

may be a problem that the reference wafer needs to be prepared regularly. Further, as consumption of the probe needles progresses, the lifetime of the probe card is shortened, which results in a cost increase. Furthermore, though the contact between the probe needles and the electrode pads or the solder bumps can be inspected by checking the needle marks with operator's naked eyes, it is difficult to improve alignment accuracy of the wafer based on such observation result through the naked eyes.

[0009] In view of the foregoing, exemplary embodiments provide a position accuracy inspecting method, a position accuracy inspecting apparatus and a position inspecting unit which enable a simple high-accuracy inspection of a contact position when performing a contact type inspection of an inspection target chip formed on an inspection target substrate.

MEANS FOR SOLVING THE PROBLEMS

[0010] In an exemplary embodiment, there is provided a position accuracy inspecting method of inspecting a contact position when performing a contact type inspection by a probe needle on a preset region of at least one inspection target chip formed on an inspection target substrate. Here, the position accuracy inspecting method includes a placement process of placing the inspection target substrate on a substrate placing table; an imaging process of placing, instead of the probe needle, at a position where the probe needle is arranged, a glass substrate on which a shape indicating a position of the probe needle to be brought into contact with the inspection target substrate is formed, and imaging the at least one inspection target chip formed on the inspection target substrate through the glass substrate; and an analysis process of analyzing a positional relationship between the shape and the preset region from at least one image obtained by the imaging process.

[0011] It is desirable that the position accuracy inspecting method includes a determination process of determining whether the probe needle is allowed to be brought into

needle with respect to an electrode pad or a solder bump of a semiconductor device formed on the semiconductor wafer when inspecting electrical characteristics of the semiconductor device by bringing the probe needle into contact with the electrode pad or the solder bump. Here, the position inspecting unit includes an imaging unit; and a holding substrate configured to hold the imaging unit. Further, the imaging unit includes a glass substrate, placed instead of the probe needle at a position where the probe needle is arranged, on which a shape indicating a position of the probe needle is formed; and an imaging device configured to image the semiconductor device formed on the semiconductor wafer through the glass substrate.

EFFECT OF THE INVENTION

[0022] According to the exemplary embodiments, when performing a contact type inspection by a probe needle on a preset region of an inspection target chip formed on an inspection target substrate, a contact position between the preset region and the probe needle is inspected in advance. For the purpose, a glass substrate on which a shape indicating a position of the probe needle to be brought into contact with the inspection target substrate is formed is placed, instead of the probe needle at a position where the probe needle is arranged, and the inspection target chip formed on the inspection target substrate is imaged through the glass substrate. Further, a positional relationship between the shape formed on the glass substrate and the preset region of the inspection target chip is analyzed based on the obtained image.

[0023] Accordingly, when performing the contact type inspection on the inspection target chip, the inspection of the contact accuracy and the determination of the acceptability thereof can be performed in advance on more accurate sub-micron level with non-contact manner. Further, the position deviation between the shape (pattern) formed on the glass substrate and the preset region formed on the inspection target substrate can be quantitatively analyzed. Furthermore, since no needle mark caused by the probe needle is left on the preset region, unlike in the conventional cases,

measurement data, and the determination unit determines, based on the stored measurement data, whether or not the semiconductor device as the inspection target has an electrical defect.

[0033] The probe needles of the probe card 17 need to correspond to positions of the electrode pads or the solder bumps of the semiconductor device formed on the wafer W as the inspection target. For this reason, the probe card 17 is configured to be replaceable depending on the shape of the semiconductor device formed on the wafer W as the inspection target.

[0034] FIG. 2 is a perspective view illustrating a schematic configuration of a driving mechanism of the stage 11 provided in the prober 10. As depicted in FIG. 2, the driving mechanism 18 of the stage 11 includes a Y-stage 19 configured to be moved along the Y direction shown in FIG. 2; an X-stage 20 configured to be moved along the X direction shown in the FIG. 2; and a Z-directional moving unit 21 configured to be moved along the Z direction shown in FIG. 2.

[0035] The Y-stage 19 is driven in the Y direction with high accuracy by a rotary motion of a ball screw 22 provided along the Y direction. The ball screw 22 is rotated by a Y-stage motor 23 which is a step motor. The X-stage 20 is driven in the X direction with high accuracy by a rotary motion of a ball screw 24 provided along the X direction. The ball screw 24 is rotated by an X-stage motor 25 of FIG. 3B to be described later, and this X-stage motor 25 is also a step motor. Further, the stage 11 is configured to be movable in a θ direction shown in FIG. 2 on the Z-directional moving unit 21 by a θ -rotation motor 26 of FIG. 3B to be described later, and the wafer W is placed on this stage 11.

[0036] The Y-stage 19, the X-stage 20, the Z-directional moving unit 21 and the stage 11 cooperate to move the semiconductor device formed on the wafer W to a position facing the probe card 17, so that the electrode pads or the like of the semiconductor device are allowed to be brought into contact with the probe needles. Driving of the Y-stage motor 23, the X-stage motor 25 and the θ -rotation motor 26 is controlled by a motor control device 27 of FIG. 3B to be described later.

[0047] FIG. 4A and FIG. 4B are diagrams schematically showing the content of image processing performed by the computer 50 in the first operation method of the position accuracy inspecting apparatus 100. FIG. 4A illustrates an example of an image obtained by the imaging device 33 in a state that the wafer W is not placed on the stage 11. Since the imaging device 33 images a top surface of the stage 11 through the reticle 31, the patterns formed on the reticle 31 appear on the obtained image. In the image of FIG. 4A, the image processing is performed such that a region of the reticle 31 where a large amount of light is transmitted is shown in gray, and a region thereof where a relatively small amount of light is transmitted is shown in white (a region of the color of a paper on which FIG. 4A is shown).

[0048] A region 66 is a region displayed on the display 50a and indicates an entire region that can be imaged by the imaging unit 40. A region 60 is a region indicating shape patterns of the semiconductor device formed on the reticle 31. Within the region 60, shapes 61, 62, 63, 64 and 65 are displayed according to the shape patterns formed on the reticle 31.

[0049] Centers of the shapes 61 to 65 respectively correspond to positions of the probe needles. A region of the reticle 31 corresponding to the region (region shown in gray) of each of the shapes 61 to 65 is a region which is transparent and well-transmits light. Further, a region corresponding to a region (region shown in gray) of the region 66 except the region 60 is the same. Meanwhile, a region of the reticle 31 corresponding to a region (region of the color of the paper of FIG. 4A) of the region 60 except the shapes 61 to 65 exhibits a smaller light transmittance than the regions of the shapes 61 to 65.

[0050] Then, the wafer W is placed on the stage 11, and the semiconductor device is observed by the imaging unit 40. The wafer W is aligned with the stage 11 and is held at a certain position. A position (coordinates) of the semiconductor device formed on the wafer W is previously known from setting conditions in a manufacturing process, and the holding position of the wafer W on the stage 11 is also known from a mechanical configuration of the position accuracy inspecting

apparatus 100. Here, it is assumed that since the contact accuracy is determined to be unacceptable in the positional relationship between the shapes 61 to 64 and the electrode pads 71 to 74 shown in **FIG. 4B**, the position correction of the stage 11 is performed.

[0061] **FIG. 5A** and **FIG. 5B** are diagrams schematically illustrating the content of an image processing performed by the computer 50 in the second operation method of the position accuracy inspecting apparatus 100. In **FIG. 5A**, the positional relationship between the shapes 61 to 65 and the electrode pads 71 to 75 is the same as in **FIG. 4B**. For the position correction of the stage 11 on the X-Y plane, deviations in X, Y and θ directions need to be corrected. Thus, the centers of the shapes and the centers of the electrode pads need to be made coincident at two positions at minimum. Here, the centers (white rectangles) of the diagonally arranged shapes 62 and 64 and the centers (black circles) of the electrode pads 72 and 74 are made coincident by the image processing.

[0062] In **FIG. 5B**, assume that coordinates (x_0, y_0) of the center P0 of the shape 64, coordinates (x_1, y_1) of the center P1 of the electrode pad 74, coordinates (x_2, y_2) of the center P2 of the shape 62 and coordinates (x_3, y_3) of the center P3 of the electrode pad 72 are calculated by the image processing. Then, a rotation correction angle θ_0 of the centers P0 and P1 and a rotation correction angle θ_1 of the centers P1 and P3 are calculated with respect to the X-axis (or Y-axis). Then, a θ correction amount $(=\theta_0 - \theta_1)$ is calculated from the rotation correction angles θ_0 and θ_1 as a difference of the rotation correction angles, and the computer 50 stores the calculated θ correction amount. Subsequently, the computer 50 outputs a signal for driving the θ rotation motor 26 to the motor control device 27, and rotates the stage 11 by the θ correction amount. As a result, a line connecting P0 and P2 and a line connecting P1 and P3 are made parallel to each other and the correction in the θ direction is ended.

[0063] By the correction in the θ direction, the coordinates of the centers P1 and P3 are respectively changed to $P1'(x_1', y_1')$ and $P3'(x_3', y_3')$. The centers P0 and P2 are not changed. From the coordinates of P0 and $P1'$, a first X-direction correction amount $(\Delta X_1) (= x_0 - x_1')$ and a first Y-