

DESCRIPTION

Title of Invention: CUTTING APPARATUS, AND METHOD FOR MANUFACTURING CUT PRODUCT

5 Technical Field

[0001] The present invention relates to a cutting apparatus and a method for manufacturing a cut product.

Background Art

10 [0002] JP 2018-142572A (Patent Document 1) discloses a cutting apparatus that cuts a package substrate along a planned cutting line to divide the package substrate into individual package devices. In this cutting apparatus, a plurality of alignment marks provided on the package substrate are detected. Also, using a reference line which is a straight line that connects one alignment mark serving as the start point of
15 the planned cutting line and another alignment mark serving as the end point of the planned cutting line, a maximum amount of warping is calculated by measuring the distance between the reference line and the alignment mark that is the farthest from the reference line among the alignment marks that correspond to the planned cutting line. Cutting of the package substrate is performed based on whether the calculated
20 maximum amount of warping is an allowable value or less (see Patent Document 1).

Citation List

Patent Document

[0003] Patent Document 1: JP 2018-142572A

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Summary of Invention

Technical Problem

[0004] In the cutting apparatus disclosed in Patent Document 1, the method for cutting the package substrate is determined with consideration given to the maximum amount of warping of the package substrate, and therefore the planned cutting line can be cut with high accuracy even if a substrate has warping. However, the above-mentioned Patent Document 1 does not disclose a technique for further improving the quality of a package device (an example of a cut product) manufactured by a cutting apparatus.

[0005] The present invention has been made to solve such problems, and an object of the present invention is to provide a cutting apparatus that can provide an operator with information that contributes to improving the quality of the cut product to be manufactured, and a method for manufacturing a cut product that can improve the quality of the cut product to be manufactured.

Solution to Problem

[0006] A cutting apparatus according to an aspect of the present invention is for cutting an object to be cut. The cutting apparatus includes a table, a cutting mechanism, and an image capturing device. The table is configured to hold the object to be cut. The cutting mechanism is configured to cut the object to be cut held by the table. The image capturing device is configured to capture an image of the object to be cut held by the table. The object to be cut has a plurality of marks formed in an image capturing region in which image capturing is performed by the image capturing device. The cutting apparatus further includes a storage unit and a display unit. The storage unit is configured to store images and coordinates of a plurality of reference marks. The display unit is configured to display, for each of the marks in the image captured by the image capturing device, a coordinate deviation amount indicating an amount of deviation of coordinates from a corresponding mark among the plurality of reference marks stored in the storage unit.

[0007] A method for manufacturing a cut product according to another aspect of the present invention is a method for manufacturing a cut product using the above-described cutting apparatus. The cutting mechanism cuts the object to be cut in accordance with a cutting rule set in advance. The method for manufacturing a cut product includes: displaying the coordinate deviation amounts respectively related to the plurality of marks in the image captured by the image capturing device; changing a setting of the cutting rule based on displayed coordinate deviation amounts; and manufacturing the cut product by cutting the object to be cut in accordance with the changed cutting rule.

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Advantageous Effects of Invention

[0008] According to the present invention, it is possible to provide a cutting apparatus that can provide an operator with information that contributes to improving the quality of the cut product to be manufactured, and a method for manufacturing a cut product that can improve the quality of the cut product to be manufactured.

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Brief Description of Drawings

[0009] FIG. 1 is a plan view schematically showing a cutting apparatus.

FIG. 2 is a plan view schematically showing a holding member.

20 FIG. 3 is a schematic cross-sectional view taken along line III-III of FIG. 2.

FIG. 4 is a diagram schematically showing an example of alignment marks shown on the ball/lead surface of a package substrate.

FIG. 5 is a diagram schematically showing a hardware configuration of a computer.

25 FIG. 6 is a diagram schematically showing an example of alignment marks used for alignment when cutting the package substrate along the lengthwise direction.

FIG. 7 is a diagram schematically showing a data table for managing data

used in first alignment.

FIG. 8 is a diagram schematically showing an example of alignment marks used for alignment when cutting the package substrate along the widthwise direction.

FIG. 9 is a diagram schematically showing a data table for managing data
5 used in second alignment.

FIG. 10 is a diagram schematically showing an example of an image showing deviation amounts calculated through the first alignment.

FIG. 11 is a flowchart showing an alignment preparation procedure.

FIG. 12 is a flowchart showing an alignment and cutting procedure.

FIG. 13 is a flowchart showing a procedure for displaying deviation amounts
10 of alignment marks.

FIG. 14 is a diagram showing an example of an image displayed on a monitor in step S320 of FIG. 13.

FIG. 15 is a flowchart showing a procedure for reviewing electronic
15 component manufacturing conditions.

FIG. 16 is a diagram for describing a first example of other information that is additionally displayed.

FIG. 17 is a diagram for describing a second example of other information that is additionally displayed.

FIG. 18 is a diagram schematically showing an example of another image
20 displayed on the monitor.

FIG. 19 is a diagram schematically showing a first alternative example of a mark whose coordinates are stored in advance in a storage unit.

FIG. 20 is a diagram schematically showing a second alternative example of
25 a mark whose coordinates are stored in advance in the storage unit.

Description of Embodiments

[0010] Embodiments according to aspects of the present invention (hereinafter also referred to as “present embodiment”) will be described in detail below with reference to the drawings. In the drawings, identical or corresponding elements are denoted by the same reference numerals, and descriptions of those elements are not repeated. Also, the illustrations in the drawings are schematic illustrations with elements omitted or exaggerated as appropriate to facilitate understanding.

[0011] [1. Configuration]

<1-1. Configuration of cutting apparatus>

FIG. 1 is a plan view schematically showing a cutting apparatus 1 according to the present embodiment. The cutting apparatus 1 is configured to cut a package substrate (an example of an object to be cut) to divide the package substrate into a plurality of individual electronic components (an example of a cut product). In the package substrate, substrate or lead frames with semiconductor chips fixed thereto are each sealed with resin. Note that the object to be cut does not necessarily need to be a package substrate, and may be, for example, a substrate (or a wafer) that is not sealed with resin.

[0012] Examples of package substrates include a BGA (Ball Grid Array) package substrate, an LGA (Land Grid Array) package substrate, a CSP (Chip Size Package) package substrate, an LED (Light Emitting Diode) package substrate, and a QFN (Quad Flat No-leaded) package substrate.

[0013] The cutting apparatus 1 is also configured to inspect each of the separated electronic components. In the cutting apparatus 1, images of the electronic components are captured, and the electronic components are inspected based on the captured images. Inspection data is generated through the inspection, and each electronic component is classified as a “good component” or a “defective component”.

[0014] In this example, a package substrate P1 is the object to be cut, and the

cutting apparatus 1 divides the package substrate P1 into a plurality of individual electronic components S1. Hereinafter, regarding the two main surfaces of the package substrate P1, the resin-sealed surface will be referred to as the mold surface, and the surface opposite to the mold surface will be referred to as the ball/lead surface.

5 Note that in the case where the object to be cut is a substrate that is not sealed with resin, the surface that faces upward during cutting (i.e., the cut surface) corresponds to the ball/lead surface in the present embodiment, and the surface opposite to the cut surface corresponds to the mold surface in the present embodiment.

[0015] As shown in FIG. 1, the cutting apparatus 1 includes a cutting module A1
10 and an inspection/storage module B1 as constituent elements. The cutting module A1 is configured to cut the package substrate P1 to produce a plurality of electronic components S1. The inspection/storage module B1 is configured to inspect each of the manufactured electronic components S1, and then store the electronic components S1 in trays. Various constituent elements of the cutting apparatus 1
15 can be removed from the other constituent elements and replaced.

[0016] The cutting module A1 mainly includes a substrate supply unit 3, a positioning unit 4, cutting tables 5, spindle units 6, and a transport unit 7.

[0017] A magazine M1 stores a plurality of package substrates P1, and the substrate supply unit 3 supplies the package substrates P1 one by one to the
20 positioning unit 4 by pushing out the package substrates P1 one by one from the magazine M1. At this time, the package substrates P1 are each arranged such that the ball/lead surface faces upward.

[0018] The positioning unit 4 positions the package substrate P1, which has been pushed out from the substrate supply unit 3, by arranging the package substrate P1
25 on the rail portion 4a. Thereafter, the positioning unit 4 transports the positioned package substrate P1 to the cutting table 5.

[0019] The cutting table 5 holds the package substrate P to be cut. Here, the

illustrated cutting apparatus 1 has a twin cut table configuration including two cutting tables 5. Each of the cutting tables 5 includes a holding member 5a, a rotating mechanism 5b, and a moving mechanism 5c. The holding member 5a holds the package substrate P1 transported by the positioning unit 4 by suctioning the package substrate P1 from below. The rotating mechanism 5b is capable of rotating the holding member 5a on a horizontal plane in a direction $\theta 1$ shown in the figure. The moving mechanism 5c is capable of moving the holding member 5a along the Y axis shown in the figure.

[0020] FIG. 2 is a plan view schematically showing the holding member 5a. FIG. 3 is a schematic cross-sectional view taken along line III-III of FIG. 2. As shown in FIGS. 2 and 3, the holding member 5a includes a holding member body 31 and a jig 32. The holding member body 31 is a metal member having a rectangular shape in a plan view. The jig 32 is attached to the top of the holding member body 31. The package substrate P1 is placed on the jig 32. A space SP1 is formed between the holding member body 31 and the jig 32 in the Z-axis direction. A suction mechanism (not shown) is connected to the space SP1.

[0021] The jig 32 includes a plate-shaped portion 33 made of metal or resin, and a rubber portion 34. The jig 32 attached to the holding member body 31 is replaceable. The rubber portion 34 is constituted by an elastic member made of rubber or the like. The plate-shaped portion 33 and the rubber portion 34 each have a rectangular shape in a plan view. A plurality of protrusions PR1 are arranged in a matrix on the upper surface of the rubber portion 34. In this example, 18 protrusions PR1 are formed in an array of 3 rows and 6 columns.

[0022] A hole H1 is formed in each of the protrusions PR1. The holes H1 pass through the rubber portion 34 and the plate-shaped portion 33. The space outside the holding member 5a is in communication with the space SP1 via the holes H1. The package substrate P1 is held by suction through the holes H1 by the suction

mechanism (not shown) connected to the space SP1. As a result, the package substrate P1 placed on the rubber portion 34 is adsorbed and held.

[0023] Grooves G1 are formed between adjacent protrusions PR1. Although details will be described later, the package substrate P1 adsorbed and held on the rubber portion 34 is cut by a blade 6a (described later). When cutting the package substrate P1, the blade 6a is at a position in a groove G1 and not in contact with the rubber portion 34.

[0024] Referring to FIG. 1 again, the spindle unit 6 divides the package substrate P1 into a plurality of electronic components S1 by cutting the package substrate P1. Here, the illustrated cutting apparatus 1 has a twin spindle configuration including two spindle units 6. The spindle units 6 can be moved along the X axis and the Z axis shown in the figure. Note that the cutting apparatus 1 may have a single spindle configuration including only one spindle unit 6.

[0025] Each of the spindle units 6 includes a blade 6a and a rotation shaft 6c. The blade 6a cuts the package substrate P1 by rotating at high speed, and thus divides the package substrate P1 into a plurality of electronic components S1. The blade 6a is attached to the rotation shaft 6c so as to be clamped between first and second flanges (not shown). The first and second flanges are fixed to the rotation shaft 6c by fastening members (not shown) such as nuts.

[0026] Each of the spindle units 6 includes a cutting water nozzle, a cooling water nozzle, a waste removal water nozzle, and the like. The cutting water nozzle sprays cutting water toward the blade 6a rotating at high speed. The cooling water nozzle sprays cooling water toward the cut region of the package substrate P1. The waste removal water nozzle sprays waste removal water for removing cutting waste and the like.

[0027] While the cutting table 5 suctions the package substrate P1, an image of the package substrate P1 is captured by a first position checking camera 5d, and the

position of the package substrate P1 is checked. The checking performed using the first position checking camera 5d is, for example, checking of the positions of alignment marks AL1 provided on the package substrate P1. Information on the positions of the alignment marks AL1 is used, for example, to determine a cutting line for the package substrate P1.

[0028] FIG. 4 is a diagram schematically showing an example of the alignment marks AL1 shown on the ball/lead surface of the package substrate P1. As shown in FIG. 4, in this example, a plurality of alignment marks AL1 are printed on the ball/lead surface of the package substrate P1. In this example, each of the alignment marks AL1 is shaped as a cross. Note that the alignment marks AL1 do not necessarily have to be cross-shaped, and may have any characteristic shape (unique shape). Furthermore, the alignment marks AL1 do not necessarily have to have the same shape.

[0029] Referring again to FIG. 1, after the positions of the alignment marks AL1 are checked, a cutting line for the package substrate P1 is determined based on the information on the positions of the alignment marks AL1. Adjustment of the rotation angle of the rotating mechanism 5b and the like are performed based on the determined cutting line. The series of operations for adjusting the cutting position of the package substrate P1 is also called “alignment”. Alignment will be described in more detail later.

[0030] After that, the cutting table 5 moves along the Y axis in the figure toward a corresponding one of the spindle units 6. After the cutting table 5 moves to a position below the spindle unit 6, the package substrate P1 is cut by moving the cutting table 5 and the spindle unit 6 relative to each other. After that, if necessary, an image of the package substrate P1 is captured by a second position checking camera 6b provided in the spindle unit 6, and the position or the like of the package substrate P1 is checked. The checking performed using the second position

checking camera 6b is, for example, the checking of a cutting position and a cutting width of the package substrate P1.

[0031] After the cutting of the package substrate P1 is complete, the cutting table 5 moves away from the spindle unit 6 along the Y axis in the figure while suctioning the separated electronic components S1. During this moving process, a first cleaner 5e cleans and dries the upper surfaces (ball/lead surfaces) of the electronic components S1. This cleaning may be performed by, for example, directly spraying cleaning water onto the upper surfaces of the electronic components S1, or supplying cleaning water to the upper surfaces of the electronic components S1 via a brush or the like. Note that although the cutting apparatus 1 includes two first cleaners 5e arranged side by side in the X-axis direction in the figure, the number of first cleaners 5e is not limited to this.

[0032] The transport unit 7 suctions the electronic components S1 held on the cutting table 5 from above, and transports the electronic components S1 to the inspection table 11 of the inspection/storage module B1. During this transportation process, a second cleaner 7a cleans and dries the lower surfaces (mold surfaces) of the electronic components S1. This cleaning may be performed by, for example, directly spraying cleaning water onto the lower surfaces of the electronic components S1, or supplying cleaning water to the lower surfaces of the electronic components S1 via a brush or the like.

[0033] The inspection/storage module B1 mainly includes the inspection table 11, a first optical inspection camera 12, a second optical inspection camera 13, an arrangement unit 14, and an extraction unit 15. Note that the first optical inspection camera 12 may be provided in the cutting module A1.

[0034] The inspection table 11 holds the electronic components S1 for optical inspection of the electronic components S1. The inspection table 11 can be moved along the X axis in the figure. Furthermore, the inspection table 11 can be vertically

inverted. The inspection table 11 includes a holding member that holds an electronic component S1 by suctioning the electronic component S1.

[0035] The first optical inspection camera 12 and the second optical inspection camera 13 capture images of the two surfaces (ball/lead surface and mold surface) of the electronic component S1. Based on the captured images (image data) generated by the first optical inspection camera 12 and the second optical inspection camera 13, various aspects of the electronic component S1 are inspected. The first optical inspection camera 12 and the second optical inspection camera 13 are each arranged in the vicinity of the inspection table 11 so as to capture an image of the upper portion of the image capturing target.

[0036] The first optical inspection camera 12 captures an image of the mold surface of the electronic component S1 that has been transported to the inspection table 11 by the transport unit 7. After that, the transport unit 7 places the electronic component S1 on the holding member of the inspection table 11. After the holding member suctions the electronic component S1, the inspection table 11 is vertically inverted. The inspection table 11 moves to a position above the second optical inspection camera 13, and an image of the ball/lead surface of the electronic component S1 is captured by the second optical inspection camera 13.

[0037] The inspected electronic components S1 are then disposed on the arrangement unit 14. The arrangement unit 14 can be moved along the Y axis in the figure. The inspection table 11 disposes the inspected electronic components S1 on the arrangement unit 14.

[0038] The electronic components S1 that were disposed on the arrangement unit 14 are transferred to a tray by the extraction unit 15. The electronic components S1 are classified as a “good component” or a “defective component” based on the results of the inspections performed using the first optical inspection camera 12 and the second optical inspection camera 13. The extraction unit 15 transfers each of the

electronic components S1 to a good component tray 15a or a defective component tray 15b based on the classification results. In other words, good components are stored in the good component tray 15a, and defective components are stored in the defective component tray 15b. When the good component tray 15a or the defective component tray 15b is completely full with electronic components S1, it is replaced with a new tray.

[0039] The cutting apparatus 1 further includes a computer 50 and a monitor 20. The monitor 20 is configured to display images. The monitor 20 is constituted by a display device such as a liquid crystal monitor or an organic EL (Electro Luminescence) monitor.

[0040] The computer 50 controls the operations of various units of the cutting module A1 and the inspection/storage module B1, for example. For example, the computer 50 controls the operations of the substrate supply unit 3, the positioning unit 4, the cutting tables 5, the spindle units 6, the transport unit 7, the inspection table 11, the first optical inspection camera 12, the second optical inspection camera 13, the arrangement unit 14, the extraction unit 15, and the monitor 20.

[0041] <1-2. Hardware configuration of computer>

FIG. 5 is a diagram schematically showing the hardware configuration of the computer 50. As shown in FIG. 5, the computer 50 includes a control unit 70, an input/output I/F (interface) 90, an input unit 95, and a storage unit 80, and these elements are electrically connected to each other via a bus.

[0042] The control unit 70 includes a CPU (Central Processing Unit) 72, a RAM (Random Access Memory) 74, a ROM (Read Only Memory) 76, and the like. The control unit 70 is configured to control constituent elements of the computer 50 and constituent elements of the cutting apparatus 1 according to information processing.

[0043] The input/output I/F 90 is configured to communicate with various constituent elements included in the cutting apparatus 1 via signal lines. The

input/output I/F 90 is used in the transmission of data from the computer 50 to various constituent elements of the cutting apparatus 1 and in the reception of data transmitted from various constituent elements of the cutting apparatus 1 to the computer 50. The input unit 95 is configured to accept instructions from the user (operator). The input unit 95 includes one or more of the following: a touch panel, a keyboard, a mouse, and a microphone, for example.

[0044] The storage unit 80 is constituted by an auxiliary storage device such as a hard disk drive or a solid state drive, for example. The storage unit 80 is configured to store a control program 81, for example. Various operations in the cutting apparatus 1 are realized by execution of the control program 81 by the control unit 70. When the control unit 70 is to execute the control program 81, the control program 81 is loaded to the RAM 74. The control unit 70 then controls various constituent elements by using the CPU 72 to interpret and execute the control program 81 loaded to the RAM 74.

[0045] [2. Overview of alignment]

As described above, in the cutting apparatus 1, alignment is performed before the package substrate P1 is cut by the spindle unit 6. Normally, the shapes of package substrates P1 prepared for the manufacturing of the electronic component S1 are not completely identical to each other. For example, the degree of warping varies slightly among the package substrates P1. From the viewpoint of suppressing deterioration in the quality of the manufactured electronic components S1, the cutting line of the package substrate P1 needs to be adjusted according to the degree of warping of the package substrate P1. Therefore, in the cutting apparatus 1, alignment is performed before the package substrate P1 is cut by the spindle unit 6. An overview of alignment will be given below.

[0046] In the cutting apparatus 1, the shapes and coordinates of the alignment marks AL1 used for alignment are registered in advance. The coordinates of the

alignment marks AL1, which are registered in advance, are used as a reference for alignment. The shapes and coordinates of the alignment marks AL1 are registered, for example, by an operator of the cutting apparatus 1 (hereinafter also simply referred to as “the operator”). Information indicating the shapes and coordinates of the alignment marks AL1 is stored in advance in the storage unit 80 of the computer 50.

[0047] FIG. 6 is a diagram schematically showing an example of an alignment mark AL1 used for alignment when cutting the package substrate P1 along the lengthwise direction (hereinafter also referred to as “first alignment”). As shown in FIG. 6, in this example, a plurality of alignment marks AL1 corresponding to three cutting lines CL1 extending in the lengthwise direction are used as a reference in the first alignment.

[0048] FIG. 7 is a diagram schematically showing a data table TB1 for managing data used in the first alignment. As shown in FIG. 7, the data table TB1 manages shape information and coordinate information for each alignment mark AL1 used as a reference during the first alignment. The shape information and the coordinate information of each alignment mark AL1 are generated based on the shape and coordinates of the alignment mark AL1 registered by the operator described above. In the data table TB1, a unique number (No.) is assigned to each alignment mark AL1, and a shape, an X coordinate value, and a Y coordinate value of an alignment mark AL1 are associated with each number. The data table TB1 is stored in the storage unit 80 of the computer 50.

[0049] FIG. 8 is a diagram schematically showing an example of an alignment mark AL1 used for alignment when cutting the package substrate P1 along the widthwise direction (hereinafter also referred to as “second alignment”). As shown in FIG. 8, in this example, a plurality of alignment marks AL1 corresponding to three cutting lines CL1 extending in the widthwise direction are used as a reference in the

second alignment.

[0050] FIG. 9 is a diagram schematically showing a data table TB2 for managing data used in the second alignment. As shown in FIG. 9, the data table TB2 manages shape information and the coordinate information for each alignment mark AL1 used as a reference during the second alignment. The shape information and the coordinate information of each alignment mark AL1 are generated based on the shape and coordinates of the alignment mark AL1 registered by the operator described above. In the data table TB2, a unique number (No.) is assigned to each alignment mark AL1, and a shape, an X coordinate value, and a Y coordinate value of an alignment mark AL1 are associated with each number. The data table TB2 is stored in the storage unit 80 of the computer 50.

[0051] In the cutting apparatus 1, a range for searching for the alignment marks AL1 during the first alignment (hereinafter also referred to as the “first search range”) is determined in advance based on the coordinate information managed in the data table TB1. The first search range is made up of, for example, a plurality of search ranges. The first search range is made up of, for example, a plurality of search ranges centered on the coordinates of each alignment mark AL1 managed in the data table TB1.

[0052] In the cutting apparatus 1, a range for searching for the alignment marks AL1 during the second alignment (hereinafter also referred to as the “second search range”) is determined in advance based on the coordinate information managed in the data table TB2. The second search range is made up of, for example, a plurality of search ranges. The second search range is made up of, for example, a plurality of search ranges centered on the coordinates of each alignment mark AL1 managed in the data table TB2.

[0053] In the first alignment, the first position checking camera 5d captures an image of the package substrate P1 while the lengthwise direction of the package

substrate P1 is aligned along the Y axis. Specifically, a search is performed in the first search range on the image captured by the first position checking camera 5d, and the coordinates of the alignment marks AL1 are detected and stored. Based on the coordinates of the alignment marks AL1, deviation amounts are calculated as described below, and a cutting line for the package substrate P1 is determined. Thereafter, the angle of the rotating mechanism 5b and the position of the blade 6a are adjusted such that cutting is performed along the determined cutting line. The first alignment is performed in this manner.

[0054] Also, in the second alignment, the first position checking camera 5d captures an image of the package substrate P1 while the widthwise direction of the package substrate P1 is aligned along the Y axis. Specifically, a search is performed in the second search range on the image captured by the first position checking camera 5d, and the coordinates of the alignment marks AL1 are detected and stored. Based on the coordinates of the alignment marks AL1, deviation amounts are calculated as described below, and a cutting line for the package substrate P1 is determined. Thereafter, the angle of the rotating mechanism 5b and the position of the blade 6a are adjusted such that cutting is performed along the determined cutting line. The second alignment is performed in this manner.

[0055] In this manner, in the cutting apparatus 1, alignment is performed before the package substrate P1 is cut by the spindle unit 6. Therefore, the cutting apparatus 1 can appropriately cut the package substrates P1 according to, for example, the degree of warping of each package substrate P1.

[0056] [3. Alignment mark deviation amount display function]

There are cases where, for example, the quality of the electronic components S1 (e.g., cut product quality) manufactured after performing the above-mentioned alignment is insufficient. Also, there are cases where further improvement in the quality of the manufactured electronic components S1 is desired. In such cases, it

is useful if the cutting apparatus 1 provides the operator with information that contributes to improving the quality of the electronic components S1 to be manufactured.

[0057] In the cutting apparatus 1, during the first alignment, for each alignment
5 mark AL1 detected in the image captured by the first position checking camera 5d, the amount of coordinate deviation from a corresponding alignment mark AL1 among the reference alignment marks AL1 managed in the data table TB1 is calculated, and the calculation results are stored in the storage unit 80. Also, during the second alignment, for each alignment mark AL1 detected in the image captured
10 by the first position checking camera 5d, the amount of coordinate deviation from a corresponding alignment mark AL1 among the reference alignment marks AL1 managed in the data table TB2 is calculated, and the calculation results are stored in the storage unit 80.

[0058] For example, the deviation amounts calculated in the first and second
15 alignment have a correlation with the degree of warping of the package substrate P1. For example, if the quality of a manufactured electronic component S1 is insufficient, by checking the deviation amounts related to the package substrate P1 used in manufacturing that electronic component S1, it may be found that the cause of the insufficient quality of the electronic component S1 is the degree of warping of the
20 package substrate P1. If the cause is identified, it is possible to improve the quality of the electronic component S1 by resolving the cause. In other words, the deviation amounts calculated through the first and second alignment can be considered to be information that contributes to improving the quality of the electronic component S1.

25 [0059] The cutting apparatus 1 includes a function for displaying deviation amounts of alignment marks. The deviation amount display function is a function for displaying on the monitor 20 the deviation amounts calculated through the first

and second alignment. For example, the deviation amounts related to a selected package substrate P1 selected by an operator from among package substrates P1 cut by the cutting apparatus 1 are displayed on the monitor 20.

[0060] FIG. 10 is a diagram schematically showing an example of an image IM1 showing deviation amounts in the X-axis direction calculated through the first alignment (shown as “X-axis offset” in FIG. 14 described later). As shown in FIG. 10, the image IM1 includes deviation amount information MA1, MA2, and MA3. The image IM1 is displayed on the monitor 20, for example.

[0061] The deviation amount information MA1 indicates the deviation amounts of the alignment marks AL1 that correspond to the left cutting line CL1 (FIG. 6). The deviation amount information MA1 is formed by connecting and grouping deviation amounts MP1. The distance between each deviation amount MP1 included in the deviation amount information MA1 and a reference line SL1 on the left side of the drawing indicates the deviation amount of the corresponding alignment mark AL1 in the X-axis direction.

[0062] The deviation amount information MA2 indicates the deviation amounts of the alignment marks AL1 that correspond to the center cutting line CL1 (FIG. 6). The deviation amount information MA2 is formed by connecting and grouping deviation amounts MP1. The distance between each deviation amount MP1 included in the deviation amount information MA2 and a reference line SL1 at the center of the drawing indicates the deviation amount of the corresponding alignment mark AL1 in the X-axis direction.

[0063] The deviation amount information MA3 indicates the deviation amounts of the alignment marks AL1 that correspond to the right cutting line CL1 (FIG. 6). The deviation amount information MA3 is formed by connecting and grouping deviation amounts MP1. The distance between each deviation amount MP1 included in the deviation amount information MA3 and a reference line SL1 on the

right side of the drawing indicates the deviation amount of the corresponding alignment mark AL1 in the X-axis direction. Note that the reference lines SL1 may or may not be displayed on the monitor 20.

[0064] In this way, in the cutting apparatus 1, for each of the alignment marks
5 AL1 in the image captured by the first position checking camera 5d, the amount of coordinate deviation (specifically, deviation in the X-axis direction) from a corresponding alignment mark AL1 among the reference alignment marks AL1 stored in the storage unit 80 is displayed. By checking the displayed coordinate deviation amounts, the operator can identify, for example, the degree of warping of
10 the package substrate P1. Since the degree of warping of the package substrate P1 is related to the quality of the electronic components S1, the coordinate deviation amounts can be said to be information that contributes to improving the quality of the electronic components S1. Therefore, according to the cutting apparatus 1, by displaying the deviation amounts of the alignment marks AL1 on the monitor 20, it
15 is possible to provide the operator with information that contributes to improving the quality of the electronic components S1 to be manufactured.

[0065] Furthermore, in the cutting apparatus 1, the deviation amounts of the alignment marks AL1 in the image captured by the first position checking camera 5d are displayed in groups (specifically, one group of alignment marks AL1 for each
20 cutting line). By checking the deviation amounts displayed in groups, the operator can more easily identify, for example, the degree of warping of the electronic component S1. Therefore, according to the cutting apparatus 1, the deviation amounts are displayed in groups on the monitor 20, thus making it possible to provide the operator with information that contributes to improving the quality of the
25 electronic components S1 to be manufactured.

[0066] [4. Operation]

<4-1. Alignment preparation>

FIG. 11 is a flowchart showing an alignment preparation procedure. The processing shown in this flowchart is executed by, for example, the control unit 70 of the computer 50. Note that hereinafter, a case will be described in which all of the alignment marks AL1 of one package substrate P1 have the same shape. In the case where some or all of the alignment marks AL1 in one package substrate P1 are different, the alignment preparation may be performed for each alignment mark AL1. The preparation procedure is substantially the same for the first alignment and the second alignment, and therefore the preparation procedure for the first alignment will be described here.

10 [0067] As shown in FIG. 11, the control unit 70 executes registration processing for each alignment mark AL1 used in the first alignment (step S100). In order to perform this registration processing, for example, the package substrate P1 selected by the operator is placed on the holding member 5a such that the lengthwise direction thereof is aligned with the Y-axis direction. An image of the package substrate P1 placed on the holding member 5a is captured by the first position checking camera 5d. For example, a plurality of alignment marks AL1 are detected based on the image captured by the first position checking camera 5d, and an alignment mark AL1 among the detected alignment marks AL1 is selected by the operator for use as a reference. This selection is made via the input unit 95 of the computer 50, for example. The coordinates and an image of each selected reference alignment mark AL1 are stored in the storage unit 80. This completes the registration processing.

15 [0068] After the registration processing is complete, the control unit 70 sets a region to be imaged by the first position checking camera 5d (image capturing region) in the first alignment (step S110). In step S110, for example, a plurality of image capturing regions are set. The image capturing regions set in step S110 correspond to the search ranges included in the above-described first search range. Information regarding the set image capturing regions is stored in the storage unit 80. This

completes preparation for the first alignment.

[0069] <4-2. Alignment and cutting>

FIG. 12 is a flowchart showing an alignment and cutting procedure. The processing shown in this flowchart is executed by the control unit 70 of the computer 50 in a state in which, for example, the package substrate P1 held by the holding member 5a is positioned below the first position checking camera 5d. Note that the procedure is substantially the same for the first alignment and the second alignment, and therefore the procedure for the first alignment and cutting will be described here.

[0070] As shown in FIG. 12, the control unit 70 controls the first position checking camera 5d to capture an image of an unimaged image capturing region among the image capturing regions set in step S110 in FIG. 11 (step S200). The control unit 70 detects the alignment mark AL1 included in the image captured by the first position checking camera 5d, and acquires coordinate information of the detected alignment mark AL1 (step S210). The control unit 70 calculates the deviation amount of the detected alignment mark AL1 in the X-axis direction (sometimes simply referred to as “deviation amount”), and stores the calculated deviation amount in the storage unit 80 (step S220).

[0071] The control unit 70 determines whether or not image capturing has been completed for all of the image capturing regions set in step S110 of FIG. 11 (step S230). If it is determined that image capturing has not been completed (NO in step S230), the control unit 70 executes the processing of step S200 again.

[0072] On the other hand, if it is determined in step S230 that image capturing has been completed (YES in step S230), the control unit 70 calculates a plurality of (three in this example) cutting lines based on the coordinate information of the detected alignment marks AL1 (step S240).

[0073] The control unit 70 determines whether or not it is possible to correct the relative positional relationship between the cutting table 5 and the blade 6a such that

cutting is performed along the calculated cutting lines (step S250). If it is determined that the positional relationship cannot be corrected (NO in step S250), the package substrate P1 is not cut, and the processing shown in this flowchart ends. For example, if the blade 6a will come into contact with a protrusion PR1 (FIG. 3) of the rubber portion 34 no matter how the rotation angle of the rotating mechanism 5b and the position of the blade 6a are adjusted, it is determined that the positional relationship cannot be corrected.

[0074] On the other hand, if it is determined that the positional relationship can be corrected (YES in step S250), the control unit 70 corrects the relative positional relationship between the cutting table 5 and the spindle unit 6 such that cutting is performed along the cutting lines calculated in step S240 (step S260). Thereafter, the control unit 70 controls the cutting table 5 and the spindle unit 6 to cut the package substrate P1 (step S270).

[0075] <4-3. Display of alignment mark deviation amounts>

FIG. 13 is a flowchart showing a procedure for displaying deviation amounts of alignment marks AL1. The processing shown in this flowchart is executed by the control unit 70 of the computer 50 when, for example, an operation for activating the deviation amount display function is performed by the operator.

[0076] As shown in FIG. 13, the control unit 70 determines whether or not the operator has selected a package substrate P1 for which deviation amounts of alignment marks AL1 are to be displayed (step S300). If it is determined that a package substrate P1 has not been selected (NO in step S300), the control unit 70 waits until a package substrate P1 is selected.

[0077] On the other hand, when it is determined that a package substrate P1 has been selected (YES in step S300), the control unit 70 reads out the deviation amounts of the alignment marks AL1 of the selected package substrate P1 from the storage unit 80 (step S310). The control unit 70 controls the monitor 20 to display the read

out deviation amounts (step S320).

[0078] FIG. 14 is a diagram showing an example of an image displayed on the monitor 20 in step S320 of FIG. 13. As shown in FIG. 14, the image includes display regions 21, 22, 23, 24, 25, and 26. In the display region 21, information for identifying the package substrate P1 selected by the operator is displayed. In the display region 22, an image showing the coordinates of the alignment marks AL1 that serve as a reference in the first alignment is displayed. In the display region 23, an image showing the coordinates of the alignment marks AL1 that serve as a reference in the second alignment is displayed.

10 [0079] In the display region 24, deviation amount information generated based on the deviation amounts calculated in the first alignment is displayed. In the display region 25, deviation amount information generated based on the deviation amounts calculated in the second alignment is displayed. In the graphs displayed in the display regions 24 and 25, the scale is adjusted such that the deviation amounts can be easily visually recognized. A reference line SL1 (FIG. 10) may also be displayed in the display regions 24 and 25. In the display region 26, coordinate information of the alignment marks AL1 displayed in the display region (the display region 22 or the display region 23) selected by a cursor CS1 is displayed. The coordinate information of the alignment marks AL1 in the display region 26 may be easily understood if the coordinate information is displayed in a separate table for each group (specifically, for each group of alignment marks AL1 corresponding to a cutting line).

[0080] In this way, in the cutting apparatus 1, for each of the alignment marks AL1 in the image captured by the first position checking camera 5d, the amount of coordinate deviation (specifically, deviation in the X-axis direction) from a corresponding alignment mark AL1 among the reference alignment marks AL1 stored in the storage unit 80 is displayed. According to the cutting apparatus 1, by

displaying the deviation amounts of the alignment marks AL1 on the monitor 20, it is possible to provide the operator with information that contributes to improving the quality of the electronic components S1 to be manufactured.

[0081] <4-4. Review of manufacturing conditions>

5 FIG. 15 is a flowchart showing a procedure for reviewing the manufacturing conditions of the electronic components S1. The steps shown in this flowchart are performed by the operator.

[0082] As shown in FIG. 15, the operator checks the deviation amount information displayed on the monitor 20 (step S400). The operator changes a cutting rule setting for the package substrate P1 based on the deviation amount
10 information displayed on the monitor 20 (step S410). Example of cutting rules include the number of alignment marks AL1 used during alignment and the cutting line calculation algorithm. The operator again performs electronic component S1 manufacturing using the cutting apparatus 1 with the changed cutting rule settings
15 (step S420).

[0083] In this manner, in the manufacturing method of the electronic component S1, a cutting rule setting is changed based on the deviation amounts of the alignment marks AL1 displayed on the monitor 20. Therefore, according to this manufacturing method for the electronic components S1, the quality of the
20 manufactured electronic components S1 can be improved by reviewing the cutting rules.

[0084] [5. Features]

 As described above, in the cutting apparatus 1 according to the present embodiment, for each of the alignment marks AL1 in the image captured by the first
25 position checking camera 5d, the amount of coordinate deviation from a corresponding alignment mark AL1 among the reference alignment marks AL1 stored in the storage unit 80 is displayed. By checking the displayed coordinate

deviation amounts, the operator can identify, for example, the degree of warping of the package substrate P1. Since the degree of warping of the package substrate P1 is related to the quality of the electronic components S1, the coordinate deviation amounts can be said to be information that contributes to improving the quality of the electronic components S1. Therefore, according to the cutting apparatus 1, by displaying the deviation amounts of the alignment marks AL1 on the monitor 20, it is possible to provide the operator with information that contributes to improving the quality of the electronic components S1 to be manufactured.

[0085] Note that the cutting apparatus 1 is an example of a “cutting apparatus” of the present invention. The cutting table 5 is an example of a “table” of the present invention. The spindle unit 6 is an example of a “cutting mechanism” of the present invention. The first position checking camera 5d is an example of an “image capturing device” of the present invention. The storage unit 80 is an example of a “storage unit” of the present invention. The monitor 20 is an example of a “display unit” of the present invention. The input unit 95 is an example of an “input unit” of the present invention. The jig 32 is an example of a “holding tool” of the present invention.

[0086] [6. Other embodiments]

The idea of the above embodiment is not limited to the embodiment described above. Examples of other embodiments to which the idea of the above embodiment can be applied will be described below.

[0087] <6-1>

In the above embodiment, the deviation amounts of the alignment marks AL1 related to the package substrate P1 selected by the operator are displayed on the monitor 20 as deviation amount information (deviation amount information MA1, MA2, and MA3) in groups each corresponding to a cutting line CL1. However, the deviation amounts do not necessarily have to be displayed in groups. For example,

for each of the deviation amount information MA1, MA2, and MA3, the deviation amounts MP1 may be displayed on the monitor 20 without the deviation amounts MP1 being connected by a line.

[0088] <6-2>

5 For example, in the display regions 24 and 25 in FIG. 14, only the deviation amount information of the alignment marks AL1 is displayed. However, for example, other information may additionally be displayed in the display regions 24 and 25.

[0089] FIG. 16 is a diagram for describing a first example of other information
10 that is additionally displayed. As shown in FIG. 16, for example, cutting lines CL11, CL12, CL13 and reference lines SL1 may be displayed on the monitor 20 in addition to the deviation amount information MA1, MA2, and MA3. The cutting lines CL11, CL12, and CL13 indicate cutting lines actually used when cutting the package substrate P1. By referring to the cutting lines CL11, CL12, and CL13, the operator
15 can examine the relationship between the cutting lines and the quality of the electronic components S1.

[0090] FIG. 17 is a diagram for describing a second example of other information that is additionally displayed. As shown in FIG. 17, for example, cutting line candidates CL21, CL22, and CL23 may be further displayed on the
20 monitor 20 in addition to the example shown in FIG. 16. The cutting line candidates CL21, CL22, and CL23 are calculated, for example, using an algorithm different from the algorithm used to calculate the cutting lines CL11, CL12, and CL13. Examples of the algorithm include an algorithm that uses an average value of the deviation amounts, and an algorithm that uses the least squares method. By
25 referring to the cutting line candidates CL21, CL22, and CL23, the operator can consider adopting another cutting line candidate. Note that a plurality of cutting line candidates may be displayed for each cutting line.

[0091] <6-3>

FIG. 18 is a diagram schematically showing an example of another image displayed on the monitor 20. As shown in FIG. 18, the image includes display regions 27, 28, and 29. In the display region 27, for example, the image in the display region 25 in FIG. 14 is displayed. For example, if the display region 25 is selected while the image in FIG. 14 is displayed on the monitor 20, the image shown in FIG. 18 is then displayed on the monitor 20. For example, if the display region 24 is selected while the image of FIG. 14 is displayed on the monitor 20, the image of the display region 24 of FIG. 14 may then be displayed in the display region 27.

[0092] A plurality of selection items are displayed in the display region 28, and each selection item is associated with one of the pieces of deviation amount information displayed in the display region 27. In this example, the selection item displayed as “COL1” is associated with the piece of deviation amount information on the left side. The selection item displayed as “COL2” is associated with the piece of deviation amount information at the center. The selection item displayed as “COL3” is associated with the piece of deviation amount information on the right side. In this example, “COL1” has been selected.

[0093] In the display region 29, the piece of deviation amount information corresponding to the item selected in the display region 28 is displayed. In addition to displaying the deviation amount information MA1, the display region 29 displays the cutting line CL1, blade position information BL1 (specifically, the blade width is displayed by two straight lines), and rubber position information RA1. The blade position information BL1 is information that indicates the position of the blade 6a during cutting along the cutting line CL1. In this example, the blade 6a is located in the groove G1. The rubber position information RA1 is information that indicates the position of the protrusion PR1 during cutting along the cutting line CL1. Also, in the display region 29, the positional relationship between the blade 6a and

the protrusion PR1 after the slope of the cutting line CL1 has been corrected is displayed. Moreover, the slope of the deviation amount information MA1 has also been corrected in accordance with the correction of the slope of the cutting line CL1.

[0094] Thus, in this cutting apparatus 1, the blade position information BL1 and the rubber position information RA1 are further displayed on the monitor 20 in addition to the cutting line. Therefore, according to the cutting apparatus 1, it is possible to provide the operator with information indicating the positional relationship between the cutting line, the protrusion PR1 of the rubber portion 34, and the blade 6a. For example, in the case where the manufacturing of electronic components S1 is stopped and the blade position information BL1 and the rubber position information RA1 overlap each other, the operator can recognize that manufacturing of the electronic components S1 has been stopped because continuing the manufacturing of the electronic components S1 would cause the blade 6a to come into contact with the protrusion PR1.

[0095] <6-4>

In the above embodiment, the coordinates of the reference alignment marks AL1 are stored in advance in the storage unit 80, and the amount of deviation between the coordinates of an alignment mark AL1 in an image captured by the first position checking camera 5d and the coordinates of the corresponding reference alignment mark AL1 is calculated. The calculated deviation amount is displayed on the monitor 20, thereby making it possible to determine the extent of deviation of the package substrate P1 in the image captured by the first position checking camera 5d from the reference package substrate P1. However, the reference for checking for deviation between the package substrates P1 is not limited to the alignment marks AL1. Other information used as a reference will be described below in order.

[0096] (6-4-1)

FIG. 19 is a diagram schematically showing a first alternative example of a

mark whose coordinates are stored in advance in the storage unit 80. As shown in FIG. 19, a mark MK1 is a portion where a pair of vertical and horizontal cut grooves CG1 intersect in the cut package substrate P1 (an example of a visually characteristic portion of the cut package substrate P1). For example, the coordinates of the reference mark MK1 may be stored in advance in the storage unit 80, and the amount of deviation between the coordinates of the mark MK1 detected in an image captured by the second position checking camera 6b and the coordinates of the reference mark MK1 may be displayed on the monitor 20. This allows the operator to recognize amounts of deviation caused by cutting the package substrate P1. Also, for example, by checking how the deviation amounts change for each cutting rule, it is possible to find a cutting rule that minimizes the deviation amounts.

[0097] (6-4-2)

FIG. 20 is a diagram schematically showing a second alternative example of a mark whose coordinates are stored in advance in the storage unit 80. As shown in FIG. 20, an inner mark IN1 is printed on, for example, the mold surface of the electronic component S1. For example, the coordinates of the reference inner mark IN1 may be stored in advance in the storage unit 80, and the amount of deviation between the coordinates of the inner mark IN1 detected in an image captured by the second position checking camera 6b and the coordinates of the reference inner mark IN1 may be displayed on the monitor 20. This allows the operator to recognize the deviation amount of the inner mark IN1 for each electronic component S1.

[0098] The embodiments of the present invention described above are illustrative. In other words, the detailed description and accompanying drawings have been disclosed for the purpose of illustration. Therefore, some of the components described in the detailed description and the attached drawings may not be essential for solving the problem. Accordingly, simply because non-essential components are described in the detailed description and accompanying drawings,

such non-essential components are not intended to be immediately identified as essential.

[0099] Furthermore, the above embodiments are merely illustrative of the present invention in all respects. Various improvements and changes can be made to the above embodiments within the scope of the present invention. In other words, when implementing the present invention, specific configurations can be adopted as appropriate depending on the embodiment.

[0100] [6. Supplementary notes]

Various technical ideas including at least the following technology are disclosed in the present specification.

[0101] <Technology 1>

(Configuration)

A cutting apparatus for cutting an object to be cut, the cutting apparatus including:

15 a table configured to hold the object to be cut;
a cutting mechanism configured to cut the object to be cut held by the table;
and

an image capturing device configured to capture an image of the object to be cut held by the table,

20 wherein the object to be cut has a plurality of marks formed in an image capturing region in which image capturing is performed by the image capturing device, and

the cutting apparatus further includes:

25 a storage unit configured to store images and coordinates of a plurality of reference marks; and

a display unit configured to display, for each of the marks in the image captured by the image capturing device, a coordinate deviation amount indicating an

amount of deviation of coordinates from a corresponding mark among the plurality of reference marks stored in the storage unit.

[0102] (Effects etc.)

In this cutting apparatus, for each of the marks in the image captured by the image capturing device, the coordinate deviation amount from the corresponding mark among the reference marks stored in the storage unit is displayed. By checking displayed coordinate deviation amounts, the operator of the cutting apparatus can recognize, for example, the degree of warping of the object to be cut. The degree of warping of the object to be cut is related with the quality of the cut product, and therefore the coordinate deviation amounts can be said to be information that contributes to improving the quality of the cut product. Therefore, according to this cutting apparatus, coordinate deviation amounts are displayed on the display unit, thereby making it possible to provide the operator with information that contributes to improving the quality of the cut product to be manufactured.

15 [0103] <Technology 2>

(Configuration)

In the cutting apparatus according to Technology 1, it is preferable that the plurality of marks are in a plurality of groups,

each of the groups is associated with a cutting line along which the object to be cut is cut by the cutting mechanism, and

the display unit displays the coordinate deviation amounts in corresponding groups.

[0104] (Effects etc.)

In this cutting apparatus, the deviation amounts of the coordinates of the marks in the image captured by the image capturing device are displayed in corresponding groups. By checking the coordinate deviation amounts displayed in groups, the operator can more easily recognize, for example, the degree of warping

of the object to be cut. Therefore, according to this cutting apparatus, coordinate deviation amounts are displayed on the display unit in groups, thereby making it possible to provide the operator with information that contributes to improving the quality of the cut product to be manufactured.

5 [0105] <Technology 3>

(Configuration)

In the cutting apparatus according to Technology 2, it is preferable that the cutting apparatus further includes a control unit configured to determine the cutting line for each of the groups based on the coordinates of the marks in the image
10 captured by the image capturing device, and

the display unit further displays the cutting line determined by the control unit.

[0106] (Effects etc.)

In this cutting apparatus, the cutting line determined by the control unit is
15 also displayed. By looking at the display unit, the operator can check the cutting line of the object to be cut. The cutting line of the object to be cut can be said to be information that contributes to improving the quality of the cut product. Therefore, according to this cutting apparatus, the cutting line is also displayed on the display unit, thereby making it possible to provide the operator with information that
20 contributes to improving the quality of the cut product to be manufactured.

[0107] <Technology 4>

(Configuration)

In the cutting apparatus according to Technology 3, it is preferable that the control unit determines one or more cutting line candidates corresponding to the
25 cutting line, based on the coordinates of the marks in the image captured by the image capturing device, and

the display unit further displays the one or more cutting line candidates

determined by the control unit.

[0108] (Effects etc.)

In this cutting apparatus, one or more cutting line candidates determined by the control unit are also displayed. By looking at the display unit, the operator can
5 check the one or more cutting line candidates. The one or more cutting line candidates can be said to be information that contributes to improving the quality of the cut product. Therefore, according to this cutting apparatus, the one or more cutting line candidates are also displayed on the display unit, thereby making it possible to provide the operator with information that contributes to improving the
10 quality of the cut product to be manufactured.

[0109] <Technology 5>

(Configuration)

In the cutting apparatus according to any one of Technology 1 to 4, it is preferable that the storage unit stores, for each of a plurality of objects to be cut, the
15 coordinate deviation amounts respectively related to the plurality of marks,

the cutting apparatus further includes an input unit configured to accept input of a selection of one of the plurality of objects to be cut, and

the display unit displays the coordinate deviation amounts related to the object to be cut selected via the input unit.

20 [0110] (Effects etc.)

In this cutting apparatus, the coordinate deviation amounts of marks related to the object to be cut selected by the operator are displayed. Therefore, according to this cutting apparatus, it is possible to provide the operator with information indicating the coordinate deviation amounts of marks related to the object to be cut
25 selected by the operator.

[0111] <Technology 6>

(Configuration)

In the cutting apparatus according to any one of Technology 1 to 5, it is preferable that the object to be cut is a package substrate, and

each of the plurality of marks is one of an alignment mark provided on the package substrate, a visually characteristic portion of the package substrate after cutting, and an inner mark provided on an individual electronic component obtained by cutting the package substrate.

[0112] <Technology 7>

(Configuration)

In the cutting apparatus according to any one of Technology 3 to 6, it is preferable that the table includes a holding tool configured to hold the object to be cut,

the cutting mechanism cuts the object to be cut using a blade, and

the display unit further displays the holding tool and the blade.

[0113] (Effects etc.)

In this cutting apparatus, the holding tool and the blade are also displayed in addition to the cutting line. Therefore, according to this cutting apparatus, it is possible to provide the operator with information indicating the positional relationship between the cutting line, the holding tool, and the blade.

[0114] <Technology 8>

(Configuration)

A method for manufacturing a cut product using the cutting apparatus according to any one of Technology 1 to 7, comprising:

the cutting mechanism cutting the object to be cut in accordance with a cutting rule set in advance,

displaying the coordinate deviation amounts respectively related to the plurality of marks in the image captured by the image capturing device;

changing a setting of the cutting rule based on displayed coordinate

deviation amounts; and

manufacturing the cut product by cutting the object to be cut in accordance with the changed cutting rule.

[0115] (Effects etc.)

5 In this method for manufacturing a cut product, a cutting rule setting is changed based on the displayed coordinate deviation amounts. Therefore, according to this method for manufacturing a cut product, through reviewing the cutting rules, it is possible to improve the quality of the cut product to be manufactured.

10

List of Reference Numerals

[0116] 1: cutting apparatus; 3: substrate supply unit; 4: positioning unit; 4a: rail portion; 5: cutting table; 5a: holding member; 5b: rotating mechanism; 5c: moving mechanism; 5d: first position checking camera; 5e: first cleaner; 6: spindle unit; 6a: blade; 6b: second position checking camera; 6c: rotation shaft; 7: transport unit; 7a: second cleaner; 11: inspection table; 12: first optical inspection camera; 13: second optical inspection camera; 14: arrangement unit; 15: extraction unit; 15a: good component tray; 15b: defective component tray; 20: monitor; 21, 22, 23, 24, 25, 26, 27, 28, 29: display region; 31: holding member body; 32: jig; 33: plate-shaped portion; 34: rubber portion; 50: computer; 70: control unit; 72: CPU; 74: RAM; 76: ROM; 80: storage unit; 81: control program; 90: input/output I/F; 95: input unit; A1: cutting module; AL1: alignment mark; B1: inspection/storage module; BL1: blade position information; CG1: cut groove; CL1, CL11, CL12, CL13: cutting line; CL21, CL22, CL23: cutting line candidate; CS1: cursor; G1: groove; H1: hole; IM1: image; IN1: inner mark; M1: magazine; MA1, MA2, MA3: deviation amount information; MK1: mark; MP1: deviation amount; P1: package substrate; PR1: protrusion; RA1: rubber position information; S1: electronic component; SL1: reference line; SP1:

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space; TB1, TB2: data table

CLAIMS

[Claim 1] A cutting apparatus for cutting an object to be cut, the cutting apparatus comprising:

5 a table configured to hold the object to be cut;
a cutting mechanism configured to cut the object to be cut held by the table;
and

an image capturing device configured to capture an image of the object to be cut held by the table,

10 wherein the object to be cut has a plurality of marks formed in an image capturing region in which image capturing is performed by the image capturing device, and

the cutting apparatus further comprises:

a storage unit configured to store coordinates of a plurality of reference
15 marks; and

a display unit configured to display, for each of the marks in the image captured by the image capturing device, a coordinate deviation amount indicating an amount of deviation of coordinates from a corresponding mark among the plurality of reference marks stored in the storage unit.

20

[Claim 2] The cutting apparatus according to claim 1,

wherein the plurality of marks are in a plurality of groups,
each of the groups is associated with a cutting line along which the object to be cut is cut by the cutting mechanism, and

25 the display unit displays the coordinate deviation amounts in corresponding groups.

[Claim 3] The cutting apparatus according to claim 2, further comprising:

 a control unit configured to determine the cutting line based on the coordinates of the marks in the image captured by the image capturing device,

 wherein the display unit further displays the cutting line determined by the
5 control unit.

[Claim 4] The cutting apparatus according to claim 3,

 wherein the control unit determines one or more cutting line candidates corresponding to the cutting line, based on the coordinates of the marks in the image
10 captured by the image capturing device, and

 the display unit further displays the one or more cutting line candidates determined by the control unit.

[Claim 5] The cutting apparatus according to any one of claims 1 to 4,

15 wherein the storage unit stores, for each of a plurality of objects to be cut, the coordinate deviation amounts respectively related to the plurality of marks,

 the cutting apparatus further comprises:

 an input unit configured to accept input of a selection of one of the plurality of objects to be cut, and

20 the display unit displays the coordinate deviation amounts related to the object to be cut selected via the input unit.

[Claim 6] The cutting apparatus according to any one of claims 1 to 5,

 wherein the object to be cut is a package substrate, and

25 each of the plurality of marks is one of an alignment mark provided on the package substrate, a visually characteristic portion of the package substrate after cutting, and an inner mark provided on an individual electronic component obtained

by cutting the package substrate.

[Claim 7] The cutting apparatus according to any one of claims 3 to 6,
 wherein the table includes a holding tool configured to hold the object to be
5 cut,
 the cutting mechanism cuts the object to be cut using a blade, and
 the display unit further displays the holding tool and the blade.

[Claim 8] A method for manufacturing a cut product using the cutting
10 apparatus according to any one of claims 1 to 7, comprising:
 the cutting mechanism cutting the object to be cut in accordance with a
 cutting rule set in advance,
 displaying the coordinate deviation amounts respectively related to the
 plurality of marks in the image captured by the image capturing device;
15 changing a setting of the cutting rule based on displayed coordinate
 deviation amounts; and
 manufacturing the cut product by cutting the object to be cut in accordance
 with the changed cutting rule.