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Semiconductor substrate carrying container with front and rear openings

Abstract

A semiconductor substrate carrying container, such as a front opening unified pod, is configured such that a semiconductor substrate can be accessed and removed from or inserted into an interior space of the container via a rear opening that is located opposite a front opening that also permits removal and insertion therethrough. The removal and insertion via the rear opening can be achieved in any suitable manner including, but not limited to, using an automated mechanism, such as a robot arm, or manually.

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Background/Summary

FIELD

(1) This technical disclosure relates to semiconductor substrate carrying containers such as front opening unified pods (FOUPs), for example those used in semiconductor manufacturing.

BACKGROUND

(2) Substrate carrying containers are used to transport substrates during semiconductor manufacturing. Substrate carrying containers include, for example, FOUPs. FOUPs typically include a shell which provides an internal space for holding substrates, and a plate that is used to interface with various conveyors and other devices, for example so that the FOUP can be moved around the processing facility. A FOUP typically includes a front opening through which a substrate can be removed and inserted into the FOUP.

SUMMARY

(3) Semiconductor substrate carrying containers, such as FOUPs, are described herein where a semiconductor substrate can be accessed and removed from or inserted into an interior space of the

container via a rear opening that is located opposite a front opening that also permits removal and insertion therethrough. The removal and insertion via the rear opening can be achieved in any suitable manner including, but not limited to, using an automated mechanism, such as a robot arm, or manually.
(4) The semiconductor substrates can be any substrates used in semiconductor manufacturing. Examples of the semiconductor substrates that can be located in the containers described herein can include, but are not limited to, wafers and panels (such as flat panels), and combinations thereof.
(5) A semiconductor substrate may be removed from the container through the rear opening, a semiconductor substrate may be inserted into the container through the rear opening, or a semiconductor substrate may be removed from the container through the rear opening and thereafter that same semiconductor substrate may be inserted back into the container through the rear opening. In one embodiment, a semiconductor substrate may be removed from the container through the rear opening, and that same semiconductor substrate may thereafter be inserted back into the container through the front opening. In another embodiment, a semiconductor substrate may be removed from the container through the front opening, and that same semiconductor substrate may thereafter be inserted back into the container through the rear opening. In another embodiment, a semiconductor may be removed from the container through the rear opening and never inserted back into the container. In another embodiment, a semiconductor substrate may be inserted into the container for the first time through the rear opening and thereafter not removed from the container until processing is completed.
(6) In an embodiment, a semiconductor substrate carrying container described herein can include a container shell having a plurality of walls, a front, and a rear, where the plurality of walls define an interior space that is sized to be able to receive a plurality of semiconductor substrates therein. A front opening is located at the front of the container shell and through which a semiconductor substrate is able to be removed from and inserted into the interior space. In addition, a rear opening is located at the rear of the container shell and through which a semiconductor substrate is able to be removed from and inserted into the interior space.
(7) In another embodiment, a FOUP described herein can include a shell having a front opening and an interior space. A rear opening is located at a rear of the shell opposite the front opening and through which a semiconductor substrate is able to be removed from and inserted into the interior space. In addition, a plurality of pairs of opposing support ledges are disposed within the interior space and are attached to side walls of the shell. Each pair of opposing support ledges is configured to support a semiconductor substrate in the interior space.
(8) In still another embodiment, a method described herein includes removing a semiconductor substrate from or inserting a semiconductor substrate into an interior space of a semiconductor substrate carrying container through a rear opening at a rear of the semiconductor substrate carrying container located opposite a front opening of the semiconductor substrate carrying container.

Description

DRAWINGS
(1) FIG. **1** is a rear perspective view of a semiconductor substrate carrying container having a rear opening.
(2) FIG. **2** is a rear perspective view similar to FIG. **1** but showing an optional removable cover in place on the container covering the rear opening
(3) FIG. **3** is a rear view of the container with the cover removed.
(4) FIG. **4** is a detailed view of the portion contained in circle **4** of FIG. **3**.
(5) FIG. **5** is a top view of the interior of the container and of a semiconductor substrate contained

in the interior space.
(6) FIG. **6** is a detailed view of the portion contained in circle **6** of FIG. **5**.
(7) FIG. **7** is close-up side view of substrate support ledges in the interior space of the container.
(8) FIG. **8** is a top view of the removable cover of FIG. **2** removed from the container.
(9) FIG. **9** is an end view of the inside of the removable cover.
DETAILED DESCRIPTION
(10) With reference to FIGS. **1-2**, an example of a semiconductor substrate carrying container **10** is depicted. In one embodiment, the container **10** may be referred to as a FOUP. The container **10** includes a container shell **12** having a plurality of walls including a first side wall **14**, a second side wall **16** opposite the first side wall **14**, a top wall **18**, and a bottom wall **20** opposite the top wall **18**. The walls define an interior space **22** that is sized to be able to receive a plurality of semiconductor substrates **24** therein (for sake of convenience, semiconductor substrates **24** are only visible at positions **2** and **13** in FIG. **1**). In one embodiment, the container **10** can be configured to receive and hold twenty-four substrates **24**, although the container **10** can be configured to hold a larger or smaller number of substrates **24**. The container **10** further includes a front **26** having a front opening **28** (visible in FIG. **5**) through which each one of the semiconductor substrates **24** is able to be removed from and inserted into the interior space **22**, and a rear **30** having a rear opening **32** through which each one of the semiconductor substrates **24** is able to be removed from and inserted into the interior space **22**. In addition, a machine interface plate **34** is secured to the bottom wall **20** of the shell **12**.
(11) The semiconductor substrates **24** can be any substrates used in semiconductor manufacturing. Examples of the semiconductor substrates **24** that can be located in the containers **10** described herein can include, but are not limited to, wafers and panels (such as flat panels), and combinations thereof. The embodiment in FIG. **1** depicts the substrates **24** as being wafers.
(12) The substrate container **10** can be formed from one or more polymer materials including, but not limited to, injection-moldable polymer materials. The polymer material(s) can include, but are not limited to, one or more polyolefins, one or more polycarbonate, one or more thermoplastic polymers and the like. In an embodiment, some or all of the substrate container **10** can be injection molded. The one or more polymer materials can form a matrix including carbon fill. In an embodiment, the one or more polymer materials can be selected to minimize particle shedding during handling and use of the substrate container **10**.
(13) With reference to FIG. **2**, an optional removable cover **40** can be removably secured to the container shell **12** to selectively cover and uncover the rear opening **32** (see FIG. **1**). In some embodiments, the cover **40** is not used and the rear opening **32** (see FIG. **1**) can remain uncovered. Further details on the cover **40** are described further below with respect to FIGS. **8** and **9**.
(14) Referring to FIGS. **3-7** (together with FIG. **1**), support structure is provided in the interior space **22** for supporting the semiconductor substrates **24** therein. The support structure can have any configuration that is sufficient to support the semiconductor substrates **24** and that permits the removal and insertion of the semiconductor substrates **24** through the rear opening **32** as described herein. In the illustrated example, the support structure supports the semiconductor substrates **24** in a vertically stacked arrangement where the substrates **24** are vertically spaced from one another and each substrate **24** is oriented horizontally substantially parallel to the top wall **18** and the bottom wall **20**.
(15) In the example illustrated in FIGS. **1** and **3-7**, the support structure comprises a plurality of pairs of opposing support ledges (referred to generally using **42**) within the interior space **22** and attached to the opposing side walls **14**, **16** of the container shell **12**. When viewing the container **12** from the top like in FIG. **5**, each pair of opposing support ledges **42** may be referred to as having a right support ledge **42***a* and a left support ledge **42***b*. The right and left support ledges **42***a*, **42***b* forming each pair of support ledges are configured to support a respective one of the semiconductor substrates **24** in the interior space **22**.

(16) Referring to FIGS. **5** and **6**, each of the right and left support ledges **42***a*, **42***b* includes a front portion **44** located toward the front **26** of the shell **12** and a rear portion **46** located toward the rear **30** of the shell **12**. The support ledges **42***a*, **42***b* position and support the substrate **24** in an X-Y plane. At least one of the rear portions **46** of the support ledges **42***a*, **42***b*, and preferably both of the rear portions **46** of the support ledges **42***a*, **42***b*, includes a stop **48** that is engageable with the semiconductor substrate **24** to limit insertion of the semiconductor substrate **24** into the interior space **22** in the Y-direction through the front opening **28**.
(17) With continued reference to FIGS. **5** and **6**, each support ledge **42***a*, **42***b* further includes a horizontal ledge portion **50** and a vertical ledge portion **52** extending upwardly from the horizontal ledge portion **50**. A plurality of semiconductor substrate positioning pads **54** (or just positioning pads **54**) are disposed on the horizontal ledge portion **50**. The positioning pads **54** are protrusions on the horizontal ledge portion **50** that the substrate **24** rests on and that position the substrate **24** in the X-Y plane. Any number of positioning pads **54** can be provided. In the illustrated example, each one of the support ledges **42***a*, **42***b* includes a front positioning pad **54** and a rear positioning pad **54**.
(18) Still referring to FIG. **5**, the rear opening **32** is sized to permit removal of each one of the substrates **24** from and insertion of each one of the substrates **24** into the interior space **22**. In the illustrated example, the substrate **24** is depicted as having a maximum width Ws. The rear opening **32** is depicted as having a width WO that is greater than the width Ws to permit the substrate **24** to pass through the rear opening **32** upon insertion into or removal from the interior space **22**. In one embodiment, the substrate **24** can remain substantially in the X-Y plane as the substrate **24** passes through the rear opening **32** during insertion or removal.
(19) Referring to FIGS. **3**, **4**, and **7**, in one embodiment the support ledges **42***a*, **42***b* may be configured in a manner such that during removal of the substrate **24**, the substrate **24** is lifted upwardly vertically before the substrate **24** is removed through the rear opening **32**. Similarly, during insertion of a substrate **24** through the rear opening **32**, the substrate **24** can be inserted through the rear opening **32** and then lowered vertically onto the support ledges **42***a*, **42***b* for support by the support ledges **42***a*, **42***b*. However, other removal and insertion sequences can be utilized that do not require any vertical movement of the substrate **24** during insertion or removal.
(20) With continued reference to FIGS. **3** and **4**, at the rear portion **46** of each support ledge **42***a*, **42***b*, there is a distance D between a top edge **60** of a support ledge and a bottom edge **62** of the support ledge located immediately above it to define a gap or space **64**. In addition, as best seen in FIGS. **3** and **4**, the support ledges **42***a*, **42***b* are configured so that when the substrates **24** are supported on the support ledges **42***a*, **42***b*, the substrates are positioned below the top edges **60** of the support ledges **42***a*, **42***b*. FIG. **3** depicts three of the substrates **24** each one of which is supported by corresponding pairs of the support ledges **42***a*, **42***b* at what can be referred to as substrate positions **2**, **13** and **24** of the shell **12**.
(21) An example removal sequence will now be described with reference to FIGS. **3** and **4**. To remove one of the substrates **24**, the substrate **24** to be removed is lifted vertically in the Z-axis direction. For example, the substrate **24** can be lifted manually or via a gripping mechanism of a robot arm that grips the substrate **24** at a location between the support ledges **42***a*, **42***b*. During lifting, the substrate **24** may remain substantially in the X-Y plane. The substrate **24** is lifted to a position above the top edges **60** of the support ledges **42***a*, **42***b* supporting the substrate **24** but below the bottom edges **62** of the support ledges **42***a*, **42***b* located above. Once the substrate **24** is lifted above the top edges **60** of the associated support ledges **42***a*, **42***b*, the substrate **24** may then be withdrawn through the rear opening **32**, for example in the Y-axis direction. Insertion of one of the substrates **24** works just the opposite, where the substrate **24** to be inserted is moved through the rear opening **32** in the Y-axis direction to a position between adjacent pairs of support ledges **42***a*, **42***b*, and the substrate **24** is then lowered vertically down onto the associated pair of support ledges **42***a*, **42***b*.

(22) Returning to FIG. **2**, use of the cover **40** is optional. If the cover **40** is used, the cover **40** can be configured to have a first position (shown in FIGS. **2** and **5**) where the cover **40** is attached to the shell **12** and covers the rear opening **32** (see FIG. **1**) and a second position where the cover **40** does not cover the rear opening **32** thereby allowing removal and insertion of one or more of the substrates **24** through the rear opening **32**. The cover **40** may remain attached to the shell **12** at the second position, or the cover **40** may be detached from the shell **12** at the second position. The example of the cover **40** illustrated in FIGS. **2**, **5** and **8-9** depicts the cover **40** as being completely detached from the shell **12** at the second position. In addition, the cover **40** can be attached to the shell **12** in any suitable manner that permits the cover **40** to assume the first position and the second position. In addition, the cover **40** may be configured to be automatically actuated between the first position and the second position, or the cover **40** may be configured to be manually actuated between the first position and the second position.

(23) Referring to FIGS. **2**, **5** and **8-9**, in the illustrated example the cover **40** is configured to be manually actuated and to snap fit connect to the shell **12**. For example, the cover **40** can have an upper retention feature **70** (FIG. **9**) with a slot that receives an edge **72** of a portion **74** of the top wall **18** of shell **12** at the rear opening **32** (see FIG. **1**), a lower retention feature **76** (FIG. **9**) with a flexible lip that is configured to snap fit connect behind a corresponding retention feature **78**, such as a flange, on the bottom wall **20** of the shell **12** at the rear opening **32** (see FIG. **1**), and a pair of side retention features **80**, **82** (FIGS. **8** and **9**) each with a slot **84** that receives an edge of one of the side walls **16**, **14** of the shell **12**.

(24) In one embodiment, the cover **40** may be created from the portion of the shell **12** that is removed to form the rear opening **32**. In other embodiments, the cover **40** can be created from separate materials. The retention features **70**, **76**, **80**, **82** can be separate elements that are later attached to the cover **40** once the portion is removed from the shell **12** to create the rear opening **32**.

(25) With reference to FIGS. **1** and **8-9**, to install the cover **40** on the shell **12** to the first position to cover the rear opening **32**, the upper retention feature **70** is engaged with the edge **72** of the shell **12** and the cover **40** is then rotated down until the slots **84** of the side retention features **80**, **82** engage the edges of the side walls of the shell **12**. Generally simultaneously with the side retention features **80**, **82** engaging, the lower retention feature **76** starts engaging the retention feature **78** and the retention feature **76** flexes and snap-fit connects with the retention feature **78**. Removal of the cover **40** to the second position is the opposite. The lower retention feature **76** is first disconnected from the retention feature **78**, and the cover **40** is then swung upwardly to disengage the side retention features **80**, **82** and the then the upper retention feature **70**. The cover **40** can then be set-aside until insertion or removal through the rear opening **32** is no longer necessary at which time the cover **40** can be re-attached to the shell **12** to cover the rear opening **32**.

(26) Having the rear opening **32** in the container **10** provides a number of benefits. With reference to FIGS. **1** and **5**, one benefit is that one of the semiconductor substrates **24** can be removed via the rear opening **32** to permit at least one analysis to be performed on the removed semiconductor substrate, without interfering with substrate removal and insertion operations occurring through the front opening **28**. The analysis may be to check the quality of a processing operation on the substrate, for example in the case of the substrate being a wafer the quality of semiconductor chips added to the wafer can be checked, or to check the cleanliness of the substrate. The removed substrate **24** may or may not be reinserted back into the container **10**. If the removed substrate **24** is to be reinserted, the reinsertion may occur through the rear opening **32** or even via the front opening **28**. In some embodiments, a substrate **24** may be inserted into the container **10** via the rear opening **32** where that substrate **24** was not previously removed from the container **10** (either via the rear opening **32** or the front opening **28**). For example, a wafer may be inserted into the container via the rear opening **32**.

(27) With continued reference to FIGS. **1** and **5**, in one embodiment, the container **10** may be configured so that a first number of the semiconductor substrates **24** can be removed from and

inserted into the interior space **22** via the front opening **28**, while a second number of the semiconductor substrates **24** can be removed from and inserted into the interior space **22** via the rear opening **32**, where the first number of substrates is greater than the second number of substrates. For example, in a non-limiting example where the container **10** is configured to hold a maximum of twenty-four of the substrates **24**, twenty-four of the substrates **24** can be inserted into and removed from the interior space **22** via the front opening, while only twenty-two of the substrates **24** may be removed from and inserted into the interior space **22** via the rear opening **32**. However, in other designs of the container **10**, the same number of substrates **24** may be inserted and removed via the front opening **28** and via the rear opening **32**.

(28) The examples disclosed in this application are to be considered in all respects as illustrative and not limitative. The scope of the invention is indicated by the appended claims rather than by the foregoing description; and all changes which come within the meaning and range of equivalency of the claims are intended to be embraced therein.

Claims

1. A semiconductor substrate carrying container, comprising: a front opening unified pod having a plurality of walls, a front, and a rear, the plurality of walls defining an interior space that is sized to be able to receive a plurality of semiconductor substrates therein; a front opening at the front of the front opening unified pod and through which a semiconductor substrate is able to be removed from and inserted into the interior space; a rear opening at the rear of the front opening unified pod and through which a semiconductor substrate is able to be removed from and inserted into the interior space; and a cover associated with the front opening unified pod, the cover has a first position where the cover is attached to the container shell and covers the rear opening and a second position where the cover does not cover the rear opening; wherein when the cover is at the second position a semiconductor substrate can be removed from and inserted into the interior space through the rear opening.

2. The semiconductor substrate carrying container of claim 1, wherein the plurality of walls include opposing side walls, and further comprising a plurality of pairs of opposing support ledges within the interior space and attached to the opposing side walls of the front opening unified pod, each pair of opposing support ledges is configured to support a semiconductor substrate in the interior space.

3. The semiconductor substrate carrying container of claim 2, wherein each support ledge comprises a front portion and a rear portion, and at least one of the rear portions of the opposing support ledges of each pair includes a stop that is engageable with a semiconductor substrate to limit insertion of the semiconductor substrate into the interior space.

4. The semiconductor substrate carrying container of claim 2, wherein each support ledge comprises: a horizontal ledge portion and a vertical ledge portion extending upwardly from the horizontal ledge portion, and further comprising a plurality of semiconductor substrate positioning pads on the horizontal ledge portion.

5. The semiconductor substrate carrying container of claim 1, wherein the semiconductor substrate carrying container is configured to permit a first number of semiconductor substrates to be removed from and inserted into the interior space via the front opening and configured to permit a second number of semiconductor substrates to be removed from and inserted into the interior space via the rear opening, and the first number of semiconductor substrates is greater than the second number of semiconductor substrates.

6. The semiconductor substrate carrying container of claim 1, wherein the semiconductor substrates comprise wafers or flat panels.

7. A front opening unified pod, comprising: a shell having a front opening and an interior space; a rear opening at a rear of the shell opposite the front opening and through which a semiconductor

substrate is able to be removed from and inserted into the interior space; a plurality of pairs of opposing support ledges within the interior space and attached to side walls of the shell, each pair of opposing support ledges is configured to support a semiconductor substrate in the interior space; and a cover associated with the container shell, the cover has a first position where the cover is attached to the container shell and covers the rear opening and a second position where the cover does not cover the rear opening, wherein when the cover is at the second position a semiconductor substrate can be removed from and inserted into the interior space through the rear opening.

8. The front opening unified pod of claim 7, wherein each support ledge comprises a front portion and a rear portion, and at least one of the rear portions of the opposing support ledges of each pair includes a stop that is engageable with a semiconductor substrate to limit insertion of the semiconductor substrate into the interior space.

9. The front opening unified pod of claim 7, wherein each support ledge comprises: a horizontal ledge portion and a vertical ledge portion extending upwardly from the horizontal ledge portion, and further comprising a plurality of semiconductor substrate positioning pads on the horizontal ledge portion.

10. The front opening unified pod of claim 7, further comprising a cover associated with the shell, the cover has a first position where the cover is attached to the shell and covers the rear opening and a second position where the cover does not cover the rear opening, and when the cover is at the second position a semiconductor substrate can be removed from or inserted into the interior space through the rear opening.

11. The front opening unified pod of claim 7, wherein the front opening unified pod is configured to permit a first number of semiconductor substrates to be removed from and inserted into the interior space via the front opening and configured to permit a second number of semiconductor substrates to be removed from and inserted into the interior space via the rear opening, and the first number of semiconductor substrates is greater than the second number of semiconductor substrates.

12. The front opening unified pod of claim 7, wherein the semiconductor substrates comprise wafers or flat panels.

13. A method comprising removing a semiconductor substrate from or inserting a semiconductor substrate into an interior space of a front opening unified pod through a rear opening at a rear of the front opening unified pod located opposite a front opening of the front opening unified pod.

14. The method of claim 13, further comprising moving the semiconductor substrate vertically within the interior space during removal of the semiconductor substrate from or insertion of the semiconductor substrate into the interior space through the rear opening.

15. The method of claim 13, wherein the semiconductor substrate comprises a wafer or a flat panel.

16. The method of claim 13, comprising removing the semiconductor substrate from the interior space through the rear opening; and after removing the semiconductor substrate, performing at least one analysis on the semiconductor substrate.

17. The method of claim 16, further comprising: after the at least one analysis, re-inserting the removed semiconductor substrate back into the front opening unified pod through the rear opening.