Method and Assembly for Wafer Positioning Inspection

FIELD OF INVENTION

The invention relates broadly to a method of inspecting wafer positioning on a plate unit, to an assembly for inspecting wafer positioning on a plate unit, to an inspection tool for inspecting wafer positioning on a plate unit and to an inspection wafer for inspecting wafer positioning on a plate unit.

BACKGROUND

During wafer processing in the semiconductor industry, wafers are typically transferred by a transfer arm onto one or more heating plate units for production processes such as coating and development, under temperature control. The plate units are used on production tracks such as the Tokyo Electron Limited (TEL) track system. To achieve uniform heating, wafers are typically transferred onto the centre of the plate units.

The transfer arm used to transfer the wafers onto a plate unit is typically driven by motors. Over time, the transfer arm may "drift" out of position and position the wafers off the centre of the plate unit. Due to requirements for positioning the wafers, with a tolerance on the scale of sub-millimeters, if the wafers are placed out of position, typical production yield is lowered as e.g. the resist profile of the wafers may be "slanted". For example, it is typically unacceptable if wafers are placed at 0.075cm away from the centre of the plate unit.

Wafer guides are typically provided on each plate unit and around the circumference of the plate unit to accommodate minor wafer drifts by allowing wafers falling on the inner edges of the wafer guides to "slide" back towards the centre region of the plate unit. This may assist in not disrupting production flow. In

addition, wafer guides can aid in the visual detection of gross mis-positioning of wafers, i.e. where wafers are mis-positioned to an extent that they rest on one or more of the wafer guides, rather than sliding onto the plate unit. One problem that arises with the use of wafer guides is that the wafers that have "slid" back onto the plate unit, after falling on the wafer guides, are typically not consistently processed since the wafers may each adopt an inconsistent and random position on the plate unit. Inconsistent processing gives rise to issues of unpredictable yield.

As wafer guides are typically mounted and remain on the plate unit, their physical dimensions, in particular their height and width, and their positioning on the plate unit cannot be varied to an extent that they would interfere with the production processes, such as causing shadowing effects or affecting the "sliding" effect. Therefore, it may not be practical to re-design the wafer guides such as to optimise the balancing of increasing detection of mis-positioning of the wafers on the one hand, and the effect of "slide" back on the other hand.

When a significant transfer drift is detected or during periodic Preventive Maintenance (PM) sessions, unit positioning or centering checks of the transfer arm are typically performed visually, together with position tuning of the transfer arm, if required. Inspection and tuning are typically carried out by utilising a commercial teaching software installed on a separate laptop and setting up a Close-Circuit (CCD) camera, to aid in identifying "slide" back and the wafer positioning/drift during the inspection and tuning, which are otherwise difficult to detect by the naked eye.

The inspection is typically carried out in a front-view position only. Without the assistance of a CCD camera, the inspector may not be able to detect or estimate the wafer shift from the centre of the plate unit due to the relatively small dimensions involved and the thin dimensions of the wafers. For example, due to the thin dimensions of wafers and the inspection position, a wafer resting on a wafer guide furthest from and directly in front of the front-view position may not be easily visible as being mis-positioned, as compared to the wafer resting on wafer guides located on e.g. the left or right sides of the inspection position. Therefore, not only is the

inspection and tuning process time consuming, it must also typically be conducted by a trained assistant engineer or an engineer so as to improve the effectiveness of the inspection and tuning based on the particular expertise acquired by the assistant engineer or engineer. This may take up precious engineer resources and further contributes to the overall cost associated with the inspection and tuning processing.

Hence, there exists a need for a method or system for wafer positioning inspection that seeks to address at least one of the above problems.

SUMMARY

In accordance with a first aspect of the present invention, there is provided a method of inspecting wafer positioning on a plate unit, the method comprising, providing an inspection tool on the plate unit, transferring an inspection wafer onto the plate unit with the inspection tool on the plate unit; and inspecting the wafer positioning based on whether an alignment element of the inspection tool mates with a corresponding alignment element of the inspection wafer when the inspection wafer is transferred onto the plate unit.

The method may further comprise providing the inspection tool substantially in the centre of the plate unit.

The alignment element of the inspection tool may comprise a stem.

The stem may protrude vertically from a surface of the plate unit when the inspection tool is provided on the plate unit.

The inspection tool may comprise a mounting pin, and the mounting pin may be received in a corresponding recess in the plate unit when the inspection tool is provided on the plate unit.

The inspection tool may comprise a base plate disposed between the stem and the mounting pin.

The inspection wafer may rest on the base plate when the stem mates with the alignment element of the inspection wafer.

The stem may be substantially cylindrical.

The alignment element of the inspection wafer may comprise a through hole formed in the inspection wafer.

The through hole may be disposed substantially in the centre of the inspection wafer.

The method may further comprise providing a foil covering the through hole during transfer of the inspection wafer utilizing a transfer arm.

The foil may be disposed such that the through hole is uncovered when the alignment element of the inspection tool mates with the corresponding alignment element of the inspection wafer.

The through hole may be substantially circular.

In accordance with a second aspect of the present invention, there is provided an assembly for inspecting wafer positioning on a plate unit, the assembly comprising, an inspection tool for disposing on the plate unit; an inspection wafer for transferring onto the plate unit with the inspection tool on the plate unit; wherein the inspection tool and the inspection wafer comprise corresponding respective alignment elements for inspecting the wafer positioning based on whether the alignment element of the inspection tool mates with the corresponding alignment element of the inspection wafer when the inspection wafer is transferred onto the plate unit.

The inspection tool may be disposed substantially in the centre of the plate unit.

The alignment element of the inspection tool may comprise a stem.

The stem may protrude vertically from a surface of the plate unit when the inspection tool is disposed on the plate unit.

The inspection tool may comprise a mounting pin, and the mounting pin may be received in a corresponding recess in the plate unit when the inspection tool is disposed on the plate unit.

The inspection tool may comprise a base plate disposed between the stem and the mounting pin.

The inspection wafer may rest on the base plate when the stem mates with the alignment element of the inspection wafer.

The stem may be substantially cylindrical.

The alignment element of the inspection wafer may comprise a through hole formed in the inspection wafer.

The through hole may be disposed substantially in the centre of the inspection wafer.

The assembly may further comprise a foil covering the through hole during transfer of the inspection wafer utilizing a transfer arm.

The foil may be disposed such that the through hole is uncovered when the alignment element of the inspection tool mates with the corresponding alignment element of the inspection wafer.

The through hole may be substantially circular.

In accordance with a third aspect of the present invention, there is provided an inspection tool for inspecting wafer positioning on a plate unit, the inspecting tool comprising an alignment element for inspecting the wafer positioning based on whether the alignment element of the inspection tool mates with a corresponding alignment element of an inspection wafer when the inspection wafer is transferred onto the plate unit with the inspection tool on the plate unit.

The inspection tool may be disposed substantially in the centre of the plate unit.

The alignment element of the inspection tool may comprise a stem.

The stem may protrude vertically from a surface of the plate unit when the inspection tool is disposed on the plate unit.

The inspection tool may comprise a mounting pin, and the mounting pin may be received in a corresponding recess in the plate unit when the inspection tool is disposed on the plate unit.

The inspection tool may comprise a base plate disposed between the stem and the mounting pin.

The inspection wafer may rest on the base plate when the stem mates with the alignment element of the inspection wafer.

The stem may be substantially cylindrical.

In accordance with a fourth aspect of the present invention, there is provided an inspection wafer for inspecting wafer positioning on a plate unit, the inspecting wafer comprising an alignment element for inspecting the wafer positioning based on whether the alignment element of the inspection wafer mates with a corresponding alignment element of an inspection tool when the inspection wafer is transferred onto the plate unit with the inspection tool on the plate unit.

The alignment element of the inspection wafer may comprise a through hole formed in the inspection wafer.

The through hole may be disposed substantially in the centre of the inspection wafer.

The inspection wafer may further comprise a foil covering the through hole during transfer of the inspection wafer utilizing a transfer arm.

The foil may be disposed such that the through hole is uncovered when the alignment element of the inspection tool mates with the corresponding alignment element of the inspection wafer.

The through hole may be substantially circular.

BRIEF DESCRIPTION OF THE DRAWINGS

Embodiments of the invention will be better understood and readily apparent to one of ordinary skill in the art from the following written description, by way of example only, and in conjunction with the drawings, in which:

Figure 1 is a schematic cross-sectional view of an inspection jig, an inspection wafer and a plate unit according to an example embodiment.

Figure 2 is a schematic cross-sectional view illustrating a wafer position on an inspection assembly in an example embodiment.

Figure 3 is a schematic cross-sectional view illustrating another wafer position on an inspection assembly in an example embodiment.

Figure 4 is a schematic cross-sectional view illustrating yet another wafer position on an inspection assembly in an example embodiment.

Figure 5 is a schematic flowchart illustrating a method of inspecting wafer positioning on a plate unit in an example embodiment.

DETAILED DESCRIPTION

The example embodiment described can provide a method and system for visually inspecting a wafer position after the wafer is transferred by a transfer arm onto a plate unit.

Figure 1 is a schematic cross-sectional exploded view of an inspection jig, an inspection wafer and a plate unit in the example embodiment. The inspection jig 106 is provided and mounted on the plate unit 104, with a mounting pin 105 of the inspection jig 106 mating with a centre hole 108 in the plate unit 104. The inspection wafer 110 with thin foil 112 covering a centre hole 113 of the inspection wafer 110 is transferred onto the plate unit 104 by a transfer arm (not shown). The thin foil 112 is flexible so that the inspection wafer 110 can be lowered and receives a stem 114 of the inspection jig 106 without significant resistance to the inspection wafer 110. The thin foil 112 is provided to cover the centre hole 108 to ensure that the inspection wafer 110 is detected by a sensor, such as a laser sensor, of the transfer arm (not shown). The transfer arm typically comprises the sensor so that an error is detected when no wafers are placed on the transfer arm during production manufacturing. In the example embodiment, the thin foil 112 is attached on one end to the inspection wafer 110 with an adhesive material

such that the centre hole 113 is uncovered when the stem 114 mates with the centre hole 113 of the inspection wafer 110.

The inspection wafer 110 is disposed on a base plate 115 of the inspection jig 106 when the stem 114 mates with the centre hole 113 of the inspection wafer 110. The dimensions of the base plate 115 are chosen in the example embodiment so that the inspection wafer 110 is prevented from "slanting" out of position or being unbalanced when the stem 114 mates with the centre hole 113 of the inspection wafer 110.

In the example embodiment, the inspection wafer 110 comprises a polycarbonate material, the thin foil 112 comprises a thin opaque cellophane material and the inspection jig 106 comprises stainless steel material.

The centre hole 108 of the plate unit 104 is typically present for heating purposes during production and is used in the example embodiment to mate with the mounting pin 105 of the inspection jig 106. During proximity baking processes, the centre hole 108 is typically used to place gap spacers to maintain a gap between the plate unit 104 and production wafers. Moveable pins e.g. 116 are typically present on the plate unit 104 to receive wafers from the transfer arm and lower the wafers onto the plate unit 104 during production manufacturing. The pins e.g. 116 are operated to move up or down by activating or deactivating a solenoid (not shown) respectively. The plate unit 104 measures about 20.15cm in diameter (between the bottom portions of the wafer guides 102) and the inspection wafer 110 measures about 20.00cm in diameter in the example embodiment, which is a typical dimension for production wafers. Therefore, there is a spatial distance of about 0.075 cm between wafers placed on the plate unit 104 and the wafer guides e.g. 102, if the wafers are centrally disposed on the plate unit 104.

The stem 114 measures about 0.5 cm in diameter and about 0.3cm in height. The inspection wafer 110 can be lowered onto the inspection jig 106 by the moveable pins e.g. 116 without the stem 114 impeding the transferring process of the inspection wafer 110 from the transfer arm onto the moveable pins e.g. 116. The mounting pin 105 measures about 0.5cm in diameter for mating with the centre hole 108 of the plate unit

104. The hole 113 of the inspection wafer 110 measures about 0.59 cm in diameter. When the inspection wafer 110 is disposed on the inspection jig 106, the inspection wafer 110 has a maximum drift allowance of about 0.045 cm around the stem 114 of the inspection jig 106 since the difference in the diameters of the stem 114 and the hole 113 is about 0.09 cm. Therefore, in the example embodiment, if the inspection wafer 110 cannot be placed on the inspection jig 106, it will be readily visually apparent to an inspector that the wafer drift is more than 0.045 cm, as the inspection wafer 110 will be "slanted" over the tip of the stem 114. The slanting is more readily visible and "exaggerated" since the stem 114 is substantially near the centre of the inspection wafer 110, as compared to e.g. a drifted thin wafer resting on one or more of the circumferentially disposed wafer guides e.g. 102.

Figures 2, 3, and 4 are cross-sectional schematic views illustrating different wafer positions on an inspection assembly according to an example embodiment.

Figure 2 shows an inspection wafer 210 being centrally disposed on a stem 214 of an inspection jig 206 mounted on a plate unit 204. The inspection wafer 210 is optimally disposed at about 0.075 cm away from the wafer guides e.g. 202. Figure 3 shows the inspection wafer 210 disposed on the stem 214 of the inspection jig 206 such that the maximum drift allowance of about 0.045 cm has been reached. Therefore, the inspection wafer 210 is disposed at about 0.120 cm away from the furthest wafer guide 218 and at about 0.03 cm away from the nearest wafer guide 220. Figure 4 shows the inspection wafer 210 being "slanted" out of position when the maximum drift allowance or threshold value of about 0.045 cm has been exceeded in the example embodiment, since the inspection wafer 210 cannot be placed on the inspection jig 206. Therefore, when the inspection wafer 210 is not disposed horizontally on the plate unit 204 since the stem 214 and the hole 213 can not be aligned due to transfer arm drift, it can be readily visually concluded that the transfer arm (not shown) has drifted more than 0.045 cm from the optimal central position.

As illustrated in Figures 2, 3 and 4, the plate unit 204 is provided for proximity heating processes with gap spacers e.g. 222 placed on the plate unit 204 by utilising the

centre hole 208. In the example embodiment, the height of the base plate 215 of the inspection jig 206 is chosen to be substantially the same as the height of the gap spacers e.g. 222 of the plate unit 204. This reduces inspection inaccuracies relating to the gap spacers e.g. 222 during wafer inspection, in the example embodiment.

It will be appreciated by a person skilled in the art that the example embodiment can provide wafer positioning inspection in which identifying of undesired drift may be readily visually concluded without a strict requirement for a particular expertise of the person conducting the visual inspection. As such, the visual inspection may be conducted by non-engineer personnel, thus saving precious and more costly engineer resources. Furthermore, it will be appreciated that differently dimensioned stems e.g. 214 may be provided on different inspection jigs e.g. 206, to inspect for different threshold values of drift. Alternatively, different inspection wafers with varying centre hole sizes can be provided for determining different threshold values of drift. Also, inspection jigs of different dimensions may be provided for plate units with different dimensions. For example, for wafer positioning inspection in a Precision Chilling Hot plate process station (PCH), an inspection jig comprising a stem, measuring about 0.5cm in diameter and about 0.25cm in height, and a mounting pin of about 0.4cm in diameter can be used with the inspection wafer 110.

In the example embodiment, the process of identifying wafer drift is thus relatively easier and faster as the track speed, i.e. the speed at which the transfer arm transfers the inspection wafer 210 onto the inspection jig 206, can be maintained at the programmed production speed, as compared to slowing down the transfer arm by manually operating the arm when using the previous inspection method. Moreover, with different sized inspection jigs, the inspector in the example embodiment can better estimate the amount of the wafer drift and then make relatively precise adjustments immediately. A CCD camera may still be used to assist during fine-tuning of the transfer arm.

The above advantages are useful when inspecting the different process stations, i.e. when a wafer flow is executed such that the inspection wafer 210 is placed on each

different plate unit at a number of process stations such as the High Temperature Process stations (HHP), Low Temperature Hot Plate Process stations (LHP), High Speed Child Process stations (HCP), Chilled Plate Process stations (CPL), Adhesion Process stations (ADH), Precision chilling hot plate process stations (PCH) and High Precision hot plate process stations (PHP).

It will be appreciated that the inspection jigs in the example embodiment can be manufactured using a number of known manufacturing methods including but not limited to e.g mill cutting. The centre holes of inspection wafers in the example embodiment can be manufactured using a number of known manufacturing methods including but not limited to drilling, and stencilling.

The example embodiment can be utilised during preventive maintenance as an early measure for avoiding further wafer drifts that can cause resist profile or process change in production wafers, as compared to undetected drifts when wafer guides can "slide" wafers into position on the plate units. The drift amounts in transfer arm position can also be estimated by using inspection jigs with different diameter stems. Additionally, the example embodiment does not need to be operated by a trained Assistant Engineer or Engineer. A Preventive Maintenance team (comprising technicians or Engineering Assistants) is adequate when using an inspection assembly according to the example embodiment.

Figure 5 is a schematic flowchart 500 illustrating a method of inspecting wafer positioning on a plate unit in the example embodiment. At step 502, an inspection tool is provided on the plate unit. At step 504, an inspection wafer is transferred onto the plate unit with the inspection tool on the plate unit. At step 506, the wafer positioning is inspected based on whether an alignment element of the inspection tool mates with a corresponding alignment element of the inspection wafer when the inspection wafer is transferred onto the plate unit.

It will be appreciated by a person skilled in the art that numerous variations and/or modifications may be made to the present invention as shown in the specific

embodiments without departing from the spirit or scope of the invention as broadly described. The present embodiments are, therefore, to be considered in all respects to be illustrative and not restrictive.

For example, it will be appreciated that an inspection jig may be provided with a replaceable set of stems of different diameters, instead of or in addition to providing integral inspection jigs having different stem dimensions.

Furthermore, in another example embodiment, the inspection jig may comprise only a stem portion for mating with a centre hole in an inspection wafer, and a pin portion for mounting onto the plate unit i.e without a base plate. In such an embodiment, the inspection wafer may rest directly on the plate unit when the stem mates with the centre hole of the inspection wafer.

CLAIMS

1. A method of inspecting wafer positioning on a plate unit, the method comprising,

providing an inspection tool on the plate unit,

transferring an inspection wafer onto the plate unit with the inspection tool on the plate unit; and

inspecting the wafer positioning based on whether an alignment element of the inspection tool mates with a corresponding alignment element of the inspection wafer when the inspection wafer is transferred onto the plate unit.

2. The method as claimed in claim 1, further comprising providing the inspection tool substantially in the centre of the plate unit.

3. The method as claimed in claims 1 or 2, wherein the alignment element of the inspection tool comprises a stem.

4. The method as claimed in claim 3, wherein the stem protrudes vertically from a surface of the plate unit when the inspection tool is provided on the plate unit.

5. The method as claimed in claims 3 or 4, wherein the inspection tool comprises a mounting pin, and the mounting pin is received in a corresponding recess in the plate unit when the inspection tool is provided on the plate unit.

6. The method as claimed in claim 5, wherein the inspection tool comprises a base plate disposed between the stem and the mounting pin.

7. The method as claimed in claim 6, wherein the inspection wafer rests on the base plate when the stem mates with the alignment element of the inspection wafer.

8. The method as claimed in any one of claims 3 to 7, wherein the stem is substantially cylindrical.

9. The method as claimed in any one of claims 1 to 8, wherein the alignment element of the inspection wafer comprises a through hole formed in the inspection wafer.

10. The method as claimed in claim 11, wherein the through hole is disposed substantially in the centre of the inspection wafer.

11. The method as claimed in claims 9 or 10, further comprising providing a foil covering the through hole during transfer of the inspection wafer utilizing a transfer arm.

12. The method as claimed in claim 11, wherein the foil is disposed such that the through hole is uncovered when the alignment element of the inspection tool mates with the corresponding alignment element of the inspection wafer.

13. The method as claimed in any one of claims 9 to 12, wherein the through hole is substantially circular.

14. An assembly for inspecting wafer positioning on a plate unit, the assembly comprising,

an inspection tool for disposing on the plate unit;

an inspection wafer for transferring onto the plate unit with the inspection tool on the plate unit;

wherein the inspection tool and the inspection wafer comprise corresponding respective alignment elements for inspecting the wafer positioning based on whether the alignment element of the inspection tool mates with the corresponding alignment element of the inspection wafer when the inspection wafer is transferred onto the plate unit.

15. The assembly as claimed in claim 14, wherein the inspection tool is disposed substantially in the centre of the plate unit.

16. The assembly as claimed in claims 14 or 15, wherein the alignment element of the inspection tool comprises a stem.

17. The assembly as claimed in claim 16, wherein the stem protrudes vertically from a surface of the plate unit when the inspection tool is disposed on the plate unit.

18. The assembly as claimed in claims 16 or 17, wherein the inspection tool comprises a mounting pin, and the mounting pin is received in a corresponding recess in the plate unit when the inspection tool is disposed on the plate unit.

19. The assembly as claimed in claim 18, wherein the inspection tool comprises a base plate disposed between the stem and the mounting pin.

20. The assembly as claimed in claim 19, wherein the inspection wafer rests on the base plate when the stem mates with the alignment element of the inspection wafer.

21. The assembly as claimed in any one of claims 16 to 20, wherein the stem is substantially cylindrical.

22. The assembly as claimed in any one of claims 14 to 21, wherein the alignment element of the inspection wafer comprises a through hole formed in the inspection wafer.

23. The assembly as claimed in claim 22, wherein the through hole is disposed substantially in the centre of the inspection wafer.

24. The assembly as claimed in claims 22 or 23, further comprising a foil covering the through hole during transfer of the inspection wafer utilizing a transfer arm.

25. The assembly as claimed in claim 24, wherein the foil is disposed such that the through hole is uncovered when the alignment element of the inspection tool mates with the corresponding alignment element of the inspection wafer.

26. The assembly as claimed in any one of claims 22 to 25, wherein the through hole is substantially circular.

27. An inspection tool for inspecting wafer positioning on a plate unit, the inspecting tool comprising an alignment element for inspecting the wafer positioning based on whether the alignment element of the inspection tool mates with a corresponding alignment element of an inspection wafer when the inspection wafer is transferred onto the plate unit with the inspection tool on the plate unit.

28. The inspection tool as claimed in claim 27, wherein the inspection tool is disposed substantially in the centre of the plate unit.

29. The inspection tool as claimed in claims 27 or 28, wherein the alignment element of the inspection tool comprises a stem.

30. The inspection tool as claimed in claim 29, wherein the stem protrudes vertically from a surface of the plate unit when the inspection tool is disposed on the plate unit.

31. The inspection tool as claimed in claims 29 or 30, wherein the inspection tool comprises a mounting pin, and the mounting pin is received in a corresponding recess in the plate unit when the inspection tool is disposed on the plate unit.

32. The inspection tool as claimed in claim 31, wherein the inspection tool comprises a base plate disposed between the stem and the mounting pin.

33. The inspection tool as claimed in claim 32, wherein the inspection wafer rests on the base plate when the stem mates with the alignment element of the inspection wafer.

34. The inspection tool as claimed in any one of claims 29 to 33, wherein the stem is substantially cylindrical.

35. An inspection wafer for inspecting wafer positioning on a plate unit, the inspecting wafer comprising an alignment element for inspecting the wafer positioning based on whether the alignment element of the inspection wafer mates with a corresponding alignment element of an inspection tool when the inspection wafer is transferred onto the plate unit with the inspection tool on the plate unit.

36. The inspection wafer as claimed in claim 35, wherein the alignment element of the inspection wafer comprises a through hole formed in the inspection wafer.

37. The inspection wafer as claimed in claim 36, wherein the through hole is disposed substantially in the centre of the inspection wafer.

38. The inspection wafer as claimed in claims 36 or 37, further comprising a foil covering the through hole during transfer of the inspection wafer utilizing a transfer arm.

39. The inspection wafer as claimed in claim 38, wherein the foil is disposed such that the through hole is uncovered when the alignment element of the inspection tool mates with the corresponding alignment element of the inspection wafer.

40. The inspection wafer as claimed in any one of claims 36 to 39, wherein the through hole is substantially circular.