

CLAIMS

1. A wafer pre-alignment device, comprising:

a first unit configured to drive a wafer to rotate or move upward or downward, the first unit comprising a first chuck for retaining the wafer;

a second unit configured to drive the wafer to translate relative to the first chuck;

a position detector comprising a light source, an image sensor disposed above the first chuck, and a lens disposed under the first chuck, wherein a light beam from the light source passes through the wafer, the first chuck and the lens and thereby provides information indicating a position of the wafer relative to the first chuck on to the image sensor, wherein:

the position detector comprises a reflective optical system, the wafer is a TSV wafer with a notch on an edge thereof and the reflective optical system is configured to obtain the information indicating the position of the TSV wafer relative to the first chuck, the reflective optical system comprises the light source, a first lens assembly, the image sensor and the lens, the light source serving as a first light source for producing a light beam having a first wavelength, the lens implemented as a reflective lens for reflecting the light beam having the first wavelength, the first lens assembly disposed above the first chuck and under the image sensor and configured to direct the light beam having the first wavelength on the wafer and the reflective lens and the light beam is then reflected onto the image sensor;

the information obtained by the image sensor of the reflective optical system comprises edge coordinates of the notch and a deviation of a center of the wafer from a center of the first chuck;

the first unit is configured to achieve an orientation process of the wafer by driving the wafer to rotate or move upward or downward based on the edge

coordinates of the notch;

the second unit is configured to adjust a radial position of the wafer relative to the first chuck, by driving the wafer to translate relative to the first chuck, based on the deviation of the center of the wafer from the center of the first chuck.

2. The wafer pre-alignment device of claim 1, wherein the first unit further comprises:

a rotating motor configured to drive the first chuck to rotate; and

a lifting motor configured to drive the first chuck to move upward or downward.

3. The wafer pre-alignment device of claim 2, wherein the second unit comprises:

a second chuck disposed lateral to the first chuck, wherein the lifting motor is configured to transfer the wafer between the first chuck and the second chuck; and

a translating motor configured to drive the second chuck and the wafer to translate so as to adjust the radial position of the wafer relative to the first chuck.

4. The wafer pre-alignment device of claim 3, wherein each of the first chuck and the second chuck comprises a plurality of suction holes.

5. The wafer pre-alignment device of claim 1, wherein the image sensor comprises a plurality of CCDs arranged in a one-dimensional linear array, an extended line of the one-dimensional linear array passes through the center of the first chuck.

6. The wafer pre-alignment device of claim 1, wherein the position detector further comprises a catadioptric optical system.

7. The wafer pre-alignment device of claim 6, wherein the catadioptric optical system comprises the light source, a second lens assembly, the image sensor and the lens, the light source serving as a second light source for producing a light beam having a second wavelength, the lens implemented as a transmissive lens allowing the transmission of the light beam having the second wavelength, the second

lens assembly disposed under the first chuck and configured to cause the light beam having the second wavelength to transmit through the wafer and the transmissive lens and then reach the image sensor.

8. The wafer pre-alignment device of claim 6, wherein the lens is a filtering lens configured to reflect a light beam having a first wavelength and allow transmission of a light beam having a second wavelength.

9. The wafer pre-alignment device of claim 6, wherein: the wafer is an ultra-thin wafer or a Taiko wafer; the catadioptric optical system is configured to obtain the information indicating the position of the ultra-thin wafer or the Taiko wafer relative to the first chuck.

10. The wafer pre-alignment device of claim 1, wherein the information further comprises a position of the notch with respect to the TSV wafer and a position of the notch with respect to the first chuck, and wherein the first unit is further configured to adjust a circumferential position of the TSV wafer relative to the first chuck based on the information.

11. A method for pre-aligning a TSV wafer using the wafer pre-alignment device as defined in claim 1, comprising the steps of:

Step 100) retaining the TSV wafer on the first chuck by suction and irradiating the edge of the TSV wafer with a light beam produced by the first light source;

Step 200) rotating the first chuck by 360 degrees, concurrently with the image sensor capturing an edge image of the TSV wafer retained on the first chuck and calculating a deviation of a center of the TSV wafer from the center of the first chuck;

Step 300) transferring the TSV wafer from the first unit to the second unit and moving the TSV wafer by the second unit based on the calculated deviation so as to align the center of the TSV wafer with the center of the first chuck;

Step 400) transferring the TSV wafer from the second unit back to the first unit,

rotating the first chuck by 360 degrees, capturing an edge image of the TSV wafer on the first chuck and determining whether a deviation of the center of the TSV wafer from the center of the first chuck is smaller than a predetermined value by the image sensor, if yes, proceeding to Step 500 and, if not, looping back to Step 300; and

Step 500) performing, by the image sensor, detailed scanning of the notch in the TSV wafer to obtain an edge image of the notch, extracting the edge coordinates of the notch from the edge image of the notch, and identifying positional attributes of the notch, thereby achieving the orientation process.

12. The method of claim 11, wherein calculating a deviation of a center of the TSV wafer from the center of the first chuck comprises:

Step 210) obtaining a two-dimensional edge image of the TSV wafer by the image sensor and extracting edge coordinates of the TSV wafer from the obtained two-dimensional edge image of the TSV wafer;

Step 220) converting the edge coordinates of the TSV wafer to coordinates in a coordinate system of the first chuck;

Step 230) determining coordinates of the center of the TSV wafer in the coordinate system of the first chuck using a method of least squares; and

Step 240) calculating a difference between the coordinates of the center of the TSV wafer and coordinates of the center of the first chuck.

13. The method of claim 12, wherein in Step 210, the image sensor is a linear-array CCD image sensor which captures one-dimensional edge images of the TSV wafer, and the captured one-dimensional edge images are combined by software into the two-dimensional edge image of the TSV wafer.

14. The method of claim 11, wherein Step 200 further comprises: determining a type of the TSV wafer based on the edge image of the TSV wafer and determining a light intensity for the first light source based on the determined type of the TSV wafer.

15. The method of claim 11, wherein in Step 500, the detail scanning comprises the steps of:

Step 511) causing the first chuck to return to an original position with the notch in the TSV wafer situated under and counterclockwise to the image sensor;

Step 512) rotating the first chuck clockwise by an angle such that the notch in the TSV wafer completely passes by the image sensor, with the image sensor capturing one-dimensional images of the notch;

Step 513) fitting the one-dimensional images of the notch together into a two-dimensional image;

Step 514) extracting edge coordinates of the notch from the two-dimensional image and comparing the edge coordinates of the notch with the attributes of the notch, if the notch is identified, ending the orientation process and, if the notch is not identified, activating a counter and sequentially proceeding with one of Step 515, Step 516, Step 517 and Step 518 according to a number of repeated times indicated by the counter;

Step 515) causing the first chuck to return to the original position, rotating the first chuck counterclockwise by an angle that is half an arc angle of the notch, repeating Step 512 to Step 514 and, if the notch is identified, ending the orientation process;

Step 516) causing the first chuck to return to the original position, rotating the first chuck clockwise by an angle that is half the arc angle of the notch, repeating Step 512 to Step 514 and, if the notch is identified, ending the orientation process;

Step 517) increasing an light intensity, causing the first chuck to return to the original position, repeating Step 512 to Step 514 and, if the notch is identified, ending the orientation process; and

Step 518) reducing the light intensity, causing the first chuck to return to the

original position, repeating Step 512 to Step 514 and, if the notch is identified, ending the orientation process.

16. The method of claim 15, further comprising:

Step 519) after Step 514, checking the number of repeated times indicated by the counter, and if the number does not exceed a set value, sequentially proceeding with one of Step 515, Step 516, Step 517 and Step 518 and, if the number exceeds the set value, ending the orientation process and hence pre-alignment.