

WAFER CARRIER DOORREFERENCE TO RELATED APPLICATIONS

This application claims priority under 35 U.S.C. § 119(e) to, and hereby incorporates by reference U.S. Provisional Application No. 60/518,238, filed November 7, 2003, and U.S. Provisional Application No. 60/518,188, filed November 7, 2003.

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FIELD OF THE INVENTION

The present invention relates generally to a system for handling semiconductor wafers. More particularly, the present invention relates to a door for a wafer carrier.

BACKGROUND OF THE INVENTION

10 Semiconductor wafers are subjected to numerous steps during processing. This process usually entails transporting the wafers from one workstation to another for processing by specialized equipment.

As part of this process, wafers may be temporarily stored or shipped in containers to other plants or to ends users. During these phases, the wafers may be subjected to contaminants that damage the wafers.

15 To reduce the deleterious effect of contaminants on wafers, specialized containers have been developed to minimize the generation of contaminants and to isolate the wafers from contaminants exterior to the containers. A principal feature common to these devices is that they are provided with removable doors or closures.

20 There are several problems associated with the above-mentioned wafer handling containers. During the working life of the containers, the closure or door is attached and removed many times by both robotic and manual means. With each attachment or removal, a portion of the door edge may scrape against the door frame of the container. This repeated process can result in the generation of loose particles that may become airborne to lodge on the wafers stored in the container.

25 The problem of particle generation may also be attributed to the process by which doors and containers are manufactured. Containers and doors are usually formed by

injection molding with plastic such as polycarbonate. Inherent in such molding is shrinkage and warpage of the molded parts.

Although plastic injection molding techniques are highly advanced, there still may be individual deviations between different components from the same mold. While slight
5 deviations do not generally compromise the function of a door in closing a container, they can change the working dimensions to the extent that contact (and the resultant particle generation) between a door and a door frame is increased. Dimensional changes can also be generated by the dies themselves, as a result of normal wear and tear. This problem is accentuated when the tolerances of the components of doors and containers are stacked or
10 added.

As the semiconductor industry has evolved, wafers, and thus wafer carriers have increased significantly in size. Semiconductor fabrication facilities are now processing 300 mm wafers. The larger carriers for 300 mm wafers amplify the warpage, shrinkage, and tolerance issues in molded carriers.

15 To minimize build up of contaminants on the components of the wafer carrier, the wafer carrier is subjected to a thorough cleaning prior to reuse. Cleaning optimally not only removes contaminants on the outer and inner surfaces of the wafer carrier but also from any interior cavities.

In an effort to reduce the generation of contaminants caused by rubbing together of
20 the wafer carrier enclosure and the wafer carrier door, door guides have been created that attach to the corners of the wafer carrier door. Examples of door guides are described in U.S. Pat. Nos. 6,206,196 and 6,464,081, which are both assigned to the assignee of the present application and are incorporated herein by reference.

SUMMARY OF THE INVENTION

25 The invention is directed to a wafer carrier door for use with a wafer carrier enclosure. The wafer carrier door includes an inner door portion and an outer door portion. In a first embodiment of the invention, the outer door portion includes a plurality of apertures formed therein to facilitate cleaning a cavity between the inner door portion and the outer door portion.

In a second embodiment of the invention, the outer door portion includes a plurality of door guides extending therefrom. The inner door portion includes a plurality of door guide recesses formed therein. When the inner door portion is attached to the outer door portion, the door guides extend through the door guide apertures so that the door guides contact the wafer carrier enclosure when the wafer carrier door is attached to the wafer carrier enclosure.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a wafer carrier using a door according to the invention.

Fig. 2 is an inner view of the wafer carrier door.

Fig. 3 is an outer view of the wafer carrier door.

Fig. 4 is an enlarged view of a corner of the wafer carrier door with inner and outer door portions in an unassembled configuration.

Fig. 5 is an enlarged view of the corner of the wafer carrier door with the inner and outer door portions in an assembled configuration.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

An embodiment of the invention is a wafer carrier door, as most clearly illustrated at 10 in Fig. 1. The wafer carrier door 10 substantially seals a wafer carrier enclosure 12 to retain semiconductor wafers (not shown) in the wafer carrier 14.

The wafer carrier door 10 of the present invention enhances the ability to efficiently clean the wafer carrier door 10 between uses. The wafer carrier door 10 also reduces contaminant generation during opening and closing the wafer carrier 14. The wafer carrier door 10 also provides door guides 80 that reduce contaminant generation caused by frictional engagement between the wafer carrier door 10 and the wafer carrier enclosure 12.

The wafer carrier door 10 includes an inner door portion 20 and an outer door portion 22, as illustrated in Figs. 2 and 3. The inner door portion 20 and the outer door portion 22 mate together to form a cavity 24 therebetween.

At least one locking mechanism 30 is mounted in the cavity 24 as is visible through the inner door portion 20. The at least one locking mechanism 30 facilitates attachment of the wafer carrier door 10 to the wafer carrier enclosure 12. Mounting the at least one locking mechanism 30 in the cavity 24 protects the at least one locking mechanism 30 from damage during use of the wafer carrier 14.

The inner door portion 20 is preferably substantially continuous to prevent contaminants from entering the wafer carrier enclosure 12 through the inner door portion 20. To further facilitate forming a seal between the wafer carrier door 10 and the wafer carrier enclosure 12, a resilient gasket 32 may be provided around an outer edge 34 of the inner door portion 20.

The inner door portion 20 preferably includes a rectangularly shaped recess 36 proximate a center thereof. The rectangularly shaped recess 36 is preferably shaped to receive a wafer cushion (not shown) such as is disclosed in U.S. Pat. No. 6,267,245, which is assigned to the assignee of the present application.

The outer door portion 22 preferably has a shape that substantially corresponds with the outer dimensions of the inner door portion 20 so that the outer door portion 22 substantially covers the inner door portion 20 when the wafer carrier door 10 is attached to the wafer carrier enclosure 12.

The outer door portion 22 has a plurality of apertures 40 formed therein. The apertures 40 facilitate removing contaminants from the cavity 24 when the wafer carrier door 10 is cleaned between uses. The apertures 40 also facilitate readily removing the cleaning fluid from the cavity 24 when the cleaning process is completed. The apertures 40 preferably extend over at least 25 percent of the surface of the outer door portion 22 and more preferably over at least 50 percent of the surface of the outer door portion 22.

The apertures 40 preferably have an elongate configuration and are oriented along sides of the at least one locking mechanism 30 as rubbing of components during operation of the at least one locking mechanism 30 has the potential of generating contaminants. The apertures 40 are preferably oriented in three groups - a first side group 62, a central group 64 and a second side group 66. The apertures 40 preferably extend over at least 50 percent of the surface of the outer door portion 22.

Through the use of an array of apertures 40 in the outer door portion 22 enables the wafer carrier to exhibit the simultaneous benefits of discharging potentially hazardous static while being able to view objects in the wafer carrier 18 without opening the wafer carrier 18.

5 The apertures 40 are preferably arranged in an array that is defined by a plurality of horizontal portions 42 and a plurality of vertical portions 44. The plurality of horizontal portions 42 and the plurality of vertical portions 44 are preferably arranged in a substantially perpendicular configuration. A width of each horizontal portion 42 is preferably less than a width of the apertures 40.

10 The apertures 40 preferably have a length that is greater than a width to facilitate flowing the cleaning fluid through the interior of the wafer carrier door 10 in a direction that is generally parallel to the length of the apertures 40.

 The horizontal portions 42 and the vertical portions 44 are fabricated with a width and thickness to provide the wafer carrier door 10 with a sufficient level of structural
15 rigidity to resist deformation during conventional use conditions.

 Because of the potential damage to semiconductor components static charges, it is known to fabricate components of wafer carriers from materials that dissipate such charges. Typically materials that exhibit desired levels of ESD are not transparent. Forming the wafer carrier door from non-transparent materials impedes the ability to view
20 items stored inside of the wafer carrier. To overcome this limitation, transparent regions have been formed in an otherwise non-transparent wafer carrier door.

 While it is possible for the apertures 40 to cover substantially all of the surface of the outer door portion 22, the apertures 40 are preferably not located above the lock mechanism 30. In this configuration an inner surface of the outer door portion 22 that is
25 below the lock mechanism 30 is substantially flat to facilitate smooth operation of the lock mechanism 30.

 Another way of looking at the wafer carrier of the present invention is that it is applicable to a wafer container comprising an inner shell creating a hermetic containment and the array, cage, or grid spaced from the inner transparent shell and extending over at
30 least a portion of the inner transparent shell. The cage, array, or grid has a plurality of apertures formed therein. The cage thereby protects the inner shell from contact and from

one or more hazards such as electro static shocks and abrasion while allowing a person to see the wafer carrier and preferably to see objects that are inside of the wafer carrier.

The outer door portion 22 is preferably secured to the inner door portion 20 using a plurality of tabs 70 that extend from the outer door portion 22, as most clearly illustrated in Figs. 4 and 5. The tabs 70 preferably include a main section 72 and an end section 74 that extends from the main section 72 opposite the outer door portion 22.

The inner door portion 20 generally includes a central panel 90 and a side panel 92 that extends substantially perpendicular from the central panel 90. The side panel 92 preferably extends substantially around the central panel 90. Opposite the central panel 90, a lip 94 extends from the side panel 92. The lip 94 is preferably oriented substantially perpendicular to the side panel 92.

At least one of the side panel 92 and the lip 94 include tab apertures 76 that are shaped to approximately conform to a size of the tabs 70. This configuration permits the end sections 74 of the tabs 70 to extend through the tab apertures 76. The end sections 74 then seat in the tab apertures 76 to retain the inner door portion 20 in a stationary position with respect to the outer door portion 22, as most clearly illustrated in Fig. 5.

When the inner door portion 20 is attached to the outer door portion 22, the tabs 70 may extend beyond the inner door portion 20 so that the tabs 70 contact the wafer carrier enclosure 12 when the wafer carrier door 10 is attached to the wafer carrier enclosure 12. This configuration reduces frictional contact between the inner door portion 20 and the wafer carrier enclosure 12.

The outer door portion 22 also preferably includes a plurality of corner guides 80 extending therefrom. The corner guides 80 preferably extend substantially straight from the outer door portion 22 as illustrated in Fig. 4. The corner guides 80 are preferably oriented substantially normal to an edge of the outer door portion 22 to which the corner guide 80 is adjacent. Each side of the outer door portion 22 preferably includes one of the corner guides 80 proximate each end thereof.

The inner door portion 20 also preferably includes corner guide apertures 82 that are shaped to approximately conform to a size of the corner guides 80. This configuration permits the corner guides 80 to extend through the corner guide apertures 82. When the inner door portion 20 is attached to the outer door portion 22, the corner guides 80 extend

beyond a side wall 84 of the inner door portion 20. The corner guides 80 are preferably fabricated from a material that minimizes frictional engagement with the wafer carrier enclosure 12.

5 Using this configuration, frictional contact between the inner door portion 20 and the wafer carrier enclosure 12 is substantially eliminated. This process also reduces the number of parts compared to the prior art corner guides that were independently formed from the inner door portion and the outer door portion.

10 The inner door portion 20 and outer door portion 22 are both preferably fabricated using injection molding. The inner door portion 20 and the outer door portion 22 are preferably fabricated from polycarbonate, polyetherimide, polyetheretherketone or other materials known to one of ordinary skill in the art.

15 It is contemplated that features disclosed in this application, as well as those described in the above applications incorporated by reference, can be mixed and matched to suit particular circumstances. Various other modifications and changes will be apparent to those of ordinary skill.

Claims:

1. A wafer carrier door comprising:

an inner door portion having a substantially continuous inner surface; and

an outer door portion extending over at least a portion of the inner door portion,
wherein the outer door portion has a plurality of apertures formed therein,
and wherein the outer door portion is attached to the inner door portion.
2. The wafer carrier door of claim 1, wherein the apertures extend over at least 50 percent of a surface area of the outer door portion.
3. The wafer carrier door of claim 1, wherein the apertures are oriented in an array having at least one row and at least one column.
4. The wafer carrier door of claim 1, wherein the apertures each have a first dimension that is greater than a second dimension, which is oriented substantially transverse to the first direction.
5. The wafer carrier door of claim 1, wherein the apertures are defined by a plurality of horizontal portions and a plurality of vertical portions.
6. The wafer carrier door of claim 1, wherein the apertures are arranged in a first side group, a central group, and a second side group, wherein the first side group is located proximate a first side of the outer door portion, wherein the second side group is located proximate a second side of the outer door portion, which is opposite the first side, and wherein the central group is located intermediate the first side group and the second side group.
7. The wafer carrier door of claim 1, and further comprising a lock mechanism mounted to at least one of the inner door portion and the outer door portion at least partially between the inner door portion and the outer door portion.
8. The wafer carrier door of claim 1, wherein at least a portion of the outer door portion is fabricated from a non-transparent material.
9. The wafer carrier door of claim 1, wherein at least a portion of the outer door portion is fabricated from a static dissipative material.

10. A wafer carrier comprising:

a wafer carrier enclosure having a recess formed therein and having a door opening that extends substantially around the recess; and

a wafer carrier door comprising:

an inner door portion having a substantially continuous inner surface; and

an outer door portion extending over at least a portion of the inner door portion, wherein the outer door portion has a plurality of apertures formed therein, and wherein the outer door portion is attached to the inner door portion.

11. The wafer carrier of claim 10, wherein the apertures extend over at least 50 percent of the surface area of the outer door portion.

12. The wafer carrier of claim 10, wherein the apertures are oriented in an array having at least one row and at least one column.

13. The wafer carrier of claim 10, wherein the apertures each have a first dimension that is greater than a second dimension, which is oriented substantially transverse to the first direction.

14. The wafer carrier of claim 10, wherein the apertures are defined by a plurality of horizontal portions and a plurality of vertical portions.

15. The wafer carrier of claim 10, wherein the apertures are arranged in a first side group, a central group, and a second side group, wherein the first side group is located proximate a first side of the outer door portion, wherein the second side group is located proximate a second side of the outer door portion, which is opposite the first side, and wherein the central group is located intermediate the first side group and the second side group.

16. The wafer carrier of claim 10, and further comprising a lock mechanism mounted to at least one of the inner door portion and the outer door portion at least partially between the inner door portion and the outer door portion.

17. A wafer carrier door comprising:

an inner door portion formed from a transparent material; and

an outer door portion formed from a static dissipative material, wherein the outer door portion has an array of apertures formed therein, wherein the outer door portion mates with the inner door portion.

18. The wafer carrier door of claim 17, wherein the apertures extend over at least 50 percent of the surface area of the outer door portion.

19. The wafer carrier door of claim 17, wherein the apertures are oriented in an array having at least one row and at least one column.

20. The wafer carrier door of claim 1, and further comprising a lock mechanism mounted to at least one of the inner door portion and the outer door portion at least partially between the inner door portion and the outer door portion.

21. The wafer carrier door of claim 17, wherein at least a portion of the outer door portion is fabricated from a non-transparent material.

22. A wafer carrier door comprising:

an outer door portion having a door guide extending from an edge thereof; and

an inner door portion having an aperture formed therein that is adapted to receive the door guide.

23. The wafer carrier door of claim 22, wherein the inner door portion comprises:

a central panel;

a side panel that extends from the central panel, wherein the side panel is oriented substantially perpendicular to the central panel; and

a lip that extends from the side panel opposite the central panel, wherein the lip is oriented substantially perpendicular to the side panel, and wherein the aperture extends through at least one of the side panel and the lip.

24. The wafer carrier door of claim 22, wherein the inner door portion is fabricated from a material that is different from the outer door portion.

25. A method of cleaning a wafer carrier door having an inner door portion and an outer door portion, wherein a cavity is defined between the inner door portion and the outer door portion, the method comprising:

forming a plurality of apertures in the outer door portion;

flowing a cleaning fluid into the cavity through at least one of the plurality of apertures; and

flowing a cleaning fluid out of the cavity through at least one of the plurality of apertures.

26. The method of claim 25, wherein the apertures extend over at least 50 percent of a surface area of the outer door portion.

27. The method of claim 25, wherein the apertures are oriented in an array having at least one row and at least one column.

28. The method of claim 25, wherein the apertures each have a first dimension that is greater than a second dimension, which is oriented substantially transverse to the first direction.

29. The method of claim 25, wherein the apertures are defined by a plurality of horizontal portions and a plurality of vertical portions.

30. The method of claim 25, wherein the apertures are arranged in a first side group, a central group, and a second side group, wherein the first side group is located proximate a first side of the outer door portion, wherein the second side group is located proximate a second side of the outer door portion, which is opposite the first side, and wherein the central group is located intermediate the first side group and the second side group.

31. The method of claim 25, and further comprising a lock mechanism mounted to at least one of the inner door portion and the outer door portion at least partially in the cavity.