VISION INSPECTION APPARATUS AND VISION INSPECTION METHOD THEREFOR

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to a vision inspection apparatus for a semiconductor device, and particularly, to a vision inspection apparatus for a semiconductor device capable of inspecting state of a semiconductor device by capturing external image of the semiconductor device, and then by analyzing the captured external image.

2. Background of the Invention

A semiconductor device having undergone a packaging process undergoes inspection process such as a burn-in test, and then is loaded in a customer tray to be distributed into the market. This semiconductor device undergoes a marking process for marking information such as a serial number and a logo for a manufacturing company, on the surface of the semiconductor device by a laser, etc.

For enhancing reliability, the semiconductor device undergoes a vision inspection process for inspecting external state and surface state of the semiconductor device, e.g., inspecting whether leads or ball grid has been damaged, whether any crack or any scratch has occurred or not, etc.

However, due to the inspection process for external state of the semiconductor device and the inspection for surface state such as an inspection process whether the

semiconductor device has successfully undergone a marking process, time for performing the inspection process with respect to the semiconductor device influences the entire processes.

Especially, when the vision inspection with respect to the external state and the surface state of the semiconductor device is inefficiently performed, the entire operation efficiency is lowered to degrade the productivity of the semiconductor device.

The vision inspection with respect to the surface state, i.e., an inspection process whether any crack or any scratch has occurred, and a marking state of the semiconductor device is performed by a two-dimensional vision inspection by capturing image of a two-dimensional shape of a upper surface or a lower surface of the semiconductor device, and then by analyzing the captured image.

And, the vision inspection with respect to whether leads, or balls, or bumps of the semiconductor device have been damaged is performed by a three-dimensional vision inspection by capturing image of a three-dimensional shape of the semiconductor device, and then by analyzing the captured image.

However, the conventional vision inspection apparatus for a semiconductor device may be configured such that only one of the two-dimensional vision inspection and the three-dimensional vision inspection is performed, or such that the two-dimensional vision inspection and the three-dimensional vision inspection are performed by separate modules in one apparatus.

When only one of the two-dimensional vision inspection and the three-dimensional vision inspection is performed, two apparatuses for the two-dimensional vision inspection and the three-dimensional vision inspection are required. This may cause the two apparatuses for vision inspections of a semiconductor device to be

unnecessarily required, resulting in increasing the costs of the vision inspection.

Furthermore, when the two-dimensional vision inspection and the three-dimensional vision inspection are performed by the separate modules in one apparatus, the entire configuration of the apparatus is complicated, and each inspection is performed with a different speed. In this case, especially, the three-dimensional vision inspection is performed with a low speed, thereby lowering the entire speed of the vision inspection.

SUMMARY OF THE INVENTION

Therefore, an object of the present invention is to provide a vision inspection apparatus for a semiconductor device capable of enhancing inspection speed by efficiently performing vision inspection with respect to a semiconductor device, by implementing a two-dimensional vision inspection unit and a three-dimensional vision inspection unit as one module, and a vision inspection method therefor.

To achieve these and other advantages and in accordance with the purpose of the present invention, as embodied and broadly described herein, there is provided a vision inspection apparatus for a semiconductor device, the apparatus including a vision inspection unit for performing vision inspection with respect to at least one semiconductor device by capturing image of the semiconductor device and analyzing the captured image, wherein the vision inspection unit includes a two-dimensional vision inspection unit including a two-dimensional light source for irradiating light onto an inspection surface of one surface of an upper and a lower surfaces of one or more semiconductor devices to be inspected, and a two-dimensional camera for capturing image of the semiconductor device so as to obtain a two-dimensional shape by

photographing inspection surface onto which the light from the two-dimensional light source has been irradiated; and a three-dimensional vision inspection unit including a three-dimensional light source for irradiating light onto the inspection surface inspected by the two-dimensional vision inspection unit, and a three-dimensional camera for capturing image of the semiconductor device so as to obtain a three-dimensional shape by photographing the inspection surface onto which the light from the three-dimensional light source has been irradiated.

The three-dimensional light source and the three-dimensional camera may be arranged to be symmetrical to each other based on a normal line perpendicular to the inspection surface, or may be arranged with an angle of 10° 45° with respect to the normal line perpendicular to the inspection surface.

The two-dimensional camera may be arranged in parallel to the normal line perpendicular to the inspection surface.

One of the three-dimensional light source and the three-dimensional camera may be arranged in parallel to the normal line perpendicular to the inspection surface, and the other may be arranged with an inclination angle from the normal line perpendicular to the inspection surface.

The semiconductor device may be loaded in a tray having a plurality of device receiving grooves.

The vision inspection apparatus for a semiconductor device may further include one or more transfer tools for transferring the semiconductor device by absorbing a surface opposite to the inspection surface of the semiconductor device. And, the vision inspection unit may inspect the inspection surface of the one or more semiconductor devices transferred by the one or more transfer tools.

The two-dimensional light source may be an LED light source, and the three-dimensional light source may be a laser light source.

The two-dimensional light source may include a plurality of lighting groups having at least one of lighting colors, lighting angles, and lighting intensities different from one another.

The plurality of lighting groups may include a first lighting group installed to have a lighting angle below 30° with respect to the inspection surface of the semiconductor device, a second lighting group installed to have a lighting angle of 30° 90° with respect to the inspection surface of the semiconductor device, and a third lighting group installed to have a lighting angle of 90° with respect to the inspection surface of the semiconductor device.

To achieve these and other advantages and in accordance with the purpose of the present invention, as embodied and broadly described herein, there is also provided a vision inspection method for a semiconductor device, the method comprising: a two-dimensional vision inspection step of capturing image for obtaining a two-dimensional shape of a semiconductor device, by irradiating light from a two-dimensional light source onto an inspection surface of one surface of upper and lower surfaces of one or more semiconductor devices to be inspected, and then by photographing the inspection surface onto which light from the two-dimensional light source has been irradiated by using a two-dimensional camera; and a three-dimensional vision inspection step of capturing image for obtaining a three-dimensional shape of the semiconductor device, by irradiating light from a three-dimensional light source to the inspection surface inspected in the two-dimensional vision inspection step, and then by photographing the inspection surface onto which light from the three-dimensional light source has been irradiated by

using a three-dimensional camera.

The two-dimensional vision inspection step and the three-dimensional vision inspection step may be simultaneously performed.

Alternatively, after completion of the two-dimensional vision inspection step, the three-dimensional vision inspection step may be performed.

The two-dimensional vision inspection step may be performed in a state that one or more semiconductor devices have been stopped.

And, the three-dimensional vision inspection step may be performed as the three-dimensional camera scans the inspection surface while relatively moving to the next semiconductor device for a two-dimensional vision inspection after the two-dimensional vision inspection step.

The two-dimensional vision inspection unit and the three-dimensional vision inspection unit of the vision inspection unit for a semiconductor device in accordance with the present invention may be configured as one module. This may allow the semiconductor device to be inspected more stably and more rapidly.

The two-dimensional vision inspection unit and the three-dimensional vision inspection unit of the vision inspection unit for a semiconductor device in accordance with the present invention may be configured as one module, and the two-dimensional vision inspection and the three-dimensional vision inspection may be sequentially performed. This may allow the semiconductor device to be inspected more stably and more rapidly.

The vision inspection unit for a semiconductor device may perform the two-dimensional vision inspection in a state that a semiconductor device has been stopped, and then perform the three-dimensional vision inspection while transferring the

semiconductor device. This may allow the semiconductor device to be inspected more rapidly.

The semiconductor device may be transferred for the three-dimensional vision inspection, and at the same time, the next semiconductor device to be inspected may be transferred to a position for the subsequent two-dimensional vision inspection. This may allow the semiconductor device to be inspected more rapidly.

The vision inspection unit for a semiconductor device may be configured so as to transfer the semiconductor device by the transfer tool, and may be installed below the semiconductor device having been transferred by the transfer tool. The vision inspection unit may perform a vision inspection with respect to the semiconductor device more precisely by using an OTF (On The Fly) method.

The vision inspection unit using the OTF method may prevent the inspection surface of the semiconductor device from having minute distortion, such as an inclination angle from the vision inspection unit. The minute distortion may occur due to a curved state or downward deformation of a tray on which the semiconductor device has been loaded for a vision inspection.

Furthermore, the vision inspection unit for a semiconductor device has not influence of the device receiving grooves of the tray at all when the semiconductor device to be vision-inspected has a thin thickness.

The foregoing and other objects, features, aspects and advantages of the present invention will become more apparent from the following detailed description of the present invention when taken in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

The accompanying drawings, which are included to provide a further understanding of the invention and are incorporated in and constitute a part of this specification, illustrate embodiments of the invention and together with the description serve to explain the principles of the invention.

In the drawings:

FIG. 1 is a conceptual view showing a vision inspection unit of a vision inspection apparatus for a semiconductor device according to the present invention;

FIGS. 2A and 2B are perspective views showing a part of lighting groups of a two-dimensional vision inspection unit of FIG. 1;

FIGS. 3 and 4 are conceptual views showing arrangements of a two-dimensional vision inspection unit and a three-dimensional vision inspection unit of the vision inspection unit of FIG. 1;

FIG. 5 is a conceptual view showing one example of the vision inspection apparatus for a semiconductor device, including the vision inspection unit of FIG. 1;

FIG. 6 is a conceptual view showing another example of the vision inspection apparatus for a semiconductor device, including the vision inspection unit of FIG. 1;

FIG. 7 is a conceptual view showing a lower surface of a transfer tool of the vision inspection apparatus for a semiconductor device of FIG. 5;

FIG. 8 is a conceptual view showing a state that a semiconductor device is being transferred by the transfer tool of FIG. 7; and

FIGS. 9A and 9B are conceptual views showing that a semiconductor device is being inspected while being transferred by the transfer tool of FIGS. 7 and 8.

DETAILED DESCRIPTION OF THE INVENTION

Description will now be given in detail of the present invention, with reference to the accompanying drawings.

Hereinafter, a vision inspection apparatus for a semiconductor device, and a vision inspection method therefor according to the present invention will be explained in more detail with reference to the attached drawings.

Referring to FIG. 1, the vision inspection apparatus for a semiconductor device according to the present invention serves to inspect external state of one or more semiconductor devices 1 by capturing image of the semiconductor device 1 and by analyzing the captured image. The vision inspection apparatus comprises a two-dimensional vision inspection unit 700 for performing a two-dimensional vision inspection, and a three-dimensional vision inspection unit 800 for performing a three-dimensional vision inspection. The two-dimensional vision inspection unit 700, and the three-dimensional vision inspection unit 800 are included in a vision inspection unit 50 configured as one module.

The semiconductor device 1 to be vision-inspected may include not only a device in a wafer state, a device in a packaging process, a device having undergone a packaging process, etc., but also a substrate having undergone a semiconductor process, such as a solar cell device and a substrate for an LCD panel.

The semiconductor device 1 to be vision-inspected may be transferred in a state loaded in a tray 2 having a plurality of device receiving grooves 2a for loading the semiconductor devices 1 therein.

As shown in FIG. 1, the two-dimensional inspection unit 700 includes a two-

dimensional light source 710 for irradiating light onto an inspection surface of one surface of upper and lower surfaces of at least one semiconductor device 1 to be inspected, and a two-dimensional camera 720 for capturing image of the semiconductor device so as to obtain a two-dimensional shape by photographing the inspection surface onto which light from the two-dimensional light source has been irradiated.

The two-dimensional light source 710 may have any configurations to allow the two-dimensional camera 720 to capture image so as to recognize a crack, a scratch, etc. on the inspection surface S of the semiconductor device 1.

An lighting color, a lighting angle, and a lighting intensity of light irradiated from the two-dimensional light source 710 become different according to a type of a two-dimensional shape such as a crack and a scratch formed on the inspection surface S of the semiconductor device 1.

Accordingly, it is preferable to use a plurality of lighting groups 711, 712, 713, 714 having at least one of lighting colors, lighting angles, and lighting intensities different from one another as shown in FIG. 1, rather than to use a single light source having one lighting color, one lighting angle, and one lighting intensity.

For instance, the plurality of lighting groups 711, 712, 713, 714 may include a first lighting group 711 installed to have a lighting angle $\alpha 1$ below 30° with respect to the inspection surface S of the semiconductor device 1, one or more second lighting groups 712, 713 installed to have lighting angles α_2, α_3 of 30° 90° with respect to the inspection surface S of the semiconductor device 1, and a third lighting group 714 installed to have a lighting angle of 90° with respect to the inspection surface S of the semiconductor device 1.

As the first to the third lighting groups 711, 712, 713, 714, various light sources

such as LED and laser may be used. As shown in FIGS. 1, 2A and 2B, the first to the third lighting groups 711, 712, 713, 714 may include substrates 711b, 712b, 713b, 714b having a plurality of LED devices 711a, 712a, 713a, 714a installed thereon. Here, the substrates 711b, 712b, 713b, 714b may have various shapes including a polygonal shape, a circular ring, etc. As shown in FIGS. 2A and 2B, the substrates 711b, 712b, 713b, 714b may have a predetermined angle with respect to the inspection surface S of the semiconductor device 1.

The third lighting group 714 irradiates the inspection surface S of the semiconductor device 1 with an angle of 90°. Accordingly, the third lighting group 714 may be configured such that the substrate 714b having the LED devices 714a installed thereon is properly positioned at a location having no interference with image capturing by the two-dimensional camera 720 or the three-dimensional camera 730.

Just above the inspection surface S of the semiconductor device 1, may be installed a half mirror (semi-transparent mirror) for allowing the two-dimensional camera 720 to capture(photograph) image of the inspection surface S of the semiconductor device 1, by reflecting light irradiated from the LED devices 714a to the inspection surface S of the semiconductor device 1, and by passing the image of the inspection surface S therethrough.

The two-dimensional light source 710 has to be configured so that light irradiation from the three-dimensional light source 810 and image capturing (or scanning) by the three-dimensional camera 820 may not interfere with each other.

More concretely, at least one of irradiation from the three-dimensional light source 810 and image capturing by the three-dimensional camera 820 is preferably performed among the plurality of lighting groups 711, 712, 713, 714 of the two-

dimensional light source 710. Especially, the three-dimensional light source 810 may irradiate light onto the inspection surface S of the semiconductor device 1 through a space between the second lighting groups 712, 713 and the third lighting group 714.

The two-dimensional camera 720 serves to capture image of the inspection surface S of the semiconductor device 1, and may be implemented as a digital camera, etc. Preferably, the two-dimensional camera 720 is arranged in parallel to a normal line LN perpendicular to the inspection surface S.

In a case that the two-dimensional light source 710 is composed of a plurality of lighting groups 711, 712, 713, 714, the two-dimensional camera 720 is preferably configured to capture the inspection surface S of the semiconductor device 1 irradiated by the lighting groups 711, 712, 713, 714 by turning-on each lighting group 711, 712, 713, 714 in consideration of an interference between each light from each lighting group.

The three-dimensional vision inspection unit 800 includes a three-dimensional light source 810 for irradiating light onto the inspection surface S inspected by the two-dimensional vision inspection unit 700, and a three-dimensional camera 820 for capturing image of the semiconductor device so as to obtain a three-dimensional shape by photographing the inspection surface S onto which light from the three-dimensional light source 810 has been irradiated.

Differently from the two-dimensional light source 710 using an LED light source, the three-dimensional light source 810 preferably uses single light, and may use a laser light source.

As the three-dimensional camera 820, may be used a digital camera having a predetermined capturing region, a line scanner for capturing an image as an object to be inspected is relatively moved, etc.

The three-dimensional vision inspection unit 800 may be variously arranged together with the two-dimensional vision inspection unit 700.

With considering that the two-dimensional camera 720 captures an entire image of the inspection surface S of the semiconductor device 1 at one time, the two-dimensional camera 720 is positioned just above the center of the inspection surface S so that the inspection surface S of the semiconductor device 1 can be entirely included in a capturing region.

And, the three-dimensional camera 820 may be also positioned just above the center of the inspection surface S so that the inspection surface S of the semiconductor device 1 can be entirely included in a capturing region. However, in case of using a line scanner as the three-dimensional camera 820, the three-dimensional camera 820 may be variously arranged based on the inspection surface S of the semiconductor device 1, together with the three-dimensional light source 810.

In case of using a line scanner as the three-dimensional camera 820, the three-dimensional light source 810 may be arranged so as to inspect an edge of the inspection surface S upon capturing an image of the inspection surface S by the two-dimensional vision inspection unit 700, and the three-dimensional camera 820 may be arranged so as to capture image of the edge of the inspection surface S. And, the three-dimensional vision inspection unit 800 may be configured so as to capture image of the inspection surface S by relatively moving with respect to the inspection surface S from the edge of the inspection surface S.

As a first embodiment with respect to the arrangement of the three-dimensional vision inspection unit 800 and the two-dimensional vision inspection unit 700, as shown in FIG. 1, the three-dimensional light source 810 and the three-dimensional camera 820

may be arranged so as to be symmetrical to each other based on the normal line LN perpendicular to the inspection surface S.

Here, the three-dimensional light source 810 and the three-dimensional camera 820 may have angles θ_1, θ_2 of 10° 45° with respect to the normal line LN of the inspection surface S, and more preferably, angles of 20° 25° so as to minimize inspection error due to scattered reflection and shadowing region.

As a second embodiment with respect to the arrangement of the three-dimensional vision inspection unit 800 and the two-dimensional vision inspection unit 700, as shown in FIG. 3, the three-dimensional light source 810 may be arranged so as to irradiate light in parallel to the normal line LN perpendicular to the inspection surface S. And, the three-dimensional camera 820 may be arranged so as to capture image of the inspection surface S with an inclination angle from the normal line LN perpendicular to the inspection surface S.

Contrary to the second embodiment with respect to the arrangement of the three-dimensional vision inspection unit 800 and the two-dimensional vision inspection unit 700, as shown in FIG. 4, the three-dimensional light source 810 may be arranged so as to irradiate light with an inclination angle from the normal line LN perpendicular to the inspection surface S. And, the three-dimensional camera 820 may be arranged so as to capture image of the inspection surface S in parallel to the normal line LN perpendicular to the inspection surface S.

The vision inspection unit 50 may include an image analyzer (not shown) for analyzing the appearance of the semiconductor device 1 captured by the two-dimensional vision inspection unit 700 and the three-dimensional vision inspection unit 800, especially, downward or upward images having a two-dimensional shape and a three-

dimensional shape.

The image analyzer, the two-dimensional vision inspection unit 700, and the three-dimensional vision inspection unit 800 may be implemented as one module, or as a part of a controller of the apparatus.

As shown in FIGS. 5 and 6, the vision inspection apparatus including the vision inspection unit 50 may be variously arranged, and may include additional components according to a design.

As shown in FIGS. 5 and 6, the vision inspection apparatus for a semiconductor dev ice according to the present invention may comprise the vision inspection unit 50, and a loading unit 100 for loading a tray 2 loaded with a plurality of semiconductor devices 1 to be vision-inspected. As aforementioned, the vision inspection unit 50 includes the two-dimensional vision inspection unit 700, and the three-dimensional vision inspection unit 800.

The loading unit 100 for supplying the semiconductor devices 1 to be vision-inspected to the vision inspection unit 50 may be configured so as to transfer the plurality of semiconductor devices 1 to the vision inspection unit 50 by loading the semiconductor devices 1 in the device receiving grooves 2a of the tray 2.

The loading unit 100 may have various configurations. As shown in FIGS. 5 and 6, the loading unit 100 may include a guide unit 110 for guiding the movement of the tray 2 loaded with the plurality of semiconductor devices 1, and a driving unit (not shown) for moving the tray 2 along the guide unit 110.

As shown in FIG. 5, the vision inspection unit 50 may be installed at one side of the guide unit 110. Alternatively, as shown in FIG. 6, the vision inspection unit 50 may be installed above the guide unit 110. With consideration of an inspection speed, the

vision inspection unit 50 may be installed in plurality in number.

As shown in FIG. 5, the vision inspection apparatus for a semiconductor device further comprises one or more transfer tools 600 installed above a moving path of the semiconductor device 1, i.e., above the loading unit 100, for transferring the semiconductor device 1 in an absorption manner by vacuum pressure. The vision inspection unit 50 may be installed below the moving path of the semiconductor device 1, and configured to inspect the inspection surface S of the semiconductor device 1 transferred by the transfer tool 600.

As shown in FIG. 5, when the vision inspection unit 50 is installed at one side of the guide unit 110, the semiconductor devices 1 loaded in the tray 2 so as to be transferred along the guide unit 110 of the loading unit 100 are transferred to the vision inspection unit 50 by the transfer tool 600 after picking up at least one the semiconductor devices 1 loaded in the tray 2. After images of the semiconductor devices 1 are captured by the vision inspection unit 50, the semiconductor devices 1 are placed in the tray 2 again.

As shown in FIGS. 5 and 7, the transfer tool 600 may be configured such that a plurality of pickers 610 for picking up the plurality of semiconductor devices 1 are arranged in at least one lines. And, the vision inspection unit 50 performs a vision inspection by capturing downward or upward images of the semiconductor devices 1 having been transferred by the transfer tool 600.

That is, once the semiconductor devices 1 have been transferred to an inspection position, i.e., an upper side of the vision inspection unit 50, by the pickers 610 arranged in a plurality of lines, the vision inspection unit 50 captures downward or upward images of the semiconductor devices 1 and analyzes the captured images. The vision inspection

unit 50 inspects the semiconductor devices 1, which is called as an 'On The Fly (OTF)' method by inspecting the semiconductor devices 1 according to a result of the analysis.

With considering that the plurality of pickers 610 are arranged in a plurality of lines, the transfer tools 600 may be arranged in 'm x n' lines ('m' and 'n' are natural numbers more than two) in a horizontal direction (X-axis direction) and a vertical direction (Y-axis direction). FIG. 7 shows that the transfer tools 600 are arranged in 10 x 2 lines. Here, the pickers 610 may be differently arranged according to an arrangement type of the device receiving grooves formed on the tray 2 so as to load the semiconductor devices 1 therein.

The transfer tool 600 include a plurality of pickers 610 installed at a supporting bracket 630, and the supporting bracket 630 is installed so as to be movable along a transfer tool guide 601 installed at a body 10.

The pickers 610 for picking up and transferring the semiconductor devices 1 may have various configurations. And, the pickers 610 may include suction heads 612 for picking up the semiconductor devices 1 in an absorption manner by generating vacuum pressure while moving in upper and lower directions (Z-direction). Each suction head 612 may be configured to be independently movable in upper and lower directions.

The semiconductor devices 1 to be inspected are transferred in a loaded state in the device receiving grooves 2a of the tray 2. A horizontal interval (X-axis direction) and a vertical interval (Y-axis direction) may be varied according to a type and a manufacturing company of the semiconductor devices 1.

Accordingly, the transfer tool 600 is preferably configured so that horizontal and vertical intervals (Ph, Pv) of the pickers 610 can be not only fixed, but also can be controlled in one or more directions (X or Y direction).

The transfer tool 600 may be configured so that an interval between the pickers 610 can be fixed in at least one direction of the horizontal and the vertical directions, and can be controlled in the other direction. Alternatively, the transfer tool 600 may be configured so that the interval between the pickers 610 can be controlled in at least one direction of the horizontal and the vertical directions.

A pitch controller (not shown) for controlling the horizontal interval or the vertical interval between the pickers 610 may be implemented as various modules including a link device, a linear moving device, etc.

The pitch controller may be configured to manually control the interval between the pickers 610, or may be configured so as to automatically control the interval between the pickers 610 by recognizing a position of the semiconductor device 1 or an interval between the device receiving grooves 2a of the tray 2. The interval between the pickers 610 may be set equally or differently from each other.

Once the transfer tool 600 has transferred the semiconductor devices 1 to the vision inspection unit 50, the interval between the semiconductor devices 1 need to be narrowed so that only images of the semiconductor devices 1 can be captured. Accordingly, the transfer tool 600 may narrow the interval between the pickers 610 arranged in a plurality of lines, in at least one direction of the horizontal and the vertical directions. Then, the vision inspection unit 50 may capture downward or upward images of the semiconductor devices 1.

The semiconductor devices 1 are transferred to an upper side of the vision inspection unit 50 by the pickers 610 arranged in 'm x n' lines. Accordingly, the vision inspection unit 50 is installed to have a proper distance from the semiconductor devices 1 arranged in 'm x n' lines, so as to capture images of the semiconductor devices 1.

As shown in FIGS. 8 and 9, since the vision inspection unit 50 is implemented as a camera, the number of the semiconductor devices 1 that can be captured at one time is limited to 1, 2, 4, etc. according to a viewing angle of the camera, i.e., a Field Of View (FOV).

As shown in FIGS. 8 and 9, the vision inspection unit 50 picks up the semiconductor devices 1 in a plurality of lines by the transfer tool 600, and then moves the picked-up semiconductor devices 1 to one direction with a constant speed or through steps, thereby capturing images of the semiconductor devices 1 positioned within the FOV of the camera.

As aforementioned, the vision inspection unit 50 captures images of the semiconductor devices 1 after the transfer tool 600 picks up the semiconductor devices 1 in a plurality of lines and moves the picked-up semiconductor devices 1 to an upper side of the vision inspection unit 50. Accordingly, an inspection speed with respect to the semiconductor devices 1 can be significantly increased.

As shown in FIG. 6, in a case that the vision inspection unit 50 is installed above the guide unit 110, the vision inspection unit 50 is installed so as to be movable in horizontal and vertical directions, i.e., X-axis and Y-axis directions, on a moving path of the tray 2, i.e., at an upper side of the loading unit 100.

The vision inspection unit 50 performs a vision inspection by performing a relative movement with respect to the tray 2, i.e., the semiconductor devices 1, i.e., by performing movement in an X-axis direction, movement in a Y-axis direction, movement in X and Y directions, a rotation movement, etc. Accordingly, at the body 10, may be installed guide units 510, 540 for guiding movement of the two-dimensional vision inspection unit 700 and the three-dimensional vision inspection unit 800 implemented as

one module in X and Y directions.

As shown in FIGS. 5 and 6, the vision inspection apparatus for a semiconductor device may further comprise a sorting unit 300 for sorting the semiconductor devices 1 from each other according to inspection results by the vision inspection unit 50, i.e. the two-dimensional vision inspection unit 700 and the three-dimensional vision inspection unit 800.

The sorting unit 300 has a similar configuration to the loading unit 100. And, the sorting unit 300 may be implemented in plurality in number, so that the semiconductor devices 1 can be sorted into good G, defection 1 or rejection 1 (R1), defection 2 or rejection 2 (R2), etc. according to inspection results of the semiconductor devices 1

Each sorting unit 300 may include a guide unit 310 installed at one side of the loading unit 100 in parallel, and a driving unit (not shown) for moving the tray 2 along the guide unit 310.

The tray 2 can be transferred by a tray transfer device (not shown) between the loading unit 100 and the sorting unit 300. And, the tray 2 may further include an empty tray unit 299 for supplying, to the sorting unit 300, an empty tray 2 having no semiconductor devices 1 loaded thereon.

The empty tray unit 200 may include a guide unit 210 installed at one side of the loading unit 100 in parallel, and a driving unit (not shown) for moving the tray 2 along the guide unit 210.

At the sorting unit 300, may be additionally installed a transfer tool 620 for transferring the semiconductor devices 1 between each sorting unit 300 according to a sorted result by each sorting unit 300.

The transfer tool 620 has the configuration similar with the aforementioned transfer tool 600, and has a structure in a plurality of lines or one line.

As a final process, upper and/or lower images of the semiconductor devices 1 are inspected. The semiconductor devices 1 having undergone the final process are loaded in the tray 2, or are inserted into a reel tape to be distributed into the market. Therefore, it is required to check whether the semiconductor devices 1 have been properly loaded onto the tray 2.

Accordingly, the vision inspection apparatus for a semiconductor device may comprise a loading state checking unit installed to be adjacent to the device receiving grooves 2a of the tray 2, for checking whether the semiconductor devices 1 have been properly loaded in the device receiving grooves 2a.

The vision inspection apparatus for a semiconductor device performs a vision inspection with respect to the semiconductor devices 1 through the following steps.

The vision inspection apparatus for a semiconductor device comprises a two-dimensional vision inspection step of capturing image for obtaining a two-dimensional shape of one or more semiconductor devices 1, by irradiating light from a two-dimensional light source 710 to one inspection surface S of upper and lower surfaces of the semiconductor devices 1, and then by photographing the inspection surface S onto which light from the two-dimensional light source 710 has been irradiated by using a two-dimensional camera 720,; and a three-dimensional vision inspection step of capturing image for obtaining a three-dimensional shape of the semiconductor device 1, by irradiating light from a three-dimensional light source 810 to the inspection surface S inspected in the two-dimensional vision inspection step, and then by photographing the inspection surface S onto which light from the three-dimensional light source 810 has

been irradiated by using a three-dimensional camera 820.

The two-dimensional vision inspection step and the three-dimensional vision inspection step may be simultaneously performed. Alternatively, after completion of the two-dimensional vision inspection step, the three-dimensional vision inspection step may be performed.

As shown in FIG. 9A, the two-dimensional vision inspection step may be performed in a state that one or more semiconductor devices 1 have been moved or stopped. As shown in FIG. 9B, the three-dimensional vision inspection step may be performed as the three-dimensional camera 820 scans the inspection surface S while relatively moving to the next semiconductor device 1 for a two-dimensional after the two-dimensional vision inspection step. In FIG. 9a, FOV indicates a capturing region by the two-dimensional camera 720, and PA indicates a capturing region by the three-dimensional camera 820.

The foregoing embodiments and advantages are merely exemplary and are not to be construed as limiting the present disclosure. The present teachings can be readily applied to other types of apparatuses. This description is intended to be illustrative, and not to limit the scope of the claims. Many alternatives, modifications, and variations will be apparent to those skilled in the art. The features, structures, methods, and other characteristics of the exemplary embodiments described herein may be combined in various ways to obtain additional and/or alternative exemplary embodiments.

As the present features may be embodied in several forms without departing from the characteristics thereof, it should also be understood that the above-described embodiments are not limited by any of the details of the foregoing description, unless

otherwise specified, but rather should be construed broadly within its scope as defined in the appended claims, and therefore all changes and modifications that fall within the metes and bounds of the claims, or equivalents of such metes and bounds are therefore intended to be embraced by the appended claims.

CLAIMS

1. A vision inspection apparatus for a semiconductor device, the apparatus comprising a vision inspection unit for performing vision inspection with respect to at least one semiconductor device by capturing image of the semiconductor device and analyzing the captured image,

wherein the vision inspection unit comprises:

a two-dimensional vision inspection unit including a two-dimensional light source for irradiating light onto an inspection surface of one surface of an upper and a lower surfaces of one or more semiconductor devices to be inspected, and a two-dimensional camera for capturing image of the semiconductor device so as to obtain a two-dimensional shape by photographing inspection surface onto which the light from the two-dimensional light source has been irradiated; and

a three-dimensional vision inspection unit including a three-dimensional light source for irradiating light onto the inspection surface inspected by the two-dimensional vision inspection unit, and a three-dimensional camera for capturing image of the semiconductor device so as to obtain a three-dimensional shape by photographing the inspection surface onto which the light from the three-dimensional light source has been irradiated;

wherein the two-dimensional vision inspection unit captures image for obtaining a two-dimensional shape of a semiconductor device in a state that one or more semiconductor devices have been stopped, and the three-dimensional vision inspection unit scans the inspection surface while relatively moving to a next semiconductor device for a two-dimensional vision inspection after the two-dimensional vision inspection operation.

2. A vision inspection apparatus for a semiconductor device, the apparatus comprising a vision inspection unit for performing vision inspection with respect to at least one semiconductor device by capturing image of the semiconductor device and analyzing the captured image,

wherein the vision inspection unit comprises:

a two-dimensional vision inspection unit including a two-dimensional light source for irradiating light onto an inspection surface of one surface of an upper and a lower surfaces of one or more semiconductor devices to be inspected, and a two-dimensional camera for capturing image of the semiconductor device so as to obtain a two-dimensional shape by photographing inspection surface onto which the light from the two-dimensional light source has been irradiated; and

a three-dimensional vision inspection unit including a three-dimensional light source for irradiating light onto the inspection surface inspected by the two-dimensional vision inspection unit, and a three-dimensional camera for capturing image of the semiconductor device so as to obtain a three-dimensional shape by photographing the inspection surface onto which the light from the three-dimensional light source has been irradiated;

wherein the three-dimensional light source and the three-dimensional camera are arranged to be symmetrical to each other based on a normal line perpendicular to the inspection surface.

3. A vision inspection apparatus for a semiconductor device, the apparatus comprising a vision inspection unit for performing vision inspection with respect to at least one semiconductor device by capturing image of the semiconductor device and analyzing the captured image,

wherein the vision inspection unit comprises:

a two-dimensional vision inspection unit including a two-dimensional light source for irradiating light onto an inspection surface of one surface of an upper and a lower surfaces of one or more semiconductor devices to be inspected, and a two-dimensional camera for capturing image of the semiconductor device so as to obtain a two-dimensional shape by photographing inspection surface onto which the light from the two-dimensional light source has been irradiated; and

a three-dimensional vision inspection unit including a three-dimensional light source for irradiating light onto the inspection surface inspected by the two-dimensional vision inspection unit, and a three-dimensional camera for capturing image of the semiconductor device so as to obtain a three-dimensional shape by photographing the inspection surface onto which the light from the three-dimensional light source has been irradiated;

wherein the three-dimensional light source and the three-dimensional camera are arranged with an angle of $10^{\circ} \sim 45^{\circ}$ with respect to a normal line perpendicular to the inspection surface.

4. The apparatus of any one of claims 1 to 3, wherein the two-dimensional camera is arranged in parallel to a normal line perpendicular to the inspection surface.

5. The apparatus of claim 1, wherein one of the three-dimensional light source and

the three-dimensional camera is arranged in parallel to a normal line perpendicular to the inspection surface, and the other is arranged with an inclination angle from a normal line perpendicular to the inspection surface.

6. The apparatus of any one of claims 1 to 3, wherein the semiconductor device is loaded in a tray having a plurality of device receiving grooves.

7. The apparatus of any one of claims 1 to 3, further comprising one or more transfer tools for transferring the semiconductor device by absorbing a surface opposite to the inspection surface of the semiconductor device,
wherein the vision inspection unit inspects the inspection surface of the one or more semiconductor devices transferred by the one or more transfer tools.

8. The apparatus of any one of claims 1 to 3, wherein the two-dimensional light source is an LED light source, and the three-dimensional light source is a laser light source.

9. The apparatus of any one of claims 1 to 3, wherein the two-dimensional light source includes a plurality of lighting groups having at least one of lighting colors, lighting angles, and lighting intensities different from one another.

10. The apparatus of claim 9, wherein the plurality of lighting groups comprise:

a first lighting group installed to have a lighting angle below 30° with respect to the inspection surface of the semiconductor device;

a second lighting group installed to have a lighting angle of 30°～90° with respect to the inspection surface of the semiconductor device; and

a third lighting group installed to have a lighting angle of 90° with respect to the inspection surface of the semiconductor device.

11. A vision inspection method for a semiconductor device, the method comprising:

a two-dimensional vision inspection step of capturing image for obtaining a two-dimensional shape of a semiconductor device, by irradiating light from a two-dimensional light source onto an inspection surface of one surface of upper and lower surfaces of one or more semiconductor devices to be inspected, and then by photographing the inspection surface onto

which light from the two-dimensional light source has been irradiated by using a two-dimensional camera; and

a three-dimensional vision inspection step of capturing image for obtaining a three-dimensional shape of the semiconductor device, by irradiating light from a three-dimensional light source to the inspection surface inspected in the two-dimensional vision inspection step, and then by photographing the inspection surface onto which light from the three-dimensional light source has been irradiated by using a three-dimensional camera.

12. The method of claim 11, wherein the two-dimensional vision inspection step and the three-dimensional vision inspection step are simultaneously performed.

13. The method of claim 11, wherein the three-dimensional vision inspection step is performed after completion of the two-dimensional vision inspection step.

14. The method of claim 11, wherein the two-dimensional vision inspection step is performed in a state that one or more semiconductor devices have been stopped,

wherein the three-dimensional vision inspection step is performed as the three-dimensional camera scans the inspection surface while relatively moving to a next semiconductor device for a two-dimensional vision inspection after the two-dimensional vision inspection step.