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(54) **SHIPPING CONTAINER FOR INTEGRATED CIRCUIT WAFERS**

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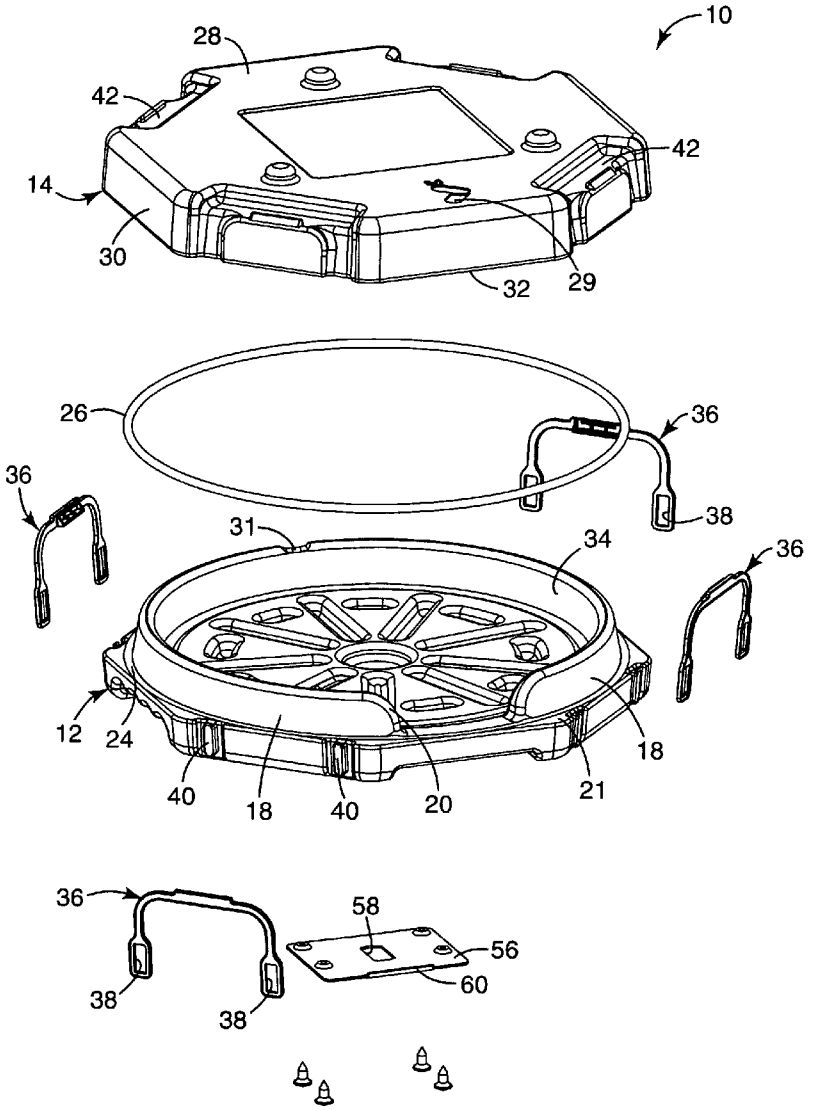
(57) **ABSTRACT**

A shipping container for integrated circuit wafers has a lower section and an upper section releasably connected to the lower section, and a seal is received on a shoulder of the lower section. The seal is in contact with a lower edge portion of the upper section and extends in a flat reference plane when the sections are assembled together in order to help protect the wafers from moisture, airborne particulates and/or other contaminates. The shipping container also preferably includes at least one info pad plug that comprises a body and an adhesive for connecting the body to the lower section of the container.



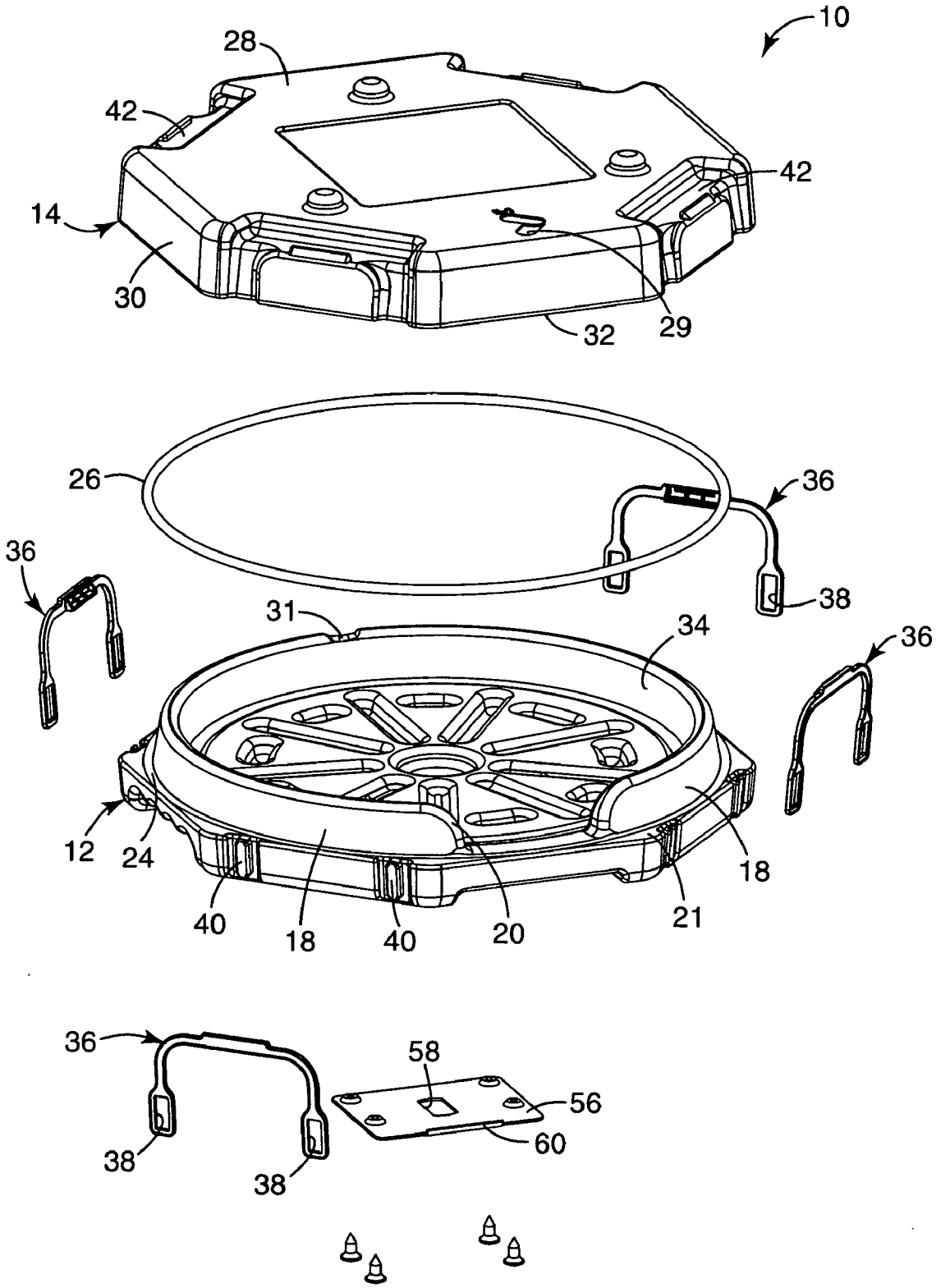

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Fig. 1

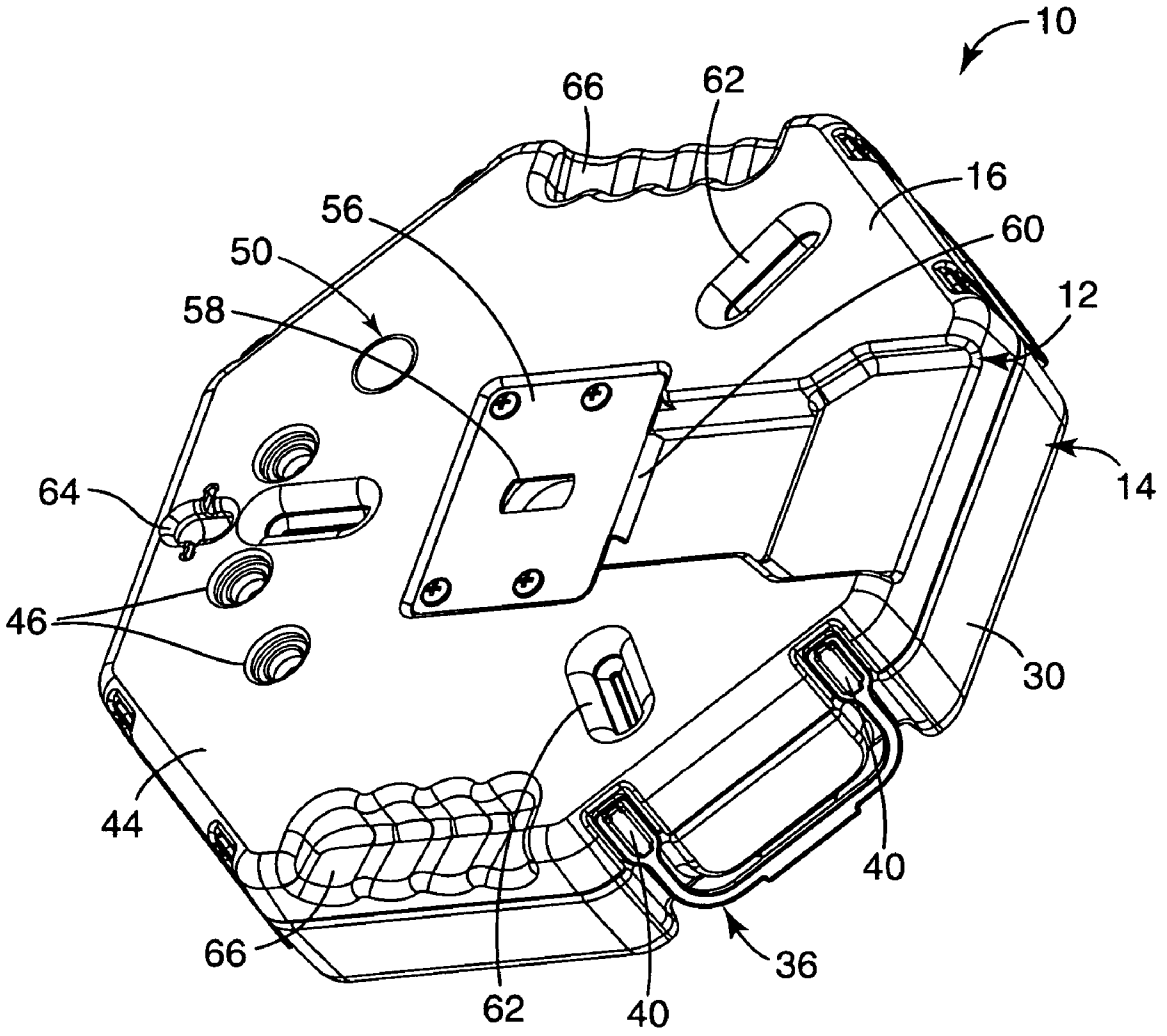

Fig. 2

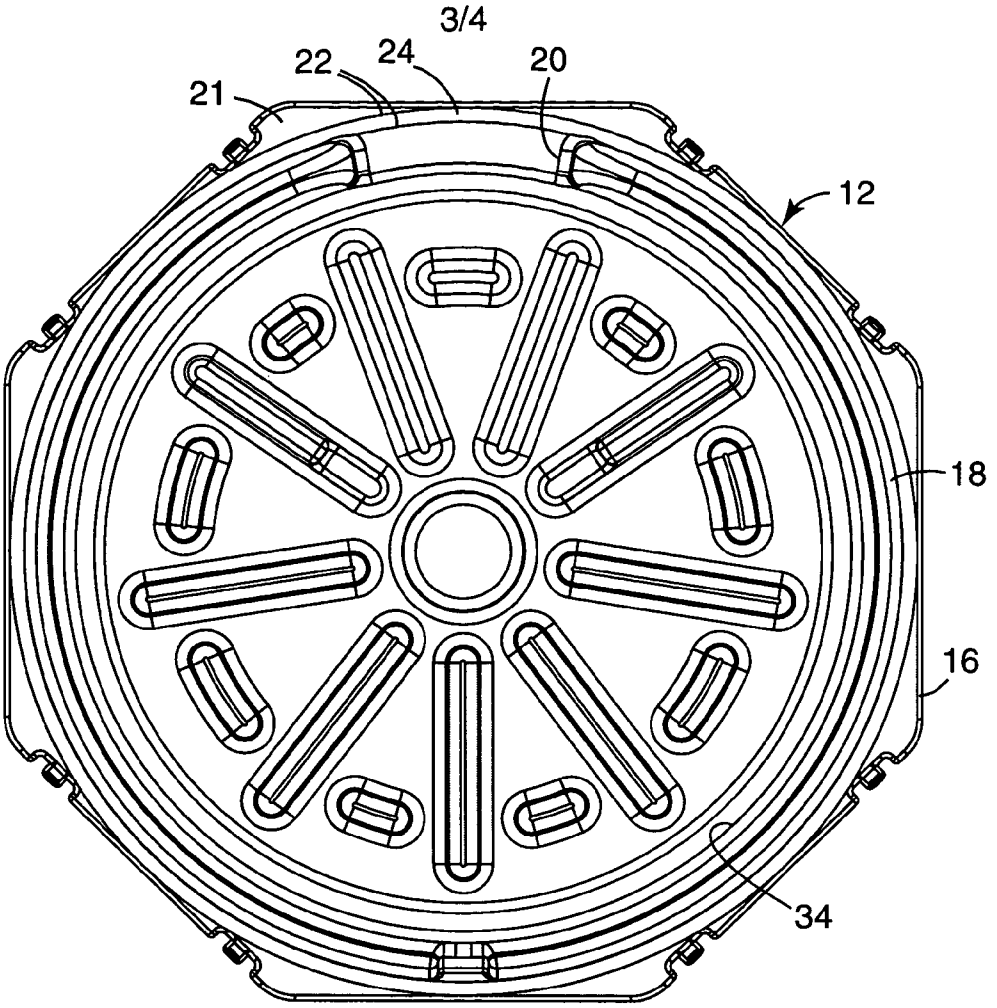

Fig. 3

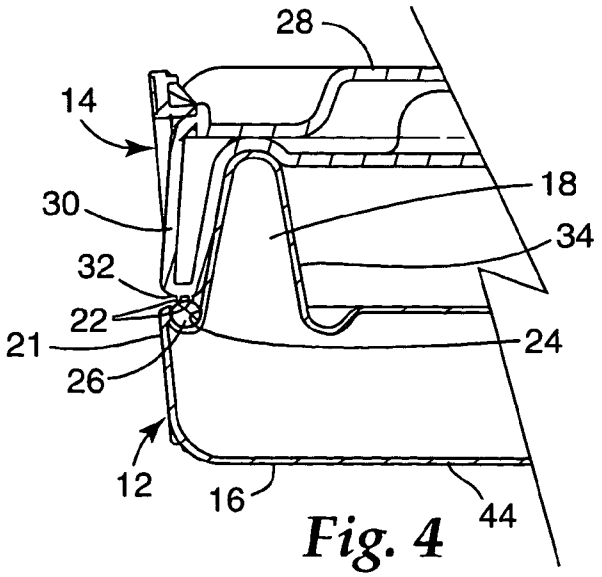

Fig. 4

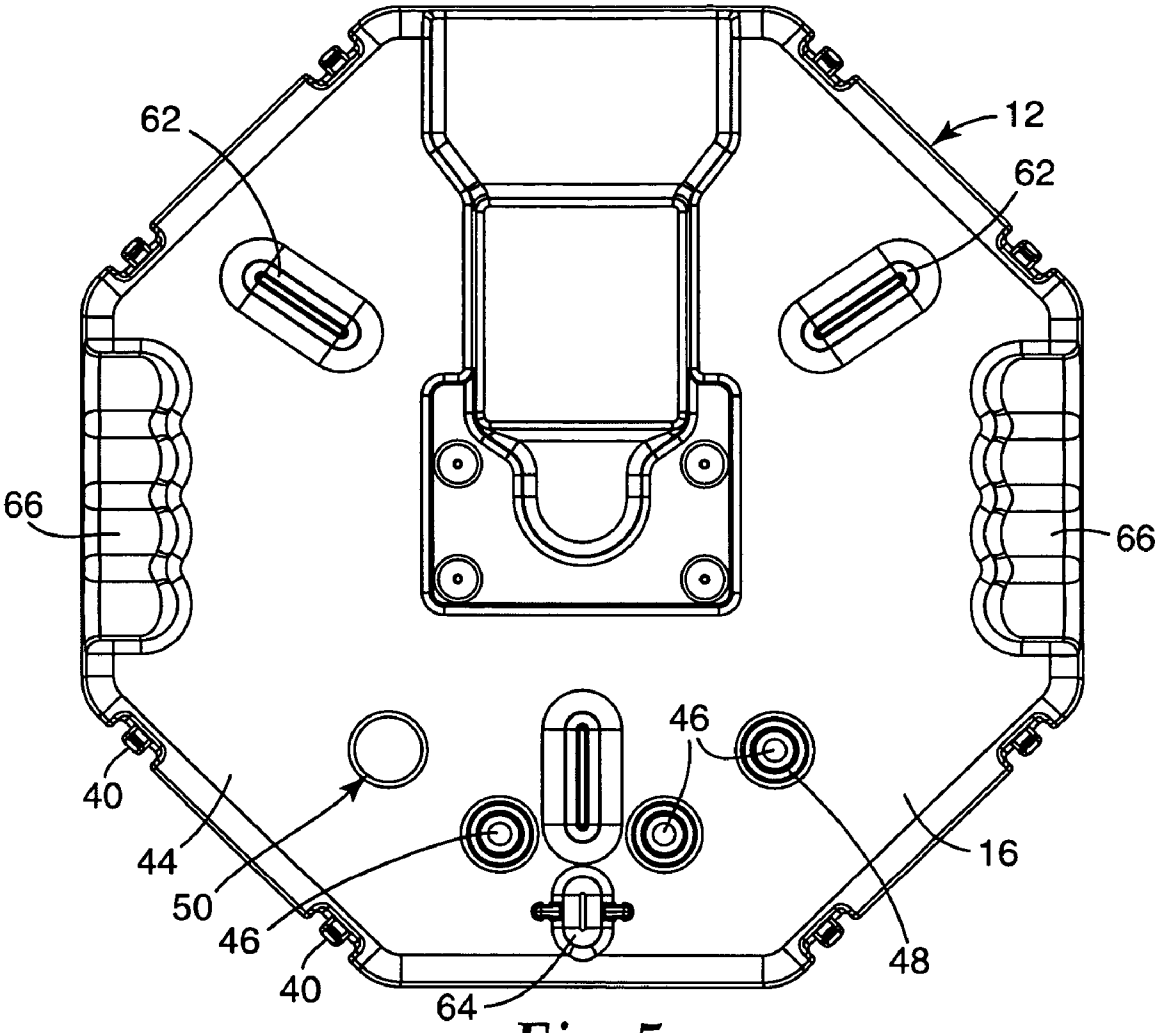

Fig. 5

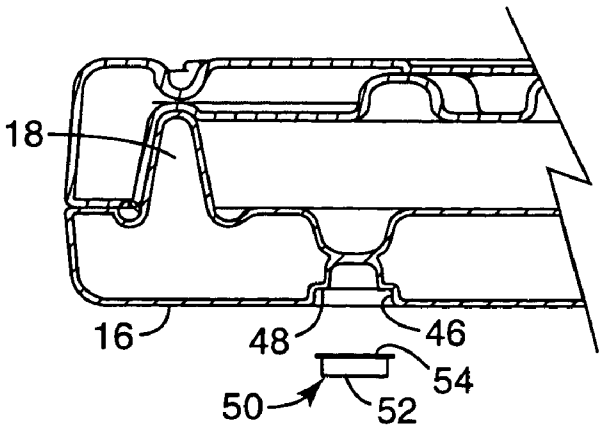

Fig. 6

SHIPPING CONTAINER FOR INTEGRATED CIRCUIT WAFERS

BACKGROUND OF THE INVENTION

[0001] 1. Field of the Invention

[0002] This invention relates to a container for shipping a stacked array of integrated circuit wafers such as semiconductor wafers. More particularly, the present invention relates to horizontal-type wafer shipping containers that may be reused a number of times.

[0003] 2. Description of the Related Art

[0004] A variety of shipping containers are known for shipping and storing integrated circuit wafers. Typically, these containers are intended to provide a stable support for shipping and handling a number of wafers simultaneously. The containers are also intended to provide sufficient protection to substantially reduce the likelihood of breakage of the wafers, which are typically brittle. It is also desirable for wafer shipping containers to protect the wafers from contamination from airborne particulates and an excessive accumulation of static electricity.

[0005] Two general types of reusable shipping containers are in common use for shipping integrated circuit wafers. One type of shipping container has a chamber with internal structure for retaining an array of disc-shaped wafers in an aligned row. This type of shipping container is known as a "vertical shipper" or "front opening shipping box". The other type of shipping container is known as a "HWS" or "horizontal wafer shipper" and has a chamber for retaining a plurality of wafers in a stacked array, with separators between the wafers and foam cushions placed above and below the stacked array for cushioning.

[0006] Shipping containers for integrated circuit wafers are often constructed to be used in conjunction with automated equipment that unloads each wafer from the container when needed for use. For example, some front opening shipping boxes have a bottom surface that is adapted to be releasably received onto a "load port" in a manufacturing assembly line. The load port typically has a clamp, such as an "L"-shaped pin or a "T"-shaped pin, that pivots to engage an overhang or other structure attached to the bottom of the container in order to retain the container in place. Once the shipping container is clamped onto the load port, a robot arm or other automated device removes the wafers from the shipping container in sequential fashion.

[0007] In many instances, the bottom sections of wafer shipping containers are provided with a series of cavities that are precisely positioned in a standardized, predetermined arrangement. These cavities are known as "information pad holes" or "info pad holes" and often comprise four circular cavities or recesses that are arranged in a generally "V"-shaped pattern. Some or all of the cavities are then filled with snap-in plastic plugs according to a pre-defined set of rules that provide information relating to the identity or use of the wafers in that container. In particular, the user may select certain cavities to be filled by plugs in order to provide information such as the type of wafers in the container, or a desired location where the wafers are to be used in a particular manufacturing line.

[0008] As an example, a shipping container with four info pad holes may be provided with one plug that fills a certain one of the four holes. In turn, the desired load port is arranged with three projections for reception in the unfilled cavities. If, for example, the three projections correspond to the arrangement of the three unfilled cavities, the shipping container will rest flatly against the upper surface of the load port. On the other hand, if the shipping container cannot be flatly received on the load port due to contact of projections against plugs mounted in one of the three cavities, the user is thereby tacitly informed that the selected shipping container is not the proper container for use at that particular load port.

[0009] While the horizontal wafer shipping containers described above have been deemed satisfactory by many, there is a continuing need to improve the state of the art with respect to such containers. In particular, features that provide additional protection for the wafers and facilitate use of the shipping container are especially desirable.

SUMMARY OF THE INVENTION

[0010] The present invention relates to a horizontal wafer shipping container that is constructed to provide enhanced protection against contaminates for integrated circuit wafers received in the container. The container includes an upper section with a continuous depending wall having a lower edge portion, and a lower section in contact with a seal. The seal contacts the lower edge portion when the lower section and the upper section are assembled together.

[0011] The present invention also relates to a shipping container for integrated circuit wafers, wherein a lower section of the container includes a plurality of cavities that receive info pad plugs. At least one of the info pad plugs includes an adhesive for connecting the plug to the lower section.

[0012] In more detail, the present invention is directed in one aspect to a shipping container for integrated circuit wafers. The shipping container comprises a lower section including a base and a wall extending upwardly from the base. The base and the wall of the lower section define a chamber for receiving a plurality of integrated circuit wafers. The base includes a shoulder that extends next to the wall of the lower section along a path that lies in a flat reference plane. The shipping container also comprises an upper section including a top and a wall depending from the top. The wall of the upper section extends continuously along a path that is adjacent the periphery of the top and has a lower edge portion. The lower edge portion extends along a path that lies in a flat reference plane and is adjacent the shoulder when the lower section and the upper section are assembled together. The shipping container also includes a seal that is in contact with the lower edge portion and the shoulder when the lower section and the upper section are assembled together.

[0013] The present invention is also directed in another aspect to a shipping container for integrated circuit wafers. The container comprises an upper section including a top and a wall depending from the top. The shipping container also comprises a lower section releasably connected to the upper section. The lower section includes a base and a wall extending upwardly from the base. The base and the wall of the lower section define a chamber for receiving a plurality of integrated circuit wafers. The lower section additionally includes a plurality of cavities for receiving info pad plugs.

The shipping container also comprises at least one info pad plug received in one of the cavities. At least one info pad plug comprises a body and an adhesive for connecting the body to the lower section.

[0014] These and other aspects are described in more detail in the description that follows and are illustrated in the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0015] **FIG. 1** is an exploded perspective view of a shipping container for integrated circuit wafers according to one embodiment of the invention, looking in a direction toward the side and top of the container;

[0016] **FIG. 2** is an inverted perspective view of the shipping container shown in **FIG. 1**, wherein the container is illustrated in assembled view, and looking at the container toward its bottom surface and back side;

[0017] **FIG. 3** is a plan view of a lower section of the shipping container shown in **FIGS. 1 and 2**;

[0018] **FIG. 4** is an enlarged side cross-sectional view taken across a portion of the shipping container illustrated in **FIGS. 1-3**;

[0019] **FIG. 5** is a bottom view of the lower section of the shipping container depicted in **FIG. 3**; and

[0020] **FIG. 6** is an enlarged side cross-sectional view taken across a portion of the lower section of the shipping container.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0021] A shipping container for integrated circuit wafers according to one embodiment of the present invention is illustrated in **FIGS. 1-6** and is broadly designated by the numeral **10**. The shipping container **10** is of the type generally known as a "horizontal wafer shipper" or "coin stack shipper", and includes a lower section **12** and an upper section **14** that may be releasably connected to the lower section **12** when desired.

[0022] In more detail, the lower section **12** includes a base **16** having an overall, generally octagonal configuration in plan view as shown in **FIG. 3**, although other shapes are also possible. The base **16** extends in a horizontal reference plane, and has a bottom surface **44** (**FIG. 5**) for reception onto a load port as will be described in more detail below.

[0023] The lower section **12** also includes a wall **18** that extends upwardly from the base **16**. As depicted in **FIG. 3**, the wall **18** extends along a circular path adjacent the periphery of the base **16**. A portion of the wall **18** is omitted to provide an access opening **20**. Although the embodiment shown in **FIGS. 1-6** includes only one access opening **20**, it should be understood in this regard that additional access openings may be provided as well.

[0024] The base **16** includes a shoulder **21** that is located radially outwardly from the wall **18**. A groove **24** is disposed on the shoulder **24** and extends along a circular path that is concentric with the path of the wall **18**.

[0025] A seal **26** is received in the groove **24**. The seal **26** extends along a circular path in a flat reference plane parallel to the plane of extension of the base **16**. The seal **26** may comprise an O-ring made of, for example, silicone rubber or other elastomeric materials. Alternatively, the seal **26** may be constructed of other gasket materials such as a resilient polymeric foam having a durometer in the range of about 10 A to about 60 A, and more preferably about 30 A. The use of foam materials is presently preferred because such materials are reduced in volume when compressed, in contrast to other materials that are displaced when compressed. However, other materials may also be used, including a molded polymer with a thermally activated foaming agent, a gel (preferably a UV-curable crosslinkable gel), a tacky adhesive or a hollow tube.

[0026] The seal **26** has sufficient memory to recover its original shape when relaxed, and yet is sufficiently flexible to ensure that the seal **26** conforms to the shape of the groove **24** when compressed. The seal **26** as shown in the drawings has a circular cross-sectional configuration, although other cross-sectional configurations (such as rectangular, square or wedge-shaped) are possible as well. Preferably, the cross-sectional configuration of the seal **26** matches the cross-sectional configuration of the groove **24**. For example, in the exemplified embodiment shown in the drawings (see, e.g., **FIG. 5**) the seal **26** and the groove **24** in areas of contact with each other have matching, partially circular shapes in cross-section.

[0027] The upper section **14** includes a top **28** having a flat configuration. Optionally, the top **28** includes a locater or index mark **29** (**FIG. 1**) that serves to inform the user of the location of the underlying opening **20** when the container **10** is closed. A wall **30** depends from the top **28** and extends continuously along a path adjacent the periphery of the top **28**. In plan view, the top **28** and the side of the wall **30** present an octagonal configuration that matches the octagonal shape of the lower section **12**. The wall **30** also has a generally cylindrical inner surface that matches and complementally receives the cylindrical shape of the outer surface of the wall **18**. Although not shown in the drawings, the upper section **14** includes an inner protrusion that fits within a notch **31** positioned along the top of the wall **18** of the lower section **12**, in order to ensure that the upper section **14** and the lower section **12** are properly oriented with respect to each other when the container **10** is closed.

[0028] The wall **30** includes a lower edge portion **32** that extends along a path lying in a flat reference plane. The lower edge portion includes a pair of ribs **22**, each of which extends along a circular path that is concentric with the inner surface of the wall **30**. When the upper section **14** and the lower section **12** are assembled together as shown in **FIG. 2**, the ribs **22** extend over the groove **24** in overlying relation and press against the seal **26**. Each of the ribs **22** contacts the seal **26** along a continuous circular path in order to provide a barrier that hinders the transmission of moisture, airborne particulates and/or other contaminates to areas within the container **10**. Preferably, the ribs **22** and the seal **26** are constructed so that an air gap is present between the seal **26** and the lower edge portion **32** in the region between the ribs **22** when the container **10** is closed, to facilitate opening of the container **10** and detachment of the sections **12**, **14** when desired.

[0029] The construction of the container **10** with respect to the shoulder **21**, the seal **26** and the ribs **22** is a particular

advantage, in that the seal **26** contacts the ribs **22** and the groove **24** in flat, parallel reference planes. Certain prior art horizontal wafer shipping containers, such as shipping containers similar to the container described in U.S. Pat. No. 6,193,090, were provided with a gasket or seal that extended along an undulating path including portions following along the periphery of one or more access openings. As a result, this gasket was relatively expensive to construct. By contrast, the present invention enables the use of a relatively inexpensive seal, such as a flat foam gasket made by a stamping process from a flat sheet of foam material. Moreover, the overall length of the seal is considerably less than the overall length of the prior art gasket, resulting in fewer areas where the integrity or sealing tightness of the seal could be compromised.

[**0030**] The base **16** and the wall **18** of the lower section **12** together partially define a chamber **34** for receiving a stacked array of integrated circuit wafers such as semiconductor wafers. The wafers are not shown in the drawings, but generally resemble thin disks of material having a diameter smaller than the inner diameter of the wall **18**. The wafers are preferably separated by circular sections of resilient packaging material such as polymeric sheet material. Preferably, circular sections of foam material are provided in the chamber **34** above and below the stack of wafers and compressed when the container **10** is closed to provide cushioning.

[**0031**] The container **10** also includes four latches **36** having a generally overall, U-shaped configuration. Each latch **36** has two end portions with apertures **38** (**FIG. 1**) that have a somewhat oval-shaped configuration. Each aperture **38** is releasably received in snap-fit relation on a tab **40** (**FIGS. 1 and 2**) that is integrally connected to the base **16** of the lower section **12**.

[**0032**] When the sections **12, 14** are assembled together, a middle portion of each latch **36** is received in a notch **42** (**FIG. 1**) that is provided on the upper section **14**. The latches **36** are made of a resilient material that can be slightly deformed or stretched as needed to fit in the respective notch **42** in snap-fit relation. An example of a suitable resilient material is Hytrel brand elastomer from Dupont, preferably having a durometer in the range of about 30 D to about 60 D, and more preferably about 40 D. As the latches **36** are received in the notches **42**, the sections **12, 14** are preferably urged together with sufficient force to compress the seal **26** in order to ensure complete, sealing contact with both of the ribs **22** as well as the bottom of the groove **24**. Other latches are also possible, such as the general type of latches found on luggage, including toggle lever-assisted latches.

[**0033**] A total compression force on the sections **12, 14** of preferably less than about 30 pounds, and more preferably less than about 10 pounds, is needed to compress the seal **26** sufficiently to close the container **10** and latch the latches **36**. Preferably, the ribs **22** each have a generally "U" or "V"-shaped cross-sectional configuration that tapers to a lowermost, slightly rounded edge. This edge provides local regions where the seal **26** is sufficiently compressed and helps to avoid the need of compressing larger regions of the seal **26**, which might otherwise require a higher compression force to close the container **10**. For example, with a low density foam material having a density in the range of two pounds to six pounds per cubic foot, a compression force of approximately 5.5 to 8.5 pounds will be needed to close the container **10** and latch the latches **36**, when at least part of the cross-sectional area of the seal is compressed to a 25% compression.

[**0034**] The base **16** includes a bottom surface **44** (see, e.g., **FIGS. 2 and 5**). Four info pad cavities or holes **46** are provided in the bottom surface **44**, although a greater or smaller number of cavities may be provided as well. The cavities **46** extend upwardly into the base **16** a limited distance. As depicted in the exemplary embodiment shown in **FIG. 6**, each cavity **46** includes two contiguous portions, comprising a lower, larger diameter, generally cylindrical portion and an upper, smaller diameter, generally cylindrical portion that is concentric with the lower cylindrical portion. An annular shoulder or ledge **48** extends in a horizontal reference plane that also defines a boundary between the lower cylindrical portion and the upper cylindrical portion.

[**0035**] Optionally, one or more info pad plugs **50** are received in the info pad cavities **46**. In the accompanying drawings, one plug **50** is shown, although other plugs may be provided as well. The presence and placement pattern of the plugs **50** in the holes **46** provides information relating to the type of wafers in the chamber **34**.

[**0036**] Preferably, each plug **50** comprises a polymeric body **52** and an adhesive **54** for connecting the body **52** to the ledge **48**. Preferably, the adhesive **54** is a high tack pressure sensitive adhesive. Preferably, the adhesive **54** has sufficient strength to reliably retain the plug **50** in the hole **46** during normal shipping, handling and manufacturing operations, but also enables the plug **50** to be removed from the hole **46** without undue effort when desired. Optionally, a lever-type hand tool may be used to pry the plug **50** from the hole **46** to facilitate disengagement of the plug **50** from the shoulder **48**. An example of a suitable plug **50** is "Bumpon" brand bumper, no. SJ-5763, from 3M Company.

[**0037**] The container also includes a clamping plate **56** (**FIGS. 1 and 2**; omitted in **FIG. 5**) that is releasably coupled to the bottom surface **44** of the lower section **12** by four self-tapping screws. Alternatively, an adhesive may be used to connect the clamping plate **56** to the bottom surface **44**. The clamping plate **56** includes a central opening **58** as well as a curved, outwardly extending lip **60** that extends along one side of the clamping plate **56**. The opening **58** and the lip **60** are provided for releasable connection to a center pin or latch pin of the loading port in order to releasably couple the container **10** to the loading port as desired.

[**0038**] As illustrated in **FIGS. 2 and 5**, the lower section **12** also includes three recesses **62** that serve to align the container **10** to the loading port. Additionally, a recess **64** is provided for receiving an RFID transponder tag. Preferably, the recess **64** has structure such as inwardly extending, resilient polymeric wall sections that deform slightly to receive the RFID transponder tag and snugly retain the same until removal is desired. An example of a suitable transponder tag is "TIRIS" 32 mm glass transponder tag, no. RI-TRP-DR2B, from Texas Instruments.

[**0039**] The lower section **12** also includes two finger-gripping recesses **66** that extend along opposite sides of the base **16**. Each recess **66** includes four side-by-side, parallel channels that are all inclined upwardly as the center of the base **16** is approached. The upward inclination of the channels facilitates gripping of the container **10** and helps to ensure that the container **10**, when loaded with wafers, is not inadvertently dropped.

[**0040**] Preferably, the sections **12, 14** are integrally made using a polymeric material in a blow molding process. Suitable polymeric materials include olefinic materials such as polypropylene copolymer and high density polyethylene.

Optionally, a static dissipative material such as carbon particles or fibers (including nanotubes) can be added to the polymeric material to enhance static dissipative properties to the container **10**. Additional information regarding the construction of the sections **12**, **14** is set out in the aforementioned U.S. Pat. No. 6,193,090 which is expressly incorporated by reference herein.

[**0041**] The embodiments described above exemplify the present invention, and other constructions are possible. Accordingly, the invention should not be deemed limited to the particular embodiments mentioned above, but instead only by a fair scope of the claims that follow along with their equivalents.

1. A shipping container for integrated circuit wafers comprising:

a lower section including a base and a wall extending upwardly from the base, the base and the wall of the lower section defining a chamber for receiving a plurality of integrated circuit wafers, wherein the base includes a shoulder that extends next to the wall of the lower section along a path that lies in a flat reference plane;

an upper section including a top and a wall depending from the top, the wall of the upper section extending continuously along a path adjacent the periphery of the top and having a lower edge portion, wherein the lower edge portion extends along a path that lies in a flat reference plane and is adjacent the shoulder when the lower section and the upper section are assembled together; and

a seal in contact with the lower edge portion and the shoulder when the lower section and the upper section are assembled together.

2. A shipping container for integrated circuit wafers according to claim 1 wherein the shoulder includes a groove having a circular shape in plan view.

3. A shipping container for integrated circuit wafers according to claim 2 wherein the wall of the lower section and the groove extend along concentric circular paths.

4. A shipping container for integrated circuit wafers according to claim 2 wherein the lower edge portion includes a pair of side-by-side ribs.

5. A shipping container for integrated circuit wafers according to claim 4 wherein both of the ribs are in contact with the seal.

6. A shipping container for integrated circuit wafers according to claim 4 wherein the ribs extend along a circular path in plan view.

7. A shipping container for integrated circuit wafers according to claim 2 wherein the lower edge portion includes at least one depending rib that extends over the shoulder along a circular path.

8. A shipping container for integrated circuit wafers according to claim 1 wherein the wall of the lower section and the wall of the upper section extend along concentric circular paths.

9. A shipping container for integrated circuit wafers according to claim 1 wherein the seal is comprised of a polymeric foam material.

10. A shipping container for integrated circuit wafers according to claim 1 wherein the base has an overall polygonal configuration in plan view, and wherein the shoulder has a groove with a circular shape in plan view.

11. A shipping container for integrated circuit wafers according to claim 1 wherein the lower section additionally includes a plurality of cavities for receiving info pad plugs, wherein the shipping container includes at least one info pad plug received in one of the cavities, and wherein at least one info pad plug comprises a body and an adhesive for connecting the body to the lower section.

12. A shipping container for integrated circuit wafers according to claim 11 wherein the adhesive releasably connects the body to the lower section.

13. A shipping container for integrated circuit wafers according to claim 12 wherein the adhesive is a pressure sensitive adhesive.

14. A shipping container for integrated circuit wafers according to claim 1 wherein the wall of the lower section includes at least one opening for accessing the wafers in the chamber.

15. A shipping container for integrated circuit wafers according to claim 1 wherein the lower edge portion includes a pair of side-by-side ribs in contact with the seal when the lower section and the upper section are assembled together, and wherein a gap is present between the lower edge portion and the seal in the region between the ribs when the lower section and the upper section are assembled together.

16. A shipping container for integrated circuit wafers comprising:

an upper section including a top and a wall depending from the top;

a lower section releasably connected to the upper section, the lower section including a base and a wall extending upwardly from the base, wherein the base and the wall of the lower section define a chamber for receiving a plurality of integrated circuit wafers, wherein the lower section additionally includes a plurality of cavities for receiving info pad plugs; and

at least one info pad plug received in one of the cavities, wherein at least one info pad plug comprises a body and an adhesive for connecting the body to the lower section.

17. A shipping container for integrated circuit wafers according to claim 16 wherein the adhesive releasably connects the body to the lower section.

18. A shipping container for integrated circuit wafers according to claim 17 wherein the adhesive is a pressure sensitive adhesive.

19. A shipping container for integrated circuit wafers according to claim 16 wherein the cavities each include a ledge, and wherein the adhesive is in contact with the ledge.

20. A shipping container for integrated circuit wafers according to claim 19 wherein the ledge has an annular configuration.

* * * * *