ABSTRACT

A carrier for holding a plurality of substrates in a generally horizontal, spaced apart, axially aligned relationship includes an enclosure portion defining an interior space, the enclosure portion having a top, a bottom, a pair of opposing sides, a back and an open front defined by a door frame, at least one substrate support structure in the enclosure portion for holding the substrates, and a door for sealingly closing the open front. A pair of selectively removable handles is coupled with each of the sides of the enclosure portion. Each handle has an elongate gripping portion presenting a longitudinal axis, and the gripping portion is oriented so that the longitudinal axis is generally horizontal and generally parallel with the sides of the enclosure portion.
This application claims the benefit of U.S. Provisional Patent Application No. 60/819,099 entitled SUBSTRATE CARRIER AND HANDLE, filed Jul. 7, 2006, hereby fully incorporated herein by reference.

FIELD OF THE INVENTION

The present invention relates generally to carriers for transporting substrates and more particularly to handles for substrate carriers.

BACKGROUND OF THE INVENTION

Semiconductor and magnetic components used in electronic devices are typically manufactured from “substrates,” meaning silicon wafers, magnetic substrates or the like. Sealable enclosures, generally termed transport modules or substrate carriers, have been used in the industry for a number of years for storing and transporting substrates between processing steps and/or between facilities. Semiconductor wafers are stored and transported in such containers because they are notoriously vulnerable to damage from contaminants such as particles. Extraordinary measures are taken to eliminate contaminants in clean rooms and other environments where semiconductor wafers are stored or processed in circuits.

Substrate carriers for larger substrates, such as 300 mm and larger wafers, typically utilize a front opening door for insertion and removal of substrates and are known as FOUPs (Front Opening Unified Pods) and FOSBs (Front Opening Shipping Box). The FOUP door does not support the load of the substrates. Instead, a container portion which includes a plastic shell and other members for supporting the substrates carries the load of the substrates. Examples of FOUPs include U.S. Pat. Nos. 6,010,008 and 6,736,268, which are hereby incorporated by reference.

Such substrate carriers also typically utilize a machine interface, such as a kinematic coupling, on the bottom of the module to repeatedly and precisely align the carrier with respect to the processing equipment. This enables robotic, automated handling means to engage the door on the front side of the carrier, open the door, and, with the necessary amount of precision, engage and remove the substrates. It is highly critical that the substrates and carriers are positioned at a particular height and in a particular orientation with reference to the equipment so that the substrates will not be damaged during the robotic withdrawal and insertion of the substrates and carriers.

Front opening substrate carriers often include side handles for manual transportation such as depicted and described in U.S. Pat. No. 6,736,268, previously incorporated by reference. A drawback of such earlier handle configurations, however, is that the handle occupies space between adjacent carriers in a stocker. This presents a challenge to robotic handling of the carriers, particularly when carriers of different sizes are stored together. The multiplicity of handles occupies the space between the side surfaces of the carriers in the stocker, tending to limit the ways in which the robotic equipment can access the carriers. This adds cost and complexity to automated handling of the carriers, and can even lead to damaged substrates. Accordingly, there is still a need in the industry for a substrate carrier having manual handles that do not interfere with robotic handling equipment when a plurality of such carriers of varying sizes are stacked with one another.

SUMMARY OF THE INVENTION

In an embodiment, the present invention includes a substrate carrier with improved manual handles. The handles extend generally horizontally from back on the sides of the carrier and are typically positioned only a short distance from the top surface of the carrier. This handle orientation and location frees up space between adjacent carriers stacked in a stacker and is especially advantageous where carriers of different sizes are stacked together. This enables the automated robotic equipment used for handling the substrate carriers to more easily access the carriers. The increased space also decreases the likelihood that the robotic equipment will bump or otherwise jar a substrate carrier, which can cause damage to the substrates contained therein.

An embodiment of the present invention includes a carrier body defining an interior region in which substrates can be stored and that can be sealed with a door. Handles extend generally horizontally front-to-back on the side surfaces of the carrier, and may be positioned proximate the top surface of the carrier. Each handle may include a generally cylindrical gripping portion and an attachment structure. The handles and attachment structure may be integrally molded with a robotic lifting flange located on the top surface of the substrate carrier.

According to an embodiment, a carrier for holding a plurality of substrates in a generally horizontal, spaced apart, axially aligned relationship includes an enclosure portion defining an interior space, the enclosure portion having a top, a bottom, a pair of opposing sides, a back and an open front defined by a door frame, at least one substrate support structure in the enclosure portion for holding the substrates, and a door for sealingly closing the open front. A pair of selectively removable handles is coupled with each of the sides of the enclosure portion. Each handle has an elongate gripping portion presenting a longitudinal axis, and the gripping portion is oriented so that the longitudinal axis is generally horizontal and generally parallel with the sides of the enclosure portion. The carrier may further include a robotic lifting flange on the top of the carrier, and the robotic lifting flange and the pair of handles may be integrally molded in a single piece. The handles may be positioned proximate the top of the carrier. In some embodiments, each of the sides of the carrier present a height dimension in a direction extending between the top and bottom, and the handles extend downwardly from the top by no more than one-third of the height dimension.

In an embodiment, a carrier for holding a plurality of substrates in a generally horizontal, spaced apart, axially aligned relationship includes an enclosure portion defining an interior space, the enclosure portion having a top, a bottom, a pair of opposing sides, a back and an open front defined by a door frame, at least one substrate support structure in the enclosure portion for holding the substrates, and a door for sealingly closing the open front. A removable handle structure including a robotic lifting flange and a pair of handles is coupled with the enclosure such that the lifting
flange projects upwardly from the top of the enclosure and a separate one of the handles is disposed adjacent each of the sides of the enclosure. Each handle has an elongate gripping portion presenting a longitudinal axis, and the gripping portion is oriented so that the longitudinal axis is generally horizontal and generally parallel with the sides of the enclosure portion.

[0011] Another embodiment includes a removable manual handle structure for a substrate carrier. The carrier includes an enclosure portion defining an interior space, the enclosure portion having a top, a bottom, a pair of opposing sides, a back and an open front defined by a door frame. The removable handle structure includes a robotic lifting flange and a pair of handles. The lifting flange projects upwardly from the top of the enclosure and a separate one of the handles disposed adjacent each of the sides of the enclosure. Each handle has an elongate gripping portion presenting a longitudinal axis, and the gripping portion is oriented so that the longitudinal axis is generally horizontal and generally parallel with the sides of the enclosure portion. The removable manual handle structure may be integrally molded in a single piece. The removable manual handle structure may include means for securing the removable handle structure to the carrier, which may include a pair of engaging structures. Each of the sides of the carrier may have structure for receiving a separate one of the engaging structures.

[0012] An object and advantage of embodiments of the present invention is ease of maneuverability of substrate carriers. The location of the manual transportation handles near the top of substrate carriers and the generally horizontal orientation increases the clearance between the robotic equipment and the carriers, making it easier for the equipment to be used to transport the carriers.

[0013] Another object and advantage of embodiments of the present invention is a decreased chance of substrate damage. Greater clearance between substrate carriers decreases the exactness with which the robotic equipment must be used to handle the carriers. This creates a smaller possibility that the equipment will bump a carrier, which could cause damage to the substrates contained therein.

[0014] Further objects and advantages of particular embodiments of the present invention may become apparent to those skilled in the art upon review of the figures and descriptions of the present invention herein.

BRIEF DESCRIPTION OF THE FIGURES

[0015] The invention may be more completely understood in consideration of the following detailed description of various embodiments of the invention in connection with the following drawings, in which:

[0016] FIG. 1 is a perspective view of a plurality of substrate carriers according to embodiments of the present invention positioned in a stocker;

[0017] FIG. 2 is a front elevation view of a plurality of substrate carriers according to embodiments of the present invention positioned in a stocker;

[0018] FIG. 3 is a side elevation view of a prior art substrate carrier; FIG. 3A is a front elevation view of a plurality of prior art substrate carriers positioned in a stocker;

[0019] FIG. 4 is a side elevation view of a carrier according to an embodiment of the invention; and

[0020] FIG. 5 is a side elevation view of a carrier according to an alternative embodiment of the invention.

[0021] While the invention is amenable to various modifications and alternative forms, specifics thereof have been shown by way of example in the drawings and will be described in detail. It should be understood, however, that the intention is not to limit the invention to the particular embodiments described. On the contrary, the intention is to cover all modifications, equivalents, and alternatives falling within the spirit and scope of the invention as defined by the appended claims.

DETAILED DESCRIPTION

[0022] Referring to FIGS. 1 and 2, there is depicted a plurality of substrate carriers 20, 22, according to embodiments of the present invention positioned on shelves 24 of a stocker 26, such as may be found in a semiconductor fabrication facility. Substrate carrier 20 is adapted to contain a greater number of substrates, such as twenty-five, than substrate carriers 22, which may contain, for example, six substrates. One of skill in the art will recognize that, in other embodiments, substrate carriers 20, 22, can contain greater or fewer substrates. Each substrate carrier 20, 22, generally includes an enclosure portion 28 defining an interior space 30 where substrates can be stored. Generally, the substrates will be supported in one or more substrate support structures (not depicted) fastened inside enclosure portion 28. Various configurations of such substrate support structures are depicted and described in U.S. Pat. Nos. 6,267,245 and 6,644,477, hereby fully incorporated herein by reference.

[0023] Enclosure portion 28 generally includes a top wall 32, a bottom wall 34, a pair of opposing side walls 36, 38, a back wall 40, and an open front 42 defined by a door frame 44. A door 46 is sealably engageable in door frame 44 to close open front 42 and thereby to create a microenvironment for semiconductor wafers or other substrates as is known in the art. Door 46 typically includes transparent vision panel 48 through which substrates stored in carrier 20, 22, can be observed from the outside with door 46 in place. Further, door 46 will typically have one or more latch mechanisms (not depicted) for securing door 46 in place in door frame 44. The latch mechanisms are operable from outside carrier 20, 22, with a key (not depicted) inserted through keyholes 50. Carrier 20, 22, may be equipped with a kinematic coupling 52 and a robotic lifting flange 54 to enable automated handling. Other details of substrate carriers are disclosed in U.S. Pat. Nos. 6,216,874; 6,206,196; 5,944,194, owned by the owner of this application and hereby fully incorporated herein by reference.

[0024] According to embodiments of the invention, substrate carriers 20, 22, also include a removable handle structure 55 including a pair of handles 56, 58, that can be used for manual transportation of substrate carriers 20, 22. Each handle 56, 58, generally includes a generally cylindrical gripping portion 60. Handles 56, 58, are coupled with an attachment structure 62. As depicted in FIG. 5, gripping portion 60 can have gripping structure 64, such as notches, ribs, or the like, to improve gripping purchase and can be given various other cross-sectional shapes, such as ovoid, and polygonal. Further, handles 56, 58, may be slightly
curved longitudinally as depicted or may be straight, and may be oriented substantially horizontally or angled toward the front or back as desired.

[0025] According to embodiments of the invention, handles 56, 58, are elongate and present a longitudinal major axis X-X. Handles 56, 58, are oriented such that axis X-X extends generally parallel with sides 36, 38, respectively, in a front to back orientation relative to carrier 20, 22. Axis X-X generally forms an angle α of between about 0 and about 45 degrees relative to the horizontal.

[0026] In carriers 20 having a larger substrate capacity, handles 56, 58, are preferably positioned adjacent sides 36, 38, proximate top wall 32. As depicted in FIG. 4, carrier 20 presents a top to bottom height dimension H. Handles 56, 58, are preferably disposed so that no portion of handles 56, 58, extends a distance of more than 1/2 of H below top wall 32, and more preferably no more than 1/4 of dimension H below top wall 32.

[0027] Attachment structure 62 as depicted in FIGS. 1, 4, and 5, generally includes central body 66, with a pair of wings 68, 70, extending laterally to handles 56, 58, respectively. Robotic lifting flange 54 extends upwardly from central body 66. Each wing 68, 70, defines aperture 72 having front edge 74. Attachment tabs 76 extend rearwardly from front edge 74. Each of sides 36, 38, has structure 76 on the outer surface thereof defining a forwardly facing pocket 78. Tabs 76 are received in pockets 78 to removably attach handles 56, 58, and attachment structure 62 to carrier 20, 22. Similar tab and pocket structure may be provided on central body 66 and top wall 32 for further security of attachment.

[0028] In use, removable handle structure 55 engaged with carrier 20, 22, by positioning handle structure 55 over top 32 of carrier 20, 22, with tabs 76 registered with pockets 78. Handle structure 55 is then advanced rearwardly until tabs 76 are fully seated in pockets 78. Removal accomplished by the reverse procedure.

[0029] Handle structure 55 may be molded from any suitable polymer material, including without limitation polycarbonate, PEI, or PEEK, and may be molded in a single, unitary piece, including handles 56, 58, attachment structure 62, and optionally lifting flange 54. The polymer material may be alloyed with other material, such as carbon, to lend desirable properties, such as electrical conductivity or static dissipation. Alternatively, handle structure 55 may also be molded in a plurality of separate pieces and assembled by any suitable methods and materials known in the art such as mechanical fasteners or adhesives.

[0030] Referring now to FIGS. 2, and 3, 3A, certain advantageous features of the carriers 20, 22, of embodiments of the present invention may be observed and understood. In FIG. 3, there is depicted a prior art substrate carrier 80. In contrast with carriers 20, 22, handles 82, 83, extend substantially vertically on side surfaces 84, 86, in a generally top to bottom orientation. As can be seen in FIG. 3A, when carriers 80 are placed on stocker shelves 24, handles 82, 83, of the carriers 80 occupy a substantial portion of the space between horizontally adjacent carriers. This occupies space that could be used by automated handling equipment in handling the substrate carriers.

[0031] In contrast as depicted in FIG. 2, with the horizontally oriented handles 56, 58, according to embodiments of the present invention, region 120 is left open, free from any intrusion of handles. Because the handles 56, 58, of carrier 20, 22, are oriented substantially horizontally and in carrier 20 are positioned proximate the top of the carrier, region 120 may be used by the robotic equipment to access the carriers 20, 22. As will be understood by those of skill in the art, this feature is particularly advantageous where carriers of different capacity are stacked alongside each other in a stocker 26 as depicted in FIG. 2.

[0032] The embodiments above are intended to be illustrative and not limiting. Additional embodiments are encompassed within the scope of the claims. Although the present invention has been described with reference to particular embodiments, those skilled in the art will recognize that changes may be made in form and detail without departing from the spirit and scope of the invention. For purposes of interpreting the claims for the present invention, it is expressly intended that the provisions of Section 112, sixth paragraph of 35 U.S.C. are not to be invoked unless the specific terms "means for" or "step for" are recited in a claim.

What is claimed is:

1. A carrier for holding a plurality of substrates in a generally horizontal, spaced apart, axially aligned relationship, the carrier comprising:

an enclosure portion defining an interior space, the enclosure portion having a top, a bottom, a pair of opposing sides, a back and an open front defined by a door frame; and

at least one substrate support structure in the enclosure portion for holding the substrates;

door for sealingly closing the open front; and

a pair of selectively removable handles on each of the sides of the enclosure portion, each handle having an elongate gripping portion presenting a longitudinal axis, the gripping portion oriented so that the longitudinal axis is generally horizontal and generally parallel with the sides of the enclosure portion.

2. The carrier of claim 1, wherein the carrier further comprises a robotic lifting flange on the top of the carrier.

3. The carrier of claim 2, wherein the robotic lifting flange and the pair of handles are integrally molded in a single piece.

4. The carrier of claim 3, wherein the handles are positioned proximate the top of the carrier.

5. The carrier of claim 4, wherein each of the sides of the carrier present a height dimension in a direction extending between the top and bottom, and wherein the handles extend downwardly from the top by no more than one-third of the height dimension.

6. The carrier of claim 1, further comprising a kinematic coupling on the bottom of the carrier.

7. A carrier for holding a plurality of substrates in a generally horizontal, spaced apart, axially aligned relationship, the carrier comprising:

an enclosure portion defining an interior space, the enclosure portion having a top, a bottom, a pair of opposing sides, a back and an open front defined by a door frame; and

at least one substrate support structure in the enclosure portion for holding the substrates;

door for sealingly closing the open front; and
a removable handle structure including a robotic lifting flange and a pair of handles, the lifting flange projecting upwardly from the top of the enclosure, a separate one of the handles disposed adjacent each of the sides of the enclosure, each handle having an elongate gripping portion presenting a longitudinal axis, the gripping portion oriented so that the longitudinal axis is generally horizontal and generally parallel with the sides of the enclosure portion.

8. The carrier of claim 7, wherein the removable handle structure is integrally molded in a single piece.

9. The carrier of claim 8, wherein the handles are positioned proximate the top of the carrier.

10. The carrier of claim 9, wherein each of the sides of the carrier present a height dimension in a direction extending between the top and bottom, and wherein the handles extend downwardly from the top by no more than one-third of the height dimension.

11. The carrier of claim 7, further comprising a kinematic coupling on the bottom of the carrier.

12. The carrier of claim 7, wherein the removable handle structure further comprises a pair of engaging structures, and wherein each of the sides of the carrier has structure for receiving a separate one of the engaging structures.

13. A removable manual handle structure for a substrate carrier, the carrier including an enclosure portion defining an interior space, the enclosure portion having a top, a bottom, a pair of opposing sides, a back and an open front defined by the door frame, the removable handle structure comprising a robotic lifting flange and a pair of handles, the lifting flange projecting upwardly from the top of the enclosure, a separate one of the handles disposed adjacent each of the sides of the enclosure, each handle having an elongate gripping portion presenting a longitudinal axis, the gripping portion oriented so that the longitudinal axis is generally horizontal and generally parallel with the sides of the enclosure portion.

14. The removable manual handle structure of claim 13, wherein the removable handle structure is integrally molded in a single piece.

15. The removable manual handle structure of claim 14, wherein the handles are positioned proximate the top of the carrier.

16. The removable manual handle structure of claim 15, wherein each of the sides of the carrier present a height dimension in a direction extending between the top and bottom, and wherein the handles extend downwardly from the top by no more than one-third of the height dimension.

17. The removable manual handle structure of claim 13, further comprising a kinematic coupling on the bottom of the carrier.

18. The removable manual handle structure of claim 13, further comprising means for securing the removable handle structure to the carrier.

19. The removable manual handle structure of claim 18, wherein means for securing the removable handle structure to the carrier comprises a pair of engaging structures, and wherein each of the sides of the carrier has structure for receiving a separate one of the engaging structures.

20. The removable handle structure of claim 18 in combination with a plurality of carriers, wherein each of the plurality of carriers receives a different number of substrates, and wherein the removable handle structure is adapted to be received on each of the plurality of carriers.