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(54) **Title:** WAFER CARRIER WITH REPLACEABLE GETTERS

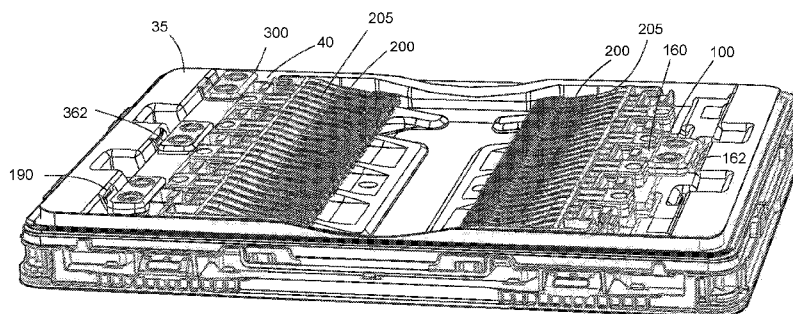


FIG. 9

(57) **Abstract:** A semiconductor wafer carrier assembly includes a carrier, the carrier defining a wafer storage area adapted to support one or more semiconductor wafers. The carrier has a door for access to the wafer storage area, the door defining an interior. The assembly also includes a getter module, the getter module including a housing, getter material disposed within the housing, the getter material adapted to decrease concentration of contaminants within the wafer storage area of the carrier, and at least one connection feature adapted to readily removably secure the getter module to the interior of the door.

WAFER CARRIER WITH REPLACEABLE GETTERS**CROSS-REFERENCE TO RELATED APPLICATION**

This application claims priority U.S. Provisional Patent Application No. 62/131,478, filed on March 11, 2015, the disclosure of which is hereby incorporated by
5 reference in its entirety.

BACKGROUND

Substrates such as wafers and reticles used in semiconductor processing are highly vulnerable to contaminants, including moisture, volatile organic components (VOC's), and particles. The presence of moisture, for example, can contribute to haze growth on both
10 reticles and wafers. One way to control contaminants, including moisture, is to continually or periodically purge the space within a container where the substrates are stored or secured. During shipping, it has not been considered practical to use purging, and devices such as getters have been used within containers during shipping to keep moisture and VOC's to acceptable levels. Desiccants and getters in substrate containers
15 typically require removal or disassembly before the container is washed, as the fluids used can destroy the desiccants or getters.

Sealed containers known as FOUPs (front opening unified pods), FOSBs (front opening shipping boxes), or SMIF (standard mechanical interface) pods are used as wafer containers or reticle pods. These containers provide a microenvironment to isolate and
20 control the volume surrounding wafers and substrates used in manufacturing integrated circuits. Such containers are available from Entegris, Inc., the owner of this application.

Due to the detrimental effect of moisture, VOC's, and particles on semiconductor production, improvements in the control of such contaminants can be desirable.

SUMMARY

25 A semiconductor wafer carrier assembly includes a carrier, the carrier defining a wafer storage area adapted to support one or more semiconductor wafers. The carrier has a front-opening door including a door housing and a latching mechanism operably coupled with the door housing to secure the door closed, the door being openable for access to the

wafer storage area, the door defining an interior side facing the wafer storage area. The assembly also includes a getter module, the getter module including a rigid polymeric housing with an access opening, getter material disposed within the getter module housing, the getter material adapted to decrease concentration of contaminants within the wafer storage area of the carrier via the access opening, and at least one rigid polymeric connection feature as a part of or extending from the getter module housing, the connection feature adapted to readily removably secure the getter module to the interior side of the door.

According to one embodiment, the getter material is in the form of a single getter pack disposed between a base and a single cover. According to other embodiments, the getter material is in the form of a plurality of getter packs supported on a base frame, with a cover disposed over each getter pack. Both single-getter and multi-getter modules or assemblies are relatively removably attached to the door of the carrier, for easy removal and replacement within receivers or attachment points on the door of the container.

Embodiments of the disclosure can be used with a variety of shippers or other carriers or containers accommodating different wafer sizes, for example 150 mm, 200 mm, 300 mm and 450 mm silicon wafers, to name several examples. Other aspects of the disclosure will be apparent to those of ordinary skill upon reading this disclosure, and this Summary should not be considered limiting.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is a front perspective view of a substrate container with door, according to an embodiment of the invention.

Figure 2 is an exploded view of a getter module, according to an embodiment of the invention.

Figure 3 is a front perspective view of the getter module of Figure 2, according to an embodiment of the invention.

Figure 4 is a rear perspective view of the getter module of Figure 2, according to an embodiment of the invention.

Figure 5 is a perspective view of a container door with getter modules of Figure 2, one getter module secured to the door and one getter module in a pre-install or post-removal position with respect to the door, according to an embodiment of the invention.

Figure 6 is a close-up perspective view of the Figure 2 getter installed in the Figure 5 door, according to an embodiment of the invention.

Figure 7 is an exploded view of a getter module according to another embodiment of the invention.

Figure 8 is a perspective view of the Figure 7 getter module, according to an embodiment of the invention.

Figure 9 is a perspective view of the Figure 5 door with both the Figure 8 getter module and the Figure 3 getter module installed, according to an embodiment of the invention.

Figure 10 is a close-up perspective view of the Figure 8 getter module installed in the Figure 5 door, according to an embodiment of the invention.

Figure 11 is a flow chart showing a method according to an embodiment of the invention.

DETAILED DESCRIPTION

Uncontrolled concentrations of moisture, oxygen, airborne molecular contaminants (AMC's), volatile organic compounds (VOC's), or other foreign matter within the interior of wafer container microenvironments can lead to circuit defects and reduced yield. Getters are used to control and reduce such concentrations. In some wafer carriers, however, for example 450 mm or larger wafer carriers, there can be insufficient space at the rear face of the carrier for placement of a getter, and there also can be insufficient space within the carrier for a 26th or other additional wafer slot for accommodating a disc outfitted with a getter. Certain embodiments of the invention address these issues by providing insertable and replaceable getters in the door of a carrier, using attachment points that also can be used to attach accessories such as wafer cushions or retainers.

More specifically, a getter assembly or module includes a housing or enclosure provided with a getter and installed on an interior face of a microenvironment door. The getter assembly is used to scavenge various chemicals or otherwise decrease concentrations of contaminants or other foreign matter within the carrier. One or more
5 getter assemblies can be attached to the door in multiple locations. In one configuration, a frame attaches to multiple locations on the door and supports multiple getters. Fasteners, press-fit, snap-fit, and friction-fit are examples of methods used to attach the frame or getter assembly to the door or other location in the carrier. The getter assemblies can be consumable or single-use commodity-type items; they can also be reused or replenished
10 from use-to-use of a specific microenvironment container.

Embodiments of the invention can provide advantages such as increased wafer yield and prolonged microenvironment protection from moisture, oxygen, acids, bases, and other contaminants. Installing getter modules in a container door eliminates or reduces a need for extra holes in the container to the outside environment, in certain
15 situations. Multiple different getter modules can be configured and arranged to scavenge various chemicals on an as-needed basis, and getter modules can be replaced by handling the door instead of handling the entire carrier assembly or otherwise intruding into the interior of the carrier nearer to wafer handling volumes.

Turning to the figures, Figure 1 illustrates semiconductor wafer carrier assembly
20 10 according to an embodiment of the invention. Assembly 10 includes carrier 15 adapted to support one or more semiconductor wafers 20 or other substrates in stack 25 within wafer storage area 30. Carrier 15 has door 35 for sealingly closing carrier 15 and for opening carrier 15 to allow access to wafer storage area 30. Also referring to Figure 5, door 35 has an interior wall 37 with interior side 40 and in interior facing surface 42, the
25 side facing wafer storage area 30, and an exterior wall 43 with an exterior side 45 and an exterior surface 46, facing away from wafer storage area 30. Door 35 includes door housing 50 with a latching mechanism 52 including tabs 55 extending from apertures 60 into corresponding recesses 65 in carrier 15 to secure door 35 closed.

In the illustrated embodiment, carrier assembly 10 is a front opening wafer
30 container known as a FOUP (front opening unified pod). Other types of carrier assemblies according to embodiments of the invention include FOSBs (front opening shipping box),

SMIF pods (standard mechanical interface pods), horizontal wafer shippers, single wafer shippers, universal wafer shippers, or any other type of carrier for semiconductor disks or wafers, for substrates, or for other items. Examples of such carriers are described in U.S. Pat. Nos. 4,815,912, 4,995,430, 5,788,082, 6,010,008, and 6,354,601, all owned by the
5 owner of this application and all incorporated herein by reference in their entirety for all purposes.

Figures 2-4 illustrate getter module 100, also referred to as a getter assembly. Getter module 100 includes housing 105 with base 110 and cover 115. Getter material 120 is disposed within housing 105, and specifically is supported on base 110 within
10 recess 112 thereof. Cover 115 is disposed over base 110 and getter material 120. Cover 115 is sealed or otherwise substantially permanently connected to base 110 by adhesive, ultrasonic or other welding, or other mode along seal or junction 125, according to one embodiment, in which getter module 100 can be entirely disposed of after use. Alternatively, cover 115 is removably attached to base 110, for example with a snap-fit
15 connection, such that getter material 120 or other components within housing 105 are replaceable or replenishable from use to use.

One or more optional filters 130 are disposed between cover 115 and getter material 120, positioned and supported by one or more optional corresponding filter covers 135. Filter covers 135 are permanently (for example by ultrasonic welding) or
20 removably secured to cover 115, according to embodiments of the invention, to hold filters 130 in place with respect to cover 115 and getter material 120, for example. Filter covers 135 also can be in the form of holders to accommodate a slide-in or snap-in filter 130. Filters 130 provide both inside-out and outside-in protection, serving to filter out particulate matter and substantially reduce contamination of getter material 120 with
25 outside particles, and also serving to retain any particles within housing 105 to prevent corresponding contamination of the microenvironment within carrier 15.

Getter module 100 also defines one or more apertures 140 through cover 115 to chemically expose getter material 120 to the interior of carrier 15 and wafer storage area 30, or otherwise promote or allow interaction between getter material 120 and
30 environment outside getter module 100. In the illustrated embodiment, aperture 140 is a central aperture surrounded by six circumferentially disposed apertures 145, although

other numbers and configurations of apertures 140, 145 will be apparent to those of ordinary skill upon reading this disclosure. Central aperture 140 and circumferentially disposed apertures 145 correspond and generally align with corresponding apertures 150, 155 in each filter cover 135.

5 Getter material 120 is optionally in the form of a getter pack, a self-contained portion of one or more getter materials pressed or otherwise formed into a unitarily removable unit, according to one example. Other forms of getter packs will be apparent to those of ordinary skill upon reading this disclosure. Getter material 120 is adapted to decrease concentration of contaminants within carrier 15, specifically in wafer storage
10 area 30. In one embodiment, getter material 120 scavenges gas, moisture, airborne molecular contaminants (AMC), volatile organic compounds (VOC) or other unwanted contaminants or substances that may have a detrimental effect on items or process within carrier assembly 10. AMC's that can be controlled according to the invention include acids and bases (e.g. NH_3 and SO_4), biotoxins, condensable or corrosive contaminants,
15 VOC's, dopants, and other categories of such contaminants or substances.

 Different types of getter packs or getter material 120 can be chosen to scavenge or decrease concentrations of specific types of contaminants or substances, as may be needed in particular applications. A user of carrier assembly 10 can pick and choose different
20 getter material 120 or getter modules 100 depending on the types of contaminants to be controlled, and/or depending on the specific items or processes occurring within carrier assembly 10.

 Examples of getter material suitable for use according to embodiments of the invention include that used in CLARILITE wafers, available from Entegris, Inc., which fit in wafer slots within FOUPs and FOSBs to absorb contaminants and moisture.
25 CLARILITE is a registered trademark of Entegris, Inc. Examples of getter material suitable for use also are disclosed in commonly assigned U.S. Patent No. 8,776,841, U.S. Patent No. 8,783,463, and Patent Cooperation Treaty Application No. PCT/US2014/054399, filed September 5, 2014, all of which are incorporated herein by reference in their entirety for all purposes.

30 Getter material according to embodiments of the invention may be in the form of granular desiccants, rigid plates, absorbent disks, molecular sieves, and/or polymer

matrices holding desiccant or molecular sieve material, to name several examples. The getter material also optionally includes a polymer base, a channeling agent and/or a desiccant. In certain embodiments the polymer is a thermoplastic polymer. Thermoplastic polymers include acrylics such as poly(methyl methacrylate) (PMMA); polyamides, such as nylon; polybenzimidazole (PBI); polyethylene, including ultra-high molecular weight polyethylenes (UHMWPE), high-density polyethylene (HDPE), and low-density polyethylene; polypropylene (PP); polystyrene; polyvinyl chloride (PVC); and polytetrafluoroethylene (PTFE). The channeling agent is a compound which is not soluble in the polymer and is used to form passages through the polymer that are communicable with the desiccant. Examples of such channeling agents include, but are not limited to, ethylene-vinyl alcohol (EVOH) and polyvinyl alcohol (PVOH). Examples of desiccants include anhydrous salts that form crystals that contain water, reactive compounds that undergo chemical reaction with water to form new compounds, and physical absorbers which have a plurality of microcapillaries therein and so wick moisture out of the environment. Examples of such absorbers include molecular sieves, silica gels, clays and starches. In embodiments, activated carbon may be the absorbing material, particularly for VOC's. Embodiments of the invention can substantially reduce the amount of oxygen, humidity, moisture, VOC's and other contaminants within the associated shipper or other container.

Getter module 100 includes one or more connection features 160, 162 adapted to readily removably secure getter module 100 to interior side 40 of door 35. Connection feature 160 includes protrusion 165 extending substantially parallel to the plane of base 110 and substantially perpendicular to connection feature 162. Central fin 170 and end fins 175 connect protrusion 165 to a remainder of base 110 and provide enhanced rigidity and structural strength of protrusion 165 with respect to base 110. Fins 170, 175 also provide proper alignment of connection feature 160 and module 100 with respect to door 35. Connection feature 162 illustrated in Figure 4 is a biased substantially V-shaped member 180 having two legs 182, 184. Leg 184 flexes with respect to leg 182 to bias getter module 100 into position on interior side 40 of door 35. Member 180 thus acts as a spring or biasing member and serves to help snap-fit getter module 100 into place in door 35. Protrusion 165 is disposed on an opposite side of getter module 100 than member 180 and extends in a direction substantially perpendicular to member 180.

Figures 5-6 show connection of getter module 100 to interior side 40 of door 35. Door 35 includes interior panel or surface 185 and exterior panel or surface 186, defining between them an internal volume of door 35. Door 35 includes a plurality of receivers 190 or attachment points for modules 100. Each receiver 190 includes recess 192, extending
5 into volume 189 and being of sufficient size and depth to at least partially accommodate getter module 100. Sidewall 194 is disposed on a side of recess 192. Stop member 196, in the form of two laterally extending stops, are disposed adjacent or in proximity to sidewall 194. Sidewall 194 and stop member 196 serve to receive and hold biased member 180. Leg 184 of member 180 contacts sidewall 194 and an upper end of leg 184 abuts or nearly
10 abuts an underside of stop member 196.

On the opposite side of getter module 100, flange 198 on interior side 40 of door 35 defines a pocket underneath flange 198 for receiving protrusion 165 of connection feature 160. To insert or attach getter module 100 into door 35, protrusion 165 is first placed into the pocket underneath flange 198. Module 100 then is rotated or pressed
15 further into recess 192, such that biased member 180 contacts sidewall 194. Biased member 180 urges getter module 100 to the right as viewed in Figure 6, locking or snap-fitting protrusion 165 into the pocket underneath flange 198 and urging fins 170, 175 toward or into aligning contact with flange 198. Stop member 196 substantially prevents member 180 from riding up and out of position along sidewall 194. Getter module 100
20 thus is disposed at least partially within recess 192 and extends into the interior volume of door 35 between interior panel or surface 185 and exterior panel or surface 186. According to alternative embodiments, getter module 100 extends completely within recess 192 such that a top surface of getter module 100 is substantially flush or substantially coplanar with interior panel 186 of door 35. For removal, according to one
25 example, module 100 is urged to the left as viewed in Figure 6, protrusion 165 is removed from the pocket underneath flange 198, and module 100 then is completely removed from recess 192 and door 35.

In Figure 5, a first getter module 100 is already attached to interior side 40 of door 35. According to one embodiment of the invention, getter material 120 within attached
30 module 100 is of a type to scavenge one or more particular types of contaminants from within carrier 15 as selected by a user. A second getter module 100' is about to be inserted into interior side 40 of door 35, as illustrated. According to one embodiment, getter

material within second getter module 100 is of a type to scavenge one or more different types of contaminants from within carrier 15, different than those controlled by attached module 100. Alternatively, such getter material may be the same as getter material 120 of attached getter module 100. By picking and choosing different getter modules for desired
5 receivers 190 within door 15, a user can customize the distribution, quantity and arrangement of getters within carrier 15 according to particular items to be carried within carrier 15, processes to be performed, or otherwise in keeping with the types and concentrations of contaminants that are likely to be present within carrier 15 and that may need to be removed.

10 Figure 5 also illustrates wafer retainer 200 for guiding or supporting wafers held within carrier 15. According to one embodiment, retainer 200 includes a plurality of stacked wafer platforms 205 to help guide or support stacked wafers 20 within carrier 15. Structure 200 includes snap-in connectors 210 for connection to receivers on interior side 40 of door 35, receivers that are similar in shape, size and/or function to receivers 190 for
15 receiving getter modules 100. As a result, according to one example, if it is desired to replace retainer 200 with a larger retainer to accommodate larger wafers 20, the larger retainer can be equipped with connectors adapted to fit within receivers 190, in the same way that getter modules 100 are equipped with connection features for reception in receivers 190. Accordingly, each receiver 190 is adapted to receive an accessory, such as
20 retainer 200, or other guiding or supporting structure for wafers 20, and each receiver 190 is also adapted to receive connection feature(s) 160 and/or 162 of getter module 100, to readily removably secure getter module 100 to interior side 40 of door 35. Each receiver 190, wherever it is located on door 35 or elsewhere within carrier 15, has multiple uses, according to embodiments of the invention.

25 Getter modules 100 are single-getter modules that include a single getter pack 120 for scavenging or otherwise decreasing concentration of one type of contaminant or set of contaminants within carrier 15. Embodiments of the invention also contemplate multi-getter modules, for accommodating multiple getter packs, for addressing multiple types or higher concentrations of contaminants within carrier 15, as will now be described
30 particularly with respect to Figures 7-8.

Figures 7-8 illustrate getter module 300, also referred to as a getter assembly. Getter module 300 includes housing 305 with base 310, in the form of a base frame, and multiple covers 315, 317, 319. Getter material 320, 322, 324 is disposed within housing 305, and specifically is supported on base 310 within recesses 312, 313, 314 thereof.

5 Getter material 320, 322, 324 is in the form of a plurality of getter packs, each being similar to those described with respect to Figures 2-4.

Covers 315, 317, 319 are disposed over base 310 and respectively over recesses 312, 313, 314 thereof and corresponding getter material 320, 322, 324. Covers 315, 317, 319 are sealed or otherwise connected to base 310 by adhesive, ultrasonic or other

10 welding, or other mode along seals or junctions 325, 327, 329, according to one embodiment, in which getter module 300 can be entirely disposed of after use. Alternatively, covers 315, 317, 319 are removably attached to base 310, for example with a snap-fit connection, such that getter material 320, 322, 324 or other components within housing 305 are replaceable or replenishable from use to use. One or more optional filters

15 330 are disposed between covers 315, 317, 319 and respective getter materials 320, 322, 324, optionally positioned and supported by one or more corresponding filter covers 335. Filter covers 335 are permanently or removably secured to cover 315, according to embodiments of the invention, to hold filters 330 in place with respect to cover 315 and getter materials 320, 322, 324 for example. Getter module 300 also defines one or more

20 apertures 340 through cover 315, 317, 319 to chemically expose the getter material to the interior of carrier 15 and wafer storage area 30, or otherwise promote or allow interaction between the getter material and environment outside getter module 300. Other aspects of the one or more apertures 340 and corresponding apertures in filter covers 335 are the same as those described with respect to apertures 140, 145, 150, 155 in Figures 2-4 and

25 will not be repeated here. Additionally, all other details relating to getter modules 300, for example their insertion into and removal from recesses 192 and internal volume of door 35, are identical to those described with respect to getter modules 100 unless indicated otherwise.

Although the illustrated embodiment of module 300 includes three getter packs and

30 three covers, alternative embodiments of module 300 include two getter packs and two covers, four getter packs and four covers, or any other desired number.

Getter module 300 includes one or more connection features 360, 362 adapted to readily removably secure getter module 300 to interior side 40 of door 35. Connection features 360, 362 are optionally identical in structure and operation to connection features 160, 162 described with respect to Figures 2-4, and their description will not be repeated
5 here. Each receiver 190 of door 35 is adapted to readily removably receive a single-getter module 100, as described above, and a plurality of receivers 190 are adapted to readily removably receive the plurality of connection features 360 to secure multi-getter module 300 to door 35.

Disposed adjacent or on opposite sides of recesses 312, 313, 314 in base frame or
10 base 310 are apertures 375. Middle recess 313 includes two such apertures 375, one on either longitudinal side thereof, and end recesses 312, 314 include one such aperture 375, on inner ends thereof. Recesses 375 accommodate a tool for assisting in inserting or removing base 310 from door 35, for example.

Figures 9-10 show connection of getter module 300 with respect to interior side 40
15 of door 35. As described previously herein with respect to Figures 5-6, door 35 includes a plurality of receivers 190 or attachment points for modules 100. Such receivers 190, including recesses 192, sidewalls 194, stop members 196, and other features thereof, accommodate connection features 360, 362 of multi-getter modules 300 in the same manner they accommodate connection features 160, 162 of single-getter modules 100.
20 Figure 9 shows both a multi-getter module 300 and a single-getter module 100 attached to interior side 40 of door 35, as may be selected by a user. The modules include a first module 170, a second module 172, a third module 174, and a fourth module 176.

As will be appreciated, single-getter modules 100 and/or multi-getter modules 300 are attachable to interior side 40 of door 35 in any desired number and combination, to
25 decrease the concentration of contaminants within container 15 in a customized manner. Each multi-getter module 300 includes getter packs as needed for a particular application, for example two or three different getter packs, two getter packs of the same type and one of a different type, or any other desired combination of getter packs. Multi-getter modules 300 can be used together with single-getter modules 100 on the same door, if desired.
30 Getter modules 100, 300 can be custom built or purchased for particular applications, or

kits having different types of getter modules 100 and/or 300 together also can be provided and used.

Figure 11 shows method steps according to an embodiment of the invention. A method of reducing concentration of gas, moisture, and/or other airborne molecular contaminants within a container microenvironment includes affixing, at 410, one or more
5 getter assemblies 100 or 300 to door 35 of container 15. Each getter assembly optionally is adapted to scavenge a different type of contaminant from the container microenvironment, and/or one getter assembly optionally is adapted to scavenge multiple different contaminants. The method additionally includes, at 415, closing door 35 of
10 container 15 to expose the getter assemblies to the container microenvironment. Door 35 is ultimately opened, at 420, and one or more of the getter assemblies are replaced, at 425.

Embodiments of the invention are especially useful in non-purge, passive environments. With such embodiments, getter modules 100, 300 are free of connection to purge ports or other purge components and thus are out of a purge stream. The containers
15 with which such passive getter modules 100, 300 are used, however, can themselves contain microenvironments in which purge gases and systems are used to actively reduce concentration of contaminants. In other embodiments, purge gases or other gases can be directly routed through modules 100, 300, such that the modules are directly in the purge stream.

It should be noted that embodiments of the invention are not limited for use with semiconductor materials, wafers or other substrates, or carriers. Embodiments of the disclosure are useful for protecting any items that should be transported in a clean, uncontaminated or otherwise protected state, and such embodiments are applicable in a variety of industries and other settings beyond the semiconductor industry. The term
20 substrates as used herein includes wafers processed into integrated circuits, solar panels, flat panels, or other semiconductor devices; substrates also include reticles used in lithography and disks used in memory disks, such as hard drives, and any other items to be protected. Embodiments of the invention are applicable to a wide variety of industries and a wide variety of contaminant-sensitive items, not just the semiconductor industry and
25 semiconductor wafers. For example, embodiments of the invention also apply to the life sciences and bio/pharma industries. Further, the terms container, carrier, shipper, cassette,
30

transport/storage bin, and the like, are also used interchangeably herein unless otherwise indicated. Still further, the terms getter module and getter assembly are used interchangeably herein. Various modifications and changes to the illustrated and described embodiments are within the scope of this application will be apparent to those
5 skilled in the art. Changes may be made in form and substance without departing from the spirit and scope of the invention.

CLAIMS

1. A semiconductor wafer carrier assembly, comprising:

a carrier, the carrier defining a wafer storage area adapted to support one or more semiconductor wafers, the carrier having a front-opening door comprising a door housing and a latching mechanism operably coupled with the door housing to secure the door closed, the door being openable for access to the wafer storage area, the door defining an interior side facing the wafer storage area; and

a getter module, the getter module comprising:

a rigid polymeric housing with an access opening;

getter material disposed within the getter module housing, the getter material adapted to decrease concentration of contaminants within the wafer storage area of the carrier via the access opening; and

at least one rigid polymeric connection feature as a part of or extending from the getter module housing, the connection feature adapted to readily removably secure the getter module to the interior side of the door.

2. The carrier assembly of claim 1, wherein the getter module housing comprises a base and at least one cover secured to the base; further wherein the getter material is disposed between the cover and the base.

3. The carrier assembly of claim 2, wherein the getter module further comprises a filter disposed between the cover and the getter material.

4. The carrier assembly of claim 2, wherein:

the getter material is in the form of a plurality of getter packs;

the at least one cover comprises a plurality of covers each corresponding to a respective getter pack; and

the base defines a base frame configured to support the plurality of getter packs between the base frame and the respective covers.

5. The carrier assembly of claim 4, wherein the getter packs are supported directly on the base frame.

6. The carrier assembly of claim 4, wherein the interior side of the door defines a plurality of receivers; further wherein the at least one connection feature defines a plurality of connection features to readily removably secure the base frame to the receivers of the door.

7. The carrier assembly of claim 6, wherein each receiver of the interior side of the door is also adapted to receive at least one connection feature of a second getter module having a single base, a single cover, and a single getter pack disposed between the single base and the single cover.

8. The carrier assembly of claim 1, wherein the getter module is form fit within a recess in the door.

9. The carrier assembly of claim 1, wherein the interior side of the door defines a receiver adapted to receive wafer guiding or supporting structure for wafers in the wafer storage area; the receiver also adapted to receive the at least one connection feature of the getter module to readily removably secure the getter module to the interior side of the door.

10. The carrier assembly of claim 1, wherein the at least one connection feature comprises a snap-fit member to snap-fit the getter module to the door.

11. The carrier assembly of claim 10, wherein the at least connection feature further comprises a protrusion, disposed on a side of the getter module opposite the snap-fit member, to fit within an opening in the interior side of the door.

12. The carrier assembly of claim 1, wherein the at least one connection feature comprises a biased substantially V-shaped member adapted to press against a receiver of the door.

13. The carrier assembly of claim 12, wherein the at least one connection feature further comprises a protrusion extending in a direction substantially perpendicular to the substantially V-shaped member.

14. A door assembly for a substrate container, comprising:

a door for closing the substrate container,

a first getter module, the first getter module defining a single getter comprising a first getter material for scavenging contaminants from the substrate container;

a second getter module, the second getter module defining a second getter comprising a second getter material, different from the first getter material for scavenging contaminants from the substrate container;

wherein the door defines a plurality of attachment points, the attachment points each being adapted to attach said first and second getter modules wherein the first and second getter modules are attached to the door at select ones of said plurality of attachment points.

15. The door assembly of claim 14, wherein the first getter module is adapted to scavenge one type of contaminant from the container; further wherein the second getter module is adapted to scavenge at least one other type of contaminant from the container, different than the one type of contaminant.

16. The door assembly of claim 14, wherein each of the first and second getter modules comprises a biased member to snap the respective getter module into engagement with the door at any of the attachment points.

17. The door assembly of claim 14, wherein the attachment points are identical in shape.

18. The door assembly of claim 14, further comprising a third getter module with a third getter material different from the first and second getter materials.

19. The door assembly of claim 14, in combination with a container.

20. A substrate container in combination with the first and second getter modules, each of the first and second getter modules comprising:

a getter pack supported by a base, the getter pack comprising a getter formulation;

a cover disposed over the base and the getter pack; and

at least one filter operatively connected between the getter pack and the cover;

wherein the getter module is readily removably secured to the substrate container at an interior of the substrate container;

wherein the cover defines at least one passageway adapted to chemically expose the getter pack to the interior of the protective carrier.

21. The substrate container in combination with the first and second getter modules of claim 20, wherein the getter formulation of the first getter pack is different than the getter formulation of the second getter pack..

22. The substrate container in combination with the first and second getter modules of claim 20 or 21, wherein each of the getter modules comprises at least one connection feature adapted to secure the getter module to a door of the substrate container.

23. The substrate container in combination with the first and second getter modules of claim 22, wherein each of the getter modules comprises at least one connection feature adapted to secure the getter module at any of multiple attachment points on an interior side of the door.

24. The substrate container in combination with the first and second getter modules of claim 23, wherein the at least one connection feature defines one of a snap fit, a press fit, and a friction fit.

25. The substrate container in combination with the first and second getter modules of claim 20, in combination with the substrate or substrates carried within the substrate container.

26. A method of reducing concentration of gas, moisture, and/or airborne molecular contaminants within a front opening container microenvironment, the method comprising:

affixing a getter assembly to a front door of the container within a recess on the front door, the getter assembly comprising getter material within a housing; and

closing the front door of the container to expose the getter assembly to the container microenvironment and thereby reduce concentration of gas, water, and/or airborne molecular contaminants within the container microenvironment.

27. The method of claim 26, wherein the affixing comprises affixing a first getter assembly to the front door and a second getter assembly to the front door, the first getter assembly being adapted to scavenge a different type of contaminant from the container microenvironment than the second getter assembly.

28. The method of claim 26, further comprising opening the front door of the container and replacing the getter assembly with a new getter assembly.

29. The method of claim 26, wherein the affixing comprises affixing a getter assembly comprising at least two different types of getter material selected by a user.

30. The method of claim 26, wherein the getter assembly is a first getter assembly comprising a single getter pack; the method further comprising affixing to the front door of the container a second getter assembly comprising a plurality of getter packs.

31. A door assembly for an item container, the door assembly comprising:

a door chassis with an inside facing surface, a recess for receiving a wafer cushion, a wafer cushion attached to the door at the recess, a receiver recessed within a door assembly surface configured to face items within the item container, the receiver adapted to receive a getter module; and

a getter module received by the receiver, the getter module adapted to decrease contamination within the item container.

32. The door assembly of claim 31, wherein the getter module is at least partially disposed in a recess of the receiver.

33. The door assembly of claim 31, wherein the door assembly surface has an interior door wall and the door assembly further comprises an exterior door wall, the interior door wall and the exterior door wall defining a volume internal to the door assembly, wherein the getter module extends past the interior door wall into the volume internal to the door assembly.

34. The door assembly of claim 31, wherein the getter module is a passive getter module free of connection to a purge stream.

35. The door assembly of claim 31, in combination with an item container, the item container being selectively opened and closed by the door assembly.

36. A semiconductor wafer carrier assembly, comprising:

a carrier, the carrier defining a wafer storage area adapted to support one or more semiconductor wafers, the carrier having a front-opening door comprising a door housing and a latching mechanism operably coupled with the door housing to secure the door closed, the door being openable for access to the wafer storage area, the door defining an interior side facing the wafer storage area; and

a press fit getter module attached in a recess on an inside surface of the front door, the getter module not in communication with the exterior of the carrier when the door is closed, the getter module comprising:

a rigid polymeric housing with an access opening;

getter material disposed within the getter module housing, the getter material adapted to decrease concentration of contaminants within the wafer storage area of the carrier via the access opening; and

at least one rigid polymeric connection feature as a part of or extending from the getter module housing, the connection feature adapted to readily press fit the getter module to the interior side of the door.

37. The semiconductor wafer carrier assembly of claim 36 comprising an additional press fit getter module attached in a recess on an inside surface of the front door, the getter

module not in communication with the exterior of the carrier when the door is closed, the getter module comprising:

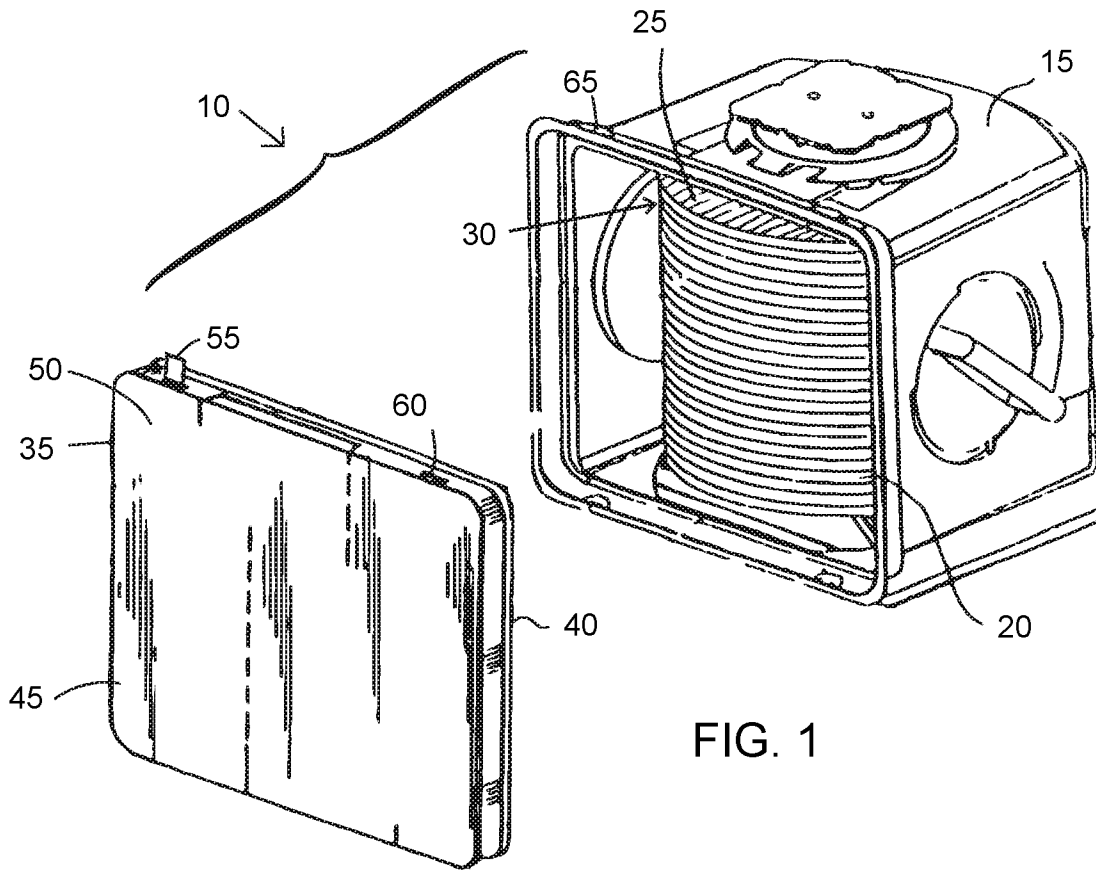
a rigid polymeric housing with an access opening;

getter material disposed within the getter module housing, the getter material adapted to decrease concentration of contaminants within the wafer storage area of the carrier via the access opening; and

at least one rigid polymeric connection feature as a part of or extending from the getter module housing, the connection feature adapted to readily press fit the getter module to the interior side of the door;

wherein the getter material of the two getter modules are different from one another.

38. The semiconductor wafer carrier assembly of claim 36 or 37 wherein the inside surface is the surface most inwardly on a chassis of the door and each of the modules are flush with or recessed from the inside surface.



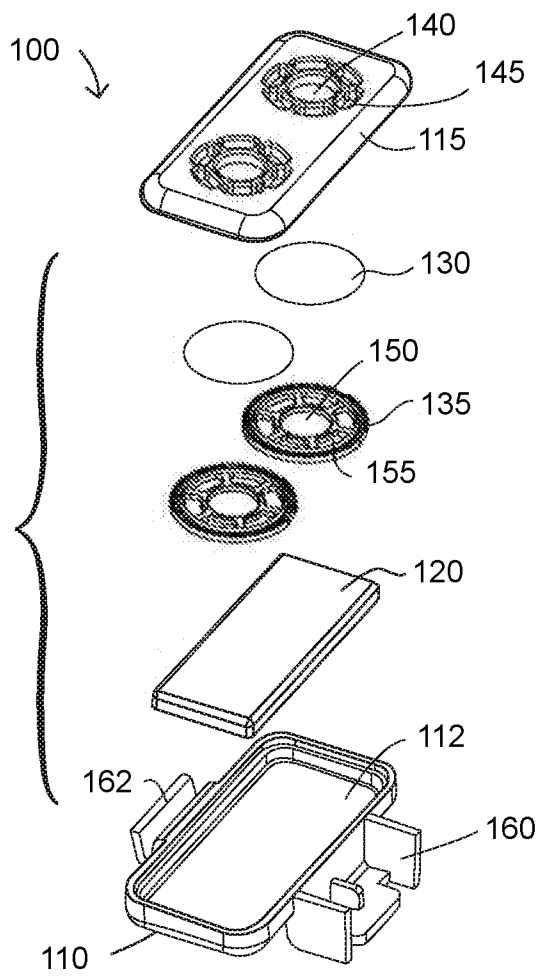


FIG. 2

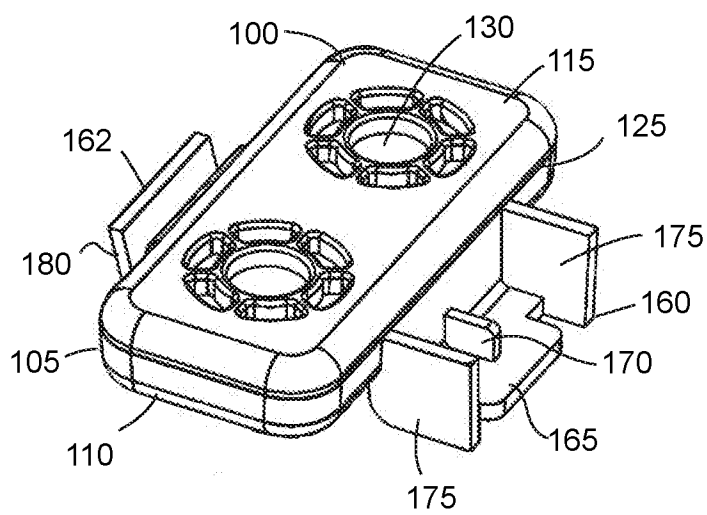


FIG. 3

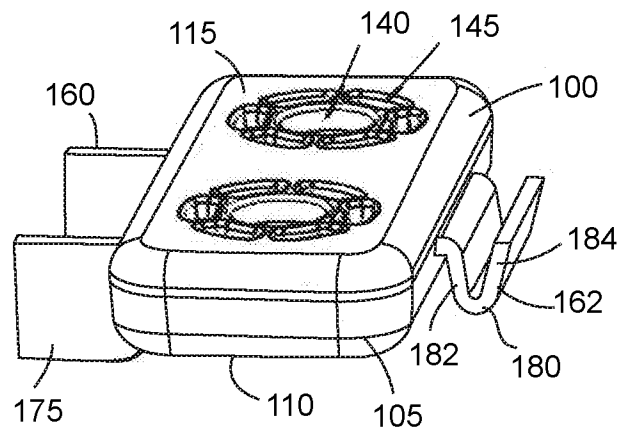


FIG. 4

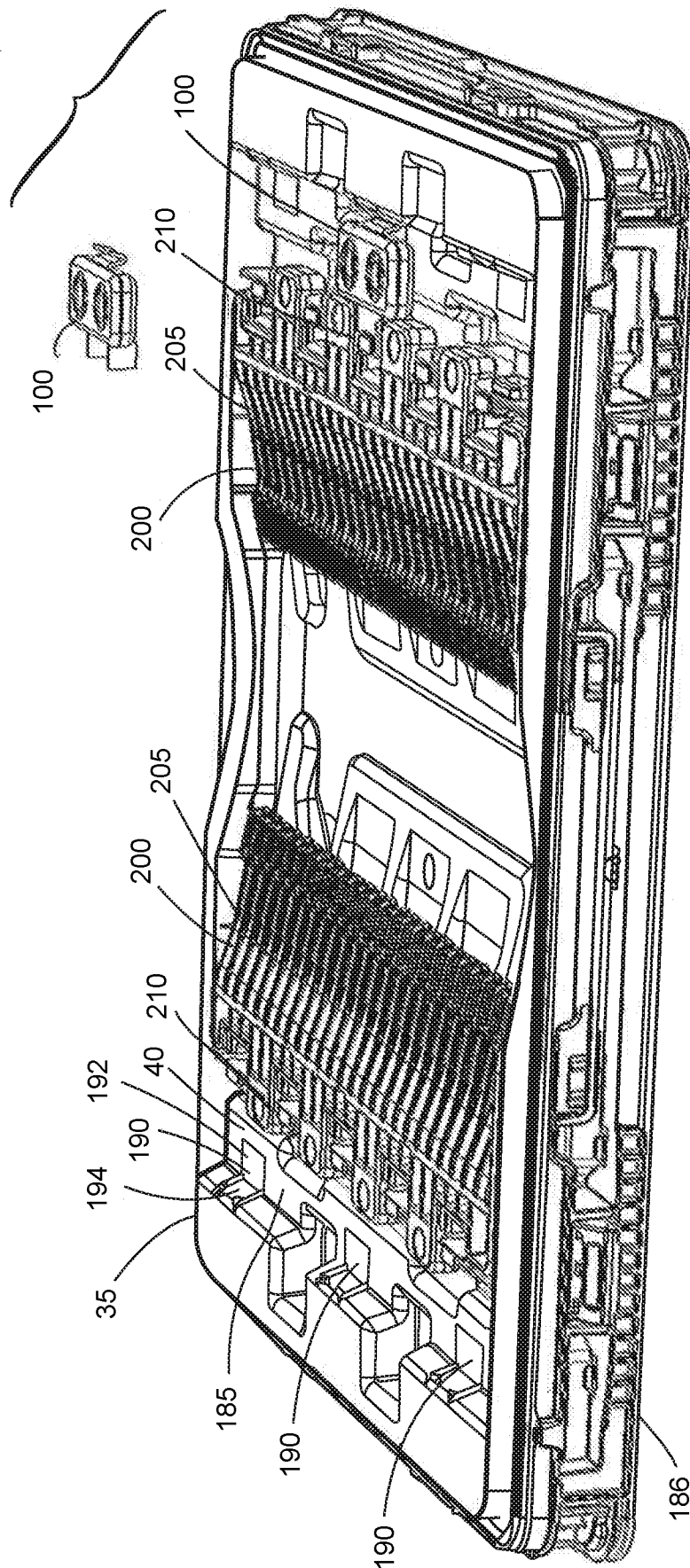


FIG. 5

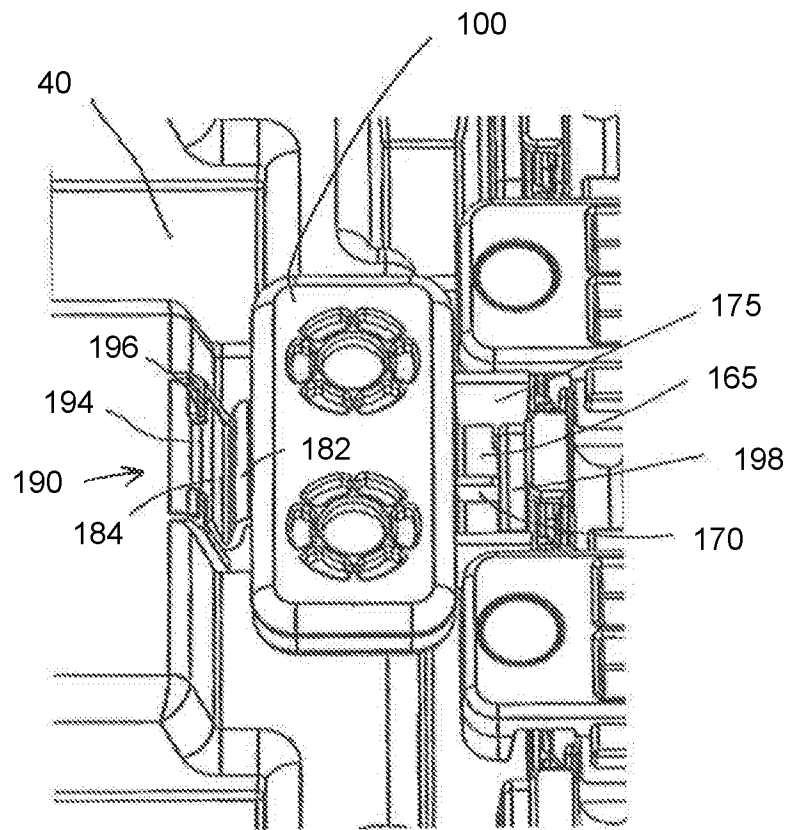


FIG. 6

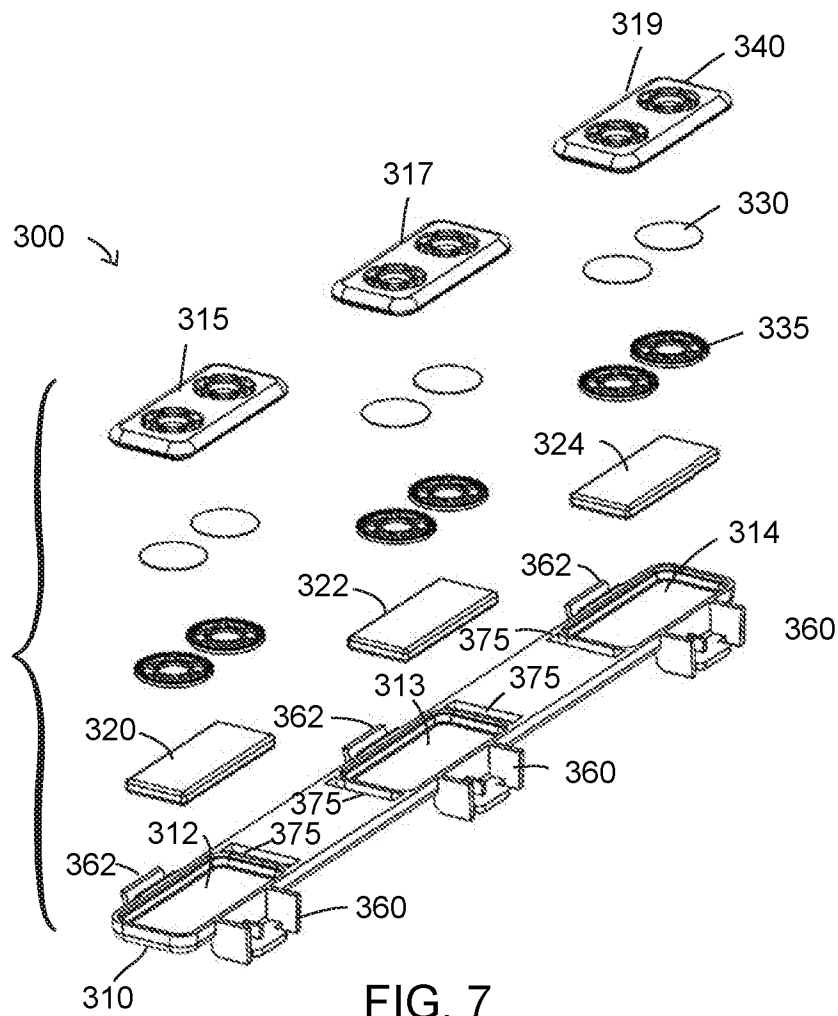


FIG. 7

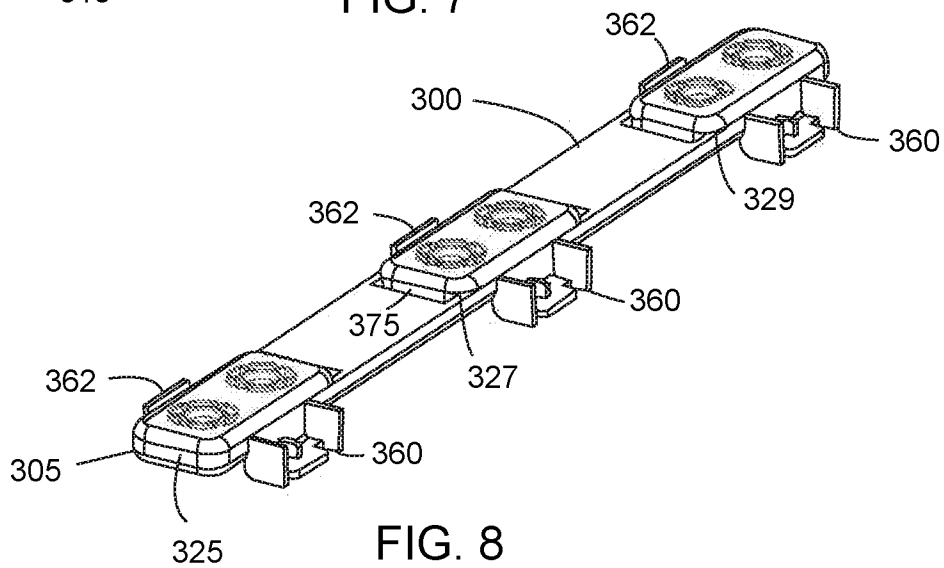


FIG. 8

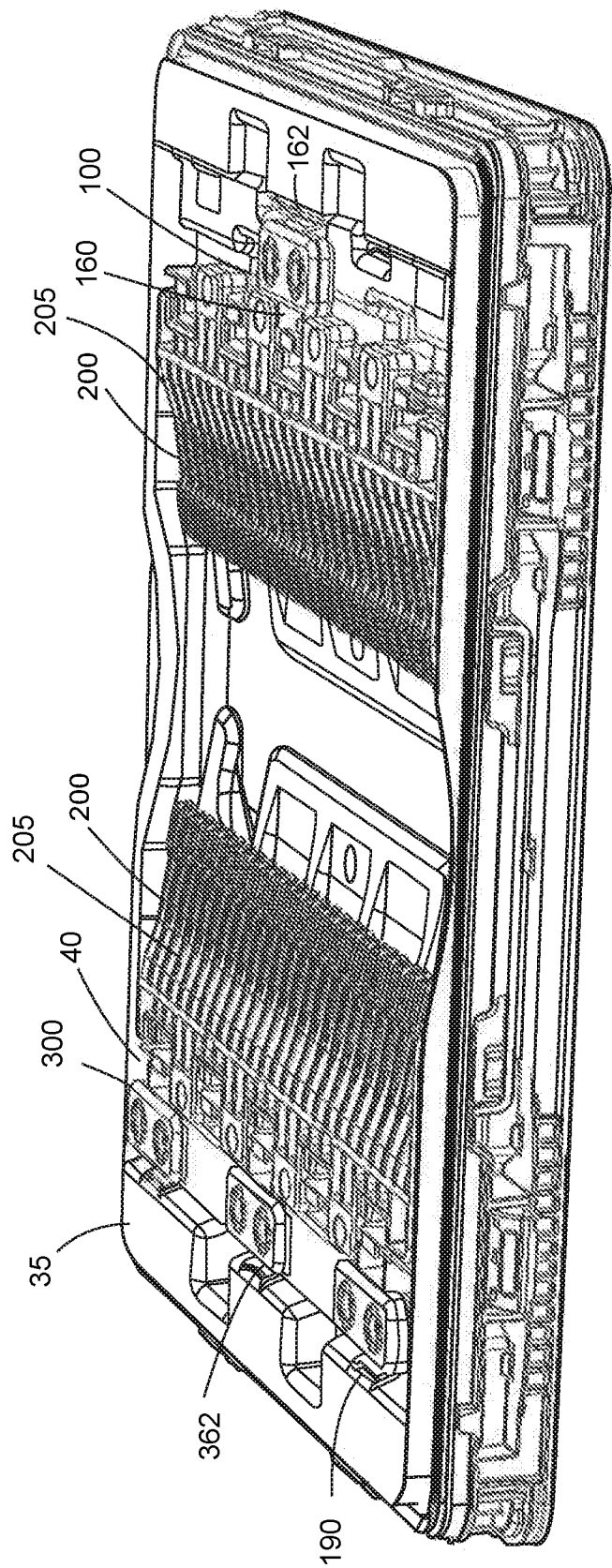


FIG. 9

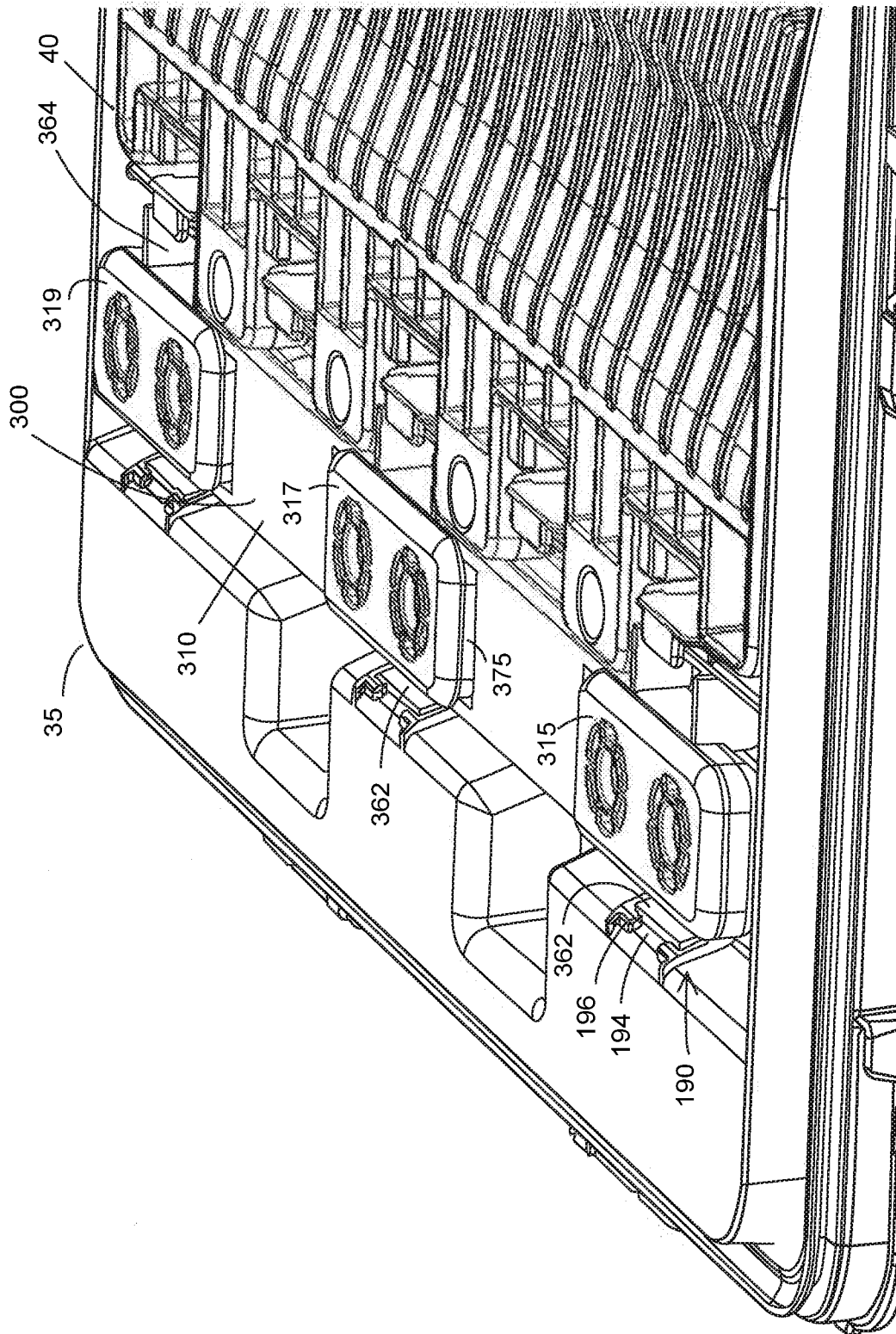


FIG. 10

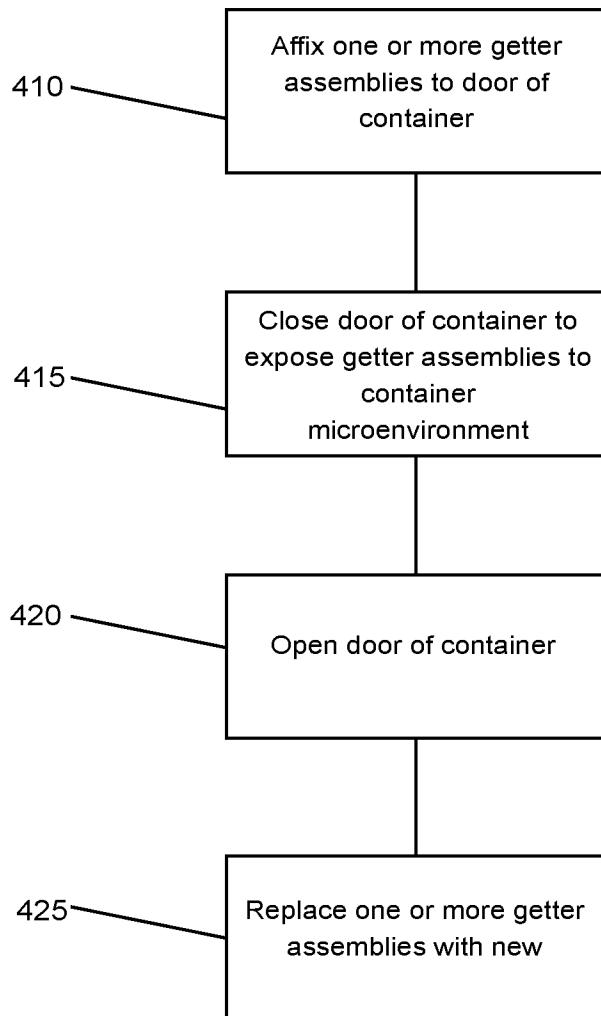


FIG. 11

A. CLASSIFICATION OF SUBJECT MATTER**H01L 21/673(2006.01)i, H01L 21/677(2006.01)i**

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

H01L 21/673; G03B 27/52; F25D 11/02; B01D 46/52; B65D 85/86; A23L 1/218; B65D 85/38; H01L 21/677

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Korean utility models and applications for utility models

Japanese utility models and applications for utility models

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

eKOMPASS(KIPO internal) & keywords: wafer carrier, door, latching mechanism, replaceable, getter module, housing, getter material, and connection feature

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2011-0114534 A1 (WATSON et al.) 19 May 2011 See abstract, paragraphs [0006], [0036]-[0043], claims 1, 11, and figures 1-21.	20-21, 25
Y		1-3, 8-13, 22, 26-38
A		4-7, 14-19, 23-24
Y	US 2008-0204680 A1 (TIEBEN et al.) 28 August 2008 See paragraphs [0036]-[0038], claims 10-11, and figures 1-4.	1-3, 8-13, 22, 26-38
A	CN 1474131 A (LEJIN ELECTRIC (TIANJIN) ELECTRICAL APPLIANCE CO., LTD.) 11 February 2004 See claim 1 and figure 3.	1-38
A	WO 2012-088172 A2 (ENTEGRIS, INC.) 28 June 2012 See claims 1, 12 and figures 1-2, 31-32.	1-38
A	JP 2006-035180 A (KONDO KOGYO K.K. et al.) 09 February 2006 See abstract, paragraphs [0013]-[0022], and figures 1-6.	1-38



Further documents are listed in the continuation of Box C.



See patent family annex.

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"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search

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Date of mailing of the international search report

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Name and mailing address of the ISA/KR

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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.

PCT/US2016/022059

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