

DESCRIPTION

STATISTICAL DATA GENERATION METHOD, CUTTING APPARATUS, AND
SYSTEM

5 Technical Field

[0001] The present invention relates to a statistical data generation method, a cutting apparatus, and a system.

Background Art

10 [0002] JP 2008-4806A (Patent Literature 1) discloses a wafer processing result management method. In this method, cutting grooves formed in a wafer process are captured by an image capturing means, and cutting groove data is generated based on generated image information. The cutting groove data is accumulatively stored in a storage means in association with image information and position information. The
15 stored cutting groove data and image information, and the like are displayed on a display panel (refer to Patent Literature 1).

Citation List

Patent Literature

20 [0003]
Patent Literature 1: JP 2008-4806A

Summary of Invention

Technical Problem

25 [0004] As described in Patent Literature 1, advanced manufacturing management is performed in a wafer process, in the semiconductor manufacturing process. On the other hand, advanced manufacturing management is not performed in a post-process, in

the semiconductor manufacturing process. However, in the post-process as well, it is necessary to perform manufacturing management that is advanced relative to that performed thus far, due to the miniaturization of package components or the like.

[0005] The present invention has been made in order to solve the problem described above, and an object of the present invention is to provide a statistical data generation method, a cutting apparatus, and a system with which data to be used for realizing manufacturing management that is advanced relative to that performed thus far can be generated, in the post-process.

10 Solution to Problem

[0006] A statistical data generation method according to an aspect of the present invention includes: collecting inspection data including inspection result information regarding a package component manufactured by cutting a package substrate; and generating statistical data based on the collected inspection data.

15 [0007] Also, a cutting apparatus according to another aspect of the present invention includes a cutting mechanism, an inspection mechanism, and a computation unit. The cutting mechanism is configured to manufacture a plurality of package components by cutting a package substrate. The inspection mechanism is configured to inspect each of the plurality of package components. The computation unit is configured to perform
20 computation using inspection data including information regarding a result of inspection performed by the inspection mechanism. The computation unit is configured to collect the inspection data, and generate statistical data based on the collected inspection data.

[0008] Also, a system according to another aspect of the present invention includes the aforementioned cutting apparatus, and a storage device that is outside of the cutting
25 apparatus. The storage device is configured to store the inspection data.

Advantageous Effects of Invention

[0009] According to the present invention, a statistical data generation method, a cutting apparatus, and a system can be provided with which data to be used for realizing manufacturing management that is advanced relative to that performed so far can be generated, in the post-process.

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Brief Description of Drawings

[0010] FIG. 1 is a diagram schematically illustrating a system.

FIG. 2 is a plan view schematically illustrating a cutting apparatus.

FIG. 3 is a side view schematically illustrating a spindle unit.

10 FIG. 4 is a diagram schematically illustrating a hardware configuration of a computer.

FIG. 5 is a diagram illustrating the relationship between functions realized by the computer.

FIG. 6 is a diagram for describing inspection regarding a package size in QFN.

15 FIG. 7 is a diagram for describing inspection regarding a corner angle in QFN.

FIG. 8 is a diagram for describing inspection regarding a bad mark in QFN.

FIG. 9 is a diagram illustrating an example of a database.

FIG. 10 is a diagram illustrating an example of an image generated by an image generating unit.

20 FIG. 11 is a flowchart illustrating a procedure of accumulating semiconductor package inspection results in a storage device.

FIG. 12 is a flowchart illustrating a procedure of outputting statistical data.

Description of Embodiments

25 [0011] Hereinafter, embodiments of the present invention will be described in detail with reference to the drawings. Note that identical or corresponding elements are indicated by the same reference signs, and descriptions thereof will not be repeated.

[0012] 1. System configuration

FIG. 1 is a diagram schematically illustrating a system 100 according to a present embodiment. As shown in FIG. 1, the system 100 includes a cutting apparatus 1 and a storage device 30.

5 [0013] The cutting apparatus 1 is configured to divide a package substrate into a plurality of package components by cutting the package substrate (object to be cut). In a package substrate, a substrate or a lead frame on which semiconductor chips are mounted are resin-sealed.

[0014] Examples of the package substrate includes a BGA (Ball Grid Array) package
10 substrate, an LGA (Land Grid Array) package substrate, a CSP (Chip Size Package) package substrate, an LED (Light Emitting Diode) package substrate, a QFN (Quad Flat No-leaded) package substrate.

[0015] Also, the cutting apparatus 1 is configured to inspect each of a plurality of divided package components. In the cutting apparatus 1, an image of each package
15 component is captured, and the inspection of the package component is performed based on the image. Inspection data is generated through the inspection, and package components are sorted into "good products" and "defective products".

[0016] The storage device 30 is configured to store inspection data generated through inspection in the cutting apparatus 1. In the storage device 30, inspection data is
20 sequentially accumulated. Note that the inspection data need not be stored in the storage device 30, and may be stored in a memory in the cutting apparatus 1.

[0017] In general, advanced manufacturing management is performed in a wafer process, out of the semiconductor manufacturing process. On the other hand, in a post-process out of the semiconductor manufacturing process, advanced manufacturing
25 management is not performed. However, in the post-process as well, it is requested to perform advanced manufacturing management, due to miniaturization of package components or the like.

[0018] The cutting apparatus 1 according to the present embodiment is configured to collect inspection data including inspection result information of package components, and generate statistical data based on the collected inspection data. As a result of using statistical data of inspection data including inspection result information of package components, early detection of problems that occur in the post-process may be promoted, for example. That is, with the cutting apparatus 1, data (statistical data) to be used in manufacturing management that is advanced relative to that performed so far, in the post-process, can be generated. In the following, the cutting apparatus 1 according to the present embodiment will be described in detail.

10 [0019] 2. Configuration of cutting apparatus

2-1. Overall configuration of cutting apparatus

FIG. 2 is a plan view schematically illustrating the cutting apparatus 1 according to the present embodiment. In the present embodiment, a package substrate P1 is used as an object to be cut, and the package substrate P1 is divided into a plurality of semiconductor packages S1 by the cutting apparatus 1. In the following, a face that is resin-sealed, of the two faces of the package substrate P1, is referred to as a molded face, and the face on the side opposite to the molded face is referred to as a ball/lead face.

[0020] As shown in FIG. 2, the cutting apparatus 1 includes a cutting module A1 and an inspection/storage module B1, as constituent elements. The cutting module A1 is configured to produce a plurality of semiconductor packages S1 by cutting the package substrate P1. The inspection/storage module B1 is configured to inspect each of the produced plurality of semiconductor packages S1, and thereafter, store the semiconductor packages S1 in trays. In the cutting apparatus 1, one constituent element can be attached to and detached from the other constituent element, and is replaceable.

25 [0021] The cutting module A1 mainly includes a substrate supplying unit 3, a positioning unit 4, a cutting table 5, a spindle unit 6, and a conveying unit 7.

[0022] The substrate supplying unit 3 supplies a package substrate P1 one by one to

the positioning unit 4 by pushing out a package substrate P1 one by one from a magazine M1 that stores a plurality of package substrates P1. Here, the package substrate P1 is arranged such that the ball/lead face faces upward.

[0023] The positioning unit 4 performs positioning of a package substrate P1 that has
5 been pushed out from the substrate supplying unit 3 by arranging package substrate P1 on a rail portion 4a. Thereafter, the positioning unit 4 conveys the package substrate P1 subjected to positioning to the cutting table 5.

[0024] The cutting table 5 holds a package substrate P to be cut. In the present embodiment, a cutting apparatus 1 having a twin cut table configuration in which two
10 cutting tables 5 are included is illustrated. Each cutting table 5 includes a holding member 5a, a rotation mechanism 5b, and a moving mechanism 5c. The holding member 5a holds a package substrate P1 that is conveyed by the positioning unit 4 by sucking the package substrate P1 from below. The rotation mechanism 5b can rotate the holding member 5a in a θ direction in the drawing. The moving mechanism 5c can move
15 the holding member 5a along a Y axis in the drawing.

[0025] The spindle unit 6 divides a package substrate P1 into a plurality of semiconductor packages S1 by cutting the package substrate P1. In the present embodiment, a cutting apparatus 1 having a twin spindle configuration in which two spindle units 6 are included is illustrated. Each spindle unit 6 can move along an X axis
20 and a Z axis in the drawing. Note that the cutting apparatus 1 may have a single spindle configuration in which one spindle unit 6 is included.

[0026] FIG. 3 is a side view schematically illustrating a spindle unit 6. As shown in FIG. 3, the spindle unit 6 includes a blade 6a, a rotation shaft 6c, a first flange 6d, a second flange 6e, and a fastening member 6f.

[0027] The blade 6a rotates at a high speed, and divides a package substrate P1 into a plurality of semiconductor packages S1 by cutting the package substrate P1. The blade 6a is attached to the rotation shaft 6c in a state of being sandwiched between one flange
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(first flange) 6d and the other flange (second flange) 6e. The first flange 6d and the second flange 6e are fixed to the rotation shaft 6c by the fastening member 6f such as a nut. The first flange 6d is also referred to as an inner flange. The second flange 6e is arranged on the fastening member 6f side of the blade 6a being interposed between two
5 flanges, and is also referred to as an outer flange.

[0028] The spindle unit 6 is provided with a cutting water nozzle for injecting cutting water to the blade 6a that rotates at a high speed, a cooling water nozzle for injecting cooling water, and a cleaning water nozzle for injecting cleaning water for cleaning cutting waste(these nozzles are not illustrated), and the like.

10 [0029] With reference to FIG. 2 again, after the cutting table 5 sucks a package substrate P1, an image of the package substrate P1 is captured by the first position checking camera 5d, and the position of the package substrate P1 is checked. The checking using the first position checking camera 5d is checking of the position of a mark provided on a package substrate P1, for example. The mark indicates a cutting position
15 on the package substrate P1, for example.

[0030] Thereafter, the cutting table 5 moves toward the spindle unit 6 along the Y axis in the drawing. After the cutting table 5 has moved below the spindle unit 6, the package substrate P1 is cut by relatively moving the cutting table 5 and the spindle unit 6. Thereafter, an image of the package substrate P1 is captured by the second position
20 checking camera 6b as needed, and the position and the like of the package substrate P1 is checked. The checking using the second position checking camera 6b is checking of the cutting position and the cutting width of the package substrate P1, for example.

[0031] After completing cutting of the package substrate P1, the cutting table 5 moves in a direction separating from the spindle unit 6 along the Y axis in the drawing, in a state of sucking the divided plurality of semiconductor packages S1. While being
25 moved, cleaning and drying of upper faces (ball/lead faces) of the semiconductor packages S1 are performed by the first cleaner 5e.

[0032] The conveying unit 7 sucks a semiconductor package S1 held on the cutting table 5 from above, and conveys the semiconductor package S1 to an inspection table 11 of the inspection/storage module B1. While being conveyed, cleaning and drying of a lower face (molded face) of the semiconductor package S1 are performed by the second cleaner 7a.

[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 arranging unit 14, and an extracting unit 15.

[0034] The inspection table 11 holds a semiconductor package S1 for optical inspection of the semiconductor package S1. The inspection table 11 can move along the X axis in the drawing. Also, the inspection table 11 can be inverted upside down. The inspection table 11 is provided with a holding member that holds a semiconductor package S1 by sucking the semiconductor package S1.

[0035] The first optical inspection camera 12 and the second optical inspection camera 13 capture images of the both sides of a semiconductor package S1 (a ball/lead face and a molded face). Various types of inspection of a semiconductor package S1 is performed based on image data generated by the first optical inspection camera 12 and the second optical inspection camera 13. The first optical inspection camera 12 and the second optical inspection camera 13 are arranged in the vicinity of the inspection table 11 so as to capture images of upward areas. The first optical inspection camera 12 and the second optical inspection camera 13 are each provided with a lighting device (not illustrated) that can emit light at the time of inspection. Note that the first optical inspection camera 12 may be provided in the cutting module A1.

[0036] The first optical inspection camera 12 captures an image of the molded face of a semiconductor package S1 that is conveyed to the inspection table 11 by the conveying unit 7. Thereafter, the conveying unit 7 places the semiconductor package S1 on the holding member of the inspection table 11. After the holding member sucks

the semiconductor package S1, the inspection table 11 inverts upside down. The inspection table 11 moves above the second optical inspection camera 13, and the ball/lead face of the semiconductor package S1 is captured by the second optical inspection camera 13. As described above, various types of inspection of the semiconductor package S1 is performed based on image data generated by the first optical inspection camera 12 and the second optical inspection camera 13. The inspection items in this inspection will be described later in detail.

[0037] A semiconductor package S1 that has been inspected is arranged in the arranging unit 14. The arranging unit 14 can move along the Y axis in the drawing. The inspection table 11 arranges a semiconductor package S1 that has been inspected in the arranging unit 14.

[0038] The extracting unit 15 transfers a semiconductor package S1 arranged in the arranging unit 14 to the tray. Semiconductor packages S1 are sorted into "good products" and "defective products" based on inspection results obtained by using the first optical inspection camera 12 and the second optical inspection camera 13. The extracting unit 15 transfers semiconductor packages S1 to the good product tray 15a or the defective product tray 15b based on the sorting result. That is, good products are stored in the good product tray 15a, and the defective products are stored in the defective product tray 15b. The good product tray 15a and the defective product tray 15b are each replaced by a new tray when filled with semiconductor packages S1.

[0039] The cutting apparatus 1 further includes a computer 50. The computer 50 controls the operations of the units of the cutting module A1 and the inspection/storage module B1. The operations of the substrate supplying unit 3, the positioning unit 4, the cutting table 5, the spindle unit 6, the conveying unit 7, the inspection table 11, the first optical inspection camera 12, the second optical inspection camera 13, the arranging unit 14, and the extracting unit 15 are controlled by the computer 50, for example.

[0040] Also, the computer 50 performs various types of inspection of the

semiconductor packages S1 based on image data generated by the first optical inspection camera 12 and the second optical inspection camera 13, for example. The computer 50 collects the inspection data generated through various types of inspection in the storage device 30 (FIG. 1), and generates statistical data based on the collected inspection data.

5 Next, the computer 50 will be described in detail.

[0041] 2-2. Hardware configuration of computer

FIG. 4 is a diagram schematically illustrating the hardware configuration of the computer 50. As shown in FIG. 4, the computer 50 includes a computation unit 70, an input/output I/F (interface) 90, a communication I/F 91, and a storage unit 80, and
10 these constituent elements are electrically connected via a bus.

[0042] The computation 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 computation unit 70 is configured to control the constituent elements in the computer 50 and the constituent elements in the cutting apparatus 1 according to the information
15 processing.

[0043] The input/output I/F 90 is configured to communicate with the constituent elements included in the cutting apparatus 1 through signal lines. The input/output I/F 90 is used to transmit data from the computer 50 to the constituent elements in the cutting apparatus 1, and to receive data transmitted from the constituent elements in the cutting
20 apparatus 1 to the computer 50.

[0044] The communication I/F 91 is configured to communicate with an external device (e.g., storage device 30 (FIG. 1)) that is provided outside of the cutting apparatus 1 through the Internet. The communication I/F 91 is constituted by a wired LAN (Local Area Network) module or a wireless LAN module, for example.

25 [0045] The storage unit 80 is 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. The storage unit 80 may store inspection data generated

through inspection using the first optical inspection camera 12 and the second optical inspection camera 13.

[0046] 2-3. Software configuration regarding inspection of package components

FIG. 5 is a diagram illustrating the relationship between functions realized by the computer 50. The computation unit 70 deploys the control program 81 stored in the storage unit 80 in a RAM 74. Also, the computation unit 70 controls the constituent elements in the cutting apparatus 1 by the computer 50 causing a CPU 72 to interpret and execute the control program 81 deployed in the RAM 74. As shown in FIG. 5, the computer 50 operates as an image acquiring unit 52, an inspection unit 54, a statistical data generating unit 56, and an image generating unit 58.

[0047] The image acquiring unit 52 sends an image capturing instruction to the first optical inspection camera 12 and the second optical inspection camera 13. The image capturing instruction includes information for specifying an image capturing area of the package substrate P1, for example. Note that the image acquiring unit 52 successively changes the image capturing area. Accordingly, both sides of all of the semiconductor packages S1 included in the package substrate P1 are captured. The image acquiring unit 52 acquires image data generated by the first optical inspection camera 12 and the second optical inspection camera 13 through the input/output I/F 90.

[0048] The inspection unit 54 performs various types of inspection regarding the semiconductor packages S1 included in image data by analyzing the image data acquired by the image acquiring unit 52. Examples of inspection items include "lead pad number", "die pad defect", and "mark angle", in QFN.

[0049] FIG. 6 is a diagram for describing inspection regarding the lead pad number in QFN. With reference to FIG. 6, an image ID1 is an image included in the image captured by the second optical inspection camera 13. That is, the image ID1 is an image showing a face (ball/lead face) on the opposite side to the molded face of a package component 60. A die pad 61 is arranged in a central portion of the package component

60, and a plurality of lead pads (electrode pads) 62 are arranged in the periphery of the package component 60.

[0050] In the inspection regarding lead pad number of a package component 60, the inspection unit 54 detects the lead pad number on each side through image analysis. The inspection unit 54 determines whether or not the lead pad numbers on the sides are each a predetermined number. If the lead pad numbers on the sides are the predetermined number, the inspection unit 54 determines that the package component 60 is a good product in terms of the "lead pad number", and if the lead pad number on any side is not the predetermined number, the inspection unit 54 determines that the package component 60 is a defective product in terms of the "lead pad number". The inspection unit 54 stores the detected lead pad numbers on the respective sides and the determination result regarding good product/defective product in the storage device 30 in association with the position information regarding the package component 60 in the package substrate. That is, the inspection unit 54 stores, depending on the inspection item, not only the determination result regarding good product/defective product, but also a measurement value of an item to be measured ("lead pad number", in this example) that is obtained through image analysis, in the storage device 30 in association with the position information regarding the package component 60 in the package substrate.

[0051] FIG. 7 is a diagram for describing inspection regarding a die pad defect in QFN. With reference to FIG. 7, an image ID2 is an image included in the image captured by the second optical inspection camera 13. That is, the image ID2 is an image showing a face (ball/lead face) on the opposite side to the molded face of a package component 60.

[0052] In the inspection regarding a die pad defect of a package component 60, the inspection unit 54 detects foreign matters on the die pad 61 through image analysis. In addition, the inspection unit 54 determines whether or not the amount of foreign matters on the die pad 61 is inside a predetermined range. If the amount of foreign matters on

the die pad 61 is inside the predetermined range, the inspection unit 54 determines that the package component 60 is a good product in terms of the die pad defect, and if the amount of foreign matters on the die pad 61 is not inside the predetermined range, the inspection unit 54 determines that the package component 60 is a defective product in terms of the die pad defect. The inspection unit 54 stores the determination result regarding good product/defective product in the storage device 30 in association with the position information of the package component 60 in the package substrate.

[0053] FIG. 8 is a diagram for describing inspection regarding a mark angle in QFN. With reference to FIG. 8, an image ID3 is an image included in the image captured by the first optical inspection camera 12. That is, the image ID3 is an image showing the molded face of a package component 60.

[0054] A brand mark of a package component 60 is printed on a molded face of the package component 60, for example. In the inspection regarding the mark angle of the package component 60, the inspection unit 54 determines whether or not the inclination of a mark Mk1 printed on the surface of a package component 60 is inside a predetermined range through image analysis. If the inclination of the mark Mk1 is inside the predetermined range, the inspection unit 54 determines that the package component 60 is a good product in terms of the mark angle, and if the inclination of the mark Mk1 is outside the predetermined range, the inspection unit 54 determines that the package component 60 is a defective product in terms of the mark angle. The inspection unit 54 stores the determination result regarding good product/defective product in the storage device 30 in association with the position information of the package component 60 in the package substrate.

[0055] The inspection unit 54 can execute inspections regarding various inspection items in addition to the items stated above. Examples of inspection items that can be inspected by the inspection unit 54 are shown in the following Table 1.

[0056]

[Table 1]

Type	Inspection Item	Measurement/Determination Details
BGA (ball/lead face)	Package Size	Measure lengths of sides, and determine whether the lengths of sides are in a predetermined range.
	Corner Angle	Measure angles of corners, and determine whether the angles of corners are in a predetermined range.
	Ball Offset	Measure shifts of solder balls from predetermined positions, and determine whether the shifts are in a predetermined range.
	Bad Mark	Determine whether or not bad mark is present.
	Ball Number (Extra Ball)	Determine whether the number of solder balls is larger than a predetermine number.
	Ball Number (Missing Ball)	Determine whether the number of solder balls is smaller than a predetermine number.
	Extra & Missing Ball	Determine whether or not there are solder balls that are not present at predetermined positions and solder balls that are present at positions other than predetermined positions.
	Ball Pitch	Measure lengths between solder balls, and determine whether the lengths are in a predetermined length.
	Ball Position	Determine whether positions of solder balls are shifted from predetermined positions by a predetermined amount or more.
	Ball Size	Determine whether sizes of solder balls are in a predetermined range.
	Ball Shape	Determine whether shapes of solder balls are a predetermined shape.
	Double Ball	Determine whether adjacent two solder balls are combined.

QFN (ball/lead face)	Package Size	Measure lengths of sides, and determine whether the lengths of sides are in a predetermined range.
	Corner Angle	Measure angles of corners, and determine whether the angles of corners are in a predetermined range.
	Lead Pad Offset	Measure shifts of lead pads (leads) from predetermined positions, and determine whether the shifts are in a predetermined range.
	Bad Mark	Determine whether or not bad mark is present.
	Lead Pad Number	Determine whether the number of lead pads is a predetermined number.
	Lead Pad Size	Determine whether sizes of lead pads are in a predetermined range.
	Lead Pad Pitch	Determine whether lengths between lead pads are in a predetermined range.
	Lead Pad Defect	Determine whether or not foreign object is present on lead pads.
	Die Pad Size	Determine whether the size of die pad exposed to the outside is in a predetermined range.
	Die Pad Defect	Determine whether or not foreign object is present on die pad.
	Die Pad Number	Determine whether the number of die pads is a predetermined number.
	Lead Pad Side	Determine whether cut surfaces of lead pads are appropriate.
Common (molded face)	Package Size	Measure lengths of sides, and determine whether the lengths of sides are in a predetermined range.
	Corner Angle	Measure angles of corners, and determine whether the angles of corners are in a predetermined range.
	Mark Offset	Measure shifts of marks (such as brand mark) from predetermined positions, and determine whether the shifts are in

		a predetermined range.
	No Marking	Detect mark that should be present is not present.
	Mark Angle	Determine whether inclinations of marks on package component is in a predetermined range.
	Broken Mark	Determine whether some characters that constitute marks are missing.
	Broken Character	Detect that some characters that constitute marks are not sufficiently printed.
	Splash Character	Determine whether blurs of some characters that constitute marks are in a predetermined range.
	Wrong Character	Detect that some characters that constitute marks are different characters.
	PKG Scratches	Determine whether the amount of scar on package component is in a predetermined range.
	PKG Crack	Determine whether the crack in package component is in a predetermined range.

In Table 1, the inspection items corresponding to BGA show inspection items regarding the ball/lead face of BGA. Also, the inspection items corresponding to QFN show inspection items regarding the ball/lead face of QFN. Also, the inspection items corresponding to these types of packages in common show inspection items regarding the molded face of BGA and QFN.

[0057] Examples of inspections specific to the package component among the various inspection items included in Table 1 include "Lead Pad Offset", "Lead Pad Number", "Lead Pad Size", "Lead Pad Pitch", "Lead Pad Defect", "Die Pad Size", "Die Pad Defect", "Die Pad Number", "Lead Pad Side", "Mark Offset", "No Marking", "Mark Angle", "Broken Mark", "Broken Character", "Splash Character", and "Wrong Character".

[0058] In "Lead Pad Offset", the inspection unit 54 measures the shift of each lead pad (lead) 62 from a predetermined position, and determines whether or not the shift is in a predetermined range. In "Lead Pad Number", the inspection unit 54 determines whether the number of lead pads 62 is a predetermined number. In "Lead Pad Size", the inspection unit 54 determines whether the size of each lead pad 62 is in a predetermined range. In "Lead Pad Pitch", the inspection unit 54 determines whether the length between lead pads 62 is in a predetermined range. In "Lead Pad Defect", the inspection unit 54 determines whether or not a foreign matter is present on a lead pad 62. In "Die Pad Size", the inspection unit 54 determines whether the size of the die pad 61 exposed to the outside is in a predetermined range. In "Die Pad Defect", the inspection unit 54 determines whether or not a foreign matter is present on the die pad 61. In "Die Pad Number", the inspection unit 54 determines whether the number of die pads 61 is a predetermined number. In "Lead Pad Side", the inspection unit 54 determines whether the state of cut surfaces of lead pads (side faces of the package component 60) is appropriate. In "Mark Offset", the inspection unit 54 measures the shift of the mark Mk1 (brand mark, and the like) from a predetermined position, and determines whether the shift is in a predetermined range. In "No Marking", the inspection unit 54 detects the absence of the mark Mk1 that should be present. In "Mark Angle", the inspection unit 54 determines whether the inclination of the mark Mk1 on a package component is in a predetermined range. In "Broken Mark", the inspection unit 54 determines whether a portion of characters that constitute the mark Mk1 is missing. In "Broken Character", the inspection unit 54 detects that a portion of characters that constitute the mark Mk1 is not sufficiently printed. In "Splash Character", the inspection unit 54 determines whether the blurring of a portion of characters that constitute the mark Mk1 is in a predetermined range. In "Wrong Character", the inspection unit 54 detects that a portion of characters that constitute the mark Mk1 are wrong characters.

[0059] With reference to FIG. 5 again, the inspection data including result

information of an inspection performed by the inspection unit 54 is stored in the storage device 30. A plurality of pieces of inspection data are collected in the storage device 30, and are managed on a database DB1.

[0060] FIG. 9 is a diagram illustrating an example of the database DB1. With reference to FIG. 9, each row in the database DB1 indicates inspection data of one package component 60. In each row, result information for each "inspection item" is shown regarding a package component 60 indicated by "lot", "No.", "frame No.", and "position".

[0061] For example, a package component 60 whose "No." is "2" is present at a position whose X coordinate is "2" and Y coordinate is "1", in a package substrate (frame) P1 whose "frame No." is "1". The frame including this package component 60 is included in "lot" whose number is "0000". The "lot" is a unit including a plurality of frames (package substrates P1). Regarding this package component 60, the result with respect to an inspection item "0" is "1 (e.g., defective product)", the result with respect to an inspection item "1" is "0 (e.g., good product)", and the result with respect to an inspection item "2" is "5.005 (measurement value)".

[0062] A user of the system 100 (FIG. 1) can acquire statistical data from the system 100 regarding the manufacturing conditions of semiconductor packages S1. This statistical data is generated based on data stored in the database DB1. For example, the user can analyze problems regarding manufacturing of semiconductor packages S1 by referring to the statistical data. The user designates the range of data to be used to generate statistical data according to the statistical data that the user desire to acquire. For example, the user designates the data range by performing input through a later-described image 200 (FIG. 10). In the system 100, the statistical data is generated using data in the designated range.

[0063] With reference to FIG. 5 again, the statistical data generating unit 56 acquires inspection data from the storage device 30, and generates statistical data by collecting the

acquired inspection data, in accordance with the user instruction. The statistical data generating unit 56 generate statistical data in which positions in the package substrate P1 are associated with good/defective conditions of semiconductor packages S1, for example. Also, the statistical data generating unit 56 generates statistical data indicating a defect occurrence rate for each position in the package substrate P1 from data indicating good/defective conditions of semiconductor packages S1 at the position in the package substrate P1 with respect to a plurality of package substrates P1 included in a specific lot, for example.

[0064] The image generating unit 58 generates image data in which the statistical data generated by the statistical data generating unit 56 is visualized.

[0065] FIG. 10 is a diagram illustrating an example of an image 200 to be generated by the image generating unit 58. As shown in FIG. 10, the image 200 includes a type selection portion 202, an instruction portion 214, an area T1, and an area T2. The user selects BGA or QFN as the type of package substrate to be analyzed through the type selection portion 202. Also, the user performs output instruction of statistical data by pressing the instruction portion 214 using a cursor (mouse pointer) or the like. The area T1 is an area for displaying an image that is obtained by visualizing statistical data in a specific package substrate (frame). The area T2 is an area for displaying an image obtained by visualizing statistical data in a specific lot.

[0066] The area T1 includes an input portion 204, a selection portion 206, and result output portions 208, 210, and 212. The user inputs a "frame No." of a package substrate (frame) P1 to be analyzed through the input portion 204. Also, the user selects an "inspection item" to be analyzed through the selection portion 206.

[0067] The result output portion 208 outputs an overall rectangular image. This rectangular image includes a plurality of blocks. The rectangular image corresponds to a package substrate P1, and the plurality of blocks correspond to respective semiconductor packages S1. In this example, the block at the upper left corner of the

rectangular image is at the coordinates (1, 1). The X coordinate is incremented from "1" at the left corner up to "14" rightward by one. The Y coordinate is incremented from "1" at the upper corner down to "48" downward by one. In this example, the color of each block is changed according to the degree of defects of the package component 60 corresponding to the block, for example. The user can visually recognize the defect occurrence situation at each position in the package substrate by referring to the image output to the result output portion 208.

5 [0068] The result output portion 210 outputs the total number of semiconductor packages S1 included in the package substrate P1 to be analyzed, the number of good products, and the number of defective products, for example. The result output portion 212 outputs the number of defective products and the occurrence rate of defective products, for example.

[0069] The area T2 includes result output portions 220, 224, and 226 and a selection portion 222. The user selects an "inspection item" to be analyzed through the selection 15 portion 222.

[0070] A result output portion 224 is for outputting an image indicating collected results of defective product occurrence positions in a plurality of package substrates P1 included in a lot. In this image, the meanings indicated by an X coordinate and a Y coordinate are the same as those in the image output in the result output portion 208. 20 The Z coordinate indicates the total number of defective products occurred at the position. The user can visually recognize the defect occurrence situation for each position in the package substrate by referring to the image output to the result output portion 224.

[0071] The result output portion 220 outputs the total number of package substrates P1 included in a lot to be analyzed, the total number of semiconductor packages S1, the number of good products, and the number of defective products, for example. The result 25 output portion 226 outputs the number of defective products and the occurrence rate of defective products, for example.

[0072] With reference to FIG. 5 again, the image generated by the image generating unit 58 is displayed in a monitor 20 included in the cutting apparatus 1. The user can statistically understand the manufacturing conditions of semiconductor packages S1 by referring to the image displayed in the monitor 20.

5 [0073] 3. Operations

3-1. Operation of accumulating inspection results

FIG. 11 is a flowchart illustrating a procedure of accumulating inspection results of semiconductor packages S1 in the storage device 30. The processing illustrated in this flowchart is executed for every predetermined cycle by the computer 50.

10 [0074] With reference to FIG. 11, the computer 50 instructs the first optical inspection camera 12 and the second optical inspection camera 13 to successively capture images of a predetermined range of a package substrate P1 on the inspection table 11 (step S100). The computer 50 successively acquires image data generated by the first optical inspection camera 12 and the second optical inspection camera 13 (step S110).
15 The computer 50 performs various types of inspection with respect to semiconductor packages S1 by analyzing the acquired image data (step S120). The computer 50 updates the database DB1 so as to add the inspection data generated through inspection (step S130).

[0075] As a result of repeating steps S100 to S130, pieces of inspection data
20 regarding semiconductor packages S1 are successively added to the database DB1.

[0076] 3-2. Operation of outputting statistical data

FIG. 12 is a flowchart illustrating a procedure of outputting statistical data. The processing illustrated in this flowchart is executed for every predetermined cycle by the computer 50.

25 [0077] With reference to FIG. 12, the computer 50 determines whether or not an output instruction of statistical data has been made by a user (step S200). For example, the computer 50 determines whether or not the instruction portion 214 (FIG. 10) has been

pressed by the user. If it is determined that an output instruction of statistical data has not been made (NO in step S200), the processing is transitioned to "return".

[0078] On the other hand, if it is determined that an output instruction of statistical data has been made (YES in step S200), the computer 50 reads out inspection data that matches the user instruction from the storage device 30 (database DB1) (step S210). The computer 50 generates statistical data by collecting the read-out inspection data (step S220). The computer 50 generates image data in which statistical data is visually expressed (step S230). The computer 50 controls the monitor 20 (FIG. 5) so as to display the generated image (step S240).

10 [0079] The user can statistically understand the manufacturing conditions of semiconductor packages S1 by referring to the image displayed in the monitor 20.

[0080] 4. Features

As described above, the cutting apparatus 1 according to the present embodiment is configured to collect inspection data including inspection result information regarding package components, and generate statistical data based on the collected inspection data. As a result of using statistical data of inspection data including inspection result information regarding package components, early detection of problems that occur in the post-process may be promoted, for example. That is, with the cutting apparatus 1, data (statistical data) to be used in manufacturing management that is advanced relative to that performed so far, in the post-process, can be generated.

[0081] Also, in the cutting apparatus 1, the inspection data includes position information regarding a semiconductor package S1 to be inspected in a package substrate P1. Therefore, with the cutting apparatus 1, inspection result information of a semiconductor package S1 can be managed in association with position information of the semiconductor package S1 in the package substrate P1, and therefore more useful statistical data can be generated.

[0082] 5. Other embodiments

The concept of the embodiment described above is not limited to the embodiment described above. In the following, an example of other embodiments to which the concept of the embodiment described above can be applied will be described.

[0083] 5-1

5 In the embodiment described above, the computer 50 controls the entirety of the cutting apparatus 1. However, the control of the cutting apparatus 1 need not be performed by one computer. For example, the control of the cutting apparatus 1 may be executed by a plurality of computers. In this case, the control of the cutting apparatus 1 by a plurality of computers can be realized by the computers communicating to each other.

10 [0084] 5-2

In the embodiment described above, an image showing generated statistical data is displayed in the monitor 20. However, the generated statistical data need not be displayed in the monitor 20. For example, the configuration may also be such that the generated statistical data is only transmitted to another device.

15 [0085] 5-3

In the embodiment described above, cutting of a package substrate P1, inspection of a semiconductor package S1, and generation of statistical data based on inspection data are executed in the same cutting apparatus 1. However, these operations need not be executed in the same apparatus. For example, these operations may be
20 executed by different apparatuses.

[0086] 5-4

In the embodiment described above, the position information regarding a semiconductor package S1 in a package substrate P1 and result information regarding inspection items are associated and managed on the database DB1. However, the
25 database DB1 need not include the position information regarding a semiconductor package S1 in a package substrate P1.

[0087] 5-5

In the embodiment described above, the cutting apparatus 1 includes the first optical inspection camera 12 and the second optical inspection camera 13 that respectively capture the molded face and the ball/lead face of a semiconductor package S1. However, the optical inspection cameras included in the cutting apparatus 1 are not limited to the first optical inspection camera 12 and the second optical inspection camera 13. For example, the cutting apparatus 1 may further include an optical inspection camera for inspecting the cut surfaces of lead pads (side faces of the package component 60). In this case, the optical inspection camera for cut surface inspection is provided between the arranging unit 14 and the good product tray 15a, for example.

[0088] As described above, an embodiment of the present invention has been illustratively described. That is, a detailed description and attached drawings are disclosed for an illustrative description. Therefore, the constituent elements described in the detailed description and the attached drawings may include constituent elements that are not essential for solving the problem. Therefore, even though constituent elements that are not essential are described in the detailed description and the attached drawings, such constituent elements that are not essential should not be immediately recognized as being essential.

[0089] Also, the embodiment described above is merely an example of the present invention in all respects. Various improvements or modifications may be made on the embodiment described above without departing from the scope of the invention. In other words, specific configurations that depend on the embodiment may be adopted as appropriate in implementing the present invention.

Reference Signs List

- [0090]
- | | |
|---|--------------------------|
| 1 | Cutting apparatus |
| 3 | Substrate supplying unit |

	4	Positioning unit
	4a	Rail portion
	5	Cutting table
	5a	Holding member
5	5b	Rotation mechanism
	5c	Moving mechanism
	5d	First position checking camera
	5e	First cleaner
	6	Spindle unit
10	6a	Blade
	6b	Second position checking camera
	6c	Rotation shaft
	6d	First flange
	6e	Second flange
15	6f	Fastening member
	7	Conveying unit
	7a	Second cleaner
	11	Inspection table
	12	First optical inspection camera
20	13	Second optical inspection camera
	14	Arranging unit
	15	Extracting unit
	15a	Good product tray
	15b	Defective product tray
25	20	Monitor
	30	Storage device
	50	Computer

	52	Image acquiring unit
	54	Inspection unit
	56	Statistical data generating unit
	58	Image generating unit
5	60	Package component
	61	Die pad
	62	Lead pad
	70	Computation unit
	72	CPU
10	74	RAM
	76	ROM
	80	Storage unit
	81	Control program
	90	Input/output I/F
15	91	Communication I/F
	100	System
	200, ID1, ID2, ID3	Image
	202	Type selection portion
	204	Input portion
20	206, 222	Selection portion
	208, 210, 212, 220, 224, 226	Result output portion
	214	Instruction portion,
	A1	Cutting module
	B1	Inspection/storage module
25	DB1	Database
	M1	Magazine
	Mk1	Mark

P1 Package substrate
S1 Semiconductor package
T1, T2, T3 Area

CLAIMS

1. A statistical data generation method, comprising:
collecting inspection data including inspection result information regarding a
5 package component manufactured by cutting a package substrate; and
generating statistical data based on the collected inspection data.
2. The statistical data generation method according to claim 1, wherein the
inspection data includes position information regarding the package component in the
10 package substrate.
3. The statistical data generation method according to claim 1 or 2, further
comprising:
inspecting each of a plurality of package components that are manufactured
15 by cutting the package substrate.
4. The statistical data generation method according to claim 3, wherein the
inspection is an inspection regarding a lead pad of the package component.
- 20 5. The statistical data generation method according to claim 3, wherein the
inspection is an inspection regarding a die pad of the package component.
6. The statistical data generation method according to claim 3, wherein the
inspection is an inspection regarding a mark formed on a surface of the package
25 component.
7. The statistical data generation method according to any one of claims 1 to 6,

further comprising:

displaying an image showing the statistical data,

wherein, in the image, the position of the package component in the package substrate and the inspection result of the package component are associated with each other.

5

8. A cutting apparatus comprising:

a cutting mechanism configured to manufacture a plurality of package components by cutting a package substrate;

10 an inspection mechanism configured to inspect each of the plurality of package components; and

a computation unit configured to perform computation using inspection data including information regarding a result of inspection performed by the inspection mechanism,

15 wherein the computation unit is configured to collect the inspection data, and generate statistical data based on the collected inspection data.

9. A system comprising:

the cutting apparatus according to claim 8; and

20 a storage device that is external to the cutting apparatus, and is configured to store the inspection data.