WAFER HANDLING SYSTEM FOR A LOADLOCK

CROSS-REFERENCE TO RELATED APPLICATION(S)

[0001] This application claims the benefit of U.S. Provisional application no. 60/864,148 filed November 2, 2006.

TECHNICAL FIELD

[0002] The present invention relates generally to semiconductor manufacturing, and more particularly to a system for handling wafer movement and centering during movement between processing devices.

BACKGROUND ART

[0003] As wafers transfer from station to station in a semiconductor manufacturing system, tolerance stack-up as well as handling problems, such as ESC sticking, result in wafer offset that causes process shift, which may ultimately lead to wafer loss. It is therefore desirable for the transfer robot to measure wafer offset and correct this offset at each station transfer.

[0004] Typically, multiple sensors are required to empirically and analytically derive the wafer center position. Sensors can be activated upon wafer movement, and a plurality of sensors can be used to determine the wafer's exact position in a station at a given moment. In one system, a robotic handling system is taught using an array of sensors positioned generally transverse to the path of movement of a substrate to detect the relative positions of the substrate for the purpose of precisely aligning the substrate relative to a predetermined destination point. In this system, a minimum of two sensors is required.

[0005] In another system, an apparatus, separate and apart from the processing system, utilizes a "spindle" type method where the wafer is incrementally rotated. This system does not take advantage of the direct movement of the wafer as it is transferred from the wafer storage cassette.

[0006] Another system requires an array of optical sensors positioned generally transverse to the linear path of the wafer support blade. Moreover, the wafer must pass over the sensors in a linear path transverse to the position of the sensors, which are positioned adjacent to the

loadlock chamber. This makes this system ill suited to multiple chamber wafer processing systems.

[0007] In all these systems, multiple sensors are used to locate the wafer in-situ while the wafer is being transferred to or placed within a station. With multiple sensors in an array, each algorithm employed necessarily requires multiple sensor activation information, which is ultimately converted into multiple location coordinate points.

[0008] Thus, a need still remains for improved wafer handling systems. Further, wafer handling systems for loadlock chambers for loading and locking processing equipment, which require wafer cooling, are required. In view of the ever-increasing commercial competitive pressures, along with growing consumer expectations and the diminishing opportunities for meaningful product differentiation in the marketplace, it is critical that answers be found for these problems. Additionally, the need to save costs, improve efficiencies and performance, and meet competitive pressures, adds an even greater urgency to the critical necessity for finding answers to these problems.

[0009] Solutions to these problems have been long sought but prior developments have not taught or suggested any solutions and, thus, solutions to these problems have long eluded those skilled in the art.

DISCLOSURE OF THE INVENTION

[0010] The present invention provides a wafer handling system including: providing a loadlock tray assembly having a plurality of vertically-stacked loadlock trays; and mounting nipples around each of the plurality of vertically-stacked loadlock trays for supporting a plurality of wafers, each of the nipples having a flat top.

[0011] Certain embodiments of the invention have other aspects in addition to or in place of those mentioned above. The aspects will become apparent to those skilled in the art from a reading of the following detailed description when taken with reference to the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0012] FIG. 1 is a plan view of a semiconductor wafer processing and handling system;

[0013] FIG. 2 is a plan view of a central transfer chamber and the loadlock chamber;

[0014] FIG. 3 is an isometric view of a loadlock tray assembly;

[0015] FIG. 4 is a wafer having particle streak defects;

[0016] FIG. 5 is a partial cross-section of the wafer tray with a wafer;

[0017] FIG. 6 is a partial cross-section of the wafer tray with the wafer resting on nipples in accordance with an embodiment of the present invention;

[0018] FIG. 7 is a plan view of the nipple with the flat, rough top;

[0019] FIG. 8 is a plan view of the robot blade;

[0020] FIGs. 9 and 10 are the front shoe and the back shoe of the robot blade in accordance with an embodiment of the present invention; and

[0021] FIG. 11 is a flow chart of a wafer handling system, for manufacturing a wafer handling system, in an embodiment of the present invention.

BEST MODE FOR CARRYING OUT THE INVENTION

[0022] The following embodiments are described in sufficient detail to enable those skilled in the art to make and use the invention. It is to be understood that other embodiments would be evident based on the present disclosure, and that process or mechanical changes may be made without departing from the scope of the present invention.

[0023] In the following description, numerous specific details are given to provide a thorough understanding of the invention. However, it will be apparent that the invention may be practiced without these specific details. In order to avoid obscuring the present invention, some well-known circuits, system configurations, and process steps are not disclosed in detail. Likewise, the drawings showing embodiments of the system are semi-diagrammatic and not to scale and, particularly, some of the dimensions are for the clarity of presentation and are shown greatly exaggerated in the drawing FIGs. Where multiple embodiments are disclosed and described, having some features in common, for clarity and ease of illustration, description, and comprehension thereof, similar and like features one to another will ordinarily be described with like reference numerals.

[0024] For expository purposes, the term "horizontal" as used herein is defined as a plane parallel to the plane or surface of the auto-align blade, regardless of its orientation. The term "vertical" refers to a direction perpendicular to the horizontal as just defined. Terms, such as "above", "below", "bottom", "top", "side" (as in "sidewall"), "higher", "lower", "upper", "over", and "under", are defined with respect to the horizontal plane. The term "on" means there is direct contact among elements. The term "system" means the method and the apparatus of the present invention, as would be evident from context. The term "processing"

as used herein includes stamping, forging, patterning, exposure, development, etching, cleaning, and/or removal of the material or laser trimming as required in forming a described structure.

[0025] Referring now to FIG. 1, therein is shown a plan view of a semiconductor wafer processing and handling system 100, which includes a cassette load station 102, a front robot 104, a loadlock chamber 106, a central transfer chamber 108, one or more processing chambers or heater chambers 110, and control towers and gas chamber 112.

[0026] The loadlock chamber 106 is provided for transferring wafers between the central transfer chamber 108, which is typically at high vacuum, and the outside, typically a clean room at atmospheric pressure. The central transfer chamber 108 is provided with a vacuum transfer robot located therein for transferring wafers between the loadlock chamber 106 and/or the heater chambers 110, which, are located about the periphery of the central transfer chamber 108.

[0027] The loadlock chamber 106 includes a left loadlock and a right loadlock. Each loadlock has six loadlock trays for transfer of wafers from the cassette load station 102 (atmospheric side) and transfer chamber 108 (vacuum side).

[0028] The wafers are loaded/unloaded by both a vacuum robot and an atmospheric robot. The vacuum robot in the central transfer chamber 108 passes wafers through slit valves in the processing chambers 110 and/or the heater chamber 110 and retrieves them after processing in the chambers is complete.

[0029] Access between the processing chambers 110 and between the central transfer chamber 108 and the loadlock chamber 106 is via vertical-motion type slit valves which selectively isolate the processing chambers 110 or heat chamber 110 from the robot (in the central transfer chamber 108) and the robot from the loadlock chamber 106. However, the loadlock chamber 106 at the atmospheric side may have other than flip door type slit valves. Other doors may also be used to separate the vacuum condition in the loadlock chamber 106 from the atmospheric conditions outside the loadlock chamber 106.

[0030] Referring now to FIG. 2, therein is shown a plan view of a central transfer chamber 108 and the loadlock chamber 106. The loadlock chamber 106 has two loadlocks 200 and 202 respectively containing robot blades 204 and 206 in accordance with an embodiment of the present invention.

[0031] The robot blades 204 and 206 are on a vacuum robot 208, which carries the wafers during transfers between the central transfer chamber 108 and the loadlocks 200 and 202.

The central transfer chamber 108 is purged with an inert gas 210, such as 350 sccm of N_2 gas, so that central transfer chamber pressure is always higher than loadlock pressure during wafer transfer to avoid cross-contamination. The transfer of the wafers from the loadlocks 200 and 202 to the central transfer chamber 108 is performed under vacuum conditions.

[0032] Referring now to FIG. 3, therein is shown an isometric view of a loadlock tray assembly 300. The loadlock tray assembly 300 is made up of vertically-stacked, individual wafer trays 301 through 306, stacked on top of each other with each capable of supporting one wafer.

[0033] Each wafer tray, such as the wafer tray 301, has nipples 308 on one side and nipples 310 on the other side, generally made of ceramic, to support a wafer to reduce backside contamination and enhance loadlock cooling.

[0034] Referring now to FIG. 4, therein is shown a wafer 400 having particle streak defects 402 and 404. The particle streak defects 402 and 404 were intermittent so their sources were previously unknown and difficult to detect.

[0035] After investigation, it was discovered that the particle streak defects 402 and 404 were due to wafer edges rubbing against the nipples 308 and 310 of FIG. 3 due to pressure turbulence caused by the increased central transfer chamber pressure of 200 mT compared to 5 mT during wafer transfer. This caused small particles to break-off from the wafers at random intervals. The problem was most severe, when it occurred, on the top wafer on the wafer tray 306.

[0036] The investigation in particular, showed that the top wafer on the wafer tray 306 moved slightly during the loadlock pump down and the wafer movement caused rubbing against centering pins on top of the nipples 308 and 310 creating additional particles.

[0037] Also, it appeared that turbulence of pressure from the central transfer chamber 108 of FIG. 1 into the loadlock 200 during interconnection of the chambers caused further rubbing.

[0038] Referring now to FIG. 5, therein is shown a partial cross-section of the wafer tray 306 with a wafer 500. In an alternate embodiment, it was discovered that another way of preventing the particle streak defects 402 and 404 of FIG. 4 was by placing a protective umbrella 502 over the wafer tray 306. The umbrella 502 has a plan view configuration that would look just like the plan view configuration of the wafer tray 306.

[0039] With the umbrella 502, the loadlock tray 306 has nipples 504 and 506 with centering pins 508 and 510, respectively. The nipples 504 and 506 are held in the wafer tray 306 by O-rings 512 and 514, respectively.

[0040] Referring now to FIG. 6, therein is shown a partial cross-section of the wafer tray 306 with the wafer 500 resting on nipples 602 and 604 in accordance with an embodiment of the present invention. The nipples 602 and 604 are held into the wafer tray 306 by O-rings 606 and 608, respectively.

[0041] After experimentation, it was discovered that the particle streak defects 402 and 404 of FIG. 4 could be reduced or eliminated by configuring the nipples to have flat tops 610 and 612 so there were no pins, such as the centering pins 508 and 510 of FIG. 5, to rub against.

[0042] Referring now to FIG. 7, therein is shown a plan view of the nipple 602 with the flat top 610. The flat top 610 has no projections. It was discovered that a grid pattern of grooves 612 would provide the flat top 610 on the nipples 602 and 604 of FIG. 6 sufficiently to hold the wafer 500 without causing the particle streak defects 402 of FIG. 4 in the presence of turbulence.

[0043] In one embodiment, it has been discovered that a grid pattern of grooves that are 0.75mm +/- 0.05 mm in width and 0.75mm +/- 0.05 mm in depth provides the optimum combination of holding effect and particle streak defect elimination. The grooves are spaced 1.8+/- 0.1mm apart, centerline to centerline.

[0044] Referring now to FIG. 8, therein is shown a plan view of the robot blade 204.

[0045] After some experimentation, it was found that, while the flat tops 610 and 612 of FIG. 6 would hold the wafer 500, the wafer 500 would sometimes not be centered on the nipples 602 and 604.

[0046] The robot blade 204 has a front shoe 800 and a back shoe 802 for holding the wafer 500 (shown in dotted outline for clarity).

[0047] Referring now to FIGs. 9 and 10, therein are shown the front shoe 800 and the back shoe 802 of the robot blade 204 of FIG. 2 in accordance with an embodiment of the present invention. It has been discovered that, by placing internal front and back chamfers 900 and 1000, respectively, of about 35 degrees plus or minus 2 degrees, and a very low surface roughness of 0.35um with a fine metallic finish, defined a as a polished nickel or chrome plating, an effective auto-centering capability is obtained for centering the wafer 500 on the nipples 602 and 604 of FIG. 6. The chamfer of about 35 degrees allows for the maximum play of the wafer in the robot blade 204 while compensating for variations in repeatability of the vacuum robot 208.

[0048] It has further been discovered that the internal back chamfer 1000 is more important than the internal front chamfer 900, which can have a rounded configuration.

[0049] Referring now to FIG. 11, therein is shown a flow chart of a wafer handling system 1100, for manufacturing a wafer handling system 100, in an embodiment of the present invention. The system 1100 includes: providing a loadlock tray assembly having a plurality of vertically-stacked loadlock trays in a block 1102; and mounting nipples around each of the plurality of vertically-stacked loadlock trays for supporting a plurality of wafers, each of the nipples having a flat top in a block 1104.

[0050] A principle aspect that has been unexpectedly discovered is that the present invention provides a reduction in defects while increasing the throughput of the wafer processing system.

[0051] Another aspect is the present invention improves manufacturing yield

[0052] Yet another important aspect of the present invention is that it valuably supports and services the historical trend of reducing costs, simplifying systems, and increasing performance.

[0053] These and other valuable aspects of the present invention consequently further the state of the technology to at least the next level.

[0054] Thus, it has been discovered that the wafer handling system for loadlock cooling of the present invention furnishes important and heretofore unknown and unavailable solutions, capabilities, and functional aspects for integrated circuit manufacturing and wafer handling. The resulting processes and configurations are straightforward, cost-effective, uncomplicated, highly versatile and effective, can be surprisingly and unobviously implemented by adapting known technologies, and are thus readily suited for efficiently and economically manufacturing integrated circuit devices fully compatible with conventional manufacturing processes and technologies.

[0055] While the invention has been described in conjunction with a specific best mode, it is to be understood that many alternatives, modifications, and variations will be apparent to those skilled in the art in light of the aforegoing description. Accordingly, it is intended to embrace all such alternatives, modifications, and variations that fall within the scope of the included claims. All matters hithertofore set forth herein or shown in the accompanying drawings are to be interpreted in an illustrative and non-limiting sense.

What is claimed is:

1. A wafer handling system comprising:

providing a loadlock tray assembly having a plurality of vertically-stacked loadlock trays; and

mounting nipples around each of the plurality of vertically-stacked loadlock trays for supporting a plurality of wafers, each of the nipples having a flat top.

2. The system as claimed in claim 1 further comprising:

providing a vacuum robot for transferring wafers to and from the loadlock tray assembly; and

attaching an auto-centering robot blade on the vacuum robot for automatically centering wafers on the nipples around each of the plurality of vertically-stacked loadlock trays.

3. The system as claimed in claim 1 wherein:

mounting the nipples around each of the plurality of vertically-stacked loadlock trays includes providing each of the nipples with a flat top with a pattern of grooves provided therein; and

further comprising:

providing a vacuum robot for transferring wafers to and from the loadlock tray assembly; and

attaching an auto-centering robot blade on the vacuum robot for automatically centering wafers on the nipples around each of the plurality of vertically-stacked loadlock trays, the auto-centering robot blade having a fine metallic finish and front and back shoes with internal chamfers of about 35 degrees for carrying the wafers.

4. The system as claimed in claim 1 further comprising attaching an umbrella over the top loadlock tray of the plurality of loadlock tray assembly.

5. The system as claimed in claim 1 further comprising attaching an umbrella over the top loadlock tray of the plurality of loadlock tray assembly, the umbrella having a plan view configuration like the plan view configuration of the top loadlock tray.

6. A wafer handling system comprising:

providing a loadlock tray assembly having a plurality of vertically-stacked loadlock trays; and

mounting nipples around each of the plurality of vertically-stacked loadlock trays for supporting a plurality of wafers, each of the nipples having a flat top with grooves 0.75 mm plus or minus 0.05 mm in depth provided therein.

7. The system as claimed in claim 6 further comprising:

mounting nipples around each of the plurality of vertically-stacked loadlock trays for supporting a plurality of wafers around the perimeters thereof;

providing a vacuum robot for transferring wafers to and from the loadlock tray assembly; and

attaching an auto-centering robot blade on the vacuum robot for automatically centering wafers on the nipples around each of the plurality of vertically-stacked loadlock trays.

8. The system as claimed in claim 6 wherein:

mounting the nipples around each of the plurality of vertically-stacked loadlock trays includes providing each of the nipples with a flat top with a grid pattern of grooves provided therein ; and

further comprising:

providing a vacuum robot for transferring wafers to and from the loadlock tray assembly; and

attaching an auto-centering robot blade on the vacuum robot for automatically centering wafers on the nipples around each of the plurality of vertically-stacked loadlock trays, the auto-centering robot blade having a fine metallic finish and front and back shoes with internal chamfers of 35 degrees plus or minus 2 degrees for carrying the wafers.

9. The system as claimed in claim 6 further comprising attaching an umbrella on the top loadlock tray of the plurality of loadlock tray assembly.

10. The system as claimed in claim 6 further comprising attaching an umbrella on the top loadlock tray of the plurality of loadlock tray assembly, the umbrella having a plan view configuration like the plan view configuration of the top loadlock tray.

11. A wafer handling system comprising:

a loadlock tray assembly having a plurality of vertically-stacked loadlock trays; and

nipples mounted around each of the plurality of vertically-stacked loadlock trays for supporting a plurality of wafers, each of the nipples having a flat top.

12. The system as claimed in claim 11 further comprising:

a vacuum robot for transferring wafers to and from the loadlock tray assembly; and

an auto-centering robot blade on the vacuum robot for automatically centering wafers on the nipples around each of the plurality of vertically-stacked loadlock trays.

13. The system as claimed in claim 11 wherein:

the nipples mounted around each of the plurality of vertically-stacked loadlock trays includes each of the nipples provided with a flat top with a pattern of grooves provided therein; and

further comprising:

a vacuum robot for transferring wafers to and from the loadlock tray assembly; and

an auto-centering robot blade on the vacuum robot for automatically centering wafers on the nipples around each of the plurality of vertically-stacked loadlock trays, the auto-centering robot blade having a fine metallic finish and front and back shoes with internal chamfers of about 35 degrees for carrying the wafers.

14. The system as claimed in claim 11 further comprising an umbrella attached over the top loadlock tray of the plurality of loadlock tray assembly.

15. The system as claimed in claim 11 further comprising an umbrella attached over the top loadlock tray of the plurality of loadlock tray assembly, the umbrella having a plan view configuration like the plan view configuration of the top loadlock tray.

16. A wafer handling system comprising:

a loadlock tray assembly having a plurality of vertically-stacked loadlock trays; and

nipples around each of the plurality of vertically-stacked loadlock trays for supporting a plurality of wafers, each of the nipples having a flat top with grooves 0.75 mm plus or minus 0.05 mm in depth provided therein.

17. The system as claimed in claim 16 further comprising:

a vacuum robot for transferring wafers to and from the loadlock tray assembly; and

an auto-centering robot blade attached on the vacuum robot for automatically centering wafers on the nipples around each of the plurality of vertically-stacked loadlock trays.

18. The system as claimed in claim 16 wherein:

the nipples around each of the plurality of vertically-stacked loadlock trays includes providing each of the nipples with a flat top with a grid pattern of grooves provided therein; and

further comprising:

a vacuum robot for transferring wafers to and from the loadlock tray assembly; and

an auto-centering robot blade attached on the vacuum robot for automatically centering wafers on the nipples around each of the plurality of vertically-stacked loadlock trays, the auto-centering robot blade having a fine metallic finish and front and back shoes with internal chamfers of 35 degrees plus or minus 2 degrees for carrying the wafers.

19. The system as claimed in claim 16 further comprising an umbrella attached on the top loadlock tray of the plurality of loadlock tray assembly.

20. The system as claimed in claim 16 further comprising an umbrella attached on the top loadlock tray of the plurality of loadlock tray assembly, the umbrella having a plan view configuration like the plan view configuration of the top loadlock tray.

ABSTRACT

WAFER HANDLING SYSTEM FOR A LOADLOCK

A wafer handling system includes providing a loadlock tray assembly having a plurality of vertically-stacked loadlock trays; and mounting nipples around each of the plurality of vertically-stacked loadlock trays for supporting a plurality of wafers, each of the nipples having a flat top.

Fig. 1