IC WAFER CARRIER SEALED FROM AMBIENT ATMOSPHERE DURING TRANSPORTATION FROM ONE PROCESS TO THE NEXT

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Publication Classification

Int. Cl. B65D 85/00 (2006.01)

U.S. Cl. ........................................... 206/710

ABSTRACT

A wafer carrying structure is provided that allows more efficient operation of the opening and closing mechanisms. More specifically, the wafer carrier includes pressure relief structures that provide appropriate pressure equalization during the opening and closing operations of the wafer carrier. This allows doors on the wafer to be more easily opened and closed while also providing significant environmental isolation for the wafers during transport operations. Relief structures specifically designed to remain closed except for those brief periods of time where pressure relief is necessary to equalize pressure during opening and closing of the carrier.
IC WAFER CARRIER SEALED FROM AMBIENT ATMOSPHERE DURING TRANSPORTATION FROM ONE PROCESS TO THE NEXT

FIELD OF THE INVENTION

[0001] The present invention relates to wafer handling techniques used during the fabrication of integrated circuits. More specifically, the present invention provides a carrier, and method for using, which protects wafers from contamination during transportation while also allowing easy opening and closing.

BACKGROUND OF THE INVENTION

[0002] Careful control of the manufacturing environment for integrated circuits is critical to the success of the process. With this in mind, considerable steps are typically taken to protect wafers, including performing the manufacturing processes in clean rooms, providing controlled environments, ensuring that processing equipment does not contribute to potential contamination, and ensuring employees are careful throughout the process. Although the particular processing steps may be readily controlled, one additional area for concern is the transportation of wafers from one process to the next. Naturally, this step of transporting the wafers requires movement between environments, which creates potential exposure to uncontrolled environments, and a potential for contamination.

[0003] To address transportation concerns, wafers are typically transported in sealed carriers. Naturally, these sealed carriers can protect wafers from contamination due to undesired particles, humidity, gases, general foreign matter or material, or any other potential sources of contamination or damage. The sealed carriers are specifically designed to control their internal environments, thus are typically sealed to avoid any undesired conditions. In some versions, this includes very tight seals to effectively prevent any airflow (gas flow) into or out of the carrier. Other versions may include filtered vents which allow airflow but prevent particles from entering the carrier.

[0004] Complications exist, however, when it is necessary to access wafers within these tightly sealed carriers. For example, when a sealed environment is created inside the carrier, it can be difficult to open existing doors or covers due to pressures within. This may create additional concerns due to the fact that these carriers are typically robotically handled, and opening forces are yet an additional consideration for these systems. Thus, it is desirable to provide a mechanism to equalize pressures and allow easy door opening. One approach to this problem is to provide vents within the carrier, thus allowing pressure within the carrier to be equalized. In order to allow such pressure equalization, while also protecting the internal atmosphere, present carriers utilize filtering mechanisms to catch any particles or undesired foreign matter which may be carried by the ambient atmosphere. Unfortunately, this venting approach cannot prevent undesirable gases from entering the internal chamber. Consequently, an alternative approach is needed to provide appropriate operability of the carrier while also prohibiting undesirable gases or contamination.

BRIEF DESCRIPTION OF THE DRAWINGS

[0009] Further objects and advantages of the present invention will be seen by reading the following detailed description, in conjunction with the drawings in which:

[0010] FIG. 1 is a perspective view of the carrier; and

[0011] FIG. 2 includes a front view and cross sectional view of the airflow relief valve utilized in the carrier.

DETAILED DESCRIPTION OF THE INVENTION

[0012] As illustrated in FIG. 1, the present invention employs the use of a wafer carrier 10 which is generally illustrated in an open state. In this particular embodiment, wafer carrier 10 is intended to be a front opening type carrier, typically referred to as a front opening unified pod (FOUP), but the present invention may be applied to other carrier types as well. In this particular example, wafer carrier 10 includes a
front door 20 and a main housing 30. Front door 20 is primarily planar, but it does include a seal 22 positioned on an interior surface thereof. Seal 22 is configured to interface with a front edge 32 of main housing 30. In this particular embodiment, seal 22 is an O-ring configured and designed to fit within appropriate ridges in door 20. Multiple different configurations are possible to achieve a desired seal between housing 30 and front door 20.

[0013] Illustrated within main housing 30 are a plurality of slots 34 shown within a sidewall 38. These slots are configured to receive wafer 40 in a convenient manner, thus maintaining separation between the various wafer within main housing 30 while also holding them in a desired position. Again, those skilled in the art will recognize that many different configurations are possible for this housing type structure. Further, a holding structure may be utilized which is separate from the sidewalls and simply inserted into or coupled with main housing 30.

[0014] In addition, main housing 30 includes handling structures 36 existing on a top portion. This handling structure is just one example of a device which will assist in the mechanical handling of wafer carrier 10. Also shown in FIG. 1 are input relief valve 40 and an output relief valve 60. In this particular context, “input” and “output” are utilized to designate the direction of airflow which is permitted by the respective valve relative to the internal portion of housing 30. As will be recognized by those skilled in the art, different positioning and different configurations of the relief valves is possible.

[0015] Referring now to FIG. 2, a more detailed illustration of input relief valve 40 is shown. This particular embodiment of input relief valve 40 is illustrated and discussed herein in considerable detail with reference to FIG. 2. It will be understood that output relief valve 60 is configured in a substantially similar manner. Both of these valves are intended to be poppet valves which will open upon a predetermined pressure condition, but will remain closed when the pressure condition does not exist. FIG. 2 includes a front view (FIG. 2A) and a cross sectional view (FIG. 2B) of input relief valve 40. As seen in these illustrations, input relief valve 40 includes an outer shell 42, a spring 44, a movable disk 46 and a retainer 48. Further, movable disk 46 includes a gasket 52 positioned on a front surface thereof. Gasket 52 provides an appropriate coupling and sealing between retainer 48 and movable disk 46. As can be appreciated, when pressure on the spring side of movable disk 46 becomes lower than the pressure on the opposite side thereof, force is created which will attempt to compress spring 44. Once this force becomes sufficient to move spring 44, the movable disk 46 will become unseated from retainer 48, thus opening an airway. This will thus allow air to pass through input relief valve 40. In the illustration of FIG. 2, air will move through relief valve 40 in a direction to the right, as oriented in FIG. 2B.

[0016] Although not specifically illustrated, output relief valve 60 is similarly configured with the spring and housing members slightly modified to allow reverse pressures to enable airflow. Those skilled in the art will recognize that a slight reconfiguration of components is easily achieved to accomplish this reverse operation.

[0017] Also illustrated in FIG. 2B are inner connecting threads 54 which provide a coupling mechanism between outer shell 42 and retainer 48. By having a threaded connection, the spring itself can be compressed more or less and adjusted once the valve is installed. Providing this threaded connection allows the force and other operating characteristics of spring 44 to be slightly adjusted due to the biases placed upon spring 44. Once installed, input relief valve 40 can thus be calibrated to open upon desired pressure conditions by achieving the desired force in the spring. Similar calibration of output relief valve 60 is also possible, thus allowing for carefully controlled operation.

[0018] By incorporating appropriate relief valves 40 and 60 into main housing 30, appropriate pressure relief is achieved which can easily allow the opening and closing of door 20. As mentioned above, further protection is provided by also incorporating a filter element 70. The filter is positioned in the airflow path, to cause any airflow to pass therethrough. Various suitable alternatives may be applied for the inclusion of the filter elements. In one embodiment, filter elements 70 are captured between outer shell 42 of valve 40 and the carrier housing 30.

[0019] Referring now specifically to FIG. 2A, a unique configuration for movable disk 46 is illustrated. More specifically, a plurality of slots 56 are shown. These slots include indentations in the outer portion of movable disk 46 to more easily accommodate airflow. In this particular configuration, movable disk 46 includes four different slots 56 equally spaced around the circumference of the movable disk. These slots provide free and clear openings for the movement of air at those times when relief is required.

[0020] In the configuration described above, the valve structure can be adapted to fit existing carriers. As discussed, carriers may include filtered vent openings to provide pressure equalization. To re-fit these existing carriers, outer shell 42 of valve 40 can be configured to tightly fit within existing vent openings and create a seal therewith. Thus, existing carriers can be easily modified by inserting valves into appropriate vent openings to create a better functioning carrier.

[0021] While certain embodiments of the invention have been described above, these specific configurations are not considered to be limiting in any way, but rather illustrative of the concepts of the present invention. The applicants intends the invention to include all variations and modifications coming within the scope and spirit of the following claims.

1. A wafer carrier for protecting wafers during transportation from one step of a manufacturing process to another, comprising:
   a carrier structure for capturing a wafer and holding the wafer in a controlled position during transportation, said carrier structure comprising:
   a housing substantially surrounding the carrier structure, the housing capable of enclosing the carrier structure and the wafer, the housing further having an opening to allow access to the wafer and having vent openings to allow airflow into and from an interior of the housing; and
   a door mechanism cooperating with the housing to form a fluid tight seal when attached thereto, the door being removable to expose access to the housing opening, wherein the door is attached to the housing with a consistent amount of force when establishing the fluid tight seal, and wherein the door is removed from the housing with the consistent amount of force when establishing the fluid tight seal; and
   a plurality of relief valves, wherein each of the plurality of relief valves is a poppet valve including:
   an outer shell configured to tightly fit within the vent openings,
a movable plate having a first surface thereof exposed to air pressure changes within the housing caused by opening and closing of the door mechanism, a spring positioned within the outer shell and in contact with the movable plate on a side opposite the first surface, and a retainer for holding the movable plate in position, wherein the retainer is coupled to the outer shell in an airtight manner and contact between the movable plate and the retainer forms an airtight seal when the valve is in a closed position, the spring of each of said plurality of relief valves being calibrated such that said relief valve is configured to generally remain in the closed position, but also allowing for movement to an open position exclusively for relieving the air pressure changes within the housing caused by the opening and closing of the door mechanism, the plurality of relief valves thereby allowing airflow into the interior of the housing responsive to air pressure changes caused by the opening of the door mechanism and allowing airflow to escape from the interior of the housing responsive to air pressure changes caused by the closing of the door mechanism.

2. The wafer carrier of claim 1, wherein the plurality of relief valves comprises a first relief valve specifically configured to relieve an air pressure vacuum generated within the carrier caused by the opening of the door mechanism, and a second relief valve specifically configured to relieve an air pressure increase generated within the carrier caused by the closing of the door mechanism.

3. The wafer carrier of claim 1, wherein each of the plurality of relief valves further includes an adjustment structure for adjusting the calibration of the relief valve.

4. The wafer carrier of claim 1, wherein each of the plurality of relief valves further includes a filter structure to provide air filtering while the relief valve is in the open position.

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