

Device and method for drying and/or cleaning pot-shaped hollow bodies, in particular transport containers for semiconductor wafers or for EUV lithography masks

5 The present invention relates to a device and to a method for drying and/or cleaning pot-shaped hollow bodies, in particular transport containers for semiconductor wafers or for EUV lithography masks.

10 The manufacture of highly integrated electronic circuits and other sensitive semiconductor components takes place today in factories in which so-called semiconductor wafers run through a large number of processing steps. A large part of these processing steps takes place in clean rooms that are kept free
15 of contaminants, in particular free of particles, with a high effort. Such a complex processing is necessary since particles that come into contact with the semiconductor material of the semiconductor wafers can in particular influence the material properties of the semiconductor wafers such that a total
20 production batch becomes defective and unusable and has to be discarded.

Since the keeping clean is becoming more and more important as the integration density of the semiconductor circuits
25 increases and the effort to keep clean increases exponentially as the size of the clean rooms increases, the semiconductor wafers are not transported from one processing station to the next in an "open" state. Special transport containers (so-called FOUPs, front opening unified pods) are used instead.
30 They are understood as box-shaped transport containers into which a large number of semiconductor wafers can be introduced. The FOUPs are typically closed by a removable cover. Without the cover the FOUPs have a pot-shaped basic

shape with a rectangular base surface. When the FOUPs are closed by their covers, the inserted semiconductor wafers can be transported from one clean room to another clean room protected from the environment. When the FOUPs have reached a processing station, they are opened, the semiconductor wafers are removed, and are processed accordingly. After processing has taken place, the semiconductor wafers are transported back into the FOUPs and are then conveyed to the next processing station.

Due to the high production downtimes on contamination of the semiconductor wafers, it is necessary to clean the FOUPs by means of a cleaning fluid from time to time. The FOUPs are in particular contaminated by the wear debris of the semiconductor wafers on the introduction into and the removal from the FOUPs.

The same applies accordingly to transport containers of lithography masks and in particular EUV lithography masks ("extreme ultraviolet radiation"). The EUV lithography masks are used to manufacture very small integrated circuits. The EUV lithography masks, like the semiconductors, also have to be transported, with a similar situation arising. When FOUPs are spoken of in the following, the statements in this respect apply equally to transport containers for EUV lithography masks.

Devices for cleaning FOUPs are known, for example, from US 5,238,703 A, US 2002/0046760 A1, US 2003/0102015 A1, WO 2005/001888 A2 and EP 1 899 084 B1.

As mentioned, a plurality of semiconductor wafers or EUV lithography masks can be introduced into an FOUP. For this purpose, the FOUP has rib-like structures on the inner surface on which the outer margins of the semiconductor wafers or EUV lithography masks can be placed. Alternatively, the rib-like structures can be arranged as separate units in the interior space. In the cleaning procedure, a cleaning fluid is typically applied to the inner surface of the FOUP in a first step and the inner surface is subsequently dried using a drying fluid.

Purified water, in particular so-called ultrapure water, is typically used as the cleaning fluid and extreme clean dried air, also called XCDA, carbon dioxide, or nitrogen are frequently used as the drying fluid. Zones are produced due to the rib-like structures that can only be accessed with difficulty by the drying fluid, but also by the cleaning fluid. The cleaning and drying procedures become correspondingly difficult. To ensure a sufficient cleaning and drying, the cleaning and drying procedures have to be performed for a correspondingly long time using the devices known from the prior art, which is time- and resource-intensive.

It is the object of an embodiment of the present invention to provide a device for drying and/or cleaning pot-shaped hollow bodies, in particular transport containers for semiconductor wafers or for EUV lithography masks, by which it is possible with simple and inexpensive means to provide a remedy for the above-named disadvantages and in particular to make possible a cleaning and drying that is time saving and resource saving in comparison with processes known from the prior art. It is furthermore the underlying object of an embodiment of the

present invention to provide a method of operating such a device.

This object is achieved by the features specified in claims 1 and 10. Advantageous embodiments are the subject of the dependent claims.

An embodiment of the invention relates to a device for drying and/or cleaning pot-shaped hollow bodies, in particular transport containers for semiconductor wafers or for EUV lithography masks, wherein the hollow body comprises

- a hollow body wall that forms an inner hollow body surface, with the inner hollow body surface bounding an inner hollow body space; and
- has a hollow body opening that is surrounded by the hollow body wall and through which the inner hollow body space is accessible;

wherein the device comprises

- a cleaning device
 - o that can be or is introduced into the inner hollow body space through the hollow body opening and which has
 - o a first dispensing unit by which a first fluid for cleaning and/or drying the inner hollow body surface can be dispensed; and
 - o a second dispensing unit by which a second cleaning fluid for cleaning and/or drying the inner hollow body surface can be dispensed; and
- an adjustment device by which the first dispensing unit and the second dispensing unit are movable independently of one another.

When a hollow body is spoken of in the following, a FOUP is primarily meant. The first fluid is typically used for drying the inner hollow body surface while the second fluid is used for cleaning the inner hollow body surface.

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The demands on a cleaning that is as optimum as possible and a drying that is as optimal as possible differ. This can be due only to the different physical and/or chemical properties of the first fluid used and of the second fluid used. In

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addition, the FOUP typically has sections that have greater contamination than other sections. They can be the already mentioned rib-like structures and/or the cover support surfaces. The cover support surface frequently has to be treated for longer by the second fluid than other sections of the inner hollow body surface to achieve a sufficient cleaning result. However, the cover support surface is relatively easily accessible so that it can be dried easily and quickly. The rib-like structures can be dried with more difficulty in contrast.

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Due to the design of the device in accordance with the proposal, according to which the first dispensing unit is movable by the second dispensing unit, the cleaning procedure and the drying procedure can be adapted to their respective

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special features. The cover support surface can thus be cleaned for a relatively long time and dried for a relatively short time while the rib-like structures can be cleaned and dried for a relatively long time. It is possible here to already dry cleaned sections while other sections are still

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being cleaned. The FOUP can thus be cleaned in a more time- and resource saving manner than is possible with known devices.

In accordance with a further embodiment, the device can define a displacement axis

- along which the first dispensing unit and the second dispensing unit are displaceable by the adjustment device; and/or
- about which the first dispensing unit and the second dispensing unit are rotatable by the adjustment device.

10 The kind of movement can be adapted to the respective procedure. A translatory movement appears suitable in the cleaning procedure while a rotational movement has proved advantageous in the drying procedure. Every movement is, however, advantageous for the cleaning and drying of the FOUP
15 since the probability of the formation of dead spaces that are only insufficiently cleaned and/or dried is hereby reduced.

In a further developed embodiment, the second dispensing unit can be displaceably supported on the first dispensing unit.

20 The construction effort for implementing the device in accordance with the proposal can hereby be kept small since a separate support of the second dispensing unit can be largely dispensed with.

25 In a further developed embodiment, the second dispensing unit can be ring shaped and can surround the first dispensing unit. The dispensing of the second fluid can hereby be carried out at a short distance from the inner hollow body surface, whereby pulse losses are kept small and the inner hollow body
30 surface can be cleaned very effectively without the drying procedure being disadvantageously influenced. Ring shaped can here in particular be understood as a second dispensing unit that has a ring shape, ellipsoid shape, or polygon ring shape

in a plan view. Polygon ring shape should here be understood as a dispensing unit that has three or more than three precisely tubular sections in a plan view that are connected to one another while forming an angle between one another.

5 Mixed shapes are likewise conceivable.

In a further embodiment, the first dispensing unit can have a plurality of first dispensing nozzles through which the first fluid can be dispensed at a spray angle with respect to a
10 reference plane extending perpendicular to the displacement axis, wherein

- the spray angle amounts to between 0° and 30° ; and/or
- the first dispensing unit has a setting device by which
15 the spray angle can be set.

The spray angle can be fixed or variable depending on the embodiment. A spray angle in the range between 0° and 30° has anyway proved advantageous, in particular for drying. When the
20 spray angle is adjustable, an additionally directed movement can be performed, whereby the probability of the formation of dead spaces that are only insufficiently cleaned and/or dried can be further reduced.

25 A further developed embodiment can be characterized in that the device comprises a support wall on which the marginal surface of the hollow body formed by the hollow body wall can be placed, wherein the support wall forms a passage opening through which the cleaning device can be led. The support of
30 the hollow body can be simply implemented with this embodiment so that the construction effort for providing the device in accordance with the proposal can be kept small.

In accordance with a further embodiment, the device can comprise a locking device by which the marginal surface of the hollow body can be releasably connected to the support wall.

5 It can be ensured by the locking device that the hollow body is held in its position and does not slip during the cleaning and drying procedure. In addition, the locking device can be designed such that it can only lock the hollow body when it is in a desired position. It is thus prevented that collisions
10 with the hollow body and damage resulting therefrom can occur on the movement of the first dispensing unit and of the second dispensing unit. It can additionally be ensured that a reproducible cleaning and drying result is achieved.

It may be suitable in a further embodiment that a sealing
15 section by which the support wall can be sealed with respect to the marginal surface when the hollow body is placed on the support wall is arranged on or in the support wall. It is prevented by the seal that in particular the second fluid is distributed in the device in an uncontrolled manner and can
20 result in further contamination there. The outer hollow body surface can also be cleaned depending on the design of the device. This is typically done separately from the inner hollow body surface, in particular because the outer hollow body surface is usually contaminated more than the inner
25 hollow body surface, with the inner hollow body surface playing a more important role for the defect proneness of the semiconductor wafers. It can be prevented by the sealing section that particles can move into the inner hollow body space as a result of the cleaning of the outer hollow body
30 surface and can be deposited on the semiconductor wafers there.

In accordance with a further embodiment, the device can have a drainage channel through which the first fluid and/or the second fluid can be drained from the device, with a particle measuring device for determining the particles contained in the first fluid and/or in the second fluid being arranged in the drainage channel. The number of particles that are drained from the device can be counted by the particle measuring device, for example. If the number is below a specific value for a specific time, it can be assumed that the hollow body has been sufficiently cleaned. In this case, the cleaning procedure can be aborted and the drying procedure can be begun. It is not necessary to carry out the cleaning procedure for considerably longer than possibly necessary for safety reasons. The volume of the second fluid and the time for the cleaning procedure can be kept small.

In accordance with a further developed embodiment, the cleaning device can have an inspection device by which the inner hollow body surface can be inspected. The inspection device can be operated in an optical manner, for example, for which purpose LiDAR or a camera can be used. The inner hollow body surface can, for example, be examined for contamination residues and/or residues that originate from wafers and/or for damage. The inspection device can have a light source, whereby a uniform illumination can be provided, so that the camera delivers images that can be evaluated. The information delivered by the inspection device can be evaluated by an evaluation unit. If irregularities are found, corresponding countermeasures can be initiated. The respective hollow body can be discarded, for example.

The inspection device is preferably part of the cleaning device. The adjustment device can consequently simultaneously

be used for the inspection device. The inspection of the inner hollow body surface takes place at the same time, in particular with the drying, since no disruptive influences emanating from the cleaning fluid have to be taken into account during the drying.

The hollow body can comprise a cover having an outer cover surface and an inner cover surface by which the hollow body opening can be closed. The device can comprise

- a cover cleaning device that has a first cover cleaning dispensing unit by which a first fluid for cleaning and/or drying the inner cover surface can be dispensed and a second cover cleaning dispensing unit by which a second fluid for cleaning and/or drying the inner cover surface can be dispensed; and
- a cover cleaning adjustment device by which the first cover cleaning dispensing unit and the second cover cleaning dispensing unit are movable.

The cover is also subject to contamination that can result in defective semiconductor wafers. To this extent, the cleaning of the inner cover surface also contributes to keeping the number of defective semiconductor wafers small. The same also applies to EUV masks. The cover cleaning device is also able to first perform a cleaning and subsequently a drying, for which purpose the first cover cleaning dispensing unit or the second cover cleaning dispensing unit is used.

In accordance with a further developed embodiment, the second dispensing unit has a number of second dispensing nozzles through which the second fluid can be dispensed at a second spray angle with respect to a reference plane extending

perpendicular to the displacement axis, with the second dispensing unit having a second setting device by which the second spray angle can be set. In this case, a further movement can also be imparted to the second fluid, whereby the probability of the formation of dead spaces can be kept low.

An embodiment of the invention relates to a method of cleaning pot-shaped hollow bodies, in particular transport containers for semiconductor wafers or for EUV lithography masks, using a device in accordance with one of the previous claims, said method comprising the following steps:

- introducing the cleaning device into the inner hollow body space through the hollow body opening;
- 15 - dispensing a first fluid for cleaning and/or drying the inner hollow body surface by means of the first dispensing unit; and
- dispensing a second cleaning fluid for cleaning and/or drying the inner hollow body surface by means of the second dispensing unit; and
- 20 - independently moving the first dispensing unit and the second dispensing unit by means of the adjustment device.

The technical effects and advantages that can be achieved with the method in accordance with the proposal substantially correspond to those that have been discussed for the present device. It must be pointed out in summary that, due to the design of the device in accordance with the proposal, according to which the first dispensing unit is movable independently of the second dispensing unit, the cleaning procedure and the drying procedure can be adapted to their respective special features. The FOUP can thus be cleaned in a

more time- and resource-saving manner than is possible with known devices.

Provision can be made in a further embodiment that the
5 dispensing of the first fluid takes place by means of the
first dispensing unit offset in time from the dispensing of
the second fluid by means of the second dispensing unit. As
initially mentioned, water is typically used as the first
10 fluid and air is typically used as the second fluid. It may
however, by all means be advantageous to use only gaseous or
only liquid fluids. If, however, water is used as the second
fluid, it primarily serves the cleaning of the inner hollow
body surface while the air that is used as the first fluid
serves the drying of the inner hollow body surface. In this
15 respect, the second fluid is first applied to the inner hollow
body surface and the first fluid is subsequently applied
thereto. It is, however, possible to already begin with the
drying in a section of the inner hollow body surface already
cleaned by the second fluid when a different section of the
20 inner hollow body surface is still being acted on by the
second fluid. To this extent, the time-offset dispensing of
the first fluid and of the second fluid can also be related to
a section of the inner hollow body surface and not to the
total device.

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A further developed embodiment can specify that the first
fluid is air and the second fluid is water. In particular
extreme clean dried air, also called XCDA, is used as the air.
In particular so-called ultrapure water having a conductance
30 of 0.052 $\mu\text{S}/\text{cm}$ or less is used as the water. A sufficient
cleaning of the inner hollow body surface can hereby be
implemented with a justifiable effort.

It is also possible that in particular the second fluid is a mixture of one or more gaseous media and one or more liquid media. As mentioned, the second fluid dispensed by the second dispensing unit primarily serves the cleaning of the inner hollow body surface while the first fluid serves the drying. If a mixture of gaseous and liquid media is used as the second fluid, increased dynamics can be provided and the pulse of the second fluid can be increased, whereby the cleaning result can be improved.

In principle, however, the first fluid and the second fluid can be largely freely selected and adapted to the respective application case. If the first fluid and/or the second fluid contain liquid media, the surface tension of the respective medium may play a role, for example.

In accordance with a further developed embodiment, the spray angle can be varied during or prior to the dispensing of the first fluid by means of the setting device. The probability of the formation of dead spaces that are only insufficiently cleaned and/or dried can hereby be kept small. The drying is in particular improved.

In accordance with a further embodiment, the method comprises the step of inspecting the inner hollow body surface by means of the inspection device. LiDAR or a camera or other suitable detection sensors can be used here. The inner hollow body surface can be examined for contamination residues and/or residues that originate from wafers and/or for damage, for example. The inspection device can have a light source, whereby a uniform illumination can be provided, so that the camera delivers images that can be evaluated. The information delivered by the inspection device can be evaluated by an

evaluation unit. If irregularities are found, corresponding countermeasures can be initiated.

The step of inspecting the inner hollow body surface in particular takes place simultaneously with the dispensing of the first fluid (air) by which the inner hollow body surface is dried since the disruptive factors emanating from air on the information delivered by the camera are considerably smaller in comparison with water.

In accordance with a further embodiment, the method comprises the following steps:

- dispensing a first fluid for cleaning and/or drying the inner cover surface by means of the first cover cleaning dispensing unit; and
- dispensing a second fluid for cleaning and/or drying the inner cover surface by means of the second cover cleaning dispensing unit.

As mentioned, the cover is also subject to contamination that can result in defective semiconductor wafers. To this extent, the cleaning of the inner cover surface also contributes to keeping the number of defective semiconductor wafers small.

The same also applies to EUV masks. The cover cleaning device is also able to first perform a cleaning and subsequently a drying, for which purpose the first cover cleaning dispensing unit or the second cover cleaning dispensing unit can be used.

[Brief Description of the Drawings]

Exemplary embodiments of the invention will be explained in more detail in the following with reference to the enclosed drawings. There are shown

Figure 1 a basic sectional representation of a first
embodiment of a device in accordance with the
proposal for drying and/or cleaning pot-shaped hollow
bodies in a first position;

Figure 2 the first embodiment of the device shown in Figure 1
in a second position;

Figure 3 the first embodiment of the device shown in Figure 1
in a third position;

Figure 4 a basic representation of a second embodiment of a
device in accordance with the proposal;

Figure 5A a basic representation of a third embodiment of a
device in accordance with the proposal in a first
position;

Figure 5B the third embodiment of the device in accordance with
the proposal shown in Figure 5A in a second position;
and

Figure 5C a detail and an enlarged representation of a cover
cleaning device.

Figures 1 to 3 show a first embodiment of a device 101 for
drying and/or cleaning pot-shaped hollow bodies 12, in
particular transport containers for semiconductor wafers or
for EUV lithography masks, with reference to a basic
representation in different positions. The hollow body 12 is
here in particular a transport container for semiconductor

wafers, also called FOUPs, or a transport container for EUV lithography masks.

The hollow body 12 has a hollow body wall 13 having a base wall 14 and, in this case, four side walls 16 so that the pot-shaped hollow body 12 is substantially parallelepiped-shaped. It is, however, by all means possible to provide the pot-shaped hollow body 12 with a different geometry, for example a cylindrical geometry. The base wall 14 and the four side walls 16 form an inner hollow body surface 18 and an outer hollow body surface 20. The inner hollow body surface 18 bounds an inner hollow body space 22.

The hollow body 12 has a hollow body opening 24 that is arranged disposed opposite the base wall 14 and that is surrounded by a marginal surface 26. The inner hollow body surface 22 is accessible through the hollow body opening 24. The hollow body 12 is designed in the manner of a flange in the region of the marginal surface 26 in the embodiment shown. In addition to the marginal surface 26, the hollow body 12 has a cover support surface 28 that is a part of the inner hollow body surface 18 and that is formed by means of a shoulder of the side wall 16.

The device 101 for drying and/or cleaning the hollow bodies 12 can in principle largely be structured such as is described, for example, in DE 10 2020 129 469 A1. Only the substantial features will consequently be looked at in the following.

The device 101 has a support wall 30 on which the marginal surface 26 of the hollow body 12 can be placed; The support wall 30 forms a passage opening 32, with a locking device 34 being arranged radially outside the passage opening 32. The

passage opening 32 of the support wall 30 and the hollow body opening 24 are at least approximately the same size and the same geometrical shape in the embodiment shown. In the embodiment shown, two passage bores 36 are provided radially outside the locking device 34 in the support wall 30 whose function will be looked at in more detail further below.

The device 101 furthermore comprises a drainage channel 38 having a channel end 40 that is in fluid communication with the passage opening 32. As can be seen from Figure 1, the drainage channel 38 is connected to the support wall 30 at the channel end 40 such that the channel end 40 terminates flush with the passage opening 32. Starting from the channel end 40, the drainage channel 38 initially maintains its diameter before the diameter reduces in the manner of a funnel.

A particle measuring device 42 is furthermore arranged in the drainage channel 38.

The device 101 is furthermore equipped with a cleaning device 44 that can be introduced into the inner hollow body surface 22 through the hollow body opening 24. The cleaning device 44 here comprises a first dispensing unit 46 by which a first fluid for cleaning and/or drying the inner hollow body surface 18 can be dispensed and a second dispensing unit 48 by which a second fluid for cleaning and/or drying the inner hollow body surface 18 can be dispensed. In the embodiment shown, the first fluid serves the drying and the second fluid the cleaning of the inner hollow body surface 18. Extreme clean dried air, also called XCDA, can be used as the first fluid, for example, and so-called ultrapure water as the second fluid.

In addition, the cleaning device 44 comprises an adjustment device 50 by which the first dispensing unit 46 and the second dispensing unit 48 are movable independently of one another.

In the embodiment of the device 101 shown, the first

5 dispensing unit 46 comprises a first tube 52 in which a second tube 54 can be telescopically inserted. An end piece 56 that forms a number of first dispensing nozzles 57 is inserted into the second tube 54. The first tube 52 and the second tube 54 are here concentrically arranged in the dispensing channel.
10 The first fluid can be conducted through the first tube 52, the second tube 54, and the end piece 56 to the first dispensing nozzles 57 and can be dispensed from there onto the inner hollow body surface 18.

15 As can be seen from a comparison of Figures 1 to 3, the adjustment device 50 has adjustment means, not shown, by which the second tube 54 can be displaced along a displacement axis A relative to the first tube 54. In addition, the end piece 56 can be rotated about the displacement axis A by means of the
20 adjustment device 50.

In addition, the first dispensing unit 46 comprises a setting device 58 by which a spray angle α can be adjusted at which the first fluid can be dispensed with respect to a reference
25 plane extending perpendicular to the displacement axis A. For this purpose, the end piece 56 can have a flexible section (not shown).

The second dispensing unit 48 serves the supply of the second
30 fluid to the inner hollow body surface 18. The second dispensing unit 48 is ring-shaped and, in the embodiment shown, surrounds the second tube 54 of the first dispensing unit 46 on which the second dispensing unit 48 is displaceably

supported along the displacement axis A. The second dispensing unit 48 can be displaced along the displacement axis A by the adjustment device 50 independently of the first dispensing unit 46, which can be seen from a comparison of Figures 1 to 3. It is also conceivable that the second dispensing unit 48 is rotatable about the displacement axis A.

An embodiment is not shown in which the second dispensing unit 48 has its own support and it thus supported independently of the first dispensing unit 46. For this purpose, the second dispensing unit 48 can, for example, be guided at the inner wall of the drainage channel 38.

The second dispensing unit 48 has a number of second dispensing nozzles 60 through which the second fluid can be dispensed at a second spray angle β with respect to a reference plane extending perpendicular to the displacement axis A, with the second dispensing unit 48 having a second setting device 62 by which the second spray angle β can be set. In the position shown in Figure 1, the second spray angle β amounts to 30° while it amounts to 0° in the positions shown in Figures 2 and 3 and therefore not drawn there.

An embodiment is not shown in which the distance of the second dispensing nozzles 60 is adjustable with respect to the displacement axis A. Such an adjustability is in particular advantageous when the hollow body 12 has a funnel-like extent and the distance of the inner hollow body surface 18 consequently changes along the displacement axis A.

A sealing section 64 that comes into contact with the marginal surface 26 when the hollow body 12 is placed on the support wall 30 is furthermore arranged in the support wall 30.

The device 101 is operated in the following manner: The marginal surface 26 of the hollow body 12 to be cleaned is placed on the support wall 30 and is fastened to the support wall 30 by the locking device 34. In this respect, the marginal surface 26 is pressed toward the sealing section 64 such that the marginal surface 26 is sealed with respect to the support wall 30.

- 10 As mentioned, the diameter of the drainage channel 38 does not initially vary starting from the passage opening 32. It is hereby ensured that the cleaning device 44 can be retracted so far that it does not project or only projects by a very small amount over the passage opening 32 (see also Figure 4).
- 15 Collisions between the cleaning device 44 and the hollow body 12 can hereby be avoided, in particular when the hollow body 12 is placed onto and removed from the support wall 30.

The second fluid can subsequently be conveyed through feed channels not shown in detail to the second dispensing unit 48 by a conveyor unit, not shown, and can be applied to the inner hollow body surface 18 through the second dispensing nozzles 60. It may be suitable in this respect to first travel the second dispensing unit 48 as far as possible to the base wall 14 before the second fluid is dispensed since the second fluid runs down the inner hollow body surface 18 driven by gravity.

25 The first dispensing unit 46 can be extended for this purpose.

While the second fluid is dispensed, the second dispensing unit 48 can be displaced along the displacement axis A as a result of a corresponding activation of the adjustment device 50. In addition, in this respect, the second spray angle β can be changed so that the total inner hollow body surface 18 is

consequently acted on by the second fluid. In this respect, for example, the second adjustment device 50 can be moved downward along the second tube 54 of the first dispensing unit 46 with respect to the representation selected in Figures 1 to 3, which can be seen from a comparison of Figures 2 and 3.

The cover support surface 28 typically has greater contamination than the remaining inner hollow body surface 18. It may therefore be suitable to apply the second fluid to the cover support surface 28 more intensively and over a longer time period than to the remaining inner hollow body surface 18 (see Figure 1).

The first dispensing unit 46 can here first remain inactive and not dispense any first fluid. If, however, the inner hollow body surface 18 has already been fully acted on by the second fluid between the base wall 14 and the cover support surface 28 and is the cover support surface 28 has been treated by the second fluid for a longer time, the first dispensing unit 46 can already be activated and the first fluid can consequently be applied to the inner hollow body surface 18 to dry the inner hollow body surface 18. The first fluid can be conveyed to the first dispensing nozzles 57 by a conveyor unit, now shown, and can then be applied to the inner hollow body surface 18.

Driven by gravity, the second fluid runs down the inner hollow body surface 18 and through the passage opening into the drainage channel 38. The number of particles contained in the second fluid can be determined by the particle measuring device 42 arranged in the drainage channel 38. If the number of particles remains below a certain value for a specified time, it can be assumed that the inner hollow body surface 18

has been sufficiently cleaned. The supply of the second fluid can then be interrupted. The supply of the first fluid can be continued for so long until it can be assumed that the inner hollow body surface 18 has been dried to a sufficient degree.

5 In this respect, the first dispensing unit 46 can be displaced along and rotated about the displacement axis A. When the inner hollow body surface 18 has been dried to a sufficient degree, the supply of the first fluid is interrupted. The cleaning device 44 is then displaced along the displacement
10 axis A toward the drainage channel 38. The cleaning of the inner hollow body surface 18 is now completed.

As mentioned, two passage bores 36 are provided in the support wall 30, with the number being able to be largely freely
15 selected and not being fixed to two. They can be used to drain a further fluid in a manner not shown by which the outer hollow body surface 20 can be cleaned. Reference is made to DE
10 2020 129 469 A1 in this respect. The sealing section 64 here prevents further fluid, that is typically greatly charged
20 with particles, from being able to enter into the inner hollow body surface 22 and to cause contamination there.

When the cleaning of the outer hollow body surface 20 has also been completed, provided that it can and should be cleaned,
25 the locking device 34 can be opened and the hollow body 12 can be removed from the device 101 and supplied to its further use.

Figure 4 shows a second embodiment of a device 102 for drying
30 and/or cleaning pot-shaped hollow bodies 12. The device 102 in accordance with the second embodiment has largely the same structure as the device 101 in accordance with the first embodiment so that only the major difference will be looked

at. The end piece 56 of the first dispensing unit 46 has a V-shaped structure so that two free ends are present where a respective number of first dispensing nozzles 57 is arranged. In comparison with the first dispensing unit 46 of the first embodiment of the device 101, a more uniform flow is generated in the inner hollow body surface 22 and the drying result is improved, in particular when air is used as the first fluid or when a different gaseous medium is used.

10 The end piece 56 has a rigid structure as a result of which the spray angle α is fixed and amounts to between 0 and 30°. The device 102 in accordance with the second embodiment consequently does not have a setting device 58.

15 The device 102 in accordance with the second embodiment moreover also does not have a second setting device 62 by which the second spray angle β can be set. Instead, the second dispensing unit 48 has a first group of second dispensing nozzles 601 and a second group of second dispensing nozzles
20 602 that are each fixedly arranged on the second dispensing unit 48. The first group of the second dispensing nozzles 601 is aligned substantially perpendicular to the displacement axis A and the second group of the second dispensing nozzles 602 is arranged in parallel with the displacement axis A. The
25 first group of second dispensing nozzles 601 primarily serves the cleaning of the side wall 16 and the second group of dispensing nozzles 602 primarily serves the cleaning of the base wall 14 of the hollow body 12. It is possible to provide a third group of second dispensing nozzles 60, not shown, that
30 has a second spray angle β of 45°, for example, in particular to be able to intensively clean the cover support surface 28.

It is only shown by outline in Figure 4 that the first group of second dispensing nozzles 601 and the second group of second dispensing nozzles 602 communicate with their own respective feed channels. The first group of second dispensing nozzles 601 and the second group of second dispensing nozzles 602 can accordingly be operated independently of one another. The second fluid can, for example, only be conducted to the second group of second dispensing nozzles 602 when the second dispensing unit 48 is in the vicinity of the base wall 14 or in the vicinity of the cover support surface 28. It is also possible to dispense two different second fluids by the first group of second dispensing nozzles 601 or by the second group of second dispensing nozzles 602.

The cleaning device 102 in accordance with the second embodiment is equipped with an inspection device 66 by which the inner hollow body surface 18 can be inspected. The inspection can in particular be carried out with respect to contamination, damage, and/or residues of semiconductor wafers. Shelf-like projections that are provided with elevated portions on which the semiconductor wafers can be placed are arranged on two of the inner hollow body surfaces 18. These elevated portions can partially melt in operation and form sharp-edged burrs that can in turn lead to damage to the semiconductor wafers. Such sharp-edged burrs can be recognized by the inspection device 66.

Due to production inaccuracies in the manufacture of the hollow bodies 12, it can furthermore occur that the distances of the adjacently arranged projections are not the same. As a result, increased wear on the semiconductor wafers and possibly also damage to the semiconductor wafers can occur.

Such production inaccuracies can also be recognized by the inspection device 66.

The information delivered by the inspection device 66 can be evaluated by an evaluation unit, not shown. If irregularities are found, corresponding countermeasures can be initiated. The respective hollow body 12 can, for example be discarded or the cleaning process can be aborted.

10 The inspection device 66 can have sensors suitable for said purpose. In particular optical sensors can be used. In the second embodiment of the device 102 shown in Figure 4, the inspection device 66 is equipped with a camera 68. Light sources 70 are additionally provided to provide a sufficient and largely unchanging illumination. The inspection device 66 is associated with the first dispensing unit 46 in the second embodiment of the device 102 and is consequently moved together with it. It is, however, also possible to associated the inspection device 66 with the second dispensing unit 48 and to move it together therewith.

As mentioned, the hollow body 12 to be cleaned has a pot-shaped basic shape with a rectangular base surface. Four side walls 16 are correspondingly present. The inspection device 66 can therefore be equipped with four cameras 68 of which one respective camera 68 is directed to one of the four side walls 16. As mentioned, the shelf-like projections are arranged on two oppositely disposed side walls 16. Since the critical points are located there, it is sufficient only to use two cameras 68 that are directed to the side walls 16 that have the shelf-like projections. Whereas the second dispensing unit 48 that dispenses the water does not necessarily have to be rotatable, it appears suitable to design the first dispensing

unit 46 by which air is dispensed as rotatable to achieve a drying that is as complete as possible. The cameras 68 can therefore be arranged on the second dispensing unit 48. The number of dispensing nozzles that are directed to the shelf-like projections can be greater than the number of those dispensing nozzles that extend perpendicular thereto.

Figures 5A to 5B show a third embodiment of a device 103 in accordance with the invention for drying and/or cleaning pot-shaped hollow bodies 12. The basic structure of the device 103 in accordance with the third embodiment can here be the same as the structure of the device 101, 102 in accordance with the first and second embodiments. The device 103 in accordance with the third embodiment in particular likewise has the cleaning device 44 having the first dispensing unit 46 and the second dispensing unit 48 that is shown only in principle in Figures 5A and 5B.

The device 103 in accordance with the third embodiment comprises a cover cleaning device 72 that is shown sectionally and enlarged in Figure 5C. The cover cleaning device 72 has a first cover cleaning dispensing unit 74 for dispensing a first fluid and a second cover cleaning dispensing unit 76 for dispensing a second fluid that are arranged on a common base body. The first fluid can, as with the first cleaning device 44, be air and the second fluid water.

In Figures 5A to 5B, details of the cover cleaning device 72 that is arranged within a housing 80 of the device 103 in which the drainage channel of the cleaning device is also located can be recognized. The housing 80 is connected to the support wall 30 on which the hollow body 12 not shown in Figures 5A to 5B can be placed.

The housing 80 forms a cleaning opening 82 that can be opened and closed by a closure body 85 rotatably supported at the housing 80. The closure body 85 has a reception unit 84 by which a cover 86, by which the hollow body 12 is closable, can be releasably fastened to the closure body 85. The cover 86 forms an inner cover surface 88 and an outer cover surface 90. The inner cover surface 88 is here that side of the cover 86 that directly adjoins the inner hollow body surface when the hollow body 12 has been closed by the cover 86. In other words, the inner cover surface 88 in this case faces toward the base wall 14 of the hollow body 12 (cf. Figure 4, for example). The reception unit 84 is designed in the embodiment shown such that it only interacts with the cover 86 at the outer cover surface 90.

In Figure 5A, the closure body 85 is in a first position in which the cleaning opening 82 is open. In the first position, the cover 86 can be placed on the reception unit 84 and can be removed from it again, for example by means of a gripping unit not shown here. In Figure 5B, the closure body 85 is in a second position in which the closure body 85 is rotated by 90° with respect to the first position and in which the closure body 85 closes the cleaning opening 82. In the second position, the cover cleaning device 72 can be activated and the inner cover surface 88 can be cleaned. For this purpose, the second fluid, for example the water, can be applied first and the first fluid, for example air, can subsequently be applied to the inner cover surface 88. The first fluid and the second fluid can be conducted through hoses or the like, not shown, to the first cover cleaning dispensing unit 74 or to the second cover cleaning dispensing unit 76. A further drainage channel is likewise not shown by which in particular

the second fluid can be drained. The further drainage channel can open into the drainage channel 38.

So that the total inner cover surface 88 can be treated, the cover cleaning device 72 is provided with a cover cleaning adjustment device 92 that can interact with a rod-shaped guide 94. The guide 94 extends approximately in parallel with the inner cover surface 88 when the closure body 85 is in the second position (see Figure 5B).

The cover cleaning adjustment device 92 can, for example, have a driven spindle nut that interacts with an external thread arranged at the guide 94. Other embodiments, for example by means of pull ropes, are likewise conceivable to move the base body 78 along the guide 94. As mentioned, the first cover cleaning dispensing unit 74 and the second cover cleaning dispensing unit 76 are arranged on a common base body 78, i.e. can only be moved together. It is, however, likewise conceivable to arrange the first cover cleaning dispensing unit 74 on a first base body 78 and the second cover cleaning dispensing unit 76 on a second base body 78 that can be moved along the guide 94 largely independently of one another. In addition, a separate guide 94 could be provided for every base body 78 so that the first cover cleaning dispensing body 74 and the second cover cleaning dispensing unit 79 can be moved completely independently of one another.

The cover cleaning device 72 has an inspection device 66 that can have the same structure as for the second embodiment of the device 102 and by which the inner cover surface 88 can be inspected.

For a better orientation of where the cover cleaning device 72 can be approximately arranged within the device 102 in accordance with the second embodiment, the cover cleaning device 72 is shown in a very greatly simplified manner in

5 Figure 4.

Reference numeral list

	101, 102, 103	device
	12	hollow body
5	13	hollow body wall
	14	base wall
	16	side wall
	18	inner hollow body surface
10	20	outer hollow body surface
	22	inner hollow body space
	24	hollow body opening
	26	marginal surface
	28	cover support surface
15		
	30	support wall
	32	passage opening
	34	locking device
	36	passage bore
20	38	drainage channel
	40	channel end
	42	particle measuring device
	44	cleaning device
25	46	first dispensing unit
	48	second dispensing unit
	50	adjustment device
	52	first tube
30	54	second tube
	56	end piece
	57	first dispensing nozzle
	58	setting device

	60	second dispensing nozzle
	601, 602	second dispensing nozzle
	62	second setting device
5	64	sealing section
	66	inspection device
	68	camera
	70	light source
	72	cover cleaning device
10	74	first cover cleaning dispensing unit
	76	second cover cleaning dispensing unit
	78	base body
	80	housing
	82	cleaning opening
15	84	reception unit
	85	closure body
	86	cover
	88	inner cover surface
	90	outer cover surface
20	92	cover cleaning adjustment device
	94	guide
	A	displacement axis
25		
	α	first spray angle
	β	second spray angle

Claims

1. A device (10) for drying and/or cleaning pot-shaped hollow bodies (12), in particular transport containers for semiconductor wafers or for EUV lithography masks, wherein the hollow body (12) comprises

- a hollow body wall (13) that forms an inner hollow body surface (18), with the inner hollow body surface (18) bounding an inner hollow body space (22); and
- has a hollow body opening (24) that is surrounded by the hollow body wall (13) and through which the inner hollow body space (22) is accessible;

wherein the device (10) comprises

- a cleaning device (44) that
 - o can be or is introduced into the inner hollow body space (12) through the hollow body opening (24) and that has
 - o a first dispensing unit (46) by which a first fluid for cleaning and/or drying the inner hollow body surface (18) can be dispensed; and
 - o a second dispensing unit (48) by which a second fluid for cleaning and/or drying the inner hollow body surface (18) can be dispensed; and
- an adjustment device (50) by which the first dispensing unit (46) and the second dispensing unit are movable independently of one another.

2. A device (10) in accordance with claim 1, characterized in that the device (10) defines a displacement axis (A)

- along which the first dispensing unit (46) and the second dispensing unit (48) are displaceable by the adjustment device (50); and/or

- about which the first dispensing unit (46) and the second dispensing unit (48) are rotatable by the adjustment device (50).

- 5 3. A device (10) in accordance with one of the claims 1 or 2, characterized in that the second dispensing unit (48) is displaceably supported on the first dispensing unit (46).
- 10 4. A device (10) in accordance with claim 3, characterized in that the second dispensing unit (48) is ring-shaped and surrounds the first dispensing unit (46).
- 15 5. A device (10) in accordance with one of the preceding claims, characterized in that the first dispensing unit (46) has a plurality of first dispensing nozzles (57) through which the first fluid can be dispensed at a spray angle (α) with respect to a reference plane extending perpendicular to the displacement axis (A), wherein
- 20 - the spray angle (α) amounts to between 0° and 30° ; and/or
- the first dispensing unit (46) has a setting device (58) by which the spray angle (α) can be set.
- 25 6. A device (10) in accordance with claim 5, characterized in that the device (10) comprises a support wall (30) on which the marginal surface (26) of the hollow body (12) formed by the hollow body wall (13) can be placed, with the support wall (30) forming a passage
- 30 opening through which the cleaning device (44) can be led.
7. A device (10) in accordance with claim 6,

characterized in that the device (10) comprises a locking device (34) by which the marginal surface (26) of the hollow body (12) can be releasably connected to the support wall (30).

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8. A device (10) in accordance with one of the claims 6 or 7, characterized in that that a sealing section (64) by which the support wall (30) can be sealed with respect to the marginal surface (25) when the hollow body (12) is placed on the support wall (30) is arranged on or in the support wall (30).

10

9. A device (10) in accordance with one of the preceding claims,

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characterized in that the cleaning device (10) has an inspection device (66) by which the inner hollow body surface (18) can be inspected.

10. A device (10) for drying and/or cleaning pot-shaped hollow bodies (12) or in accordance with one of the preceding claims,

20

wherein the hollow body (12) has a cover (86) having an outer cover surface (90) and an inner cover surface (88) by which the hollow body opening (24) can be closed,

25

characterized in that the device (10) comprises

- a cover cleaning device (72) that has

o a first cover cleaning dispensing unit (74) by which a first fluid for cleaning and/or drying the inner cover surface (88) can be dispensed; and/or

30

o a second cover cleaning dispensing unit (76) by which a second fluid for cleaning and/or drying the inner cover surface (88) can be dispensed; and

- a cover cleaning adjustment device (92) by which the first cover cleaning dispensing unit (74) and the second cover cleaning dispensing unit (76) are movable.

5 11. A method of cleaning pot-shaped hollow bodies (12), in particular transport containers for semiconductor wafers or for EUV lithography masks, using a device (10) in accordance with one of the previous claims, said method comprising the following steps:

- 10 - introducing the cleaning device (44) into the inner hollow body space (22) through the hollow body opening (24;
- dispensing a first fluid for cleaning and/or drying the inner hollow body surface (18) by means of the first
- 15 dispensing unit (46); and
- dispensing a second fluid for cleaning and/or drying the inner hollow body surface (18) by means of the first dispensing unit (48); and
- independently moving the first dispensing unit (46) and
- 20 the second dispensing unit (48) by means of the adjustment device (50).

12. A method in accordance with claim 11, wherein the dispensing of the first fluid takes place by means of the

25 first dispensing unit (46) offset in time from the dispensing of the second fluid by means of the second dispensing unit (48).

13. A method in accordance with claim 11 or claim 12,

30 characterized in that the first fluid is air and the second fluid is water.

14. A method in accordance with one of the claims 11 to 13,

The method comprising the following step:

- inspecting the inner hollow body surface (18) by means of the inspection device (66).

5 15. A method in accordance with one of the claims 11 to 14,
the method comprising the following steps:

- dispensing a first fluid for cleaning and/or drying the inner cover surface (88) by means of the first cover cleaning dispensing unit (74); and/or
- 10 - dispensing a second fluid for cleaning and/or drying the inner cover surface (88) by means of the second cover cleaning dispensing unit (76).