM (Random Access Memory) which stores a processing programs and the like. The auxiliary storage device 82b is comprised of a hard disk drive (HDD) or a solid state drive (SSD) which
25 stores control data and image data necessary for control.

Further, the controller 80 can be connected with an external storage device.

[0025]

An input/output device 83 has a monitor 83a which
5 displays a device state, information, etc., a pointing device such as a touch panel 83b for inputting operator's instructions, a mouse 83c for operating the monitor 83a, etc., and an image capturing device 83d which captures image data from the optical system 88. The input/output device 83
10 further includes a motor control device 83e and an I/O signal control device 83f. The motor control device 83e controls the drive unit 86 such as an XY table (not illustrated) of the wafer supply section 10, a pick-up head table 23, a bond head table 43, or the like. The I/O signal
15 control device 83f takes in signals from various sensors of the signal unit 87 and controls switches and volumes which control the brightness of the lighting device or the like in the signal unit 87, valves which control vacuum suction, and the like. The optical system 88 includes a wafer
20 recognition camera 14, a stage recognition camera 34, and a substrate recognition camera 44. The wafer recognition camera 14, the stage recognition camera 34, and the substrate recognition camera 44 digitize the light intensity and color. The control/arithmetic device 81 takes in
25 necessary data via a bus line 84, performs calculations

thereof, controls the pick-up head 21 and the like, and sends information to the monitor 83a and the like.

[0026]

The controller 80 stores image data captured by the
5 wafer recognition camera 14, the stage recognition camera 34,
and the substrate recognition camera 44 in the storage
device 82 via the image capturing device 83d. Using
software programmed based on the stored image data, the
control/arithmetic device 81 determines the positions of the
10 die D and the package area P of the substrate S, and
performs a visual inspection of the die D and the substrate
S. Based on the positions of the die D and the package area
P of the substrate S calculated by the control/arithmetic
device 81, the drive unit 86 is operated by the software via
15 the motor control device 83e. By this process, the die on
the wafer is positioned, and the pick-up head table 23 and
the bond head table 43 are operated to bond the die D onto
the package area P of the substrate S.

[0027]

20 The controller 80 can be configured by installing the
above-described programs stored in the external storage
device into a computer. The external storage device
includes, for example, an HDD, a USB memory, an SSD, etc.
The auxiliary storage device 82b and the external storage
25 device are configured as computer-readable recording media.

Hereinafter, these are also collectively simply called recording media. In the present specification, when the term "recording medium" is used, it may include only the auxiliary storage device 82b, or only external storage
5 device 89 alone, or it may include both of them.
Incidentally, the provision of programs and data to the computer and the provision of programs and data from the computer to an external device may be performed using communication means such as Internet or a dedicated line,
10 without using the external storage device.

[0028]

A part of a manufacturing process of a semiconductor device using the die bonder 1 (a method of manufacturing a semiconductor device) will be described with reference to
15 FIG. 4. FIG. 4 is a flowchart illustrating a method of manufacturing a semiconductor device using the die bonder illustrated in FIG. 1. In the following description, the operation of each component which constitutes the die bonder 1 is controlled by the controller 80.

20 [0029]

(Wafer Carry-In Process: Step S1)

A wafer cassette with a wafer ring WR stored therein is placed into a wafer cassette lifter 11. The wafer ring WR placed therein is supplied (carried in) to the wafer
25 holding table 12.

[0030]

(Substrate Carry-In Process: Step 2)

A transport jig having stored the substrate S therein is inserted into the substrate supply section 60. The
5 substrate supply section 60 takes out the substrate S stored in the transport jig from the transport jig. Then, the substrate S is supplied (carried in) into the bonding section 40 via the transport section 50.

[0031]

10 (Pick-Up Process: Step S3)

After Step S1, the wafer holding table 12 is moved so that a desired die D can be picked up from the dicing tape DT. The die D is photographed by the wafer recognition camera 14, and the die D is positioned and its surface is
15 inspected on the basis of the image data acquired by photographing. By performing image processing on the image data, the amount of deviation (in the X, Y, and θ directions) of the die D on the wafer holding table 12 from a die position reference point of the die bonder is
20 calculated, and thereby positioning is carried out. Note that the die position reference point is held in advance at a predetermined position of the wafer holding table 12 as an initial setting for the device. The image data is subjected to image processing to perform surface inspection of the die
25 D.

[0032]

The positioned die D is peeled off from the dicing tape DT by the peeling unit 13 and the pick-up head 21. The die D peeled off from the dicing tape DT is adsorbed to and
5 held by the collet unit 22 provided on the pick-up head 21, and is transported to and placed on the intermediate stage 31.

[0033]

The die D on the intermediate stage 31 is photographed
10 by the stage recognition camera 34, and the positioning and surface inspection of the die D are carried out based on the image data acquired by photographing. By performing image processing on the image data, the amount of deviation (X, Y, and θ directions) of the die D on the intermediate stage 31
15 from the die position reference point of the die bonder is calculated, and thereby positioning is performed. Note that the die position reference point is held in advance at a predetermined position of the intermediate stage 31 as an initial setting for the device. The image data is subjected
20 to image processing to perform surface inspection of the die D.

[0034]

The pick-up head 21 having transported the die D to the intermediate stage 31 is returned to the wafer supply
25 section 10. According to the above-described procedure, the

next die D is peeled off from the dicing tape DT, and thereafter, the dice D are peeled off one by one from the dicing tape DT according to the same procedure.

[0035]

5 (Bond Process: Step S4)

The substrate S is transported to the bond stage 46 by the transport section 50. The substrate S placed on the bond stage 46 is imaged by the substrate recognition camera 44, and image data is acquired by the imaging. With the
10 image data subjected to image processing, the amount of deviation (X, Y, and θ directions) of the substrate S from a substrate position reference point of the die bonder 1 is calculated. Note that the substrate position reference point is held in advance at a predetermined position of the
15 bonding section 40 as an initial setting for the device.

[0036]

The adsorption position of the bond head 41 is corrected based on the amount of deviation of the die D on the intermediate stage 31 which has been calculated in Step
20 S3, and the die D is adsorbed by the collet unit 42. The die D is bonded to a predetermined location of the substrate S supported by the bond stage 46 by means of the bond head 41 having adsorbed the die D from the intermediate stage 31. The die D bonded to the substrate S is photographed by the
25 substrate recognition camera 44. Based on the image data

acquired by photographing, an inspection (inspection of the relative position of the die D and the substrate S) or the like is performed to determine whether the die D has been bonded in a desired position.

5 [0037]

The bond head 41 having bonded the die D onto the substrate S is returned to the intermediate stage 31. In accordance with the procedure described above, the next die D is picked up from the intermediate stage 31 and bonded to the substrate S. This is repeated until the dice D are bonded to all the package areas P of the substrate S.

[0038]

(Substrate Delivery Process: Step S5)

The substrate S with the die D bonded thereto is delivered from the bonding section 40 to the substrate delivery section 70 by the transport section 50. At the substrate delivery section 70, the substrate S is removed and stored in the transport jig, and then the substrate S is carried out. The transport jig with the substrate S stored therein is carried out from the die bonder 1.

[0039]

As described above, the die D is mounted on the substrate S and delivered from the die bonder 1. Thereafter, for example, the transport jig having stored the substrate S mounted with the die D is transported to a wire bonding

process, and the electrodes of the die D are electrically connected to the electrodes of the substrate S via Au wires or the like. The substrate S is then transported to a molding process, where the die D and the Au wires are sealed with a molding resin (not illustrated), thereby completing a semiconductor package.

[0040]

Next, the optical system in the bonding section will be described with reference to FIG. 5. FIG. 5 is a view illustrating an example of the optical system in the bonding section.

[0041]

The substrate recognition camera 44 as an imaging device includes a first camera 441, a second camera 442, and a lens unit 443 to which the first camera 441 and the second camera 442 are attached. The first camera 441 and the second camera 442 are configured to photograph a main surface (front surface, upper surface) of the substrate S or a main surface of the die D bonded to the substrate S through the lens unit 443. A lighting device 45 is arranged between the lens unit 443 and the substrate S or the like. The first camera 441 and the lighting device 45 are arranged directly above the package area P of the substrate S, which is a subject to be photographed (object).

[0042]

The lens unit 443 includes a first lens 443a and a second lens 443b. The lens unit 443 further includes a half mirror (beam splitter) 443c provided between the first lens 443a and the lighting device 45, and a mirror 443d provided
5 between the second camera 442 and the second lens 443b. Each component of the lens unit 443 may be stored in a lens barrel (cylinder), and the first camera 441 and the second camera 442 may each be fixed to the lens barrel.

[0043]

10 For example, the first camera 441 is a camera which photographs a subject at a low magnification (low resolution). The second camera 442 is a camera which photographs a subject at a high magnification (high resolution). Here, the low magnification means a
15 magnification which allows a sufficient field of view required for positioning to be obtained. The high magnification means a magnification which can provide a pixel resolution capable of detecting the edge of a reference lead to be described later with high accuracy.

20 Note that the first camera 441 may be a camera which photographs a subject at a high magnification (high resolution), and the second camera 442 may be a camera which photographs a subject at a low magnification (low resolution).

25 [0044]

The first lens 443a is an objective lens provided between the first camera 441 and the half mirror 443c. The second lens 443b is an objective lens provided between the mirror 443d and the half mirror 443c. The half mirror 443c splits the light (optical axis 0A) incident on the Z1 side from the Z2 side into transmitted light (optical axis 0A1) toward the Z1 side and reflected light (optical axis 0A2) toward the X1 side. The mirror 443d reflects the light reflected by the half mirror 443c to the Z1 side.

10 [0045]

The number of pixels of each of the first camera 441 and the second camera 442 is, for example, 300,000 pixels to 60 million pixels. For example, when the first camera 441 and the second camera 442 have approximately the same number of pixels, the magnification of the first lens 443a is set to be smaller than the magnification of the second lens 443b. Consequently, the resolution of the first camera 441 becomes smaller than the resolution of the second camera 442. When the number of pixels of the first camera 441 is made smaller than the number of pixels of the second camera 442, the first lens 443a and the second lens 443b are set to be approximately the same magnification. Consequently, the resolution of the first camera 441 becomes smaller than the resolution of the second camera 442.

25 [0046]

The lighting device 45 includes a surface light-emitting illumination (light source) 451 and a half mirror 452 inside the lens barrel. The light irradiated from the surface light-emitting illumination 451 is reflected by the half mirror 452 to the same optical axis as the first camera 441 and the second camera 442, and irradiates the substrate S, etc. The light irradiated to the substrate S through the same optical axis OA as the first camera 441 and the second camera 442 is reflected by the substrate S or the like, and the reflected light passes through the half mirror 452 to reach the first camera 441 and the second camera 442, thereby forming an image of the substrate S or the like. That is, the lighting device 45 has a function of coaxial epi-illumination (coaxial illumination).

15 [0047]

Next, the reference position used for positioning, etc. will be described with reference to FIG. 6. FIG. 6 is a view illustrating a position recognition mark and a bonding center provided on a substrate.

20 [0048]

A position recognition mark M is provided in each package area P of the substrate S. At least one position recognition mark M is provided outside an area (tab area) where the die D is placed. Incidentally, when stack bonding is carried out, the position recognition mark M may be

25

provided on the die D. The position recognition mark M is constituted of, for example, a reference lead. When bonding a die, the coordinates of a bonding center C_B may be expressed as the distance (dx, dy) from the edge (edge, boundary, reference position) of the reference lead. The reference lead may simply be referred to as a lead LE. Incidentally, the coordinates of the bonding center C_B may also be expressed as the distance from a center C_M of the reference lead. The reference position of the position recognition mark M may be the center line in the width direction of the lead, or may be the center or center of gravity of the position recognition mark M. Further, as a reference on the die D side, the coordinates of the corner or center of a bonding pad provided on the die D may be used instead of the coordinates of the bonding center C_B .

[0049]

In this case, the die bonder needs to grasp the coordinates of the reference position by measuring and detecting the width of the lead LE and the center of the lead LE by image processing of the edge of the lead LE, etc. Even if either the edge, center or center line of the reference lead is used as the reference, the substrate recognition camera 44 needs to use a high-magnification lens to make pixel resolution finer in order to more accurately detect the position of the edge of the lead LE or the like.

[0050]

On the other hand, since the substrate recognition camera 44 recognizes (positions) the bonding position and inspects the surface of the die or substrate S, it is
5 necessary to use a low-magnification lens to have a wide field of view which includes at least one package area P.

[0051]

The first camera 441 is capable of photographing the die D and the substrate S at a low magnification, and the
10 second camera 442 is capable of photographing the position recognition mark M at a high magnification. The first camera 441 can capture as a subject, at least an area including the tab area and the position recognition mark M provided outside the tab area. The second camera 442
15 captures the position recognition mark M as a subject. Therefore, the substrate recognition camera 44 is capable of solving the two problems described above.

[0052]

Next, a method for detecting the position of the edge
20 of the lead LE more accurately will be described.

[0053]

First, the lead LE and the lighting device will be described. FIG. 7 is a view illustrating a cross-section of a substrate having leads LE. FIG. 8 is a view illustrating

the relationship between the leads illustrated in FIG. 7 and the lighting device.

[0054]

As illustrated in A of FIG. 7, the surface (upper
5 surface) of the lead LE needs only to be flush (same height) with the surface (upper surface) of the substrate S. However, the surface of the lead LE is not flush with the surface of the substrate S, and the surface of the lead may protrude or be recessed from the surface of the substrate S,
10 or the side thereof may be rounded. For example, as illustrated in B of FIG. 7, the lead LE may be convex with respect to the surface of the substrate S, and the side thereof may be curved.

[0055]

15 Even when observing at a high magnification in the state illustrated in B of FIG. 7, only the flat portion of the upper surface of the lead LE becomes bright as illustrated in A of FIG. 8 when using coaxial illumination close to parallel light as the lighting device 45, and
20 therefore only the flat portion of the upper surface of the lead LE can be observed.

[0056]

Oblique lighting may be used as the lighting device 45 so that light is irradiated onto the side of the lead LE.
25 However, since the reflected light from the lead LE have a

large amount of specular reflection components, only the edge of the lead LE becomes bright as illustrated in B of FIG. 8, and only the side of the lead LE is emphasized, thereby making it difficult to detect the edge in image processing. This is because the shading distribution (brightness: BR) becomes a pair of pulses on the side of the lead LE. It is preferable that the shading distribution is a rectangular wave.

[0057]

Next, a lighting device suitable for the lead LE as illustrated in B of FIG. 7 will be described with reference to FIG. 9. FIG. 9 is a view illustrating the lighting device according to the embodiment.

[0058]

As illustrated in A of FIG. 9, it is preferable to use the surface light-emitting type coaxial lighting device illustrated in FIG. 5 as the lighting device 45.

Alternatively, it is preferable to use a coaxial lighting device 453 and a dome lighting device 454 in combination as illustrated in B of FIG. 9. The coaxial lighting device 453 may be the surface light-emitting type coaxial lighting device illustrated in FIG. 5, or may be a parallel light type or a coaxial lighting device which emits nearly parallel light. The dome lighting device 454 has an opening in the center of its ceiling, above which the coaxial

lighting device 453 is provided. The surface light-emitting type coaxial lighting and dome lighting can have large incident light NA (range of light which reaches a point where the subject is located), so that light can also be
5 applied onto the side of the lead LE.

[0059]

In this case, it is preferable to determine the incident light NA of the illumination in consideration of the following. It is sufficient to emit illumination in a
10 range wider than the incident light NA determined by these conditions.

[0060]

(a) The horizontal distance from the edge of the lead LE to the position where bending starts (d illustrated in B
15 of FIG. 7)

(b) The amount of inclination of the side part of the lead LE (θ illustrated in B of FIG. 7)

(c) The light intensity of reflected light on the surface of the lead LE

20 [0061]

An example of a positioning method will be described with reference to FIGS. 10 and 11. FIG. 10 is a view describing a teaching operation. FIG. 11 is a view describing a production operation.

25 [0062]

A positioning algorithm mainly uses pattern matching using a template model (search algorithm using template matching), and is taken to be model matching such as calculation on the basis of a commonly known normalized correlation formula or a geometric search. The result is taken to be a matching rate. The template matching includes the teaching operation of reference learning and the production operation of product assembly.

[0063]

10 Substrate positioning will be described by way of example. The teaching operation is an operation performed in advance of the die bonding process illustrated in FIG. 4.

[0064]

 The controller 80 photographs the reference substrate S by the first camera 441 of the substrate recognition camera 44 to acquire an image PCr as illustrated in FIG. 10. The second camera 442 of the substrate recognition camera 44 photographs the position recognition mark M formed on the reference substrate S to acquire an image.

20 [0065]

 An operator of the die bonder uses a human interface (touch panel 83b or mouse 83c) to select a unique area UA including a characteristic pattern from within the image PCr. Here, the characteristic pattern of the unique area UA is, 25 for example, a position recognition mark M. The position

recognition mark M is illustrated in a cross shape by way of example, but is not limited thereto. For example, among the wirings formed on the substrate S, a wiring (lead) having a characteristic pattern (for example, an L-shaped pattern) ,
5 or a circular lead illustrated in FIG. 10 may be used as the position recognition mark M.

[0066]

The controller 80 stores the positional relationship (coordinates) between the selected unique area UA and the
10 reference substrate S in the storage device 82. For example, the reference position coordinates on the die side (refer to FIG. 6) of the bonding center C_B of the reference substrate S relative to the reference position of the position recognition mark M, or the like are stored.

15 [0067]

The controller 80 stores an image of the unique area UA serving as a reference (hereinafter referred to as a template image PT) and its coordinates in the storage device 82. For example, the template image PT includes an image of
20 a position recognition mark M. The coordinates of the stored template image PT are the position coordinates of the center C_M of the position recognition mark M calculated based on the image of the position recognition mark M, and the reference position (refer to FIG. 6) calculated based on

the lead width of the reference lead which constitutes the position recognition mark M.

[0068]

Next, the production operation in the die bonding
5 process illustrated in FIG. 4 will be described.

[0069]

In Step S4, the controller 80 images the product substrate S with the first camera 441 of the substrate recognition camera 44 to acquire an image PCn illustrated in
10 FIG. 11.

[0070]

As illustrated in FIG. 11, the controller 80 compares the template image PT stored in the teaching operation with the acquired image PCn of the product substrate S, and
15 calculates the coordinates of an image PTn of the most similar portion.

[0071]

The controller 80 compares the coordinates of the image PTn with the coordinates measured on the reference
20 substrate S, and calculates the position of the product substrate S (the offset between the image PTn and the template image PT).

[0072]

Next, the effects brought about by the present
25 embodiment will be described.

[0073]

Even if a value of the pixel resolution is greater than the repeat bonding accuracy, the image system used for positioning is capable of having the positioning performance
5 required for the bonding accuracy by statistical calculations in image processing. However, this only achieves reproducibility accuracy. In order to mount the die accurately at the location desired to mount the die, there is a need to feed back the result of the amount of
10 deviation measured by a separate offline system after temporary bonding. Although this system can secure the reproducibility of bonding, it is difficult to detect the reference surface of a workpiece (for example, the edge of the reference lead (called reference edge)) at a resolution
15 below the pixel resolution. Therefore, it is difficult to realize a teaching operation which specifies an offset from the reference surface.

[0074]

Therefore, the above-described problem can be solved
20 by increasing the magnification and thereby making the pixel resolution finer. However, the high magnification leads to narrowing of the field of view, thereby making it impossible to obtain a sufficient field of view required for positioning.

25 [0075]

It is possible to obtain both high magnification and a wide field of view by a zoom lens and a twin-lens optical system. However, there are the following problems.

[0076]

5 The zoom lens can solve the above-described problem because the magnification can be changed actively. However, in the case of a zoom lens having a drive system, the field of view position reproducibility accuracy is affected when the magnification is changed. In other words, when the
10 magnification is returned to the original magnification after being changed, mechanical movement errors are involved, and therefore 100% coordinate reproducibility is not possible. Therefore, the offset between the template model and the reference edge used during positioning contains
15 variations. It is also conceivable to solve the above-described problems by preparing a plurality of cameras different in magnification, but this may result in one of the cameras being arranged such that it loses its perpendicularity to a workpiece (the optical axis becomes
20 tilted).

[0077]

According to the present embodiment, at least one or more of the following effects is brought about.

[0078]

(a) Since the cameras with two types of magnifications are installed on the same optical axis, it is possible to maintain high reproducibility of the field of view position when switching.

5 [0079]

(b) It is possible to detect the reference edge more accurately with a high magnification optical system. Consequently, it becomes possible to accurately detect the offset of the template model of the reference edge. The
10 accuracy of detecting the reference edge can be improved.

[0080]

(c) Positioning using pattern matching with a wide-field (low magnification) optical system is possible.

[0081]

15 (d) The above method makes it possible to stably obtain the offset between the reference position for positioning specified at a high magnification and the model registered at a low magnification (the offset can be obtained accurately even if teaching is performed again).

20 [0082]

(e) An offset measurement in offline is no longer necessary.

[0083]

<Modifications>

Several representative modifications of the embodiment will be described below. In the following description of the modifications, the same reference numerals as in the above-described embodiment may be used for parts having the same configurations and functions as those described in the above-described embodiment. Further, for the description of such parts, the description in the above-mentioned embodiment may be appropriately cited within the technical non-inconsistent scope. Further, parts of the above-described embodiment and all or part of the multiple modifications may be applied complexly as appropriate within a scope which is not technically inconsistent.

[0084]

The arrangement of the mirrors and lenses in the lens unit 443 may be changed. The arrangement of the camera may also be changed. Further, the arrangement of the lighting device may be changed. These will be described below.

[0085]

(First Modification)

An optical system in a first modification will be described with reference to FIG. 12. FIG. 12 is a view illustrating the arrangement of the optical system of the bonding section in the first modification.

[0086]

In the first modification, the mirror 443d is provided on the Z1 side of the first lens 443a. Incidentally, the arrangement of the first lens 443a, the second lens 443b, and the half mirror 443c is the same as in the embodiment.

5 The first camera 441 is provided on the X1 side of the mirror 443d. The second camera 442 is provided on the X1 side of the second lens 443b. Similarly to the embodiment, the half mirror 443c splits the light incident on the Z1 side from the Z2 side into transmitted light to the Z1 side
10 and reflected light to the X1 side. The mirror 443d reflects the transmitted light from the half mirror 443c to the X1 side.

[0087]

(Second Modification)

15 An optical system in a second modification will be described with reference to FIG. 13. FIG.13 is a view illustrating the arrangement of the optical system of the bonding section in the second modification.

[0088]

20 In the second modification, the mirror 443d is not provided. Incidentally, the arrangement of the first lens 443a, the second lens 443b, and the half mirror 443c is the same as in the embodiment. The first camera 441 is provided on the Z1 side of the first lens 443a. The second camera
25 442 is provided on the X1 side of the second lens 443b.

Similarly to the embodiment, the half mirror 443c splits the light incident on the Z1 side from the Z2 side into transmitted light to the Z1 side and reflected light to the X1 side.

5 [0089]

(Third Modification)

An optical system in a third modification will be described with reference to FIG. 14. FIG.14 is a view illustrating the arrangement of the optical system of the bonding section in the third modification.

[0090]

In the third modification, the second lens 443b is provided between the second camera 442 and the mirror 443d. Other arrangements are the same as in the embodiment.

15 [0091]

(Fourth Modification)

An optical system in a fourth modification will be described with reference to FIG. 15. FIG.15 is a view illustrating the arrangement of the optical system of the bonding section in the fourth modification.

[0092]

In the fourth modification, a lighting device 47 is inserted into the lens unit 443 in the second modification. The lighting device 47 is an insertion type coaxial illumination having a light source 471, and a half mirror

25

472 provided between the half mirror 443c and the second lens 443b. The light source 471 may be parallel light or diffused light.

[0093]

5 (Fifth Modification)

An optical system in a fifth modification will be described with reference to FIG. 16. FIG.16 is a view illustrating the arrangement of the optical system of the bonding section in the fifth modification.

10 [0094]

In the fifth modification, a lighting device 47 is inserted into the lens unit 443 in the second modification. The lighting device 47 is an insertion type coaxial illumination having a light source 471, and a half mirror 472 provided between the half mirror 443c and the first lens 443a. The light source 471 may be parallel light or diffused light.

[0095]

The disclosure made by the present inventors has been specifically described above based on the embodiment and the modifications. However, it goes without saying that the present disclosure is not limited to the above-described embodiment and modifications, and can be modified in various ways.

25 [0096]

A lens having an NA capable of accurately detecting a lead edge may be used. This makes it possible to apply illumination light even to the side of the lead even when using a coaxial illumination device which emits parallel
5 light or nearly parallel light.

[0097]

In the embodiment, there has been described the example in which the die attach film is used, but a preform portion for applying an adhesive to the substrate may be
10 provided to make it unnecessary to use a die attach film. The preform portion includes a preform head which applies a paste adhesive and a preform table which drives the preform head in vertical and horizontal directions.

[0098]

15 In the embodiment, there has been described the die bonder in which the die is picked up from the wafer supply section by the pick-up head and placed on the intermediate stage, and the die placed on the intermediate stage is bonded to the substrate by the bond head. However, the
20 present invention is not limited to this, and can also be applied to a die bonder which picks up a die from a wafer supply section with a bond head and bonds it to a substrate.

[0099]

For example, the present invention can also be applied
25 to a die bonder which has no intermediate stage and pick-up

head and bonds a die of a wafer supply section to a substrate with a bond head.

[0100]

Further, the present invention can be applied to a
5 flip chip bonder which does not have an intermediate stage,
picks up a die from a wafer supply section, turns a flip
pick-up head upside down, transfers the die to a bond head,
and bonds the die to a substrate by the bond head.

[0101]

10 In the embodiment, the die bonder has been described
by way of example, but the present invention can also be
applied to a mounting device which picks up a workpiece by
suction and places the picked-up workpiece on a substrate or
the like.

15 Reference Signs List

[0102]

- 1: die bonder (semiconductor manufacturing device)
- 44: substrate recognition camera (imaging device)
- 441: first camera
- 20 442: second camera
- 443: lens unit
- 443a: first lens
- 443b: second lens
- 443c: half mirror (beam splitter)
- 25 45: lighting device

[CLAIMS]

[Claim 1]

A semiconductor manufacturing device comprising:

5 an imaging device including: a first camera which photographs a substrate having a tab area on which a die is placed and a reference mark; a second camera which photographs the reference mark; and a lens unit; and

 a coaxial lighting device, wherein

10 the lens unit includes:

 a first lens which functions as an objective lens of the first camera;

 a second lens which functions as an objective lens of the second camera; and

15 a beam splitter which splits reflected light from a subject into the first lens and the second lens.

[Claim 2]

The semiconductor manufacturing device according to Claim 1, wherein

20 the beam splitter is arranged to split the reflected light from the subject into transmitted light in an upward vertical direction and reflected light in a horizontal direction, and

 the coaxial lighting device is provided more on the

25 substrate side than the lens unit.

[Claim 3]

The semiconductor manufacturing device according to Claim 1, wherein

the beam splitter is arranged to split the reflected
5 light from the subject into transmitted light in an upward
vertical direction and reflected light in a horizontal
direction, and

the coaxial lighting device is provided to be inserted
into the lens unit.

10 [Claim 4]

The semiconductor manufacturing device according to Claim 1, wherein

the coaxial lighting device has a surface light-
emitting light source.

15 [Claim 5]

The semiconductor manufacturing device according to Claim 1, further including

a dome lighting device provided more on the substrate
side than the coaxial lighting device.

20 [Claim 6]

The semiconductor manufacturing device according to Claim 1, wherein

the reference mark is constituted of a lead.

[Claim 7]

The semiconductor manufacturing device according to Claim 1, including

a controller that is configured to position the substrate based on an image acquired by photographing the substrate by the first camera and an image acquired by photographing the reference mark by the second camera.

[Claim 8]

A method for manufacturing a semiconductor device, comprising the steps of:

10 photographing a substrate by an imaging device of a semiconductor manufacturing device, the semiconductor manufacturing device comprising the imaging device and a coaxial lighting device, the imaging device including a first camera that photographs a substrate having a tab area on which a die is placed and a reference mark, a second camera that photographs the reference mark, and a lens unit, the lens unit having a first lens which functions as an objective lens of the first camera, a second lens which functions as an objective lens of the second camera, and a beam splitter which splits reflected light from a subject into the first lens and the second lens; and

25 positioning the substrate based on an image acquired by photographing the substrate by the first camera and an image acquired by photographing the reference mark by the second camera.