SYSTEM FOR THE CONVEYING AND STORAGE OF CONTAINERS OF SEMICONDUCTOR WAFERS, AND TRANSFER MECHANISM

The present invention relates to the conveying and storage of containers of semiconductor wafers in centres manufacturing semiconductor wafers, and more especially to an integrated system suitable for transferring and storing the containers of semiconductor wafers between the tools for processing the semiconductor wafers, said tools being disposed in a row of processing tools in a semiconductor wafer manufacturing centre, and also to a mechanism for transferring the containers intended for use in a system for the conveying and storage of containers of semiconductor wafers.

The semiconductor wafers are conveyed and processed under conditions which guarantee a clean environment, in which the number and size of the particles suspended in the air are controlled, corresponding to precise methods, notably the SMIF method. To this end, the semiconductor wafers are placed in impervious containers during transport, these containers being positioned against wafer loading and unloading openings which are disposed on the processing tools, which operate in a controlled atmosphere, so as to transfer the said wafers into the said tools for processing these wafers by means of robots, which are appropriately disposed in the tools. One row in the wafer manufacturing centre generally includes several wafer processing tools, therefore there are several openings for loading and unloading the wafers, and the containers are conveyed from one row to another in the centre by means of a supply line or an inter-row conveyor which usually uses a suspended rail that runs above the loading/unloading openings, and a lift which allows the container to be raised or lowered from the rail in front of an opening. The speeds of processing the wafers in each processing tool in one row are different and this gives rise to problems managing the flow of the containers in the rows and to the need to adopt buffer or temporary storage regions. Between one tool with a normal wafer throughput and a tool with a slow rate of measurement, both of which can be located in the same row, the difference in throughput can be to the order of 25 containers per hour in order to keep each tool at optimum performance.

The prior art refers to integrated systems that include temporary storage regions for the containers, including means for the distribution of these containers between one supply line in the row of containers, the storage and temporary storage locations and the openings for loading/unloading in the tools disposed in the row.

A system including storage at the front of the row, for example, is known. The inter-row conveyor, which links the rows so as to supply each of them with containers, deposits and picks up the containers from a storage unit at the entrance to the row, then a row-based conveyor picks up the containers parked in storage and takes them to the loading/unloading openings in the

processing tools or to the buffer storage placed in a protruding manner at the front face of the tools, that-is-to-say protruding forwards in a plane defined by the opening for the loading/unloading of the wafers. Where there is a buffer storage at the front face of certain tools, a tool-based supply mechanism allows the conveyance of the containers from the temporary storage region towards the loading/unloading opening and vice versa, as the row-based conveyor can no longer operate due to the fact that congestion caused by the temporary storage region at the front face hampers any movements of the row-based conveyor trying to supply the loading/unloading opening of the tool in a direct manner. Alternatively, a container can be directly transferred from the inter-row conveyor to the row-based conveyor without calling at the storage at the front of the row, to be conveyed then to the loading/unloading openings or the temporary storage regions, as explained above. The row-based conveyor can comprise a combination of a rail, which is disposed above the loading/unloading openings of the tools, and a lift, which allows a container to be lowered, suspended on the rail, opposite the loading/unloading opening of the tool; in this case it is necessary for the upward or downward path to be free, which is not the case when the storage regions are disposed at the front face above the loading/unloading openings, and, additionally, it is not possible for the lift to grasp hold of containers placed at the front face and below a first line of containers, hence the need for a specific additional device, often bulky, to convey the containers that are situated in the lower temporary storage regions to the loading/unloading openings.

Such an arrangement of storage regions requires a large floor surface and specific means to take into account the set-up of these temporary storage regions, as well as specific additional mechanisms to supply the containers. Moreover, the complexity of the mechanical systems for container conveyance also entails more risks of breakdowns and extra management costs. The breakdown of a supplying mechanism specific to one tool leads to the isolation of that tool and the inability of it being supplied with containers. Moreover, there is reason to remember that the floor surface in units that process semiconductor wafers is extremely costly considering the current requirements for cleanliness.

US 5,980,183 puts forward a solution consisting of eliminating the conventional storage and temporary storage regions by creating an additional space inside a row of tools without increasing the size of that row. US 5,980,183 actually puts forward a system for storing general containers at the front face of the processing tools and above the loading/unloading openings, protruding from the front face and from the plane defined by the wafer loading/unloading openings, and being able to exceed the height of the tools, thereby replacing the storage at the front of the row and the temporary storage at the front face provided for a specific tool of the previous state of the art. This method of storage requires the presence of a shuttle which is able to access the front face of the storage shelves and an interface with the inter-row supply line for containers. This shuttle includes a means for gripping mobile containers when travelling in the direction of two perpendicular axes, travelling in the vertical plane just in front of the storage shelves, therefore in a

vertical plane placed in front of the containers stored at the front face of the tools. The shuttle allows the containers deposited by the inter-row supply line to be picked up at the entry to the row on the appropriate shelves, and therefore replaces the row-based conveyor and the mechanism for conveying the containers specific to each tool having a buffer storage, from the previous state of the art. This represents a considerable simplification of the system. However, the containers are stored at the front face of the tools, such that they protrude from this latter, and require a conveying mechanism placed further in front of the stored containers; consequently, such a storage system calls for a large set-up on the ground, and therefore large production and operating costs. Moreover, there is an increased risk of contamination in the openings between the storage shelves and the conveying mechanism placed in front of and above the loading/unloading openings.

It is the object of the present invention to remedy these disadvantages. More especially, the invention includes a system for the conveying and storage of containers of semiconductor wafers, intended for use in at least one row in a semiconductor factory, the said at least one row including one or several tools for processing the semiconductor wafers, the said processing tool or tools including respectively a front face provided with at least one opening for loading/unloading the semiconductor wafers, said opening being suitable for association with a semiconductor wafer container, all the openings for loading/unloading the wafers of the said processing tool or tools being approximately included in one vertical plane, the said row being supplied with containers by a row conveyor located above the processing tool or tools and parallel to the said vertical plane, characterised in that the said system includes,

- means for storing the containers in a space located above the said tool or tools for processing the semiconductor wafers and set back towards the back of the said openings for loading/unloading the semiconductor wafers,
- means for temporary support of at least one container, protruding from the front face of the processing tools, said means situated directly below the row conveyor, suited for leaving free the space located above the said openings for loading/unloading the semiconductor wafers,
- first means of transfer of the containers from the said temporary support means towards the said storage means, and vice versa,
- second means of transfer of the containers from the said storage means towards the said openings for loading/unloading the semiconductor wafers, and vice versa,
- third means of transfer of the containers from the said temporary support means towards the said openings for loading/unloading the semiconductor wafers, and vice versa.

According to an advantageous characteristic, the said storage means comprise a plurality of shelves located in a volume situated in its entirety above the said tool or tools for processing the semiconductor wafers and behind the said openings for loading/unloading the wafers.

According to another advantageous characteristic, the said storage shelves extend along the length of the said at least one row and are in several levels one above the other.

According to another advantageous characteristic, the said storage means include a framework comprising:

- a upper part to which the plurality of shelves are secured, all supported on the framework,
- a floor situated above the tool or tools for processing the semiconductor wafers, the said floor including a free region located along the length of the shelves and the row, allowing an operator to move around freely,
- pillars supporting the said floor resting on the ground.

Alternatively, the said storage means includes a framework comprising:

- an upper part to which the plurality of shelves are secured, all supported on the framework,
- a floor situated above the tools for processing the semiconductor wafers, the said floor including a free region located along the length of the shelves and the row, allowing an operator to move around freely,
- means for suspending the floor and the upper part as a ceiling in the row.

According to another advantageous characteristic, the said floor includes means to allow air to circulate in a vertical manner.

According to another advantageous characteristic, the said first, second and third means of transfer of the containers are combined into one transfer mechanism, which includes means for gripping a container, means for displacing said gripping means in the three spatial directions, enabling said gripping means to reach the openings of the tool or tools for the loading/unloading of the wafers, the storage shelves and the temporary support means.

According to another advantageous characteristic, the said means for displacing the gripping means have at least three degrees of freedom when travelling in the three perpendicular directions X, Y and Z.

According to another advantageous characteristic, the said transfer mechanism includes the first guiding means, which is parallel to the row and allows a degree of freedom to be obtained when travelling in the direction X, the second guiding means, which allows a degree of freedom to be obtained when travelling in the direction Z, a carriage carrying the gripping means and guided when travelling on the said second guiding means, the gripping means being connected to the carriage by means of a connection with a degree of freedom when travelling in the direction Y.

According to another advantageous characteristic, the said second guiding means travel freely on the said first guiding means.

According to another advantageous characteristic, the length of the said first guiding means is approximately equal to the length of the row, and the height of the said second guiding means is approximately equal to the height of the upper part of the framework.

According to another advantageous characteristic, the said first guiding means and the said second guiding means are disposed set back towards the back of the openings of the tools in a space situated above the tools for processing the semiconductor wafers, and just in front of the storage shelves.

According to another advantageous characteristic, the said gripping means are also connected to said carriage through the intermediary of a vertical lift system, which bestows on the gripping means an ability to access a region situated below the said carriage.

According to another advantageous characteristic, the said connection, with a degree of freedom when travelling in the direction Y between the gripping means and the said carriage, is obtained by means of a device, which allows the gripping means to be displaced in the direction Y on both sides of the first guiding means and the second guiding means.

According to another advantageous characteristic, the system according to the invention includes displacement means of the said temporary support means in such a manner as to allow the space situated above the said openings for loading/unloading the semiconductor wafers to be freed.

According to another advantageous characteristic, the said displacement means of the said temporary support means include a degree of freedom when travelling on the Y axis, such that the said temporary storage means can be displaced on the Y axis between a first position, so-called "pulled-out position", with the front face protruding, and a second position, so-called "closed position", in which the said support means does not extend beyond the front face of the processing tool or tools.

The invention also relates to a mechanism for the transfer of containers intended for use in a system for the conveying and storing of containers of semiconductor wafers in rows in a semiconductor factory, the said row including one or more tools for the processing of the semiconductor wafers, the tool or tools for processing each comprise a front face provided with at least one opening for loading/unloading the semiconductor wafers, said opening being suitable for association with a semiconductor wafer container, all of the openings for loading/unloading the wafers of the said processing tool or tools being approximately included in a vertical plane, the said row being supplied with containers by a row conveyor situated above the processing tool or tools and parallel to the said vertical plane, the said system for conveying and storing containers including means for storing the containers, means for the temporary support of at least one container and the transfer mechanism which includes:

- the means for gripping a container,

- the means for displacing the said gripping means in the three spatial directions (X, Y, Z), enabling the said gripping means to reach the openings of the tool or tools for loading /unloading the wafers, the means for storing and the means for temporary support, the said means for displacement of the gripping means presenting three degrees of freedom when travelling in the three perpendicular directions X, Y and Z,
- first guiding means parallel to the row, allowing a degree of freedom to be obtained when travelling in the direction X,
- second guiding means allowing a degree of freedom to be obtained when travelling in the direction Z,
- a carriage carrying the gripping means and guided when travelling on the said first guiding means or on the said second guiding means, the gripping means being connected to the said carriage by at least one connection with a degree of freedom when travelling in the direction Y,

characterised in that the said gripping means are moreover connected to said carriage through the intermediary of a vertical lift system which bestows on the gripping means an ability to access a region situated below the said carriage.

Other advantages and characteristics can be found by reading the following description of an exemplified embodiment of a system for the conveying and storage of containers of semiconductor wafers according to the invention, and of a mechanism for the transfer of containers according to the invention, accompanied by the appended drawings, the example quoted is for information only and is in no way restrictive, in which:

Figure 1 is a perspective view of the exemplified embodiment of a system according to the invention,
Figure 2 is a front view of the example in Figure 1,
Figure 3 is a top view of the example in Figure 1,
Figure 4 is a side view of the example in Figure 1,
Figure 5 is an enlarged view in perspective of a detail in the example in Figure 1,
Figures 6A and 6B show, in two different operating positions, a bottom view in perspective of an enlarged detail in the example in Figure 5,
Figure 7 is a schematic sectional view in the direction of the Y-axis of the detail shown in Figures 6A and 6B.

The system represented in Figure 1 for the conveying and storage of containers 1 of semiconductor wafers (not represented), is intended for use in at least one row 2 in a semiconductor wafer factory, the row represented in the example including, for example, four 300 mm-selector tools 3 for processing the semiconductor wafers and two tools 4 for measuring purposes. The tools 3, 4 for processing the wafers each include front faces 5, 6, each front face of each tool being provided with an opening 7 for loading/unloading the semiconductor wafers, said opening being suitable for association with a container 1 containing a plurality of semiconductor wafers to be processed, all of the openings for loading/unloading the wafers of the said processing tool or tools being approximately included in a vertical plane 8, the row 2 being

supplied with containers by a row conveyor 9 situated above the processing tools 3 and 4 and parallel to the vertical plane 8 , such as is represented in Figures 1, 3 or 4. The system represented in Figures 1 to 7 also includes,

- means for storing 10 the containers 1 in a space 11 which is situated above the tools 3 and 4 for processing the semiconductor wafers, is set back from the openings 7 for loading/unloading the semiconductor wafers, and towards the back of these openings, more especially is set back from the vertical plane which includes the loading/unloading openings, and towards the back of this vertical plane; Figure 1 representing the system as viewed from the front,
- means for temporary support 12 of two containers 1, notably respectively a support means for the container coming into the storage means and a support means for the output of a container out of the storage means, protruding from the front face 5, 6 of the processing tools 3, 4, said support means situated directly below the row conveyor 9 and, in the example, offset laterally from the openings 7 for loading/unloading the semiconductor wafers positioned on the processing tools, such that the space situated above the openings 7 for loading/unloading the semiconductor wafers is left free,
- first means of transfer 13 of the containers 1 from the temporary support means 12 towards the storage means 10, and vice versa,
- second means of transfer 13 of the containers 1 from the storage means 10 towards the openings 7 for loading/unloading the semiconductor wafers, and vice versa,
- third means of transfer 13 of the containers 1 from the temporary support means 12 towards the openings for loading/unloading the semiconductor wafers, and vice versa.

As is represented more especially in Figures 5 to 7, the first, second and third means of transfer of the containers 1 are combined in one transfer mechanism 13, which includes means for gripping 14 a container 1, means for displacing 15 the gripping means 14 in the three spatial directions X, Y, Z, enabling these gripping means 14 to reach the openings 7 of the tools 3, 4 for loading/unloading the wafers, the storage shelves 16 and the temporary support means 12. The transfer mechanism 13 will be described in a more detailed manner later in the document.

The storage means 10 comprise a plurality of shelves 16 located in a volume situated in its entirety above the tools 3, 4 for processing the semiconductor wafers and behind the openings 7 for loading/unloading the wafers. As represented in Figures 3 and 4, the shelves 16 allow the containers 1 to be stored approximately against a vertical plane 17 set back from the vertical plane 8, which includes the openings 7, by a spacing in excess of the dimension of the containers 1 in the direction of the Y-axis, that is said to be the width of the container 1. The plurality of shelves 16 includes, for example, four horizontal levels or stages one above the other, preferably extending approximately along the length of the row 2 so as to utilise the maximum space available. Each shelf making up one level can be continued or discontinued, and allows, in the example, nine containers 1 to be aligned. The quantity of containers aligned on one level depends on the length of the

row, which is itself conditioned by the number of processing tools provided in one row. The storage height in the direction Z is only limited by the space available above the tools. It is possible to construct a higher number of levels of shelving, up to the maximum admissible height in terms of the construction housing the row. The shelves must allow free front access to each of the containers that have been stored independently from the other stored containers, more especially they must allow the gripping means 14 to access the upper part of each container 1 where the container is picked up. Consequently, the height separating two shelves one from the other must be sufficient to allow the gripping means 14 to penetrate between these shelves along with a container associated with said gripping means, to allow a container to be released or picked up or gripped.

The storage means 10 include a framework 18, which comprises a floor 19 situated above the tools 3, 4 for processing the semiconductor wafers, pillars 20 for supporting the floor 19 that rest on the ground, and an upper part to which the plurality of shelves 16 are secured, all being supported by the framework 18.

The floor 19 taken in its frame, the pillars 20 and the upper part 22 of the framework 18, for example, are machine-welded, tubular metal sections. The floor 19 itself, in an advantageous manner, is produced from punched or openwork sheets so as to allow it to be traversed by a vertical air flow, and in an advantageous manner includes a free region 21 situated along the length of the shelves 16 and the row 2 behind the plane 17 of support of the shelves 16, as shown in Figures 3 and 4, allowing an operator to move freely. The framework 18 will be designed and manufactured by applying the known rules of mechanical construction so that it can support at least its own weight, that of the transfer mechanism 13 and of the temporary support means 12, that of a number of containers filled with wafers equal to the capacities of storage and support of the containers, as well as the weight of at least one operator in the free region 21. The free region 21 will preferably include a vertical access, reached, for example, by means of a ladder 26, along with protection barrier means 27, as represented in Figures 3 and 4.

The upper part 22 of the framework 18, which provides a structure supporting the shelves 16 and the transfer mechanism 13, as represented more especially in Figure 1, can adopt the shape of an open parallelepipedal skeleton structure formed by the edges 23 of the parallelepiped and the vertical and/or horizontal intermediate reinforcing rods (24) and does not impede access to the shelves 16. The sides of the parallelepiped that are not utilised to access the stored containers 1, that is the side ends 24 of the row 2 and the top 25, can be closed by protective sheets.

The tools for processing 3, 4 the wafers are mounted in the row 2 between the pillars 20 of the framework 18 and below the floor 19, as can be seen in Figure 1, the front face of the tools, which includes the openings 7, being positioned in the vertical plane 8 approximately defined by the pillars 20 and the vertical edges of the parallelepiped making up the upper part 22 of the framework 18, when viewing their exterior faces.

The framework 18 also has to be suitable to support the row conveyor 9, situated above the processing tools 3, 4 and parallel to the vertical plane 8, by means of one or several locking supports 28 of the conveyor 9, preferably secured to one or several vertical edges of the upper part 22 of the framework 18.

Alternatively and according to need, the floor 19 and the top part 22 can be suspended as a ceiling instead of being supported on the ground, thanks to all the types of known means of suspension (not represented), for example, the unit formed by the floor 19 and upper part 22 can be attached to the ceiling of the row by means of suitable pins and fixing screws. Such an arrangement can be advantageous for minimising interaction between the bearing structure of the system and the equipment mounted on the ground.

The temporary support means consist of two shelves 12 secured against the vertical plane 8 on the framework 18, preferably approximately at the level of the floor 19, and protruding towards the front as shown in Figure 1. The shelves 12 are horizontal and each has a surface that corresponds at the most and approximately to the bottom surface of a container 1 so as to reduce the floor-space taken up by these temporary storage means. One support 12 is allocated for the receipt of the containers from the row conveyor 9, the other support 12 being allocated for the departure of the containers to the row conveyor. It must be noted that this allocation of departure and arrival can equally well be reversed. Alternatively, in the case of a storage system with a short length in the direction X, for example a system comprising one single tool or a few tools, the temporary support means can each be constituted in an advantageous manner by an extractable drawer, that-is-to-say in the direction of the Y-axis, in accordance with any known extractable drawer-type means, that-is-to-say at right angles to the vertical plane 8 which includes the openings 7. The storage system will comprise a means for displacing each extractable drawer, for example a motorised drawer, in such a manner that this latter can adopt a first position, the so-called "pulled-out position", protruding from the front face as shown in Figure 1, and a second position, the so-called "closed position" (not shown), in which the temporary support means 10 does not extend beyond the front face 5, 6 of the processing tools 3, 4, and does not impede access to the openings 7 from above for the transfer mechanism if this temporary support 12 is mounted above said opening.

The transfer mechanism will now be described in more detail by way of Figures 5 to 7. As represented more especially in Figure 5, the means for displacing 15 the gripping means 14 presents three spatial degrees of freedom travelling in the three perpendicular directions X, Y and Z. The transfer mechanism 13, to this end, includes:

- first guiding means 29 parallel to the row 2, secured to the framework 18 and bestowing on the gripping means 14 a degree of freedom when travelling in the direction X,

- second guiding means 30 connected to the first guiding means 29 and travelling freely on these latter, bestowing on the gripping means 14 a degree of freedom when travelling in the direction Z,
- a carriage 31 carrying the gripping means 14, connected to the second guiding means 30 and travelling freely on this latter,
- gripping means 14 which are connected to the carriage 31 by a connection with a degree of freedom when travelling in the direction Y, and a degree of freedom when travelling in the direction of the Z-axis by means of a vertical lift system 36, which bestows on the gripping means 14 an ability to access a region situated below the said carriage and notably below the lower limit of the second guiding means 30.

Alternatively, the second guiding means 30, which bestows on the gripping means 14 a degree of freedom when travelling in the direction Z, can be directly connected to the framework 18, the first guiding means 29, which bestows on the gripping means 14 a degree of freedom when travelling in the direction X, then being mounted to travel freely along the second guiding means (not represented).

The length of the first guiding means 29 is approximately equal to the length of the row 2, the height of the second guiding means 30 is approximately equal to the height of the upper part 22 of the framework 18, which means that the displacement of the carriage 31 in the directions X and Z covers the access, for the gripping means, to all the storage shelves 16. The first guiding means 29 and the second guiding means 30 each adopt, in an advantageous manner, the form of prismatic rails and are disposed set back from the openings 7 of the tools 3, 4 and from the vertical plane 8 which includes them, in a space 32 situated above the tools 3, 4 for processing the semiconductor wafers, and in front of the shelves 16.

In the example represented in Figure 5, the two prismatic rails 29, constituting the first guiding means, are secured in a rigid manner respectively approximately at the level of the apex 33 and a little above the floor 19 of the framework 18, in a horizontal manner. In the arrangement represented in Figure 5, which includes a single vertical rail 30 as the second guiding means, there must be a sufficient gap between the floor 19 and the horizontal rail 29 for a container 1 to pass through on both sides of the vertical plane 8 and under the lower horizontal rail 29.

The second guiding means, constituted by one or two (not represented) prismatic rails 30, are maintained vertical and parallel in a rigid manner, thereby adopting the form of a frame in the case of the two rails, the rail or rails 30 being guided when travelling on the horizontal rails 29 by their ends in accordance with any known means, for example by means of bearing connections. The carriage 31 adopts the form of a rigid structure guided when travelling on the vertical rail or rails 30 by any known means, for example by means of a bearing connection. The displacement on the X-axis on the horizontal rails 29 of the vertical rail or rails 30 is advantageously obtained according to any known means, for example by means of a linear motor (not represented), and the displacement of the carriage 31 on the

vertical rail or rails 30 on the Z-axis is advantageously also obtained according to any known means, for example by means of a servomotor and a belt drive (not represented).

As confirmed in the example represented in Figure 5, where a single vertical rail 30 is used, it is not possible to displace the gripping means 14 in the Y-axis unless the carriage 31 is in the bottom position at the lower end of the vertical rail 30. At this location, in fact, the telescopic device 37 can move on the Y-axis on both sides of the rails 29 and 30 without being impeded by these latter. If the gripping means 14 have to be moved on both sides of the rails 29, 30 to any location in the storage shelves 16, it is necessary to use two vertical rails 30 connected by a carriage 31 carrying the gripping means 14, the gap between the two vertical rails being in excess of the width of one container 1. Thus, the telescopic device 37 operates between the two vertical rails between which the container 1 has to pass, its displacement not being hampered any longer by this or these latter. The horizontal rails 29 are mounted such that they do not impede the displacement of the telescopic device 37 at the relevant locations.

The gripping means 14 are constituted by a standard pair of pincers 35, suitable for grasping a container 1 by its upper part, and by a vertical lift system 36 allowing the pincers 35 to be displaced in the direction of the Z-axis, the pincers 35 and the vertical lift system being connected to the carriage 31 through the intermediary of any means bestowing a degree of freedom in the direction Y on the pincers 35 and on the lift system 36, as shown in Figures 5, 6A, 6B and 7. It must be noted that the telescopic device 37, when there is a container 1 present in the pincers 35 and when this latter is brought to a high position, the pincers 35 against the telescopic device 37, allows the container 1 to be displaced in the direction of the Y-axis on both sides of the rails 30, as previously indicated. When the telescopic device 37 is behind the rails 30, the gripping means 14 can place or pick-up a container placed on a shelf 16. When the telescopic device 37 is ahead of the rails 30, the gripping means 14 can place or pick-up a container 1 placed in a loading/unloading opening 7 or a temporary storage means 12.

In Figure 5, the telescopic device 37 following the Y-axis has been represented in its extended position, as well as in Figure 6A. In Figure 6B the same telescopic device has been represented in its intermediate position as described above. Figure 7 shows the telescopic device in its extended position.

The lift system 36 following the Z-axis can be obtained by any means, notably a cable lift means as represented in Figure 5. It can be noted that the transfer mechanism 13, via the lift system, when the pincers 35 are placed directly above the openings 7 of the tools 3, 4, has a function similar to that of the row conveyor 9 which, thanks to its lift (not represented) allows notably the depositing or the picking-up of a container 1 at these same openings. The transfer mechanism 13 can thereby carry out tasks given previously to the row conveyor 9. Such a system makes the device according to the invention very versatile, and results in an appreciable time gain as the speed of

displacement of the containers 1 with the transfer mechanism means 3 is much more rapid than the speed of displacement of the containers 1 with the row conveyor 9.

The system for conveying and storing the containers 1 of semiconductor wafers is managed by a central computer (not represented) and includes system driving software which acts as the interface for an operator, and authorises computer control determined by the transfer mechanism in terms of the requirements of the tools for processing the wafers, that-is-to-say a control of the displacement and the actuation of the gripping means, or of the corresponding motor devices, in the three directions X, Y and Z. To this end, the system includes sensors (not represented) picking-up the presence of the containers 1 at each container storage or support location, so that at all times which locations are available or occupied can be known. The system can obviously operate automatically, using system control programming software, adapted in terms of the requirements.

The system for conveying and storing containers 1 of semiconductor wafers such as represented in the Figures operates in the following manner:

The row conveyor 9 supplies the row with containers 1. The conveyor deposits the containers 1 one by one on an incoming support 12, or directly in the openings of the tools placed directly below the lift (not represented) of the row conveyor 9.

If the container is deposited on the incoming support 12, this container is then grasped by the gripping means 14 of the transfer mechanism 13, which has just positioned itself above the container thanks to the displacements in the directions X, Y and Z, then grasps the container to convey it and deposit it on a storage location on the shelves 16, waiting to be allocated to a specific processing tool, thanks to the displacements in the directions X, Y and Z and to the lift system 36 of the transfer mechanism. The incoming support is thus freed to receive another container from the row conveyor. The container thus stored on the shelves 16 is then, when the processing tool to which the container is to go allows it, grasped again by the gripping means 14 then conveyed and deposited in the opening 7 of the intended tool, by means of the displacements in the directions X, Y and Z of the transfer mechanism, and of the lift system 36 of this latter which lowers the pincers 35 and the container into the opening 7 of the intended tool. Alternatively, the container, deposited on the incoming support 12 by the row conveyor 9, can then be grasped and conveyed directly to an opening of the intended tool, then, from this opening, conveyed to the outgoing support 12 or conveyed to a storage location on the shelves 16.

If the container is deposited directly in an opening of the tool by the row conveyor, this container, once the semiconductor wafers have been processed in the tool, can be directly picked up again by the row conveyor or grasped by the transfer mechanism and conveyed towards a storage location on the shelves 16 or conveyed to the outgoing support 12, by means of the displacements in the X, Y and Z directions of the transfer mechanism, and of

the lift system 36 of this latter, which raises the pincers 35 and the container from the tool opening 7 so that this container can be placed waiting for another tool allocation in the row, or respectively can wait to be picked up by the row conveyor.

It must be noted that the structure of the system described by way of Figures 1 to 5 allows the gripping means 14 of the transfer mechanism 13 to reach, in a physical manner, a container deposited at any location in the system that is able to support a container, that-is-to-say to reach the storage shelves 16 above and behind the tool openings, the incoming and outgoing supports 12 and the openings 7 of the tool in the row, and to displace a container located in any one of these locations towards any other location. However, the driving software of the system loaded in the central computer can, according to requirements and in terms notably of the type of tool present in the row, limit the displacements of the gripping means towards just certain of these locations, excluding for example, the supports 12, and reserving these latter solely for access by the row conveyor.

Claims

1. System for the conveying and storage of containers (1) of semiconductor wafers, intended for use in at least one row (2) in a semiconductor wafer factory, the said at least one row including one or several tools (3, 4) for processing the semiconductor wafers, the said processing tool or tools including respectively a front face (5, 6) provided with at least one opening (7) for loading/unloading the semiconductor wafers, said opening being suitable for association with a semiconductor wafer container (1), all the openings for loading/unloading the wafers in the said processing tool or tools being approximately included in a vertical plane (8), the said row being supplied with containers by a row conveyor (9) located above the processing tool or tools and parallel to the said vertical plane, characterised in that the said system comprises:
   - means for storing (10) the containers in a space (11) situated above the said tool or tools for processing the semiconductor wafers and set back towards the back of the said openings for loading/unloading the semiconductor wafers,
   - means for temporary support (12) of at least one container, protruding from the front face (5, 6) of the processing tool or tools (3, 4), said means situated directly below the row conveyor (9) suited for leaving free the space located above the said openings (7) for loading/unloading the semiconductor wafers,
   - first means of transfer (13) of the containers (1) from the said temporary support means (12) towards the said storage means (10), and vice versa,
   - second means of transfer (13) of the containers (1) from the said storage means (10) towards the said openings (7) for loading/unloading the semiconductor wafers, and vice versa,
   - third means of transfer (13) of the containers from the said temporary support means (12) towards the said openings (7) for loading/unloading the semiconductor wafers, and vice versa.

2. System according to claim 1, characterised in that the said storage means (10) comprise a plurality of shelves (16) located in a volume situated in its entirety above the said tool or tools (3, 4) for processing the semiconductor wafers and behind the said openings (7) for loading /unloading the wafers.

3. System according to claim 2, characterised in that the said storage shelves (16) extend along the length of the said at least one row (2), and are in several levels one above the other.

4. System according to claim 2 or 3, characterised in that the said storage means (10) include a framework (18) comprising:
   - an upper part (22) to which the plurality of shelves (16) are secured, all supported on the framework (18),

- a floor (19) situated above the tools (3, 4) for processing the semiconductor wafers, said floor including a free region located along the length of the shelves and the row, allowing an operator to move around freely,
- pillars (20) supporting the said floor resting on the ground.

5. System according to claim 2 or 3, characterised in that the said storage means (10) include a framework (18) comprising:
   - an upper part (22) to which the plurality of shelves (16) are secured, all supported on the framework (18),
   - a floor (19) situated above the tools (3, 4) for processing the semiconductor wafers, said floor including a free region located along the length of the shelves and the row, allowing an operator to move around freely,
   - means for suspending the floor and the upper part as a ceiling in the row.

6. System according to claim 4 or 5, characterised in that the said floor (19) includes means to allow air to circulate in a vertical manner.

7. System according to one of claims 2 to 6, characterised in that the said first, second and third means of transfer of the containers are combined in one transfer mechanism (13), which includes means for gripping (14) a container (1) and means for displacing (15) said gripping means in the three spatial directions, enabling said gripping means to reach the openings (7) of the tool or tools (3, 4) for the loading/unloading of the wafers, the storage shelves (16) and the temporary support means (12).

8. System according to claim 7, characterised in that the said means for displacing (15) the gripping means (14) have a least three degrees of freedom when travelling in the three perpendicular directions X, Y and Z.

9. System according to claim 8, characterised in that the said transfer mechanism (13) includes the first guiding means (29), which is parallel to the row (2) and allows a degree of freedom to be obtained when travelling in the direction X, the second guiding means (30), which allows a degree of freedom to be obtained when travelling in the direction Z, a carriage (31) carrying the gripping means (14) and guided when travelling on the said first guiding means (29) or second guiding means (30), the gripping means being connected to the said carriage by at least one connection with a degree of freedom when travelling in the direction Y.

10. System according to claim 9, characterised in that the said second guiding means (30) travel freely on the said first guiding means (29).

11. System according to claim 9 or 10, characterised in that the length of the said first guiding means (29) is approximately equal to the length of

the row (2), in that the height of the said second guiding means (30) is approximately equal to the height of the upper part (22) of the framework (18).

12. System according to one of claims 9 to 11, characterised in that the said first guiding means (29) and the said second guiding means (30) are disposed set back towards the back of the openings (7) of the tool or tools (3, 4) in a space situated above the tool or tools for processing the semiconductor wafers, and just in front of the storage shelves (16).

13. System according to claim 12, characterised in that the said gripping means (14) are moreover connected to the said carriage (31) through the intermediary of a vertical lift system (36), which bestows on the gripping means an ability to access a region situated below the said carriage.

14. System according to one of claims 9 to 13, characterised in that the said connection, with a degree of freedom when travelling in the direction Y between the gripping means (14) and the said carriage (31), is obtained by means of a device (37) which enables the gripping means to be displaced in the direction Y on both sides of the first guiding means (29) and the second guiding means (30).

15. System according to one of claims 1 to 14, characterised in that the said system includes displacement means of the said temporary support means (12) in such a manner as to allow the space situated above the said openings (7) for loading/unloading the semiconductor wafers to be freed.

16. System according to claim 15, characterised in that the said displacement means of the said temporary support means (12) include a degree of freedom when travelling on the Y axis, such that the said temporary storage means can be displaced on the Y axis between a first position, so-called "pulled-out position" with the front face protruding, and a second position, so-called " closed position", in which the said support means (12) does not extend beyond the front face (5, 6) of the processing tool or tools (3, 4).

17. Mechanism for the transfer of containers intended for use in a system for the conveying and storing of containers of semiconductor wafers for a row (2) in a semiconductor wafer factory, the said row including one or more tools (3, 4) for the processing of the semiconductor wafers, the tool or tools for processing each comprising a front face (5, 6) provided with at least one opening (7) for loading/unloading the semiconductor wafers, said opening being suitable for association with a semiconductor wafer container (1), all of the openings for loading/unloading the wafers of the said processing tool or tools being approximately included in a vertical plane (8), the said row being supplied with containers by a row conveyor (9) situated above the processing tool or tools and parallel to the said vertical plane, the said

system for conveying and storing containers including means for storing the containers, means for the temporary support of at least one container and the transfer mechanism which includes:

- means for gripping (14) a container (1),
- means for displacing (15) the said gripping means in the three spatial directions (X, Y, Z) enabling the said gripping means to reach the openings (7) of the tool or tools (3, 4) for loading /unloading the wafers, the means for storing (10) and the means for temporary support (12), the said means for displacement (15) of the gripping means (14) presenting three degrees of freedom when travelling in the three perpendicular directions X, Y and Z,
- first guiding means (29) parallel to the row (2), allowing a degree of freedom to be obtained when travelling in the direction X,
- second guiding means (30) allowing a degree of freedom to be obtained when travelling in the direction Z,
- a carriage (31) carrying the gripping means (14) and guided when travelling on the said first guiding means (29) or said second guiding means (30), the gripping means being connected to the said carriage by at least one connection with a degree of freedom when travelling in the direction Y,

characterised in that the said gripping means (14) are moreover connected to the said carriage (31) through the intermediary of a vertical lift system (36), which bestows on the gripping means an ability to access a region situated below the said carriage.

18. Mechanism for transfer according to claim 17, characterised in that the said second guiding means (30) travel freely on the said first guiding means (29).

19. Mechanism for transfer according to claim 17 or 18, characterised in that the said connection, with a degree of freedom when travelling in the direction Y between the gripping means (14) and the said carriage (31), is obtained by means of a device (37) which allows the said gripping means to be displaced in the direction Y on both sides of the first guiding means (29) and the second guiding means (30).