

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 scrapped.

Since the keeping clean is becoming more and more important as the integration density of the semiconductor circuits and the
25 effort to keep clean increase exponentially as the size of the clean rooms increase, 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. They are
30 understood as box-shaped transport containers into which a large number of semiconductor wafers is inserted. 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,
5 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.

10 Due to the high production downtimes on contaminations 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
15 from the FOUPs.

The same applies accordingly to transport containers for EUV lithography ("extreme ultraviolet radiation") masks. The EUV lithography masks are used to manufacture very small
20 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.

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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.

30 With such cleaning devices, the FOUPs are cleaned on both their inner surfaces and their outer surfaces. The FOUPs are typically contaminated much more on their outer surfaces than on their inner surfaces. As a result, the cleaning fluid

accumulates both particles that originate from the outer surface and particles that originate from the inner surface during the cleaning procedure. The particles can therefore be transported from the outer surface to the inner surface. A
5 satisfactory cleaning result is, however, only reached when the number of particles has fallen below a certain value. Due to the particles originating from the outer surface, the cleaning procedure has to be carried out for a correspondingly long time period to be able to remove a sufficient portion of
10 the particles.

Once the cleaning procedure has been completed, a vacuum acting on the outer surface and/or on the inner surface can be applied. The application of a sufficiently large vacuum serves
15 to remove residues of the cleaning fluid that remain on the surface of the hollow body and of the cover as a result of the cleaning of the hollow body in the cleaning device. Moisture also diffuses into microscopically small pores of the surface of the hollow body and of the cover due to the capillary
20 effect. This moisture can likewise be removed by the vacuum so that a drying is also made possible on a microscopic level. The application of a sufficiently large vacuum however, is a relatively energy intensive and laborious procedure, whereby the cleaning procedure is made more expensive and is drawn
25 out.

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
30 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 drying that is inexpensive and time 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.

5 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
10 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
15 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
- 20 - a first holding means by which the device can interact with the hollow body wall in a holding manner;
 - o an evacuation device for applying a vacuum in the inner hollow body space; and/or
 - o a conveying device for conveying a flushing fluid
25 through the inner hollow body space; and
- a displacement member that can be or is introduced into the inner hollow body space through the hollow body opening.

The first holding means serves the positioning of the hollow
30 body within the device during the application of a vacuum and/or during the conveying of the flushing fluid through the inner hollow body space. In the simplest case, the first holding means can be a support surface.

A displacement member could be understood as a member that takes up a volume that cannot be or can very largely cannot be flowable through for a certain fluid. The displacement member
5 does not necessarily have to be solid here and can be flowable through by a different fluid that is conducted separately from the certain fluid.

The displacement member is arranged such that it projects into
10 the inner hollow body space. The volume in which the vacuum is to be generated is reduced with the aid of the displacement member. As a result, the time period up to the reaching of the desired vacuum is reduced so that the total drying process of in particular the inner hollow body surface is accelerated. At
15 the same time, the energy that is required to apply the desired pressure is reduced.

The conveying of a flushing fluid can take place alternatively or accumulatively to the application of a vacuum using the
20 same device. Nitrogen can be used as the flushing fluid, for example. So-called AMC (airborne molecular contamination) is, however, eliminated by vaporization of the inner hollow body surface with the aid of the flushing fluid. Such AMCs are inter alia fluorine, metals, and radicals. The use of the
25 displacement member reduces the volume of the required flushing fluid. In addition, a flow of the flushing fluid through the inner hollow body space can be induced by means of the displacement member, whereby it can be ensured that the flushing fluid can also reach surfaces that are difficult to
30 access at which dead spots can form. The above-described vaporization process can therefore be carried out effectively and thoroughly.

It must again be pointed out at this point that the device can be used both for drying by means of vacuum and for cleaning using the flushing fluid. The device only has to be connected to corresponding units for this purpose, such as to the
5 evacuation device or to a reservoir for the flushing fluid. In this respect, the evacuation device can also simultaneously take over the function of the conveying device, or vice versa, so that no different units are necessary. It is possible to pass on to the cleaning process without any real time loss
10 after a completed drying process using a correspondingly automated valve connection.

In accordance with a further embodiment, the displacement member can have a passage bore that opens into the inner
15 hollow body space when the displacement member has been introduced into the inner hollow body space and through which the flushing fluid can be conveyed into the inner hollow body space and/or by which a vacuum can be applied in the inner hollow body space. In this embodiment, the valve body also
20 serves the supply of the flushing fluid into the inner hollow space. As a result, a targeted flow of the flushing fluid in the inner hollow body space can be generated in a simple manner, whereby the cleaning effect can be improved.

25 In a further developed embodiment, the device can have a device wall and the displacement member can be releasably connectable to the device wall or can be formed in one part with the device wall.

30 In the event that the displacement member is releasably connected to the device wall, it can be replaced with another displacement member without any great effort in the event of any damage. It is additionally possible to connect differently

shaped displacement members to the device wall. Consequently, a given device can be quickly converted for differently shaped hollow bodies, whereby the flexibility of the device is increased.

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In the event that the displacement member is formed in one part with the device wall, a mass production of the device can be simplified since a part can be saved. A connection step is additionally omitted.

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In a further developed embodiment, the device wall can have a first wall section and a second wall section that are releasably connectable to one another and that surround an inner device space in the connected state, with the first holding means comprising a holding surface and the first wall section forming the holding surface that at least partially bounds the inner device space. The holding surface serves the support of the hollow body. Since the holding surface at least partially bounds the inner device space, the holding surface faces into the inner device space. The hollow body is consequently arranged in the inner device space when the hollow body is placed on the holding surface. The inner device space is a closed space when the first wall section and the second wall section are connected to one another. Since the first wall section and the second wall section can be released from one another, the hollow body can be introduced into and removed from the inner device space without problem. The device wall here protects the hollow body from external influences, in particular during the drying and cleaning. It is likewise possible that the holding surface is formed by the second wall section if this appears sensible.

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In a further embodiment, the hollow body wall can form an outer hollow body surface and the device can have at least one fluid conducting device by which the flushing fluid can be conducted from the inner hollow body space to the outer hollow
5 body space and/or by which a vacuum can be applied in the inner hollow body space and/or in the inner device space.

As mentioned, the semiconductor wafers are arranged in the predominantly closed inner hollow body space. Consequently,
10 due to the spatial proximity, the contaminants of the semiconductor wafers are mainly caused by contaminants that originate from the inner hollow body surface. The cleaning of the inner hollow body surface is therefore of greater importance than that of the outer hollow body surface. The
15 outer hollow body surface is, however, typically contaminated more than the inner hollow body surface. Since particles can move onto the inner hollow body space and from there onto the semiconductor wafers with an open hollow body, the cleaning of the outer hollow body space also contributes to a reduction in
20 the number of defective semiconductor wafers. It is possible in this embodiment to also dry the outer hollow body surface as a result of an application of vacuum and/or to clean it with a corresponding conducting of the flushing fluid. Both measures contribute to the reduction of the soiling of the
25 outer hollow body surface.

As mentioned, the inner hollow body surface is typically less soiled than the outer hollow body surface. In this embodiment, the flushing fluid is first conducted from the fluid
30 conducting device over the inner hollow body surface and subsequently over the outer hollow body surface. The flushing fluid consequently first flows over the less soiled surface and subsequently to the more soiled surface. It is hereby

prevented that flushing fluid that is highly charged with particles is conducted over comparatively lightly soiled surfaces that are then less effectively cleaned or are even soiled.

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A further developed embodiment can be characterized in that the hollow body has a cover by which the hollow body opening can be closed and the device has second holding means by which the cover is releasably fastenable to the device wall. As

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mentioned, the FOUPs can be closed by a removable cover. In this embodiment, the cover can likewise be dried and cleaned in the present device. Corresponding separate processes only for the cover are dispensed with.

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According to a further embodiment, the cover can have an inner cover surface and an outer covers surface and the device can comprise a gripping and moving device by which the cover is connectable to the second holding means such that the outer cover surface faces toward the outer hollow body surface.

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The simultaneous cleaning of the hollow body and of the cover requires a separation thereof before the introduction into the device. The introduction into the device takes place separately. In gripping and moving devices known from the

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prior art that would be suitable for such a handling, the case occurs that the inner cover surface of the cover separated from the hollow body faces toward the outer hollow body surface. Since it is, for example, endeavored for the reasons named further above to keep the volume of the inner device

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space as small as possible, the distance between the outer hollow body surface and the inner cover surface is typically not particularly large. Consequently, due to the soiling of the outer hollow body space, highly charged flushing fluid

would also flow over the inner cover surface, whereby it could hardly be effectively cleaned or could even be soiled. The flushing fluid has to be supplied for a correspondingly long time. Since the cover is arranged in the inner device space in this embodiment such that the outer cover surface faces toward the outer hollow body surface, this situation is avoided and the cleaning process is accelerated. It can be assumed here that the charging of the flushing fluid increases as the distance from the surface to be cleaned decreases.

It can be suitable in a further embodiment that at least one flow straightener is arranged in the inner device space by which the flow of the flushing fluid can be conducted in the inner device space. The flow straightener can comprise a number of baffle plates and/or a partition wall. The flow of the flushing fluid can be conducted such that more highly charged flushing fluid does not flow or only flows to a small extent over the inner cover surface. The above described case is avoided that more highly charged flushing fluid flows over the comparatively clean inner cover surface and possibly even contaminates it instead of cleaning it.

A further developed embodiment can be characterized in that the hollow body wall forms a marginal surface that surrounds the hollow body opening and the first holding means comprises a locking device by which the hollow body is sealingly connectable to the marginal surface and releasably connectable to the holding surface. The hollow body is clearly fixed and positioned during the drying and the cleaning by the use of the locking device so that it can be ensured that the desired flow is adopted. The marginal surface separates the inner hollow body surface from the outer hollow body surface. Due to the fact that the marginal surface of the hollow body lies

sealingly on the holding surface, it is prevented that the flushing fluid can flow in an uncontrolled manner from the inner hollow body space to the outer hollow body space or vice versa. It is additionally possible only to apply a vacuum
5 permanently in the inner hollow body space.

A further embodiment is characterized in that the displacement member surrounds a hollow space that is accessible by means of a passage opening and in that a heating device is arranged in
10 the hollow space by which the hollow body can be heated for drying. The heating device serves to heat the hollow body after the cleaning to support the drying process. Since the displacement member is introduced into the inner hollow body space, the distance between the heating device and the hollow
15 body wall is small so that an effective heating can be implemented. Atmospheric pressure is present in the hollow space due to the fact that the hollow space is open. It is therefore not necessary to take special measures to protect the heating device from the vacuum. In addition, the heating
20 device is easily accessible through the passage opening so that the assembly and repair can be carried out without special measures.

A further developed embodiment can specify that the heating
25 device comprises a number of infrared diodes and the displacement member consists of or comprises a material permeable for infrared radiation. The infrared diodes have the advantage that the infrared radiation generated by them is in a tightly bounded frequency range that can be optimized to the
30 cleaning fluid used. Some of the infrared diodes can generate infrared radiation by which the cleaning fluid is heated; other infrared diodes can generate infrared radiation by which the hollow body wall is heated. The residues of the cleaning

fluid still remaining on the inner hollow body surface or on the outer hollow body surface are very effectively heated and thus eliminated in interaction with the vacuum.

5 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:

- 10 - holding interaction of the hollow body wall by the first holding means;
- introducing the displacement member into the inner hollow body space; and
- applying a vacuum in the inner hollow body space by means
- 15 of an evacuation device; and/or
- conveying a flushing fluid through the inner hollow body space by means of a conveying device.

The technical effects and advantages that can be achieved with
20 the method proposed in accordance with the invention correspond to those that have been discussed for the present device. It must be pointed out in summary that the volume in which the vacuum is to be generated is reduced with the aid of the displacement member. As a result, the time period up to
25 the reaching of the desired vacuum is reduced so that the total drying process of in particular the inner hollow body surface is accelerated. At the same time, the energy that is required to apply the desired pressure is reduced. The volume of the flushing fluid that is required to clean the inner
30 hollow body surface is also kept small for the same reason. It appears sensible here to carry out the cleaning after the drying process.

Provision can be made in a further embodiment that the hollow body has a cover having an inner cover surface and an outer cover surface by which the hollow body opening is closable. The device here has a device wall, second holding means by which the cover is releasably fastenable to the device wall, and a gripping and moving device, wherein the method comprises the following steps:

- releasably fastening the cover using the gripping and moving device by the second holding means such that the outer cover surface faces toward the outer hollow body surface.

In the event that the inner cover surface faces toward the outer hollow body surface, due to the soiling of the outer hollow body space, highly charged flushing fluid would also flow over the inner cover surface, whereby it could hardly be effectively cleaned or could even be soiled. Since the cover is arranged in the inner device space in this embodiment such that the outer cover surface faces toward the outer hollow body surface, this situation is avoided.

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

Figures 1A to 1F different steps of operating a device in accordance with a first embodiment of the present invention;

Figure 2 a second embodiment of the device in accordance with the invention;

Figure 3 a third embodiment of the device in accordance with the invention;

Figure 4 a fourth embodiment of the device in accordance with the invention;

Figure 5A a sectional representation of a fifth embodiment of the device in accordance with the invention;

Figure 5B a plan view of the displacement member shown in Figure 5A;

Figure 6A a perspective representation of a fifth embodiment of the device in accordance with the invention; and

Figure 6B a sectional representation through the sixth embodiment of the device in accordance with the invention shown in Figure 6A.

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A first embodiment of a device 10₁ in accordance with the invention 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 basic representations is shown in Figures 1E and 1F. A cup-shaped hollow body 12, that is also called a FOUP, is shown in Figures 1E and 1F to which reference will be made in the following. The hollow body 12 comprises a hollow body wall 14 that forms an inner hollow body surface 16, with the inner hollow body surface 16 bounding an inner hollow body space 17. The hollow body 12 furthermore has a hollow body opening 18 that is surrounded by the hollow body wall 14 and through which the inner hollow body space 17 is accessible, for

example to charge the hollow body 13 with semiconductor wafers. The hollow body wall 14 forms a marginal surface 20 that surrounds the hollow body opening 18.

- 5 The hollow body 12 furthermore has an outer hollow body surface 22. The marginal surface 20 separates the outer hollow body surface 22 from the inner hollow body surface 16.

A cover 24 by which the hollow body opening 18 is closable is
10 likewise shown in Figures 1E and 1F. The cover 24 forms an inner cover surface 26 and an outer cover surface 28. The association here relates to the state not shown in the Figures in which the hollow body opening 18 is closed by the cover 24. The inner cover surface 26 then faces into the inner hollow
15 body space 17 and the outer cover space 28 faces outward.

The device 10₁ has a first holding means 30 that can interact with the hollow body 12. In the embodiment shown, the first holding means 30 comprises a holding surface 32 on which the
20 marginal surface 20 of the hollow body 12 can be placed. The first holding means 30 furthermore comprises a locking device 33 by which the hollow space 12 can be sealingly connected to the marginal surface 20 and releasably connected to the holding surface 32.

25 In the embodiment shown, the holding surface 32 is formed by a device wall 34 that in turn comprises a first wall section 36 and a second wall section 38. The first wall section 36 and the second wall section 38 can be connected to one another and
30 separated from one another again. The holding surface 32 is formed by the first wall section 36 in this case. In the connected state, the first wall section 36 and the second wall section 38 surround an inner device space 40.

As can be seen from Figures 1E and 1F, the holding surface 32 is arranged on projections 42 of the first wall section 36. A number of passage channels 44 are arranged in the projections 42 and belong to a fluid conducting device 46 whose function will be looked at in even more detail in the following.

A displacement member 48₁ in accordance with a first embodiment, that is designed in conical shape, is furthermore releasably fastened to the first wall section 36, with it also being conceivable to design the displacement member 48₁ in one part with the first wall section 36. If the hollow body 12 is placed on the holding surface 32, as shown in Figures 1E and 1F, the displacement member 48₁ projects into the inner hollow body space 17, with a gap arising between the displacement member 48₁ and the hollow body wall 14. The shape of the displacement member 48₁ is selected here such that it approximately corresponds to the shape of the inner hollow body space 17. The gap consequently at least approximately has a constant width. A passage bore 50 runs through the displacement member 48₁ and opens into the inner hollow body space 17 provided that the hollow space 12 has been placed on the holding surface 32, as shown in Figures 1E and 1F.

As mentioned, the hollow body opening 18 can be closed by means of the cover 24. The cover 24 is connected to the second wall section 38 by a second holding means 52.

The device 10₁ in accordance with the first embodiment can be operated in the following manner:

Before the steps described in the following are carried out, the hollow body 12 and the cover 24 have been cleaned by a cleaning fluid in a manner that is not shown.

5 With reference to Figure 1A, it can be recognized that the first wall section 36 has been released from the second wall section 38. The first wall section 36 is not shown in Figure 1A for illustration reasons. The cover 24 has been separated from the hollow body 12 by means of a gripping and moving
10 device 54, with this separation step likewise not being shown in Figure 1A. It can only be recognized that the cover 24 is connected to the gripping and moving device 54. The gripping and moving device 54 has a rotational device 56 by which the cover 24 can be rotated about an axis of rotation R. In this
15 respect, the cover 24 is rotated such that the inner cover surface 26 faces toward the second holding means 52. As soon as the cover 24 has adopted the corresponding rotational position, the cover 24 is gripped by means of a displacement device 58 of the gripping and moving device 54 and is moved
20 into the inner hollow body space 17 such that the cover 24 comes into contact with the second holding means 52 and can be held thereby (see Figure 1B).

The marginal surface 20 of the hollow body 12 is placed on the
25 holding surface 32, as can be seen from Figure 1C. The locking device 33 is subsequently activated, as a result of which the hollow body 12 is sealingly connected to the first wall section 36. As can be seen from Figure 1D, the first wall section 36 and the second wall section 38 are now connected to
30 one another, likewise making use of the gripping and moving device 54. With reference to Figure 1E, a vacuum is applied in the inner device space 40. For this purpose, the device 10₁ comprises an evacuation device 60 that comprises a vacuum pump

62 in the embodiment shown. The evacuation device is connected to the inner device space 40 by means of a connection valve 63. Due to the activation of the vacuum pump 62, the fluid in the inner device space 40, typically air, is sucked out of the inner device space 40. To prevent a flowing on of air through the passage bore 50, the passage bore 50 is connected to a check valve 64 that is closed for this purpose. The flow of the fluid in the inner device space 40 that is adopted is shown with reference to the arrows. It must be mentioned that the fluid can flow through the passage channels 44 so that the fluid that is in the inner hollow body space 17 can also be sucked off. The locking device 33 is formed here such that the flow toward the vacuum pump 62 is not appreciably disrupted.

As a result, a vacuum is formed over the inner hollow body surface 16, the outer hollow body surface 22, the inner cover surface 26, and the outer cover surface 28, whereby residues of the cleaning fluid are removed that remain on the surface of the hollow body 12 and of the cover 24 due to the preceding cleaning of the hollow body 12 in the cleaning device. The inner hollow body surface 16, the outer hollow body surface 26, the inner cover surface 26, and the outer cover surface 28 are hereby dried.

It can be recognized with reference to Figure 1F that, on completion of the drying process, the passage bore 50 is now connected to a fluid reservoir 65 in which a flushing fluid is located, for example nitrogen. This can take place manually or by means of a corresponding valve connection, with the check valve 64 also being able to be used and being able to be actuated accordingly to open. The flushing fluid is conveyed through the device 10₁ by means of a conveying device 66, with the conveying device 66 having a conveying pump 68. The

evacuation device 66 is likewise connected to the inner device space 40 by means of the already mentioned connection valve 63. It must be pointed out at this point that the vacuum pump 62 can be adapted such that it can also be used as a conveying pump 68. The vacuum pump 62 and the conveying pump 68 can to this extent be formed by the same component.

In the event that a vacuum is still applied in the inner device space 40 before the drying process, the flushing fluid can also be conveyed into the inner device space 40 in the following manner: With a corresponding embodiment of the check valve 64 and of the fluid reservoir, the flushing fluid can be sucked into the inner device space 40 as a consequence of an opening of the check valve 64. An active conveying of the flushing fluid by means of the conveying device 66 is at least not necessary until the full pressure balance. The connection valve 63 and/or the check valve 64 can be adapted here such that they are able not only to release and to block the flow of the flushing fluid or of another fluid, but also to set the volume flow. In particular when a greater vacuum is present in the inner device space 40, it is meaningful to first keep the volume flow through the check valve 64 small to carry out the pressure balance slowly and to avoid pressure bumps.

The flushing fluid flows substantially along the same direction as the fluid on the application of a vacuum, as described in connection with Figure 1E. The arrows also indicate the flow direction in Figure 1F. The still uncharged flushing fluid here flows out of the fluid reservoir 65 through the passage bore 50 and subsequently over the inner hollow body surface 16. AMCs (airborne molecular contaminants) are eliminated from the inner hollow body surface 16 by vaporization with the aid of the flushing fluid and are in so

doing taken up by the flushing fluid and transported on. The flushing fluid subsequently flows through the passage channels 44 and then impinges on the outer hollow body surface 22. The above-named contaminants are also eliminated here.

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The outer hollow body surface 16 is typically soiled more than the inner hollow body surface 16 so that the charge of the flushing fluid considerably increases on the flowing over the outer hollow body surface 22. That portion of the flushing
10 fluid has the greatest charge here that flows directly over the outer hollow body surface 22. Since the distance between the cover 24 and the hollow body 12 in the inner device space 40 is not particularly large, comparatively greatly contaminated flushing fluid also flows over the outer cover
15 surface 28. The portion of the flushing fluid that flows along the second wall section 38 and is consequently less charged flows over the inner covers surface 26. It is consequently avoided that strongly charged flushing fluid flows over the comparatively clean inner cover surface 26 and soils it
20 instead of cleaning it. The flushing fluid subsequently exits the device 10₁ and can be stored in a container, not shown, to be disposed of or prepared.

A second embodiment of the device 10₂ in accordance with the
25 invention is likewise shown with reference to a basic representation in Figure 2. The basic design of the device 10₂ in accordance with the second embodiment here largely corresponds to that of the device 10₁ in accordance with the first embodiment so that only the major differences will be
30 looked at. The device 10₂ in accordance with the second embodiment comprises a flow straightener 70 that is designed as a partition wall 72 that can be arranged in the inner device space 40 with an adjustment device, not shown. The

partition wall 72 divides the inner device space 40 into a first subsection 74 and a second subsection 76. The hollow body 12 is her located in the first subsection 74 while the cover 24 is located in the second subsection 76. The
5 adjustment device is therefore necessary to allow access to the second subsection 76 so that the cover 24 can be arranged there and removed from there.

The inner device space 40 is connected to a further fluid
10 reservoir 78 in which further flushing fluid can be stored that is identical to the flushing fluid that is stored in the fluid reservoir 65. The further fluid reservoir 78 is here in communication with the second subsection 76.

15 As already mentioned for the first embodiment of the device 10₁, the flushing fluid is conveyed through the inner device space 40 by means of the conveying device 66. In the second embodiment of the device 10₂, however, the further flushing fluid is also conveyed from the second fluid reservoir 78 into
20 the second subsection 76, with the still uncharged further flushing fluid flowing directly over the inner cover surface 26 and subsequently over the outer cover surface 28. The further flushing fluid then exits the second subsection 76 through a partition wall opening 80 and merges there with the
25 flushing fluid of the first subsection 74. As mentioned, the flushing fluid can be conducted into a container, not shown, to be disposed of or prepared. It is hereby ensured that the inner cover surface 26 is acted on by a flushing fluid that is not charged or is only very slightly charged so that an
30 effective cleaning of the inner cover surface 26 can be achieved.

An embodiment is not shown in which the fluid conducting device 46 has a number of baffle plates that divide the flushing fluid into two part flows as soon as the flushing fluid has flowed through the passage channels 44. An outer
5 part flow is conducted along the second wall section 38 to the cover 24 and an inner part flow is conducted along the outer hollow body surface 22. A mixing of the outer part flow and the inner part flow is largely avoided as long as the outer part flow has not yet reached the cover 24. It is also hereby
10 prevented that greatly charged flushing fluid flows over the inner cover surface 26. It is not necessary here to provide a further fluid reservoir 78.

A third embodiment of the device 10₃ in accordance with the
15 invention is likewise shown with reference to a basic representation in Figure 3. The first wall section 36 forms a passage opening 82 that is approximately flush with the hollow body opening 18 when the hollow body 12 is placed on the first wall section 36. The fluid conducting device 46 also comprises
20 the passage channels 44 in this embodiment. The first wall section 36 divides the inner device space 40 into a first subsection 74 and a second subsection 76, with the hollow body 12 being able to be arranged in the first subsection 74 and the cover 24 being able to be arranged in the second
25 subsection 76. The displacement member 48 projects from the second subsection 76 through the passage opening 82 into the first subsection 74 and into the inner hollow body space 17.

In the second subsection 76, the first wall section 36 forms a
30 wall opening 84. The second holding means 52 by which the cover 24 can be fixed in place are arranged at a cover handling unit 86 in the third embodiment by which the cover 24 is releasably connectable while using the second holding means

52. The cover handling unit 86 is rotatably supported about an axis of rotation by means of a fastening device 88 rotatable at the first wall section and is movable between an open position at which the cover handling unit 86 releases the wall opening 84 and consequently the access to the inner device space 40 and a closed position at which the wall opening 84 is closed. The cover handling unit 86 is in the closed position in Figure 3. Care must be taken here that the wall opening 84 is closed by the cover 24, with the inner cover surface 26 facing into the inner device space 40.

The main operating mode of the device 10₃ in accordance with the third embodiment here corresponds to the one that has been described for the first and second embodiments. One of the major differences is the manner of handling the cover 24. Once the cover 24 has been separated from the hollow body 12 by means of the gripping and moving device 54 not shown in Figure 3, the cover 24 is placed onto the second holding means 52. At this point in time, the cover handling unit 86 is in the open position in which it is rotated by 90° in comparison with the closed position shown in Figure 3. The cover 24 is placed onto the second holding means 52 from above and the cover handling unit 86 is subsequently rotated by 90° into the closed position, as shown in Figure 3. The cover 24 now closes the wall opening 84. The evacuation device 60 that is not shown in Figure 3 can now be activated such that a vacuum is applied in the inner device space 40. Residues of the cleaning fluid that are located on the inner hollow body surface 16, on the inner cover surface 26, and on the outer hollow body surface 22 are removed and the hollow body 12 and the cover 24 are dried. It must be noted that in this embodiment the vacuum is not applied to the outer cover surface 28 so that residues of the cleaning fluid can still remain here.

After the completion of the drying process, a transition to the cleaning process that is shown in Figure 3 can take place as a result of a corresponding valve connection. As also
5 mentioned for the other embodiments, the conveying pump 68 of the conveying device 66 is activated, the check valve 64 is opened, and the flushing fluid is conveyed through the passage bore 50, that is connected to the fluid reservoir 65 as a result of the valve connection, into the inner device space 40
10 where it flows over the inner hollow body surface 16, the inner cover surface 26, and the outer hollow body surface 22 and can remove any contaminants located there. It also applies here that the outer cover surface 28 is not reached by the flushing fluid and is also not cleaned by it.

15 A fourth embodiment of the device 10₄ in accordance with the invention is in turn shown with reference to a basic representation in Figure 4. The basic design of the device 10₄ in accordance with the fourth embodiment here largely
20 corresponds to that of the device 10₁ in accordance with the first embodiment so that only the major differences will be looked at. As also in the first embodiment, the device wall 34 is divided into a first wall section 36 and a second wall section 38, with the separation zone extending differently. As
25 can be recognized from Figure 4, the first all section 36 is of U shape while the second wall section is planar and is substantially of plate form or disk form. The first holding means 30 is attached to the second wall section 38 and interacts with the outer hollow body surface 22 using the
30 holding surface 32 such that the hollow body 12 is arranged spaced apart from the device wall 34 within the inner device space 40. To this extent, the holding surface 32 in the fourth embodiment is formed by the second wall section 38. In the

fourth embodiment of the device 10₄, the hollow body 12 is therefore not placed onto a surface, but rather "floats" in the inner device space 40. The first holding means 30 is configured such that a gap 90 remains between the marginal surface 20 and the first wall section 36 that can be flowed through by the flushing fluid to move from the inner hollow body surface 16 to the outer hollow body surface 22. To this extent, the first holding means 30, the hollow body wall 14, and the device wall 34 form the fluid conducting device 46 and take over their functions in the second embodiment. The first holding means 30 is designed here such that the flow of the flushing fluid within the inner device space 40 is not substantially disruptive. it is therefore not necessary to provide the projections 42 and the passage channels 44. The locking device 33 can also be dispensed with.

The second holding means 52 for fastening the cover 24 is also arranged on the second wall section 38.

The displacement member 48₁ is formed in one piece with the first wall section 36 in the fourth embodiment of the device 10₄.

The device 10₄ in accordance with the fourth embodiment is operated in substantially the same manner as described for the other embodiments. It must be noted, however, that the hollow body 12 and the cover 24 are first fastened to the second wall section 38 using the gripping and moving device 54 before it is connected to the first wall section 36. In this respect, the gripping and moving device 54 grips at least one of the two wall sections 36, 38.

A displacement member 48₂ in accordance with a second embodiment is shown in Figures 5A and 5B. While the displacement member 48₁ in accordance with the first embodiment is formed as a solid body, the displacement member 48₂ in accordance with the second embodiment surrounds a hollow space 92 that is accessible by means of a passage opening 94 that is formed by a displacement member wall 96. The displacement member 48₂ is introduced into the device 10₅ in accordance with a fifth embodiment such that a vacuum can be applied to its outer side of the displacement member wall 96 located in the inner device space 40 while atmospheric pressure is present in the hollow space 92. Only the second wall section 38 of the device wall 34 is shown of the device 10₅ in accordance with the fifth embodiment that can have exactly the same design in principle as the devices 10₁ to 10₄ in accordance with the previously described embodiments. Only the displacement member 48₂ is shown in Figure 5B.

A reception flange 104 is arranged in the second wall section 38 that forms a flange opening 106 through which the displacement member 48₂ can be plugged and can thus be introduced into the inner device space 40 of the device 10₅. The reception flange 104 can also be designed as a separate component. At least one O ring seal 108, two O ring seals 108 here, are arranged in the reception flange 104 that seal the second wall section 38 with respect to the displacement member wall 96 when the displacement member 48₂ is plugged through the flange opening 106 as shown in Figure 5A. It is hereby made possible to apply a vacuum in the device 10₅. To prevent the displacement member 48₂ from being drawn into the device 10₅ here, the displacement member 48₂ has a radial expansion 110 at its passage opening.

A heating device 98 is arranged in the hollow space 92 that is fastened to the displacement member wall 96 by means of a holder 100. The heating device 98 is accessible through the passage opening 94. Since, as mentioned, atmospheric pressure is present in the hollow space 92, no special measures are required to protect the heating device 98 with respect to a vacuum. The heating device 98 comprises a number of infrared diodes 102 for generating infrared radiation. Two groups of infrared diodes 102 can be distinguished here. The first group of infrared diodes 102 irradiates the infrared radiation mainly along a longitudinal axis L of the displacement member 48₂. This first group of infrared diodes 102 is arranged in the region of the closed end of the displacement member 48₂ arranged opposite the passage opening 94, in the upper region in Figure 5A. The second group of infrared diodes 102 irradiates the infrared radiation mainly perpendicular to the longitudinal axis and is arranged centrally. The displacement member wall 96 is produced from a material permeable for infrared radiation, for example from glass.

As mentioned, the volume in which the vacuum is to be generated is reduced with the aid of the displacement member 48₂. As likewise mentioned, the vacuum serves to remove residues of the cleaning fluid from the inner hollow body surface 16 and/or for the outer hollow body surface 22. The removal can be supported by means of the heating device 98. The infrared radiation generated by the infrared diodes 102 is in a tightly bounded frequency range that can be optimized to the cleaning fluid used. The residues of the cleaning fluid still remaining on the inner hollow body surface 16 or on the outer hollow body surface 22 are very effectively heated and thus eliminated in interaction with the vacuum.

As previously described, the displacement member 48₁ in accordance with the first embodiment has the passage bore 50 (cf., for example, Figures 1F and 2) through which, on completion of the drying process, a flushing fluid, nitrogen
5 for example, can flow along the inner hollow body surface 16 and/or along the outer hollow body surface 22 of the hollow body 12 not shown in Figures 5A and 5B. In contrast with this, the displacement member wall 96 of the displacement member 48₂ in accordance with the second embodiment is closed, in
10 particular due to the fact that it is produced from glass. To nevertheless be able to introduce the flushing fluid into the inner device space 40 of the device 10₅, a plurality of connection channels 112 are arranged in the reception flange 104, arranged distributed at the periphery of the reception
15 flange 104, and, as described for the passage bore 50, can be connected to the check valve 64 and/or to the fluid reservoir 65 (cf. Figure 2, for example). Only one check valve 65 is shown in Figure 5A for illustration reasons. In another respect, the device 10₅ is operated in the same way as
20 described for the other embodiments of the device 10₁ to 10₄.

A sixth embodiment of the device 10₆ in accordance with the invention is shown with reference to perspective representations in Figures 6A and 6B. The device 10₆ has a
25 displacement member 48₃ in accordance with a third embodiment. The displacement member 48₃ is designed in parallelepiped-shape in the third embodiment and can be configured as a hollow body or as a solid body, but is closed, in contrast with the second embodiment of the displacement member 48₂ shown in Figures 5A
30 and 5B. The displacement member 48₃ is also connected in this embodiment to the reception flange 104 that is fastened to the second wall section. The reception flange 104 likewise has the connection channels to introduce the flushing fluid into the

inner device space 40. The heating device 98 comprises a total of four groups of infrared diodes 102 that are arranged outside the displacement member 48₃. The holder in this case is formed as a cruciform disk that is fastened to the free end of
5 the displacement member 48₃. The holder has one respective reception bore 114 for each group of infrared diodes 102. In addition, each group of infrared diodes 102 is connected to the reception flange 104.

10 The infrared diodes 102 are arranged such that they irradiate the infrared radiation mainly perpendicular to the longitudinal axis of the displacement member 48₃ not shown in Figures 6A and 6B. A portion of this infrared radiation consequently impinges on the displacement member 48₃. The
15 displacement member 48₃ has a reflective surface 116 by which the infrared radiation incident on the displacement member 48₃ is reflected and can consequently be used for the heating of the hollow body 12 and is not lost. The reflective surface 116 can be provided, for example, in that the displacement member
20 48₃ is produced from metal, for example aluminum, and is equipped with particularly small roughness, by polishing for example, where the reflective surface 116 is to be arranged.

In another respect, the device 10₆ in accordance with the sixth
25 embodiment is essentially operated exactly as described for the fifth embodiment of the device 10₅.

Reference numeral list

	10	device
	10 ₁ , 10 ₂ , 10 ₃ , 10 ₄ , 10 ₅ , 10 ₆	device
5	12	hollow body
	14	hollow body wall
	16	inner hollow body surface
	17	inner hollow body space
	18	hollow body opening
10		
	20	marginal surface
	22	outer hollow body surface
	24	cover
	26	inner cover surface
15	28	outer cover surface
	30	first holding means
	32	holding surface
	33	locking device
20	34	device wall
	36	first wall section
	38	second wall section
	40	inner device space
25	42	projections
	44	passage channel
	46	fluid conducting device
	48	displacement member
	48 ₁ , 48 ₂ , 48 ₃	displacement member
30		
	50	passage bore
	52	second holding means
	54	gripping and moving device

	56	rotational device
	58	displacement device
	60	evacuation device
5	62	vacuum pump
	63	connection valve
	64	check valve
	65	fluid reservoir
	66	conveying device
10	68	conveying pump
	70	flow straightener
	72	partition wall
	74	first subsection
15	76	second subsection
	78	further fluid reservoir
	80	partition wall opening
	82	passage opening
20	84	wall opening
	86	cover handling unit
	88	fastening device
	90	gap
25	92	hollow space
	94	passage opening
	96	displacement member wall
	98	heating device
30	100	holder
	102	infrared diodes
	104	reception flange
	106	flange opening

108 O ring seal

110 radial expansion

112 connection channel

5 114 reception bore

116 reflective surface

L longitudinal axis

R axis of rotation

10

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 (14) that forms an inner hollow body surface (16), with the inner hollow body surface (16) bounding an inner hollow body space (17); and
 - has a hollow body opening (18) that is surrounded by the hollow body wall (14) and through which the inner hollow body space (17) is accessible;
- wherein the device (10) comprises
- a first holding means (30) by which the device (10) can interact with the hollow body (12) in a holding manner;
 - o an evacuation device (60) for applying a vacuum in the inner hollow body space (17); and/or
 - o a conveying device (66) for conveying a flushing fluid through the inner hollow body space (17);
 - and
 - a displacement member (48) that can be or is introduced into the inner hollow body space (17) through the hollow body opening (18).
2. A device (10) in accordance with claim 1, characterized in that the displacement member (48) has a passage bore (50)
- that opens into the inner hollow body space (17) when the displacement member (48) has been introduced into the inner hollow body space (17); and
 - through which the flushing fluid can be conveyed into the inner hollow body space (17) and/or by which a

vacuum can be applied in the inner hollow body space (17).

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

characterized in that

- the device (10) has a device wall (34); and
- the displacement member (48) is releasably connectable to the device wall (34) or is formed in one piece with
10 the device wall (34).

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

characterized in that

- 15 - the device wall (34) has a first wall section (36) and a second wall section (38) that are releasably connectable to one another and that surround an inner displacement space (40) in the connected state, with
- the first holding means (30) comprising a holding
20 surface (32) and
- the first wall section (36) forming the holding surface (32) that at least partially bounds the inner device space (40).

25 5. A device (10) in accordance with claim 4,
characterized in that

- the hollow body wall (14) forms an outer hollow body surface (22); and
- in that the device (10) has at least one fluid
30 conducting device (46) by which the flushing fluid can be conducted from the inner hollow body space (17) to the outer hollow body surface (22) and/or by which a

vacuum can be applied in the inner hollow body space (17) and/or in the inner device space (40).

6. A device (10) in accordance with one of the claims 4 or 5,
5 characterized in that the hollow body (12) has a cover (24) by which the hollow body opening (18) can be closed and the device (10) has second holding means (52) by which the cover (24) is releasably fastenable to the device wall (34).

10 7. A device (10) in accordance with claim 6, characterized in that the cover (24) has have an inner cover surface (26) and an outer cover surface (28) and the device (10) comprises a gripping and moving device (54) by
15 which the cover (24) is connectable to the second holding means (52) such that the outer cover surface (28) faces toward the outer hollow body surface (22).

8. A device (10) in accordance with one of the claims 4 to 7,
20 characterized in that at least one flow straightener (70) is arranged in the inner device space (40) by which the flow of the flushing fluid can be conducted in the inner device space (40).

25 9. A device (10) in accordance with one of the claims 4 to 8, characterized in that

- the hollow body wall (14) forms a marginal surface (20) that surrounds the hollow body opening (18); and
- the first holding means (30) comprises a locking device
30 (33) by which the hollow body (12) is sealingly connectable to the marginal surface (20) and releasably connectable to the holding surface (32).

10. A device (10) in accordance with one of the preceding
claims,
characterized in that the displacement member (48) has a
heating device (98) by which the hollow body (12) can be
5 heated for drying.

11. A device (10) in accordance with claim 10,
characterized in that the heating device (98) comprises a
number of infrared diodes (102).

12. A device (10) in accordance with claim 11,
characterized in that the displacement member (48) has a
reflective surface to reflect the infrared radiation
emitted by the infrared diodes.

13. A device (10) in accordance with one of the claims 1 to 11,
characterized in that the displacement member (48)
- surrounds a hollow space (92) that is accessible by
means of a passage opening (94); and
20 - the heating device (98) is arranged in the hollow
space; and
- a heating device (98) is arranged in the hollow space
(92).

14. A device (10) in accordance with claim 13,
characterized in that the displacement member (48) consists
of or comprises a material permeable or infrared radiation.

15. A method of cleaning pot-shaped hollow bodies (12), in
30 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:

- holding interaction of the hollow body wall (14) by the first holding means (30);
- introducing the displacement member (48) into the inner hollow body space (17); and
- 5 - applying a vacuum in the inner hollow body space (17) by means of an evacuation device (60); and/or
- conveying a flushing fluid through the inner hollow body space (17) by means of a conveying device (66).

10 16. A method in accordance with claim 15,

- wherein the hollow body (12) has a cover (24) having an inner cover surface (26) and an outer cover surface (28) by which the hollow body opening (18) can be closed; and

15 - the device (10) has

- o a device wall (34);
- o second holding means (52) by which the cover (24) is releasably fastenable to the device wall (34);
- and

20 o a gripping and holding device (54);

and wherein the method comprises the following steps:

- releasably fastening the cover using the gripping and moving means (54) by the second holding means (52) such that the outer cover surface (28) faces toward the
- 25 outer hollow body surface (22).