

FRONT OPENING SUBSTRATE CONTAINER WITH BOTTOM PLATE**CROSS-REFERENCES 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. 60/518,064, filed 7 November
5 2003.

FIELD OF THE INVENTION

This invention relates to sealable containers with latching systems for confining silicon wafers, flat panels, other substrates and the like for transport storage and processing. More particularly the invention relates to such containers with lower plates
10 for providing engagement and interface with associated equipment.

BACKGROUND

Wafer carriers or pods are utilized for holding, transporting, and storing substrates before, during and after processing. Such substrates are used in the fabrication of semiconductors such as integrated circuits and liquid crystal display panels. In their
15 transformation into the end product, these delicate and highly valuable substrates are subjected to repeated processing, storage, and transportation. Such substrates must be protected from damage from particular contaminants, static discharges, physical damage from breakage, or contamination from vapors or gasses such as those outgassing from materials used in processing.

Such substrate containers are termed FOUPs, an acronym for front opening unified pods and FOSBs, an acronym for front opening shipping box. Industry standards specify that such substrate containers utilize kinematic couplings comprising three radially oriented grooves on the bottom of the container that interface with three rounded projections arranged in a triangle on the processing equipment. These kinematic couplings
20 provide for the precise orientation of the wafer containers, thereby allowing for precise manipulation of the container and contents, for example robotic removal and insertion of the wafers. Such containers typically will have means for allowing robotic transfer of the containers with contents. Such means may include a robotic flange on the top of the wafer container as well as suitable rails or other features on the bottom of the container to allow

the container to be suitably conveyed on conveyors with rollers or suitable carriages. It is apparent that sudden starts and stops, that is jarring of the wafer container with loaded wafers, can cause damage to the wafers. Thus, it is appropriate to provide suitable cushioning for the wafers during transport, including conveyance within a facility. The wafer restraints and exterior packaging conventionally provide such cushioning during transport from facility to facility. It is also desirable to have additional dampening and cushioning for the wafers when the containers are transported by way of conveyors that engage the bottom plate of the FOUP and/or FOSB's within a facility.

Such FOUP's and FOSB's utilize latching mechanisms in their doors with seals to create a hermetically sealed container. Such containers then need vents and/or purges to prevent deformation of the carrier or unintended leakages due to pressure differentials, for example, changes in barometric pressure. Utilizing such filters in various locations on the pods are known in the art and typically have an aperture in the shell with a suitable fixture and filter secured at the aperture.

Generally, it is considered desirable by the industry to minimize the number of openings leading into such containers. Prior art containers typically utilize molded-in openings in the shell portion for attachment of such filters or purging features.

In that the kinematic coupling must be precisely positioned with respect to wafer shells to allow for these precise interactions of processing equipment with the container and wafers, the positioning of the three grooves on the bottom of the wafer container with respect to the shelf location is absolutely critical. In that these wafer containers are conventionally molded of thermal plastics which may warp and distort during the molding process or subsequently, great care must be taken to provide this precise positioning. Known means for attaching the kinematic coupling features to the container portion include direct molding of the grooves in the shell, attachment of a separate plate with the grooves by way of screws, utilization of an interior super structure that includes the wafer shell and a lower plate that has the grooves and that is inserted within the shell portion. It would be desirable to utilize a separately molded plate attachable to the container that has adjustment capability and that is securely attached by more than the minimal near point attachment provided by screws. Such a separate plate can thus easily add additional features such as conveyor interface features, for example rails, coating means, and

attachment means for other accessories by using different plate configurations or simply attaching the items to the plate. Also suitable means should ideally be provided for facilitating grounding of the wafer contact areas on the shell through the kinematic coupling to the kinematic coupling protrusions on the equipment or other receiving base
5 upon which the wafer container is seated.

SUMMARY OF THE INVENTION

A front opening substrate carrier having a container portion and a latching door to close the container portion has a separately formed plate that attaches to the bottom of the container portion providing unique attachment means and novel features and advantages.
10 In preferred embodiments the bottom plate has a kinematic coupling groove with contact surfaces formed therein and conveyor rails positioned at the perimeter of said plate. In preferred embodiments the plate may be attached at a plurality of locations on the bottom of the container portion by way of a plurality of large diameter connectors, for example, greater than about one-half inch and less than three inches, extending through cooperating
15 holes on the plate and container portion. Such connections may be made by a unitary snap-in bushing that may be closed or have a bore extending therethrough. Said bore in preferred embodiments may be configured for receiving filter and/or valve cartridges or members. Additionally, such attachment positions may utilize elastomeric bushings or differently configured elastomeric members to provide dampening between the conveyor
20 plate and the shell.

In other preferred embodiments, the container portion may have a plurality of openings on the bottom that have a first member attached thereto with a threaded end that engages a second member attached to the plate with at least one of the members rotatable to provide precise vertical positioning of the plate with respect to the shell or container
25 portion and thus with respect to the wafer support shell. Said adjustment means may utilize an O-ring or similar friction-providing device to secure the two threaded members in the desired position. Said threaded members may both be formed separately from the container portion and plate, may snap into place, may utilize O-rings for suitable sealing, and may have a bore extending through both members for receiving a filter and/or valve
30 cartridge or members.

In preferred embodiments, a cartridge may be provided that includes a duck bill purge valve formed of a thermal plastic elastomer with a V or inverted V-shape in one direction and a rectangular shape in a direction taken perpendicular to said first direction. Adding a slit subsequent to the molding of said member may preferably form said duckbill valve. Additionally, the cartridge may have filter members.

In preferred embodiments elastomeric cushioning members may be positioned at some of the connection points between the container portion and the plate or between all of the connection points between the plate and the container portion thereby providing total isolation of the plate from the container portion by way of the elastomeric dampeners.

In other embodiments, the elastomeric dampeners may be positioned to dampen the vibrations caused by conveyance on peripheral rails of the plate while allowing separate rigid fasteners to provide precise and rigid connection of the more inner portions of the conveyor plate, thereby allowing the precise positioning of the kinematic coupling grooves to the wafer shells.

DESCRIPTION OF THE FIGURES

Figure 1 is a perspective view of a front opening wafer container tipped on its backside to illustrate the bottom plate, which embodies aspects of the invention herein.

Figure 2 is a bottom plan view of a plate attached to the bottom of a wafer container embodying the inventions herein.

Figure 3 is a side elevational view of a wafer carrier according to the invention herein.

Figure 4 is an exploded perspective view of a container portion, plate, and connectors according to the inventions herein.

Figure 5 is a perspective view of the bottom of the wafer container of Figure 1 without the plate attached.

Figure 6 is a perspective view of the top side of the plate illustrated in Figure 1.

Figure 7 is a perspective view of a pronged connector according to aspects of the invention herein.

Figure 8 is a cross-sectional view of an apparatus and method to adjust wafer plane using threaded members connecting the container portion with the plate in accordance to
5 the invention herein.

Figure 9 is a perspective view of an alternative filter/valve cartridge according to aspects of the invention herein.

Figure 10 is a perspective view of an alternative filter/valve cartridge according to aspects of the invention herein.

10 Figure 11 is a cross-sectional view of a duckbill valve in accordance to the invention herein.

Figure 12 is an exploded view of the duckbill valve of Figure 11.

Figure 13 is a perspective view of an elastomeric dampener according to aspects of the invention herein.

15 DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

Figures 1, 2, 3, and 4 show different views of a wafer carrier that embody the inventions herein. The carrier is configured as a wafer container, such as a FOSB or FOUP, and is comprised principally of a container portion 20 with an open front 22, a door 24 to close the open front, and a bottom plate 26. The container portion generally has
20 a top 30, a bottom 32, sides 34, back 36, bottom surface 37, and an open interior 38. Positioned in the interior at the sides of the container portion are wafer supports 40 for supporting wafers with a single wafer W illustrated in Figure 4. Front opening wafer carriers know in the art have features such as illustrated in U.S. Pat. Nos. RE 28,221; 6,010,008; 6,267,245; commonly assigned with this application, all of which are
25 incorporated herein by reference.

Referring to Figures 2, 3, 4, and 6 details of the bottom plate are illustrated. The bottom plate has a top surface 44, a bottom surface 46, and a periphery 48. Rail portions

50 for interfacing with conveyor, such as the conveyor 51 illustrated in Figure 3, are located on the front side, back side, left side, and right side of the periphery of the plate. The plate has three kinematic coupling grooves 52 each having kinematic coupling surfaces 54 for engaging the prongs of a cooperating kinematic coupling interface on the processing equipment or other fixture upon which the container is seated. The plate has four apertures 60 which match cooperating apertures 62 on the bottom 37 of the container portion. In one embodiment, pronged bushings as illustrated in Figure 4 and Figure 7 may be utilized to extend through the aperture in the container portion and the aperture in the plate to secure the two aperture peripheries 64, 66 together. Additional structural ribbing 68 provides structural support and engagement contact with the bottom surface 37 of the container portion.

Referring to Figure 8, a further methodology and apparatus (spacer) 169 for connecting the bottom plate 26 to the container portion or shell 20 is disclosed. A first bushing 70 snaps into place into the aperture 72 in the shell and is secured in place by way of detents 76. O-rings 78, 80 provide tightening and stability of the system as well as frictionally securing the first bushing in place. The first bushing has a bore 84, a threaded end portion 86, and a collar 88. A second connecting member 92 configured as a second annular bushing snaps into place into an aperture 94. In the plate detents 96 secure the second annular bushing in place within the aperture in the plate. The second annular bushing has an upper end 100 that is threaded to cooperate with the threaded end of the first annular bushing. The spacing between the conveyor plate 26 and the shell can be precisely adjusted by way of rotation, in this embodiment, of the second annular bushing 92 with respect to the first annular bushing 70. Additional O-rings 102 provide a frictional means to retain the second annular bushing at the desired rotational position for the correct adjusted position. The filter/cartridge described below, a plug, or a filter may be deposited in the bore 84.

Referring to Figures 9, 10, 11, and 12 embodiments of a filter/valve cartridge 130, 132 are illustrated. The cartridges significantly have a duckbill valve member 138 that is preferably formed from injection molding a material and secondly slicing a slit 140 in the apex 142 of the duckbill valve member, thereby forming flaps 144 and 146. The duckbill valve member is suitably positioned in place by way of collars 160 into a cartridge shell 164. O-rings 168 may be utilized to seal the cartridge in place in a suitably sized aperture

such as bore 84. The cartridges of Figures 9, 10, and 11 also have a filter member 172, 174 made of suitable filtering material that is known in the art. Retention member 178, 180 respectively holds the filter members in place in the cartridge.

Referring to Figure 13, a further inventive aspect of the wafer carrier is illustrated and comprises an elastomeric dampener 190. Said dampener is positioned intermediate the shell and the plate to absorb any shock imparted to the plate to minimize transference of same to the wafers. The elastomeric dampener, as illustrated by the numbers 190 in phantom in Figure 4, may be positioned at the respective apertures 60, 62 of the plate shell. Alternatively, the elastomers can be placed using other suitable structural features at other locations in between the shell and plate. The bushing may be utilized to provide complete isolation that is in between the plate and the shell with no direct rigid plastic to rigid plastic contact between the shell and the plate. Alternatively there can be direct engagement between rigid components of the shell and the plate and the dampeners can be placed near the periphery of the plate to provide some measure of dampening at the plates periphery particularly when the conveyor rails 50 are in use for conveying the wafer carrier. In a further embodiment, the kinematic coupling can be integral with the shell or container portion and be exposed at the bottom; the plate can have the conveyor rails that engage a conveyor 51 as shown in Figure 3 and be isolated from the shell by the dampeners.

Various materials are suitable for manufacturing the components of the wafer carrier. For example PEI with carbon fiber filler is suitable for the shell as well as the plate. Carbon fiber filled peek is also suitable but is more expensive. Polycarbonate particularly carbon powder filled polycarbonate may also be utilized but has less desirable characteristics with regard to flammability and smoke and fume generation when burning.

Thus, various inventive aspects of the substrate carrier are described and portrayed herein. Said inventive aspects specifically include, without limitation, individually and in various combinations, the utilization of the elastomeric dampener intermediate the conveyor plate and the shell; the utilization of a plurality of relatively large diameter that is greater than one-half inch structural attachment members, extending through the shell and plate; utilization pronged bushings to secure the plate on the shell; utilization of connectors with bores extending therethrough that permit insertion of filter/valve

cartridges within said bores; utilization of adjustable threaded members for positioning the precise location of the plate with regard to the wafer shell and wafer planes; utilization of O-rings to lock or secure the respective members in the appropriate position; utilization of threaded members for the adjustment and attachment that utilize a bore extending
5 therethrough for insertion of a filter cartridge, valve cartridge, a combination of both, or a solid blank. The utilization of a valve configured as a duckbill valve formed from the elastomeric material to provide purging and/or pressure equalization is further provided.

Although the features herein are illustrated generally with reference to semiconductor wafer containers, the inventive aspects also are applicable and claimed
10 with respect to flat panel carriers, reticle carriers, film frame carriers and the like.

CLAIMSWHAT IS CLAIMED:

1. A substrate container, comprising a container portion with an open front and a door for sealingly closing the open front, a bottom plate connecting to the container portion through a plurality of adjustable spacers;

the container portion comprising:

a pair of opposite side walls, a bottom wall, a top wall, and a back wall connecting and defining an open interior;

a plurality of substrate supports at the pair of side walls and extending into the open interior for supporting the substrates horizontal spaced array,

the bottom wall having a plurality of bottom surface apertures;

the bottom plate having a plurality of plate apertures, each of said plate apertures aligning with one of said plurality of bottom surface apertures, and

a plurality of radially disposed kinematic coupling grooves;

the plurality of adjustable spacers for adjusting the positioning of said container portion and said plate, each of said adjustable spacers comprising:

a first member disposable in one of said bottom surface apertures, and

a second member disposable in one of said plate apertures and threadably connected to said first member.

2. The container of claim 1, in which each said first member is a first bushing.

3. The container of claim 2, in which each said first member further comprises a detent to attach said first member to the container portion.

4. The container of claim 3, further comprising an O-ring disposed between said detent and said container portion.
5. The container of claim 2, in which each said second member is a second bushing.
6. The container of claim 6, in which each said second bushing is generally annular.
7. The container of claim 5, further comprising an O-ring disposed between the second bushing and the bottom plate.
8. A method of adjusting a distance between a container and a bottom plate by using an adjusting device, said container accommodating a generally axially aligned plurality of substrates, said bottom plate having a plurality of radially disposed kinematic grooves, said adjusting device including a first member disposed in an aperture in the container and a second member disposed in an aperture in the bottom plate and threadably connected to the first member, the method comprising rotating the second member relative to the first member, thereby adjusting said distance between said container and said bottom plate.
9. A method of making a system for accommodating a substrate, comprising:
 - forming a container with an interior and a bottom surface, a plurality of supports extending from the interior, the bottom surface defining a plurality of bottom surface apertures;
 - defining a plate with a plurality of radially disposed kinematic grooves and a plurality of apertures, each of said apertures generally aligning with one of said bottom surface apertures;
 - fixing the container to a first member disposed in one of the bottom surface apertures; and
 - fixing the bottom plate to a second member disposed in one of the plate apertures and threadably connected to the first member.
10. The method of claim 9, in which said first member and said second member are bushings.

11. The method of claim 10, in which one of said first and second members are generally annular.
12. The method of claim 9, further comprising disposing an O-ring between the first member and the container.
13. The method of claim 9, further comprising disposing an O-ring between the second member and the container.
14. A container, comprising:
- a container portion having an interior and an aperture fluidly communicating the interior with an exterior of the container portion;
 - supports disposed in the interior for accommodating a substrate;
 - a door sealingly accommodated by the container portion;
 - a bottom plate fixed to the container portion and having a plurality of radially aligned kinematic grooves; and
 - a valve disposed in said container portion aperture and comprising a valve member, the valve member including a pair of valve flaps, said pair of valve flaps in a non-contacting relation when said valve member is open, said pair of valve flaps in a contacting relation at a valve member apex when said valve member is closed.
15. The container of claim 14, in which the valve further comprises a collar disposed proximate a base of said flaps.
16. The container of claim 14, further comprising a filter positionally disposed to filter air entering the container portion via said valve when said valve is open.
17. A method of venting a container configured for accommodating a substrate, a valve disposed in an aperture of the container, the valve comprising a pair of valve flaps in a contacting relation when the valve is closed, the method comprising opening said valve flaps, thereby venting said container.

18. A method of making a container for a substrate, comprising:

forming the container, the container having an interior, an aperture, and supports for supporting the substrate;

disposing a valve in the aperture, said valve comprising a pair of valve flaps, said valve closed when said valve flaps are in a contacting relation at an apex thereof and said valve open when said valve flaps are in a non-contacting relation.

19. A system, comprising:

a container defining an interior;

supports extending from the interior and accommodating a plurality of axially aligned substrates;

a door sealing the container;

a bottom plate defining a plurality of radially disposed kinematic grooves; and

an elastomeric dampener afixed intermediate the container and the bottom plate.

20. A method of dampening a container afixed to a bottom plate, an elastomeric dampener disposed between the container and the bottom plate, the container having an interior and a plurality of supports accommodating a substrate, the bottom plate defining a plurality of radially disposed kinematic grooves, the method comprising administering a mechanical shock to said bottom plate, said dampener thereby attenuating a magnitude of said mechanical shock before said mechanical shock reaches said container.

21. A system comprising:

a container defining an interior;

supports extending from the interior and accommodating a plurality of axially aligned substrates;

a door sealing the container;

a bottom plate defining a plurality of radially disposed kinematic grooves; and

a plurality of adjustable spacers disposed between the container and the bottom plate.