

Treatment device for transport and storage boxes

The present invention relates to the devices used for cleaning and decontaminating the transport and storage boxes used for semiconductor substrates or photomasks.

5 In a facility that manufactures semiconductors, substrates such as semiconductor wafers and/or masks undergo treatments in process chambers. These treatments include various steps performed in different tools, such as steps of depositing material or etching steps for example. Between each step, the substrates are placed in transport and storage boxes which are themselves moved between the
10 various tools in the semiconductor manufacturing facility. The time spent waiting during transfers between tools may be long, typically lasting a few hours. The transport and storage boxes therefore serve as means for storing the substrates during the waiting times.

 At the present time, the lots of substrates are contained in mini
15 environments consisting of transport and storage boxes, notably such as the side opening or front opening unified transport pods known as FOUP (front opening universal pods) or bottom-opening standardized transport and storage pods known as SMIF (standard mechanical interface) pods.

 During the storage steps, particulate contamination carried in the air (or
20 AMC which stands for airborne molecular contamination), which results from the presence of reactive gases in the atmosphere inside the transport and storage boxes, reacts with the substrates and creates defects. These defects may make the semiconductor wafers unusable and cause the semiconductor manufacturing facilities considerable productivity losses. They are then responsible for expensive
25 losses of semiconductor wafers when the defect is not detected until after treatment.

 In order to avoid these drops in productivity of the semiconductor manufacturing facilities and the losses of semiconductor wafers already treated, proposals have been made for the transport and storage boxes, and the lot of substrates they contain, to be decontaminated using a method and a module for the
30 decontamination of confined environments. A decontamination module usually comprises a decontamination chamber with a side access door capable of containing

a single transport and storage box. The decontamination performed using such a module may last several hours.

One single module is therefore not capable of treating, under acceptable conditions, the high number of transport and storage boxes used in a semiconductor manufacturing facility.

One idea might be to increase the number of modules in the semiconductor manufacturing facility, so that the required throughput for decontamination of transport and storage boxes can be achieved. However, the disadvantage with this is that the space occupied by the decontamination modules, particularly the floor space they occupy, is likewise increased. Specifically, these decontamination modules are located in the clean room of the semiconductor manufacturing facility and clean room floor area represents a high investment and operating cost. At the same time, the layout of the decontamination modules has to be compatible with the Overhead Hoist Transport (OHT) system used for transporting the boxes in a semiconductor manufacturing facility.

Thus the present invention aims first of all to reduce the floor space occupied by the decontamination means.

Another object of the invention is to ensure that the decontamination means are compatible with the standardized overhead hoist transport (OHT) system used for transporting the boxes in a semiconductor manufacturing facility.

Another object of the present invention is to ensure that the decontamination modules are independent and operate in exactly the same way. The goal is to collect together several decontamination modules and arrange them in one and the same compact treatment device.

Another object of the invention is to meet environmental standards, particularly noise standards, as well as safety standards.

Because the number of decontamination modules is multiplied in order to create a single treatment device, compliance with noise standards entails confining the device inside an acoustically insulating chassis. However, the acoustic insulating means necessarily have a thermal insulating capability, which encourages the components of the treatment device to heat up, which heating is liable to damage

these components. It is therefore necessary to provide means for avoiding excessive heating, and this is another object of the present invention.

Another difficulty in permanently maintaining a sufficient treatment capacity is that of allowing individual maintenance of the decontamination modules that make up the treatment device, allowing maintenance to be carried out on one module without affecting the operation of the other modules.

Moreover, the invention aims to minimize the cost of producing such a treatment device, notably the cost of the means that handle the transport and storage boxes within the device.

One subject of the present invention is a treatment device for transport and storage boxes, comprising a decontamination module that has:

- a decontamination chamber with a side access door which is capable of containing a transport and storage box,
- means of introducing gas into the decontamination chamber,
- means of pumping the gases from the decontamination chamber,
- command and control means for controlling the gaseous atmosphere within the decontamination chamber.

The device according to the invention comprises:

- a plurality of decontamination modules supported by a common chassis; the decontamination modules being superposed on one another to form at least one column of modules,
- each decontamination module comprises its own pumping means having at least a primary pump,
- the primary pump is housed in a primary pumping compartment that is longitudinally offset with respect to the decontamination chamber.

In that way, each decontamination module is independent of the other modules and a significant space saving is made in the vertical direction and in the transverse direction, and the decontamination modules are interchangeable in use because their performance is identical.

For preference, the primary pump is supported by the common chassis with interposition of elastic connecting means preventing the transmission of vibration to the decontamination enclosure.

Such an arrangement may be particularly beneficial when the vacuum pumps are located in the upper levels of the treatment device, because any transmission of vibration from the pumps could give rise to resonance that causes vibration and defects in the semiconductor wafers contained in the transport and storage boxes.

Compliance with noise standards means that the walls of the primary pumping compartments need to comprise absorbent panels for acoustic insulation. In this event in particular, the thermal insulation that results from this means that special means have to be provided to avoid heating.

Thus, preferably it is ensured that:

- the primary pumping compartments of the decontamination modules of one and the same column of modules communicate with one another with no horizontal separation,
- each primary pump comprises an air cooling system with a cooling air intake at a first end of the pump and with a cooling air discharge at a second end of the pump,
- in one and the same column of modules, an intermediate vertical wall separates one from the other:
 - a first pumping compartment zone receiving all the cooling air discharges and comprising a lower air outlet, and
 - a second pumping compartment zone containing all the cooling air intakes and comprising an upper ambient air inlet.

The air flows that result from this arrangement allow the heating resulting from operation of the primary pumps to be reduced very substantially so that all of the components of the treatment device are kept at a satisfactory temperature.

According to one embodiment, it is ensured that:

- the side access doors to the decontamination modules are all oriented along one and the same access side and are each controlled by actuating means which open and close them,
- a lateral transfer zone is provided on the access side and comprises a robot capable of moving the transport and storage boxes between a frontal loading-unloading station and the decontamination chamber of each of the decontamination modules.

Thanks to the fact that several modules are superposed in a column, and to the fact that the columns of modules are arranged in a line in a longitudinal row of

columns, the transverse size of the treatment device is limited to the width of one decontamination module increased by the width of the lateral transfer zone containing the robot. This transverse size defines the length occupied by the treatment device in the path defined by the box overhead hoist transport (OHT) system.

At the same time, the vertical space occupancy of the treatment device can be optimized to suit the height available in the semiconductor manufacturing facility.

Finally, the longitudinal occupancy of the treatment device can be optimized to suit the length available in a semiconductor manufacturing facility bay between two successive spans of the box overhead hoist transport (OHT) system, by a suitable choice of the number of columns of modules arranged in a line.

According to an alternative, it is ensured the side access door of each decontamination module is a sliding access door which, when open, is laterally offset to the side of the primary pumping compartment and which is controlled by a sliding actuator

The sliding nature of the side access doors avoids any risk of damage to the robot and to the doors when the sliding of the doors is outside of the lateral transfer zone occupied by the robot.

At the same time, the sliding movement of the door is parallel to the lateral transfer zone, between the decontamination chamber and the primary pumping compartment, without increasing the amount of space occupied by the decontamination module. This yields a significant space saving.

For preference, the sliding access door is mounted to slide longitudinally on a frame itself mounted with pivoting about a vertical axis of pivoting and made to pivot by a pivoting actuator.

This arrangement makes it possible in a simple way to ensure that the access door seals well and at the same time makes it possible to reduce seal friction, which friction is liable to release contaminating particles the presence of which would be particularly detrimental in a semiconductor manufacturing facility clean room.

According to another embodiment, each decontamination chamber of the decontamination modules comprises, on the opposite side to the access side, a maintenance door that can be opened by an operator so that individual maintenance

can be carried out on one decontamination module. Thus, an operator can perform individual maintenance on one decontamination module without affecting the operation of the other modules or the operation of the robot.

For preference, each decontamination module comprises a safety device
5 which:

- locks the maintenance door if the side access door is opened,
- locks the side access door and partially disables the robot if the maintenance door is opened.

This then guarantees the safety of the operators tasked with carrying out
10 maintenance and avoids any risk of damage to the robot or degradation of the content of the transport and storage boxes during maintenance on at least one decontamination module.

The device according to yet another embodiment further comprises:

- at least one first loading-unloading station,
- 15 - a lateral transfer zone provided on the side of the access to the decontamination modules, in line with the loading-unloading station,
- a robot, placed in the lateral transfer zone, capable of moving the transport and storage boxes between the frontal loading-unloading station and the decontamination chamber of each of the decontamination modules.

20 The overall architecture of the treatment device as defined hereinabove makes it possible to provide a robot that is particularly simple and inexpensive, for example a robot of a type comprising:

- longitudinal-translation means,
- vertical-translation means,
- 25 - means of rotating through 90° about a vertical axis,
- a radially extending arm.

Particularly in the case where there are a great many columns of modules arranged in lines in a longitudinal row, it is necessary to provide loading-unloading means that offer sufficient throughput that the operation of the other components of
30 the treatment device is not delayed. To do that, provision may advantageously be made for the device to comprise:

- a first loading-unloading station, in line with the lateral transfer zone,

- a second loading-unloading station, in line with the longitudinal row of columns of modules and comprising means of longitudinal movement and means of rotating through 90° about a vertical axis.

5 This then doubles the loading-unloading capacity, allowing loading-unloading operations to be performed in parallel time, without slowing down the robot.

 In order to comply with safety standards, each loading-unloading station may advantageously comprise a safety airlock.

10 For preference, it is also ensured that:

- each decontamination module comprises its own control means,
- the control means are arranged in a control panel positioned to the side on the same side as the primary pumping compartment.

 The control means positioned laterally on the primary pumping
15 compartment side make it possible to avoid any increase in the space required by the decontamination module. This then affords a significant space saving.

 In general, the decontamination modules entail the use of a primary pump and of a secondary pump, allowing pumping in two successive steps, namely a primary pumping step during which the primary pump is connected to the
20 decontamination chamber, and a strong vacuum pumping step during which the secondary pump is interposed between the decontamination chamber and the suction side of the primary pump.

 In this case, provision may advantageously be made for each decontamination module to comprise a secondary pump housed above the
25 decontamination chamber.

 In order to use small size secondary pumps (for example of the "ATH 31" type of the "ADIXEN" make or equivalent), provision may advantageously be made for the secondary pumps each to be associated with a permanent purge device and with a selective coupling device which:

- 30 - couples each of them to the respective primary pump of their decontamination module during the steps in which the pumps create a strong vacuum in the decontamination chamber or during the standby steps,

- couples all of them to one and the same common primary pump during the primary pumping steps.

The permanent purge and the presence of the common primary pump allow the secondary pumps to be kept in constant operation, avoiding any increase
5 in concentration of harmful gases that could degrade and destroy the secondary pumps.

Other objects, features and advantages of the present invention will become apparent from the following description of some embodiments, which is
10 given with reference to the attached figures in which:

- Figure 1 schematically illustrates a treatment device for transport and storage boxes according to one embodiment of the present invention;
- Figure 2 is a plan view illustrating the overall layout of a semiconductor manufacturing facility;
- 15 - Figure 3 schematically illustrates, in a plan view, the position of a treatment device for transport and storage boxes, according to one embodiment of the present invention;
- Figure 4 is a schematic view illustrating the supply means and the pumping means associated with the decontamination chamber of a decontamination module
20 according to one embodiment of the invention;
- Figure 5 is another block diagram of the supply and pumping means associated with the decontamination chambers of a treatment device according to the present invention;
- Figure 6 is a schematic side view illustrating the overall architecture of a treatment
25 device for transport and storage boxes according to an embodiment of the invention that employs four decontamination modules;
- Figure 7 is a schematic plan view of the treatment device of Figure 6;
- Figure 8 is a plan view illustrating the details of the kinematics of the doors of a decontamination chamber of the treatment device of Figures 6 and 7;
- 30 - Figures 9 and 10 illustrate another embodiment of the kinematics governing the movement of the doors of a decontamination chamber of the treatment device of Figures 6 and 7;

- Figure 11 is a schematic side view in cross section illustrating the ventilation system of the primary pumps of the treatment device according to one embodiment of the present invention; and

- Figure 12 is a schematic side view in cross section illustrating the general arrangement of the pumping means of the treatment device of Figures 6 and 7.

Reference is made first of all to Figure 1 which illustrates a transport and storage box **1**, defining a non-fluidtight confined environment in the form of a volume **2** bounded by a wall **3** and comprising a leak **4**. The wall **3** is generally made of polycarbonate.

A decontamination chamber **5** has an interior volume **5a** just a little greater than the volume of the transport and storage box **1**. The decontamination chamber **5** comprises a fluidtight peripheral wall **5b**, with an access door **5c** allowing the transport and storage box **1** to be introduced and removed. The wall **5b** of the decontamination chamber **5** is, for example, made of stainless steel with a polished interior surface, capable of withstanding a vacuum of one atmosphere. The interior polishing prevents the degassing of the peripheral wall **5b** during vacuum decontamination operations.

An inlet **6** allows a gaseous flow from a source of treatment gas **13** to be introduced into the decontamination chamber **5**, while an outlet **7** connected to gas pumping means **8** allows a vacuum to be created inside the decontamination chamber **5**.

The pumping means **8** comprise at least one primary pumping unit **8a**, and advantageously also a secondary pumping unit **8b**, for example of the turbomolecular, molecular or hybrid type.

In the embodiment illustrated, the decontamination chamber **5** is associated with a pressure sensor **10**, with an isolation valve **12** coupled in the pumping line in series with the pumping means **8**, a source of treatment gas **13** coupled to the inlet **6**, a degassing flow sensor **11**, control means **14** and a deformation sensor **15**.

The control means **14** may comprise a processor **14a** associated with a memory **14b** in which control programs are loaded. The processor **14a** may receive data from the various sensors such as the pressure sensor **10**, the deformation sensor **15**, the degassing flow sensor **11**.

At output, the processor **14a** is connected in a way known per se to various actuators able to act on the isolation valve **12**, on the motors that drive the primary pump **8a** and the second pump **8b**, on a valve that controls the flow rate of the stream of gas passing through the gas introduction means **6**, **13**.

5 The deformation sensor **15** comprises a laser emitter/receiver which, through the viewing port **9a**, detects the distance separating it from the wall **3** of the transport and storage box **1**. Thus, the deformation sensor **15** can be used both for detecting the deformation of the transport and storage box **1** during a decontamination operation and to detect the presence, absence or correct
10 positioning of a transport and storage box **1** in the decontamination chamber **5**.

The way in which such a decontamination chamber **5** works is, for example, described in document WO-2007/135 347.

Reference is now made to Figure 2 which illustrates the overall organization of part of a semiconductor manufacturing facility **200**.

15 Methods of manufacturing semiconductors comprise a great many successive steps and so the semiconductor manufacturing facility **200** comprises a great many work stations which are known as “tools”.

Thus, Figure 2 illustrates a set of forty-seven tools, such as the tools **16** and **17**, arranged in two regions or bays **18** and **19** of six rows each, such as the
20 rows **18a** and **18b**. Each tool **16** or **17** comprises, on one and the same side, a first loading-unloading station **16a** or **17a** and a second loading-unloading station **16b** or **17b**. Thus, in a row such as the row **18a** of tools **16** and **17**, loading and unloading stations are aligned along one branch **20** of the box transport system OHT, which itself comprises guiderails, usually situated in the roof of the facility, and which follow
25 a standardized path.

The box transport system OHT has a branch **20** or **21** for each row **18a** or **18b** of tools **16**, **17**. The branches **20** and **21** are coupled in pairs in a loop known as the “intra-bay” loop such as the loop **22** formed for example by the branches **20** and **21** of two successive rows **18a** and **18b**. A loop known as an “extra bay” loop **122**
30 extends between the two successive regions **18** and **19**, and supplies the “intra bay” loops such as the loop **22**.

The box transport system OHT moves the transport and storage boxes **1**, containing the semiconductor wafers or masks that are to be treated, distributes the transport and storage boxes **1** to the tools **16** or **17** which perform the planned

treatment on their contents, and then collects the transport and storage boxes **1** after treatment.

According to the invention, a treatment device **23** is provided for treating the transport and storage boxes **1** and/or the contents thereof which device is structured and sized so that it occupies a space of the same order of magnitude as
5 the conventional tools **16**, **17** found in a semiconductor manufacturing facility **200**, and so that they are compatible with the box transport system OHT.

For that, the treatment device **23** according to the invention is able to take the place of one of the tools **16**, **17** as illustrated in Figure 2.

10 Consider, for example, the embodiment illustrated in Figure 3, in which we again have the tools **16** and **17** and the branch **20** of the box transport system OHT.

The treatment device **23** is located in the same row of tools **18a** as the tools **16** and **17**. It can be seen that the floor space occupied by the treatment device **23** is similar to the floor space occupied by the tool **16**. In this treatment device **23** it
15 is possible to make out two loading-unloading stations **23a** and **23b** capable of collaborating with the branch **20** of the box transport system OHT. It is also possible to make out a first module of columns **23c** and a second column of modules **23d**, which is optional.

According to the invention, the treatment device **23** make comprise
20 several columns of modules, such as the column of modules **23c**, each having a superposition of four decontamination modules each consisting of a decontamination chamber **5** associated with its own means **6**, **13** of introducing gas, its own pumping means **8** and with its own control means **14**.

Reference is now made to Figures 6 and 7 which illustrate, in a side view
25 and a plan view respectively, a treatment device **23** according to the invention in an embodiment that comprises just one column of modules **23c**.

Thus, the treatment device **23** comprises, in this embodiment, four decontamination modules **24**, **25**, **26** and **27**, vertically superposed on one another to form the column of modules **23c**.

30 Each decontamination module comprises a decontamination chamber **5**, pumping means **8**, and various ancillary means illustrated in Figure 1 but not repeated in Figures 6 and 7 in order to make the latter easier to understand.

The decontamination chamber **5** of a module comprises a side access door **5c**. In the treatment device **23**, all the side access doors **5c** of the decontamination modules **24-27** are oriented along one and the same access side (to the right in Figure 7) and are each acted upon by actuating means that open and close them. On the opposite side to the access side, the decontamination chamber **5** comprises a maintenance door **5d**, that an operator can open in order to carry out individual maintenance on one decontamination module.

As may be seen from these Figures 6 and 7, in a decontamination module such as the module **24**, the decontamination chamber **5** is in line on one and the same level with the pumping means **8**, and in Figure 7, the whole set is in line in the longitudinal direction I-I with one of the loading-unloading stations **23b**. The whole set occupies half of the transverse space of the treatment device **23**, namely the left-hand half in Figure 7. The right-hand half is occupied firstly by the second loading-unloading station **23a** and by a lateral transfer zone **129**, situated on the same side as the access to the decontamination chambers **5** and containing a common box transfer robot **29**.

The robot **29** is designed to move the transport and storage boxes **1** between each of the loading-unloading stations **23a** and **23b** and the decontamination chambers **5** of each of the decontamination modules **24-27**.

To do that, the robot **29** comprises a support **29a** with three upper pins such as the pins **29b** and **29c**, arranged in a triangle in a layout that corresponds to the standardized support points for a transport and storage box **1**.

The support **29a** is mounted at the end of a radially extensible arm **29d** that allows it to be moved horizontally, and is itself mounted on a carriage **29e** capable of vertical movement along a vertical guide **29f**. The vertical guide **29f** is itself mounted on a turntable **29g** that can rotate about a vertical axis through an amplitude of 90°, supported by a lower carriage **29h** itself mounted so that it can slide longitudinally along the longitudinal guide **29i**. The vertical guide **29f** is of a height such that it is able to bring the support **29a** up to the height of each of the decontamination chambers **5** of the decontamination modules **24-27**. The longitudinal guide **29i** allows the lower carriage **29h** to be moved longitudinally so as to bring the support **29a** either to face the loading-unloading station **23a** or to face the decontamination chambers **5** of the decontamination modules **24-27**.

To transfer a transport and storage box **1** between the robot **29** and the loading-unloading station **23b** there is a transfer device which, on the one hand, allows the box support to be moved linearly as illustrated by the arrow **30** between the loading-unloading station **23b** and an intermediate station **31** then allows the intermediate station to be rotated through 90° about a vertical axis, as illustrated by the arrow **30a**. Next, the arm **29d** of the robot **29** can pick up or sit down the transport and storage box **1** from or onto the intermediate station **31**. The structure of the robot **29** is thus compatible, with no complex modification, with the presence of two loading-unloading stations **23a** and **23b**.

The transport and storage boxes **1** may be loaded onto the loading-unloading stations **23a** and **23b** either automatically by the robot **29** of the facility box transfer system OHT or manually by an operator. Automatic loading presents no safety problems. By contrast, manual loading entails the provision, at the loading-unloading stations **23a** and **23b**, of two doors which belong to loading-unloading airlocks: an outer door on the operator side and an inner door on the robot side. The command and control device manages the safe opening and closing of the two doors, not allowing the outer door to be opened while the inner door is open, and vice versa.

Reference is now made to Figure 8 which illustrates a first embodiment for moving the access door **5c** of the decontamination chamber **5**.

In this case, the access door **5c**, driven by suitable actuating means, is moved in two perpendicular movements, namely a low-amplitude horizontal transverse first movement **32**, toward and away from the opening of the decontamination chamber **5**, and a longitudinal second movement **33**, perpendicular to the first movement **32**, to move the access door **5c** horizontally from a position of engagement facing the opening of the decontamination chamber **5** and a wide open position away from the decontamination chamber **5**, on the side of the pumping means **8**. In that way, in the open position, the access door **5c** does not impede the movement of the robot **29**, does not disrupt access to the other decontamination chambers **5** positioned above or below, and does not add to the total space occupied by the treatment device **23**.

Figures 9 and 10 illustrate a preferred embodiment of the means of moving the access door **5c**. Figure 9 illustrates the access door **5c** in the closed state, while Figure 10 illustrates the access door **5c** in the open state.

In its longitudinal movement, the access door **5c** is actuated by a sliding
 5 actuator **34**, such a pneumatic ram. The access door **5c**/pneumatic ram **34** assembly is mounted on a frame **35** itself mounted so that it can rotate about a posterior vertical axis **36** and rotationally driven by a pivoting actuator **37**. Thus, the frame **35** can pivot between a closed position illustrated in Figure 9, in which position the access door **5c** is pressed firmly against the opening of the decontamination
 10 chamber **5**, and an open position in which the frame **35** is away from the decontamination chamber **5**.

Thus, the seals **38** and **39** provided on the access door **5c** are able to seal against the decontamination chamber **5** without experiencing friction during opening and closing operations.

15 As may be seen from Figures 7 to 10, the maintenance door **5d** is a swing door, opened manually.

Figures 9 and 10 illustrate another embodiment detail of the treatment device **23** according to one embodiment of the invention.

In this case, in the pumping means **8**, it is possible to differentiate
 20 between a primary pump **8a** placed in a primary pumping compartment **8c**, horizontally aligned with the decontamination chamber **5**. The access door **5c** in its open position moves on one side of the primary pumping compartment **8c**, as can be seen in Figure 10. On the opposite side of the primary pumping compartment **8c** there is an electronic panel **8d** containing the control means **14** that control the
 25 decontamination module **24**. Thus, the control means **14** in the panel **8d** do not increase the amount of vertical space occupied by the decontamination module **24-27**, thus allowing four decontamination modules **24-27** to be stacked vertically in a clean room of a semiconductor manufacturing facility **200**.

In the treatment device **23** illustrated in Figures 6 and 7, each
 30 decontamination module **24-27** comprises its own pumping means **8** having at last one primary pump **8a**. In each decontamination module **24-27**, the primary pump **8a** is housed in the primary pumping compartment **8c** (Figures 9 and 10) which is longitudinally offset from the decontamination chamber **5**. For preference, the decontamination chamber **5** is closer to the loading-unloading stations **23a-23b**, it

being possible for the primary pumping compartment **8c** to be offset away from the loading-unloading stations **23a-23b** so as to reduce the longitudinal travel of the robot **29**.

As illustrated schematically in Figure 12, the decontamination modules **24-27** are supported by a common chassis **100**. A separate chassis supports the robot **29** (not depicted) and the loading-unloading stations **23a-23b**. The whole entity is confined within a common casing.

Within the primary pumping compartment **8c**, the primary pump **8a** of each of the decontamination modules **24-27** is supported by the common chassis **100** with the interposition of elastic connecting means **101** preventing the transmission of vibration to the decontamination chamber **5**. The decontamination chamber **5** is itself positioned in a decontamination chassis **102**, which also carries the sensors and actuators associated with the decontamination chamber **5**. The secondary pump **8b** is advantageously positioned below the decontamination chamber **5**, its suction inlet being connected directly to the inside of the decontamination chamber **5**, its discharge outlet being connected by an intermediate line **48** to the suction inlet of the primary pump **8a**. The same is true of the other decontamination modules **25-27**.

Reference is made again to Figure 3. In this view from above, it is possible to make out the column of modules **23c** comprising, as illustrated in Figures 6 and 7, a superposition of four decontamination modules **24-27**. That makes it possible to obtain four times the throughput of one decontamination module. Figure 3 illustrates a second column of decontamination modules **23d**, that forms a second superposition of four decontamination modules like the modules **24-27** of Figures 6 and 7.

The two columns of decontamination modules **23c** and **23d** form a longitudinal row **28** of two columns **23c** and **23d** of decontamination modules superposed on one another, the row **28** of columns of modules extending in the longitudinal direction I-I perpendicular to the direction of travel of the branch **20** of the box transport system OHT. This then increases the number of decontamination modules **24-27** without increasing the space occupied by the treatment device **23** along the branch **20** of the box transport system OHT. Further, the depth available in

the longitudinal direction I-I of the longitudinal row **28** of columns **23c**, **23d** of decontamination modules is also put to use.

Reference is now made to Figure 4 which schematically illustrates one possible functional arrangement of the pumping and supply means of the decontamination chamber **5**. The decontamination chamber **5** is associated with two pressure gauges **13a** and **13b**. Gas sources (not depicted) are operated by the control device **14** (see Figure 1) so as to introduce the gases at the appropriate moments during the course of the process.

The primary pump **8a** is connected to the decontamination chamber **5** by a primary pumping line **40** associated with a primary control valve **41**, discharging the pumping gases via an outlet line **42** to the semiconductor manufacturing facility gas extraction and/or treatment system.

The intake side of the secondary pump **8b** is connected to the decontamination chamber **5** by a short secondary pumping line **43** fitted with a secondary control valve **44**, and its discharge side discharges into a secondary discharge line **45** which is itself connected firstly to a transfer line **46** by a valve **47**, and secondly to an intermediate line **48** which leads to the intake side of the primary pump **8a**, with the interposition of a valve **49**. A purge inlet **50** constantly introduces a purge gas into the secondary pump **8b**. The transfer line **46** is connected to a primary pump **51** (Fig. 5) with low delivery, this pump being common to all the decontamination modules **24-27**.

The secondary pump **8b** is in constant rotation, constantly supplied with purge gas by the purge inlet **50**, periodically supplied with treatment gas from the decontamination chamber **5**, and discharging either into the transfer line **46** or into the intermediate line **48**. As the pressure in the decontamination chamber **5** drops, a first, pre-emptying, phase is carried out by opening the primary control valve **41** so that only the primary pump **8a** does the pumping, the secondary pump **8b** being isolated by the secondary control valve **44** and by the valve **49**. In this phase, the valve **47** is open so that the common primary pump **51** pumps to the discharge side of the secondary pump **8b**. Beyond a fixed pressure threshold, a second emptying phase is undertaken, during which phase the primary control valve **41** is closed and the valves **44** and **49** are opened, allowing the two pumpings of the primary **8a** and secondary **8b** pumps to combine in series. During this phase, the valve **47** is closed to avoid contaminating the common primary pump **51** with the gases pumped from

the decontamination chamber **5**. The most independent possible operation between the various decontamination modules **24-27** is thus ensured.

Reference is now made to Figure 5 which illustrates the common primary pump **51**, connected by the transfer line **46**, to all the secondary pumps **8b** of the decontamination modules **24-27** of the treatment device **23**.

Reference is now made to Figure 11 which illustrates the ventilation means for thermally cooling the primary pumps, and the acoustic insulating means for insulating the treatment device according to one embodiment of the invention.

The primary pumps such as the primary pump **8a** of the four decontamination modules **24-27** of the treatment device of Figures 6 and 7 has been illustrated schematically. The primary pump **8a** is housed in its primary pumping compartment **8c**. The primary pumping compartments such as the compartment **8c** of the four decontamination modules **24-27** communicate with one another in the vertical direction and are each divided into two half-compartments forming a common intake compartment **52** and a common discharge compartment **53** which are separated from one another by an intermediate wall **54** through which the primary pumps **8a** pass. The primary pumps such as the primary pump **8a** themselves each comprise an air cooling system, with a cooling air intake **55** at a first end of the pump and with the cooling air discharge **56** at a second end of the pump.

Thus, the intermediate vertical wall **54** separates from one another a first pumping compartment zone, that receives all the cooling air discharges from the primary pumps and constitutes the common discharge compartment **53**, and a second pumping compartment zone containing all the cooling air intakes of the primary pumps and that constitutes the common intake compartment **52**.

The first pumping compartment zone that constitutes the common discharge compartment **53** has a lower air outlet **57**. The second pumping compartment zone that constitutes the common intake compartment **52** has an upper ambient air inlet **58**.

Thus, the primary pump cooling air flow is as indicated by the arrows **59**, **60**, **61** and **62**, from the top downwards through the primary pumps **8a**.

Also illustrated in Figure 11 are acoustic insulation means that reduce the acoustic omissions towards the environment from the treatment device **23**. For that, all of the primary pumping compartments are isolated by absorbent panels **63** used

for sound insulation. The air circulation lower outlet **57** and upper inlet **58** are themselves fitted with baffles that absorb acoustic emissions.

The common primary pump **51** is also sited in one of the primary pumping compartments, to ensure that it is cooled and acoustically insulated in the same way
5 as the other primary pumps.

A common control device manages the flow of transport and storage boxes **1** that are to be treated according to the availabilities of the decontamination chambers **5** and the treatment demands from the semiconductor manufacturing facility production supervisor, and thus manages the loading-unloading stations **23a**,
10 **23b**, the movement of the robot **29**, and the starting of the processes in the decontamination modules **24-27**.

The common control device comprises means of communicating with the semiconductor manufacturing facility supervisor and with the box transport system OHT to allow the transport and storage boxes **1** to be loaded automatically onto the
15 loading-unloading stations **23a, 23b**.

The present invention is not restricted to the embodiments explicitly described but includes the various variations and generalizations that are within the competence of those skilled in the art.

CLAIMS

1. Treatment device for transport and storage boxes (1), comprising a decontamination module that has:
 - a decontamination chamber (5) with a side access door (5c) which is capable of containing a transport and storage box (1),
 - means (6, 13) of introducing gas into the decontamination chamber (5),
 - means (7, 8) of pumping the gases from the decontamination chamber (5),
 - command (14) and control (12) means for controlling the gaseous atmosphere within the decontamination chamber (5),
- in which:
 - the device comprises a plurality of decontamination modules (24-27) supported by a common chassis (100),
 - the decontamination modules (24-27) are superposed on one another to form at least one column (23c, 23d) of modules,
 - each decontamination module (24-27) comprises its own pumping means (8) having at least a primary pump (8a),
 - the primary pump (8a) is housed in a primary pumping compartment (8c) that is longitudinally offset with respect to the decontamination chamber (5).
2. Treatment device according to Claim 1, in which
 - the primary pumping compartments (8c) of the decontamination modules (24-27) of one and the same column of modules (23c, 23d) communicate with one another with no horizontal separation,
 - each primary pump (8a) comprises an air cooling system with a cooling air intake (55) at a first end of the pump and with a cooling air discharge (56) at a second end of the pump,
 - in one and the same column of modules (23c, 23d), an intermediate vertical wall (54) separates one from the other
 - a first pumping compartment zone (53) receiving all the cooling air discharges and comprising a lower air outlet (57), and
 - a second pumping compartment zone (52) containing all the cooling air intakes and comprising an upper ambient air inlet (58).

3. Treatment device according to either of Claims 1 and 2, in which the primary pump (8a) is supported by the common chassis (100) with the interposition of elastic connecting means (101) preventing the transmission of vibration to the decontamination enclosure (5).
- 5 4. Treatment device according to one of Claims 1 to 3, in which the side access doors (5c) of the decontamination modules (24-27) are all oriented along one and the same access side and are each controlled by actuating means (34, 37) which open and close them.
- 10 5. Treatment device according to one of Claims 1 to 4, in which the access door (5c) of each decontamination module (24-27) is a sliding access door which, when open, is laterally offset to the side of the primary pumping compartment (8c) and which is controlled by a sliding actuator (34).
- 15 6. Treatment device according to Claim 5, in which the sliding access door (5c) is mounted to slide longitudinally on a frame (35) itself mounted with pivoting about a vertical axis of pivoting (36) and made to pivot by a pivoting actuator (37).
- 20 7. Treatment device according to one of Claims 4 to 6, in which each decontamination chamber (5) of the decontamination modules (24-27) comprises, on the opposite side to the access door, a maintenance door (5d) so that individual maintenance can be carried out on one decontamination module (24-27).
- 25 8. Treatment device according to one of the preceding claims, further comprising:
 - at least one loading-unloading station (23a),
 - a lateral transfer zone (129) provided on the side of the access to the decontamination modules (24-27), in line with the loading-unloading station (23a),
 - a robot (29), placed in the lateral transfer zone, capable of moving the transport and storage boxes (1) between the loading-unloading station (23a) and the decontamination chamber (5) of each of the decontamination modules (24-27).
- 30 9. Treatment device according to Claim 8, further comprising:
 - a first loading-unloading station (23a), in line with the lateral transfer zone (129),

- a second loading-unloading station (23b), in line with the longitudinal row (28) of columns of modules (23c, 23d) and comprising means (30) of longitudinal movement and means (31) of rotating through 90° about a vertical axis.

10. Treatment device according to either of Claims 8 and 9 considered together
5 with Claim 7, in which each decontamination module (24-27) comprises a safety device which:

- locks the maintenance door (5d) if the side access door (5c) is opened,
- locks the side access door (5c) and partially disables the robot (29) if the maintenance door (5d) is opened.

10 11. Treatment device according to one of the preceding claims, in which:

- each decontamination module (24-27) comprises its own control means (14),
- the control means (14) are arranged in a control panel (8d) positioned to the side on the same side as the primary pumping compartment (8c).