

SMIF Pods Handling System and the Method Thereof

Field of the Invention

[0001] The present invention relates to a wafer handling system. Specifically, the present invention relates to an add-on system and method for handling SMIF pods thereof under a clean room environment.

Background

[0002] Standard Mechanical InterFace, or simply SMIF, is widely adapted in semiconductor wafer fabrication under cleanroom environments. Its purpose is to isolate the wafers from contamination through small space under a controlled airflow, pressure and particle counts. Operationally, SMIF pod is loaded into the fabrication/processing equipment, such as wet bench equipment, whereby the contents, i.e. wafer cassette, will be removed therefrom and subsequently be processed through automation machinery under the controlled environment. The SMIF pod comprises a pod cover for enclosing and protecting the contents therein. As the SMIF pod is loaded on the equipment at its upstream, the content is unloaded from the pod for automated processing. The emptied pod is then manually carried to the downstream of the processing equipment by hand to reload the processed contents. Under such operation, it usually requires an operator to load the SMIF pod onto the processing equipment, then to carry the emptied pod to the downstream, and once the processed contents are reloaded in the SMIF pod, to remove the pod from the equipment and to load another SMIF pod onto the upstream of the processing equipment. It is to be noted that all these processes are required be carrying out under a clean environment for wafers.

[0003] There exist add-on equipment for loading the SMIF pods for loading and unloading of the contents there of, i.e. wafer cassettes, commonly known as SMIF pod loader interface (PLI), or simply pod loader. Operationally, the pod loader is adapted to open the cover of the pod to reveal the contents therein, and transport the contents
5 into the processing equipment for processing. Such add-on equipment still require an operator to be present to carry the emptied SMIF pod to the downstream loader for reloading the processed contents back to the SMIF pod.

[0004] It is an industrial practice that the processed contents are re-loaded onto the same carrying pods before it was processed. However, due to the manual handling
10 work, human errors occurs.

[0005] It is also well known in the art that not all wafers are processed in the exact same way. Some wafers may require longer processing time whereby some may take shorter processing cycle. Accordingly, the wafers are grouped when they are loaded onto the cassettes, and the cassettes are also grouped according to their
15 processing requirements. It further increases the challenge for operators to monitor and manage these wafer cassettes.

[0006] To improve the workload, the current processing equipment often adapts to handle a pair of pods simultaneously. Most often, the pods are paired according to the processing requirement as stated above. Accordingly, the operators are also required
20 to identify the paired pods and place them onto the pod loaders appropriately.

[0007] There are also occasions where the sequence of processing the cassettes in the processing equipment is being shuffled internally within the processing equipment.

It can be a hassle to the operators to handle the pods to match with the corresponding cassettes.

[0008] Accordingly, there exist a need to lighten the demand over the human works through an automation.

5

Summary

[0009] In accordance with an aspect of the present invention, there is provided a SMIF pod handler for handling Standard Mechanical InterFace (SMIF) pods to be processed under the processing equipment. The processing equipment having an input pod loader and an output pod loader for handing the contents in the SMIF pod, the SMIF carrier comprises an upstream unit disposed over the input pod loader; a downstream unit disposed over the output pod loader; and a bridge conveyer connecting the upstream unit and the downstream unit. Operationally, a plurality of SMIF pods are loaded on the upstream unit, said upstream unit comprises input handling means adapted to load the SMIF pods on the input pod loader and transport the emptied SMIF pods to the bridge conveyer, the bridge conveyer automatically conveys the emptied SMIF pods to the downstream unit, said downstream unit comprises input handling means adapted to load the emptied pods onto the output pod loader for receiving the processed contents from the processing equipment.

[0010] In one embodiment, the upstream unit comprises an input carrier buffering unit for preloading a plurality of SMIF pods thereon, and an input towering elevator disposed over the input loader, the input towering elevator comprises handling means for picking up SMIF pods from the input carrier buffering unit, racks for loading

SMIF pods thereto. The input towering elevator may further comprise two tiers of racks for loading the SMIF pods thereon, the top rack is connected to the bridge conveyer.

[0011] In accordance with another embodiment, the downstream unit comprises an output carrier buffering unit for the plurality of processed SMIF pods thereon; and
5 an input towering elevator disposed over the output loader, the output towering elevator comprises racks for loading SMIF pods transported through the bridge conveyer, and handling means for picking up SMIF pods and loading the same onto the output loader for receiving the processed contents. The output towering elevator may further comprise two tiers of racks for loading the SMIF pods thereon, the top rack is connected
10 to the bridge conveyer.

[0012] In yet a further embodiment, each of the towering elevator may comprise a handling arm slidably mounted on a sliding bar, wherein the sliding bar is adapted to slide vertically over height of the towering elevator.

[0013] In yet a further embodiment, the bridge conveyer comprises motorized
15 wheels for conveying loaded pods.

[0014] In another embodiment, the upstream unit may comprise a RFID scanner for reading an RFID tag attached to each of the SMIF pod. The downstream unit may also comprise a RFID scanner for reading an RFID tag attached to each of the SMIF pod.

20 **[0015]** In a further embodiment, the bridge conveyer comprises a buffering and sorting rail, the buffering and sorting rail comprises two rolls of sorting lots extending along the length of the pod handler; and a shuttle movable along an aisle rail between

the two rolls of sorting lots, wherein the shuttle is adapted to operably load and unload SMIF pods over the two rolls of the sorting lots. Each of the sorting lots and shuttle may include a wheel conveyer oriented horizontally against the length of the buffering and shorting rail, wherein SMIF pod loaded thereon can be conveyed sideways between the two rolls of lots and the shuttle. The wheel conveyer may include individually motorized in-line wheels.

Brief Description of Drawings

[0016] **FIG. 1** illustrates a front perspective view of SMIF pod carrier system in accordance with an embodiment of the present invention;

10 [0017] **FIG. 2** illustrates a back perspective view of the SMIF pod carrier system of **FIG. 1**;

[0018] **FIG. 3** illustrates a closed up view of a picking means in accordance with an embodiment of the present invention;

[0019] **FIG. 4** illustrates a back perspective view of a SMIF pod handler in
15 accordance with an embodiment of the present invention.

Detailed Description

[0020] Embodiments of the present invention shall now be described in detail, with reference to the attached drawings. It is to be understood that no limitation of the scope of the invention is thereby intended, such alterations and further modifications in
20 the illustrated device, and such further applications of the principles of the invention as

illustrated therein being contemplated as would normally occur to one skilled in the art to which the invention relates.

[0021] The present invention provides a comprehensive add-on system that provides handling automation for bulk number of SMIF pods. **FIG. 1** and **FIG. 2** illustrate a front perspective view and a back perspective view of a SMIF pod handler **100** in accordance with an embodiment of the present invention. The SMIF pod handler **100** is adapted for providing automatic SMIF pods **101** allocations and buffering management over the wafer processing. The handler **100** comprises an upstream unit **102**, a downstream unit **104** and a bridge conveyer **106** connecting the upstream unit **102** and the downstream unit **104**. Operationally, a plurality of SMIF pods **101** are loaded at the upstream unit **102**, and subsequently be conveyed to the downstream unit **104** through the bridge conveyer **106**. It is desired that the SMIF handler **100** is adapted to handle at least 8 pods buffer or more. With the SMIF pod handler **100**, operator may load up more number of pods on the handler, whereby the handler manages the sequence and handling of the pods automatically from the upstream to the downstream of the processing equipment without human interaction substantially. As the handler **100** is adapted with more spaces to standby the pods for processing, the operator may perform other tasks while the cassettes are being processed.

[0022] Still referring to **FIG. 2**, the upstream unit **102** comprises an input carrier-buffering unit **122**, an input SMIF pod loader **124** and an input towering elevator **126**. The input carrier-buffering unit **122** is a starting point where the operator loads the SMIF thereon. It comprises a conveyer rail **152** that conveys the SMIF pods **101** loaded thereon toward the other end. In the present embodiment as shown, the conveyer rail **152** comprises roller wheels for transporting the pods from one end to another.

Depending on the space available, the input carrier buffering unit **122** allows a plurality of SMIF pods **101** be pre-loaded thereon for processing in, preferably, first in first out (FIFO) sequence.

[0023] Next to the end of the input carrier-buffering unit **122** is the SMIF pod

5 loader **124**, whereby the contents, i.e. wafer cassette, in the SMIF pods **101** are being transferred automatically to the processing equipment. As mentioned before, current processing usually requires two pod loaders for handling two pods. The SMIF pod loader **124** is an equipment adapted for transferring the contents loaded within the SMIF pods to the processing equipment. It is also commonly known as pod loader interface
10 (PLI). Such PLI can be a loading/reloading module built in to the wafer processing equipment, or it can be an interfacing add-ons adapted to work in conjunction with the wafer processing equipment. Typically, the PLI also include machinery, such as robot arms, that is adapted to transfer the contents into the processing equipment. Various designs and configurations are available in the market and it is well known in the art,
15 therefore, no specific details is provided herein unless it is required for the purpose of this application. As illustrated in the present embodiment, the pod loaders **124** are not provided with the lifting arm to remove the cover because opening the cover is handled by the input towering elevator **126**, which will be described in more details later. In another embodiment, the pod loaders may be equipped with a pod cover lifter.
20 Operationally, the SMIF pods **101** are loaded one by one the operator on the input carrier-buffering unit **122** will be conveyed to the other end, and whenever the input pod loaders **124** are vacant, the SMIF pods **101** are transported to the loader **124** for removing the contents therefrom. Once the contents in the SMIF pods **101** are removed, the emptied pods **101** are being lifted the bridge conveyer **106**.

[0024] The input towering elevator **126** is configured as a high-rise frame **158** and it is adapted to lift the SMIF pods **101** onto the racks above the SMIF pod loader **125** for standing by. These racks are configured in at least two tiers **154** with a capacity to hold up a plurality of SMIF pods on each tier. Each rack too comprises

5 guiding rail **152** having conveyer wheels for transporting the pods **101** along the guiding rail **152**. The guiding rails are adapted as holding areas or buffering area for standing by the pods for handling.

[0025] Still referring to **FIG. 2**, the input towering elevator **126** may provide suitable actuating arms or carrier frames for lifting and conveying the pods from one

10 locations to another, depending on the configuration of the SMIF pod. In one illustrative example, the input towering elevator **126** comprises movable rail **156** that operably elevates up and down over the height of the frame **158** of the input towering elevator **126**. The movable rail further includes picking mean **159** movable along the width of the towering elevator (i.e. length of the movable rail **156**). That makes it capable to pick

15 and place within any location framed within the tower's frame **158**. In the illustrated example, the picking means **159** comprises a pair of forks that configure to engage with the SMIF pod **101**. In one embodiment, the pair of forks is moveable sideways away/toward each other. The pair of forks is guided to park on two sides of the SMIF pod, and once they move toward each other, it holds on to the cover of the SMIF pod

20 **101**.

[0026] In one embodiment, each SMIF pod **101** is RFID (Radio Frequency Identity) tagged (not shown), whereby the SMIF handler **100** is also equipped with RFID scanner (not shown). In one alternative embodiment, the RFID scanner is located at the upstream unit **102**. More specifically, the RFID scanner may be positioned at the input

carrier-buffering unit **122** to scan the ID, and only validated and paired pods are loaded to the POD loader **124** for further processing. The SMIF pods that can't be validated or pairs will be removed by the operator manually.

[0027] It is well understood that RFID tag is used to identifying the pods. Other identity tagging may also be adapted, for example, bar code or any 2D matrix code, or smart chip or smart tag or the like can also be adapted herewith.

[0028] With the above configurations, several SMIF pods can be loaded from the loading bay of the input carrier-buffering unit **122** one after another, and they are conveyed to the lifting end of the input carrier-buffering unit **122**. As the pods **101** passes through the rail **152** of the input carrier-buffering unit **122**, each pod is being scanned for identity. Pods that failed for validation, on the other hand will be removed by the operator manually. The pods that pass the validation and pairing (for twin pod processing equipment) will be converted to the other end of the input carrier buffering unit **122** to standby.

[0029] As the pods reach the end of the rail **152**, when the pod loaders are not occupied, the priority is given where the loaded pods **101** are being lifted by the picking means and transport to the input pod loaders **124**. Once they are loaded onto the input pod loader **124**, the pod cover is being opened to reveal the contents, i.e. the wafers and cassette, and the contents thereof are transferred to the processing equipment for further processing. After the contents are removed from the pods, the emptied pods are then lifted to the buffering areas.

[0030] As the pods **101** reach the end of the rail **152** while the input pod loaders **124** are occupied, the pods are transported to the racks of the input towering elevator, from top rack to bottom rack for standing by.

[0031] The emptied pods are then conveyed from the input loaders onto the bridge conveyer **106**. Through the bridge conveyer **106**, the pods are conveyed to the downstream unit **104**. In one embodiment, the bridge conveyer **106** comprises motorized conveyer wheels for transporting the pods from one end to another. It is to be noted that the entire carrier unit **100** is to be constructed according to clean room environment ISO14644:1 Class 5 standard or better.

[0032] Still referring the **FIG. 1** and **FIG. 2**, the downstream unit **104** is constructed in substantially the same configuration as the upstream unit **102**, except that it is configured to operate in a reversed flow. The downstream unit **104** comprises an output towering elevator **146**, an output pod loader **144** and an output buffering carrier unit **142**.

[0033] The emptied pods are conveyed from the upstream unit **102**, and placed at the buffering area, i.e. racks, of the output towering elevator **146**. The emptied pods are then lifted therefrom and loaded onto the output pod loaders **144** for reloading with their corresponding cassettes. Similarly, as the pods **101** load onto the output pod loaders, the pod cover is being opened automatically on the pod loader **144** whereby the processed contents, i.e. wafer cassettes, are being reloaded onto the corresponding pods, and once reloaded, the pods are being covered again. Reloaded pods are then lifted and transport to the rail **164** of the output buffering carrier unit **142**. At the output buffering carrier unit **142**, each pod is being scanned again for the carrier ID with a scanner

deployed on the output buffering carrier unit **142**. The carriers ID can be displayed on a HMI monitor (not shown) for ease of unloading by the operator.

[0034] **FIG. 3** shows a close up view of a picking means of the carrier **100** in accordance with an embodiment of the present invention. The picking means **300** is installed on the input and output towering elevator **126, 146**. The picking means **300** comprises a motorized horizontal slide assembly **302**, a motorized vertical slide assembly **304** and a pair of carrier arms **306**. Both the motorized horizontal slide assembly **302** and the vertical slide assembly **302** are disposed on a sliding bar attached across the inner width of the supporting frame of the towering elevator. The motorized horizontal slide assembly **302** is attached on the body length of the sliding bar **150**, wherein operationally, it is slidable along the length of the sliding bar **150** via the motorized assembly. The motorized vertical slide assembly **304** may be mounted on both ends of the sliding bar **150** to support the sliding bar **150** on the frame of the towering elevators, which allow the sliding bar **150** to move vertically along the height of the towering elevator. The carrier arm **306** is further supported on the motorized horizontal slide assembly **302** that allows the carrier arm **306** too movable along the body length of the sliding bar **150**. Such configuration allows the carrier arm **306** movable in any location within the frame of the towering elevator. Accordingly, it is able to load and unload the SMIF pods in any locations within the carrier system **100**.

[0035] In one embodiment of the present invention, the carrier arm **306** may be adapted as a fail-safe type mechanism to protect the equipment it handles. Desirably, it comprises extended arms projected to engage with the SMIF pod **101**.

[0036] **FIG. 4** illustrates a SMIF pod handler **400** in accordance with an embodiment of the present invention. The SMIF pod handler **400** has a similar configuration as the pod handler **100** of **FIG. 1** except that the conveyer bridge is configured with buffering and sorting rails **410**. The buffering and sorting rails **410** comprises a shuttle **412** movable along an aisle rail **414** extending from the upstream unit **402** to the downstream unit **404**, with two rolls **416**, **418** of sorting lots extending along the length of the handler **400**. Each of the shuttle **412** and the sorting lots comprises a wheel conveyer oriented horizontally against the length of the buffering and sorting rail **410** in a manner that articles loaded thereon can be conveyed sideways between the two rolls of lots and the shuttle through the aisle rail **414**. In one embodiment, each wheel conveyer comprises individually motorized in-line wheels disposed on two sides of the wheel conveyer.

[0037] Operationally, the picking means on the input towering elevator picks up an SMIF pod **101** and lift it high up and loaded in on an initial loading lot. Once it is loaded thereon, the shuttle **412** slide across the length of the aisle rail **414** and return to the initial loading lot. Once the shuttle **412** is aligned adjacent the initial loading lot, the individual rollers are driven to transport the SMIF pod **101** sideways towards the shuttle **412**. Similarly, the individual rollers are also driven to receive the SMIF pod **101**. Once the SMIF pod is properly loaded on the shuttle **412**, the shuttle **412** travels lengthwise to align with a designated lot and unload the SMIF pod therefrom to the designated lot. Following that, as and when a specific SMIF pod is required, the shuttle **412** travels to a corresponding lot and received the required SMIF pod. Once it is properly loaded on the shuttle **412**, the shuttle **412** travels to the end of the aisle rail and unload the same onto an unloading bay **417**. A picking means on the output towering

elevator will then lift up the SMIF pod therefrom and transport to the output pod loader on the downstream unit **404** to reload with the wafer cassette.

[0038] The pod handler **400** having the buffering and sorting rail **410** offers advantages on more buffering space for handling more SMIF pod, and it has greater flexibility on handling the SMIF pods to match with the corresponding wafer cassette in the event that the cassettes sequence is being shuffled at the processing equipment.

[0039] From the input carrier-buffering unit **122**, to the racks of the input towering elevator **126**, to the conveyer bridge **106**, to the racks of the output towering elevator **146** to the output carrier-buffering unit **142**, the SMIF carrier **100** offers a relatively considerable amount of extra buffering for handling the SMIF pods. Further, the SMIF pods, once loaded, are handled automatically from the upstream to the downstream of the processing equipment. It offers the merit for better time management, free up more floor space, as well as better segregation of the SMIF Carriers during the operation activities.

[0040] While specific embodiments have been described and illustrated, it is understood that many changes, modifications, variations, and combinations thereof could be made to the present invention without departing from the scope of the invention.

CLAIMS

1. A SMIF pod handler for handling Standard Mechanical InterFace (SMIF) pods
5 to be processed under the a processing equipment, wherein the processing equipment
having an input pod loader and an output pod loader for handing the contents in the
SMIF pod, the SMIF carrier comprising:
- an upstream unit disposed over the input pod loader;
 - a downstream unit disposed over the output pod loader;
 - 10 a bridge conveyer connecting the upstream unit and the downstream unit;
- whereby operationally, a plurality of SMIF pods are loaded on the upstream unit,
said upstream unit comprises input handling means adapted to load the SMIF pods on
the input pod loader and transport the emptied SMIF pods to the bridge conveyer, the
bridge conveyer automatically conveys the emptied SMIF pods to the downstream unit,
15 said downstream unit comprises input handling means adapted to load the emptied pods
onto the output pod loader for receiving the processed contents from the processing
equipment.
2. The SMIF pod handler according to claim 1, wherein the upstream unit
20 comprises:
- an input carrier buffering unit for preloading a plurality of SMIF pods thereon,
 - an input towering elevator disposed over the input loader, the input towering
elevator comprises handling means for picking up SMIF pods from the input carrier
buffering unit, racks for loading SMIF pods thereto.
- 25
3. The SMIF pod handler according to claim 2, wherein the input towering elevator
comprises two tiers of racks for loading the SMIF pods thereon, the top rack is
connected to the bridge conveyer.
- 30 4. The SMIF pod handler according to claim 1, wherein the downstream unit
comprises:
- an output carrier buffering unit for the plurality of processed SMIF pods thereon,

an input towering elevator disposed over the output loader, the output towering elevator comprises racks for loading SMIF pods transported through the bridge conveyer, and handling means for picking up SMIF pods and loading the same onto the output loader for receiving the processed contents.

5

5. The SMIF pod handler according to claim 4, wherein the out towering elevator comprises two tiers of racks for loading the SMIF pods thereon, the top rack is connected to the bridge conveyer.

10

6. The SMIF pod handler according to claim 2 and claim 4, wherein each of the towering elevator comprises a handling arm slidably mounted on a sliding bar, wherein the sliding bar is adapted to slide vertically over height of the towering elevator.

15

7. The SMIF pod handler according to claim 1, wherein the bridge conveyer comprises motorized wheels for conveying loaded pods.

8. The SMIF pod handler according to claim 1, wherein the upstream unit comprises a RFID scanner for reading an RFID tag attached to each of the SMIF pod.

20

9. The SMIF pod handler according to claim 1, wherein the downstream unit comprises a RFID scanner for reading an RFID tag attached to each of the SMIF pod.

25

10. The SMIF pod handler according to claim 1, wherein the bridge conveyer comprises a buffering and sorting rail, the buffering and sorting rail comprising: two rolls of sorting lots extending along the length of the pod handler;

a shuttle movable along an aisle rail between the two rolls of sorting lots,

30

wherein the shuttle is adapted to operably load and unload SMIF pods over the two rolls of the sorting lots.

11. The SMIF pod handler according to claim 10, wherein each of the sorting lots and shuttle comprises a wheel conveyer oriented horizontally against the length of the buffering and shorting rail, wherein SMIF pod loaded thereon can be conveyed sideways between the two rolls of lots and the shuttle.

5

12. The SMIF pod handler according to claim 11, wherein the wheel conveyer comprises individually motorized in-line wheels.