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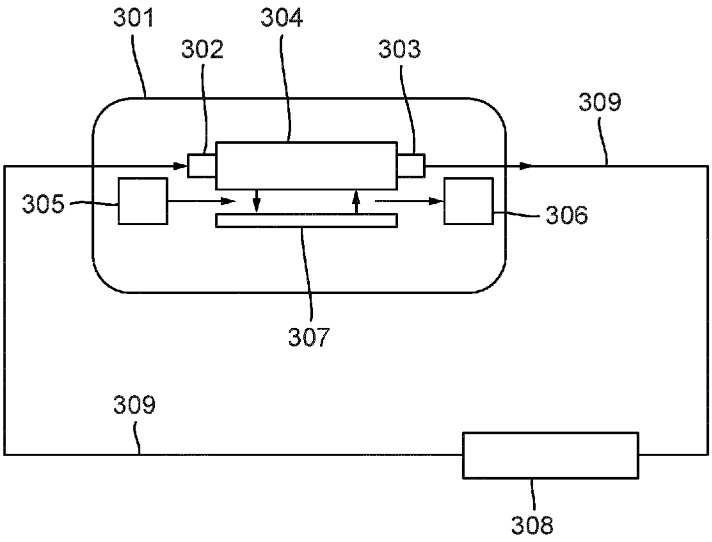
(54) Title: A CONDITIONING SYSTEM, ARRANGEMENT AND METHOD

Fig. 3



(57) **Abstract:** Disclosed herein is a stand-alone conditioning system for a fluid handling structure of a lithographic apparatus, comprising: an inspection system configured to inspect the fluid handling structure and to determine one or more different types of conditioning to be performed on a major surface of the fluid handling structure; and a conditioning device configured to perform the determined one or more different types of conditioning on the major surface of the fluid handling structure.

[Continued on next page]

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A CONDITIONING SYSTEM, ARRANGEMENT AND METHOD

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application claims priority of EP application 22191309.8 which was filed on August 19, 2022 and which is incorporated herein in its entirety by reference.

FIELD

[0002] The present invention relates to a stand-alone conditioning system for conditioning fluid handling structures.

BACKGROUND

[0003] A lithographic apparatus is a machine constructed to apply a desired pattern onto a substrate. A lithographic apparatus can be used, for example, in the manufacture of integrated circuits (ICs). A lithographic apparatus may, for example, project a pattern (also often referred to as “design layout” or “design”) of a patterning device (e.g., a mask) onto a layer of radiation-sensitive material (resist) provided on a substrate (e.g., a wafer). Known lithographic apparatus include so-called steppers, in which each target portion is irradiated by exposing an entire pattern onto the target portion at one time, and so-called scanners, in which each target portion is irradiated by scanning the pattern through a radiation beam in a given direction (the "scanning"-direction) while synchronously scanning the substrate parallel or anti-parallel to this direction.

[0004] As semiconductor manufacturing processes continue to advance, the dimensions of circuit elements have continually been reduced while the amount of functional elements, such as transistors, per device has been steadily increasing over decades, following a trend commonly referred to as ‘Moore’s law’. To keep up with Moore’s law the semiconductor industry is chasing technologies that enable to create increasingly smaller features. To project a pattern on a substrate a lithographic apparatus may use electromagnetic radiation. The wavelength of this radiation determines the minimum size of features which are patterned on the substrate. Typical wavelengths currently in use are 365 nm (i-line), 248 nm, 193 nm and 13.5 nm.

[0005] Further improvements in the resolution of smaller features may be achieved by providing an immersion fluid having a relatively high refractive index, such as water, on the substrate during exposure. The effect of the immersion fluid is to enable imaging of smaller features since the exposure radiation will have a shorter wavelength in the fluid than in gas. The effect of the immersion fluid may also be regarded as increasing the effective numerical aperture (NA) of the system and also increasing the depth of focus.

[0006] The immersion fluid may be confined to a localized area between the projection system of the lithographic apparatus and the substrate by a fluid handling structure. The flows of the immersion fluid need to be appropriately controlled during operation of the lithographic apparatus.

[0007] There is a general need to improve on techniques for maintaining and repairing fluid handling structures.

SUMMARY

[0008] According to a first aspect of the invention there is provided a stand-alone conditioning system for a fluid handling structure of a lithographic apparatus, comprising: an inspection system configured to inspect the fluid handling structure and to determine one or more different types of conditioning to be performed on a major surface of the fluid handling structure; and a conditioning device configured to perform the determined one or more different types of conditioning on the major surface of the fluid handling structure.

[0009] According to a second aspect of the invention there is provided a conditioning system and a fluid handling structure; wherein: the conditioning system is according to the first aspect; and the fluid handling structure is received by the conditioning system.

[0010] According to a third aspect of the invention there is provided an arrangement in a clean room comprising: a lithographic apparatus; and a conditioning system according to the first aspect.

[0011] According to a fourth aspect of the invention there is provided a method for reconditioning a fluid handling structure of a lithographic apparatus, the method comprising: removing a fluid handling structure from a lithographic apparatus; providing the fluid handling structure to a stand-alone conditioning system; inspecting the fluid handling structure to determine one or more different types of conditioning to be performed on a major surface of the fluid handling structure; and performing the determined one or more different types of conditioning on the major surface of the fluid handling structure.

[0012] Further embodiments, features and advantages of the present invention, as well as the structure and operation of the various embodiments, features and advantages of the present invention, are described in detail below with reference to the accompanying drawings.

DESCRIPTION OF THE DRAWINGS

[0013] Embodiments of the invention will now be described, by way of example only, with reference to the accompanying schematic drawings, in which corresponding reference symbols indicate corresponding parts, and in which:

[0014] Figure 1 depicts the schematic overview of the lithographic apparatus;

[0015] Figures 2a, 2b, 2c and 2d each depict, in cross section, two different versions of a fluid handling system with different features illustrated on the left hand side and the right hand side of each version, which may extend around the complete circumference;

[0016] Figure 3 schematically depicts a conditioning system according to a first embodiment.

[0017] Figure 4 schematically depicts a conditioning system according to a second embodiment.

[0018] The features shown in the figures are not necessarily to scale, and the size and/or arrangement depicted is not limiting. It will be understood that the figures include optional features which may not be essential to the invention. Furthermore, not all of the features of the apparatus are depicted in each of the figures, and the figures may only show some of the components relevant for describing a particular feature. In the figures, like parts are indicated by like references.

DETAILED DESCRIPTION

[0019] In the present document, the terms “radiation” and “beam” are used to encompass all types of electromagnetic radiation, including ultraviolet radiation (e.g. with a wavelength of 365, 248, 193, 157 or 126 nm).

[0020] The term “reticle”, “mask” or “patterning device” as employed in this text may be broadly interpreted as referring to a generic patterning device that can be used to endow an incoming radiation beam with a patterned cross-section, corresponding to a pattern that is to be created in a target portion of the substrate. The term “light valve” can also be used in this context. Besides the classic mask (transmissive or reflective, binary, phase-shifting, hybrid, etc.), examples of other such patterning devices include a programmable mirror array and a programmable LCD array.

[0021] Figure 1 schematically depicts a lithographic apparatus. The lithographic apparatus includes an illumination system (also referred to as illuminator) IL configured to condition a radiation beam B (e.g., UV radiation or DUV radiation), a mask support (e.g., a mask table) MT constructed to support a patterning device (e.g., a mask) MA and connected to a first positioner PM configured to accurately position the patterning device MA in accordance with certain parameters, a substrate support (e.g., a substrate table) WT constructed to hold a substrate (e.g., a resist coated wafer) W and connected to a second positioner PW configured to accurately position the substrate support WT in accordance with certain parameters, and a projection system (e.g., a refractive projection lens system) PS configured to project a pattern imparted to the radiation beam B by patterning device MA onto a target portion C (e.g., comprising one or more dies) of the substrate W. A controller 500 controls the overall operation of the apparatus. Controller 500 may be a centralised control system or a system of multiple separate sub-controllers within various sub-systems of the lithographic apparatus.

[0022] In operation, the illumination system IL receives the radiation beam B from a radiation source SO, e.g. via a beam delivery system BD. The illumination system IL may include various types of optical components, such as refractive, reflective, magnetic, electromagnetic, electrostatic, and/or other types of optical components, or any combination thereof, for directing, shaping, and/or controlling radiation. The illuminator IL may be used to condition the radiation beam B to have a desired spatial and angular intensity distribution in its cross section at a plane of the patterning device MA.

[0023] The term “projection system” PS used herein should be broadly interpreted as encompassing various types of projection system, including refractive, reflective, catadioptric, anamorphic, magnetic, electromagnetic and/or electrostatic optical systems, or any combination thereof, as appropriate for the exposure radiation being used, and/or for other factors such as the use of an immersion liquid or the use of a vacuum. Any use of the term “projection lens” herein may be considered as synonymous with the more general term “projection system” PS.

[0024] The lithographic apparatus is of a type wherein at least a portion of the substrate W may be covered by an immersion liquid having a relatively high refractive index, e.g., water, so as to fill an immersion space 11 between the projection system PS and the substrate W – which is also referred to as immersion lithography. More information on immersion techniques is given in US 6,952,253, which is incorporated herein by reference.

[0025] The lithographic apparatus may be of a type having two or more substrate supports WT (also named “dual stage”). In such “multiple stage” machine, the substrate supports WT may be used in parallel, and/or steps in preparation of a subsequent exposure of the substrate W may be carried out on the substrate W located on one of the substrate support WT while another substrate W on the other substrate support WT is being used for exposing a pattern on the other substrate W.

[0026] In addition to the substrate support WT, the lithographic apparatus may comprise a measurement stage (not depicted in figures). The measurement stage is arranged to hold a sensor and/or a cleaning device. The sensor may be arranged to measure a property of the projection system PS or a property of the radiation beam B. The measurement stage may hold multiple sensors. The cleaning device may be arranged to clean part of the lithographic apparatus, for example a part of the projection system PS or a part of a system that provides the immersion liquid. The measurement stage may move beneath the projection system PS when the substrate support WT is away from the projection system PS.

[0027] In operation, the radiation beam B is incident on the patterning device, e.g. mask, MA which is held on the mask support MT, and is patterned by the pattern (design layout) present on patterning device MA. Having traversed the mask MA, the radiation beam B passes through the projection system PS, which focuses the beam onto a target portion C of the substrate W. With the aid of the second positioner PW and a position measurement system IF, the substrate support WT can be moved accurately, e.g., so as to position different target portions C in the path of the radiation beam B at a focused and aligned position. Similarly, the first positioner PM and possibly another position sensor (which is not explicitly depicted in Figure 1) may be used to accurately position the patterning device MA with respect to the path of the radiation beam B. Patterning device MA and substrate W may be aligned using mask alignment marks M1, M2 and substrate alignment marks P1, P2. Although the substrate alignment marks P1, P2 as illustrated occupy dedicated target portions, they may be located in spaces between target portions. Substrate alignment marks P1, P2 are known as scribe-lane alignment marks when these are located between the target portions C.

[0028] To clarify the invention, a Cartesian coordinate system is used. The Cartesian coordinate system has three axis, i.e., an x-axis, a y-axis and a z-axis. Each of the three axis is orthogonal to the other two axis. A rotation around the x-axis is referred to as an Rx-rotation. A rotation around the y-axis is referred to as an Ry-rotation. A rotation around about the z-axis is referred to as an Rz-rotation. The x-axis and the y-axis define a horizontal plane, whereas the z-axis is in a vertical direction. The Cartesian coordinate system is not limiting the invention and is used for clarification only. Instead, another coordinate system, such as a cylindrical coordinate system, may be used to clarify the invention. The orientation of the Cartesian coordinate system may be different, for example, such that the z-axis has a component along the horizontal plane.

[0029] Immersion techniques have been introduced into lithographic systems to enable improved resolution of smaller features. In an immersion lithographic apparatus, a liquid layer of immersion liquid having a relatively high refractive index is interposed in the immersion space 11 between a projection system PS of the apparatus (through which the patterned beam is projected towards the substrate W) and the substrate W. The immersion liquid covers at least the part of the substrate W under a final element of the projection system PS. Thus, at least the portion of the substrate W undergoing exposure is immersed in the immersion liquid.

[0030] In commercial immersion lithography, the immersion liquid is water. Typically the water is distilled water of high purity, such as Ultra-Pure Water (UPW) which is commonly used in semiconductor fabrication plants. In an immersion system, the UPW is often purified and it may undergo additional treatment steps before supply to the immersion space 11 as immersion liquid. Other liquids with a high refractive index can be used besides water as the immersion liquid, for example: a hydrocarbon, such as a fluorohydrocarbon; and/or an aqueous solution. Further, other fluids besides liquid have been envisaged for use in immersion lithography.

[0031] In this specification, reference will be made in the description to localized immersion in which the immersion liquid is confined, in use, to the immersion space 11 between the final element 100 and a surface facing the final element 100. The facing surface is a surface of substrate W or a surface of the supporting stage (or substrate support WT) that is co-planar with the surface of the substrate W. (Please note that reference in the following text to surface of the substrate W also refers in addition or in the alternative to the surface of the substrate support WT, unless expressly stated otherwise; and vice versa). A fluid handling structure 12 present between the projection system PS and the substrate support WT is used to confine the immersion liquid to the immersion space 11. The immersion space 11 filled by the immersion liquid is smaller in plan than the top surface of the substrate W and the immersion space 11 remains substantially stationary relative to the projection system PS while the substrate W and substrate support WT move underneath.

[0032] Other immersion systems have been envisaged such as an unconfined immersion system (a so-called 'All Wet' immersion system) and a bath immersion system. In an unconfined immersion system, the immersion liquid covers more than the surface under the final element 100. The liquid outside the immersion space 11 is present as a thin liquid film. The liquid may cover the whole surface of the substrate W or even the substrate W and the substrate support WT co-planar with the substrate W. In a bath type system, the substrate W is fully immersed in a bath of immersion liquid.

[0033] The fluid handling structure 12 is a structure which supplies the immersion liquid to the immersion space 11, removes the immersion liquid from the immersion space 11 and thereby confines the immersion liquid to the immersion space 11. It includes features which are a part of a fluid supply system. The arrangement disclosed in PCT patent application publication no. WO 99/49504 is an early fluid handling structure comprising pipes which either supply or recover the immersion liquid from the immersion space 11 and which operate depending on the relative motion of the stage beneath the projection system PS. In more recent designs, the fluid handling structure extends along at least a part of a boundary of the immersion space 11 between the final element 100 of the projection system PS and the substrate support WT or substrate W, so as to in part define the immersion space 11.

[0034] The fluid handling structure 12 may have a selection of different functions. Each function may be derived from a corresponding feature that enables the fluid handling structure 12 to achieve that function. The fluid handling structure 12 may be referred to by a number of different terms, each referring to a function, such as barrier member, seal member, fluid supply system, fluid removal system, liquid confinement structure, etc..

[0035] As a barrier member, the fluid handling structure 12 is a barrier to the flow of the immersion liquid from the immersion space 11. As a liquid confinement structure, the structure confines the immersion liquid to the immersion space 11. As a seal member, sealing features of the fluid handling structure 12 form a seal to confine the immersion liquid to the immersion space 11. The sealing features may include an additional gas flow from an opening in the surface of the seal member, such as a gas knife.

[0036] In an embodiment the fluid handling structure 12 may supply immersion fluid and therefore be a fluid supply system.

[0037] In an embodiment the fluid handling structure 12 may at least partly confine immersion fluid and thereby be a fluid confinement system.

[0038] In an embodiment the fluid handling structure 12 may provide a barrier to immersion fluid and thereby be a barrier member, such as a fluid confinement structure.

[0039] In an embodiment the fluid handling structure 12 may create or use a flow of gas, for example to help in controlling the flow and/or the position of the immersion fluid.

[0040] The flow of gas may form a seal to confine the immersion fluid so the fluid handling structure 12 may be referred to as a seal member; such a seal member may be a fluid confinement structure.

[0041] In an embodiment, immersion liquid is used as the immersion fluid. In that case the fluid handling structure 12 may be a liquid handling system. In reference to the aforementioned description, reference in this paragraph to a feature defined with respect to fluid may be understood to include a feature defined with respect to liquid.

[0042] A lithographic apparatus has a projection system PS. During exposure of a substrate W, the projection system PS projects a beam of patterned radiation onto the substrate W. To reach the substrate W, the path of the radiation beam B passes from the projection system PS through the immersion liquid confined by the fluid handling structure 12 between the projection system PS and the substrate W. The projection system PS has a lens element, the last in the path of the beam, which is in contact with the immersion liquid. This lens element which is in contact with the immersion liquid may be referred to as ‘the last lens element’ or “the final element”. The final element 100 is at least partly surrounded by the fluid handling structure 12. The fluid handling structure 12 may confine the immersion liquid under the final element 100 and above the facing surface.

[0043] Figures 2a, 2b, 2c and 2d show different features which may be present in variations of a fluid handling system. The designs may share some of the same features as Figures 2a, 2b, 2c and 2d unless described differently. The features described herein may be selected individually or in combination as shown or as required. The figures depict different versions of a fluid handling system with different features illustrated on the left hand side and the right hand side, which may extend around the complete circumference. Thus, for example, the fluid handling system may have the same features extending around the complete circumference. For example, the fluid handling system may have only the features of the left hand side of Figure 2a, or the right hand side of Figure 2a, or the left hand side of Figure 2b, or the right hand side of Figure 2b, or the left hand side of 2c, or the right hand side of 2c, or the left hand side of 2d, or the right hand side of 2d. Alternatively, the fluid handling system may be provided with any combination of features from these figures at different locations around the circumference. The fluid handling system may comprise the fluid handling structure 12 as described in the variations below.

[0044] Figure 2a shows a fluid handling structure 12 around the bottom surface of the final element 100. The final element 100 has an inverted frusto-conical shape. The frusto-conical shape having a planar bottom surface and a conical surface. The frusto-conical shape protrudes from a planar surface and having a bottom planar surface. The bottom planar surface is the optically active portion of the bottom surface of the final element 100, through which the radiation beam B may pass. The final element 100 may have a coating 30. The fluid handling structure 12 surrounds at least part of the frusto-conical shape. The fluid handling structure 12 has an inner-surface which faces towards the conical surface of the frusto-conical shape. The inner-surface and the conical surface may have complementary shapes. A top surface of the fluid handling structure 12 may be substantially planar. The fluid handling structure 12 may fit around the frusto-conical shape of the final element 100. A bottom surface of the fluid handling structure 12 may be substantially planar and in use the bottom surface may be parallel with the facing surface of the substrate support WT and/or substrate W. Thus, the bottom surface of the fluid handling structure 12 may be referred to as a surface facing the surface of the substrate W. The distance between the bottom surface and the facing surface may be in the range of 30 to 500 micrometers, desirably in the range of 80 to 200 micrometers.

[0045] The fluid handling structure 12 extends closer to the facing surface of the substrate W and substrate support WT than the final element 100. The immersion space 11 is therefore defined between the inner surface of the fluid handling structure 12, the planar surface of the frusto-conical portion and the facing surface. During use, the immersion space 11 is filled with immersion liquid. The immersion liquid fills at least part of a buffer space between the complementary surfaces between the final element 100 and the fluid handling structure 12, in an embodiment at least part of the space between the complementary inner-surface and the conical surface.

[0046] The immersion liquid is supplied to the immersion space 11 through an opening formed in a surface of the fluid handling structure 12. The immersion liquid may be supplied through a supply opening 20 in the inner-surface of the fluid handling structure 12. Alternatively or additionally, the immersion liquid is supplied from an under supply opening 23 formed in the bottom surface of the fluid handling structure 12. The under supply opening 23 may surround the path of the radiation beam B and it may be formed of a series of openings in an array or a single slit. The immersion liquid is supplied to fill the immersion space 11 so that flow through the immersion space 11 under the projection system PS is laminar or at least well defined. The supply of the immersion liquid from the under supply opening 23 additionally prevents the ingress of bubbles into the immersion space 11. This supply of the immersion liquid may function as a liquid seal.

[0047] The immersion liquid may be recovered from a recovery opening 21 formed in the inner-surface. The recovery of the immersion liquid through the recovery opening 21 may be by application of an underpressure; the recovery through the recovery opening 21 as a consequence of the velocity of the immersion liquid flow through the immersion space 11; or the recovery may be as a consequence of both. The recovery opening 21 may be located on the opposite side of the supply opening 20, when viewed in plan. Additionally or alternatively, the immersion liquid may be recovered through an overflow recovery 24 located on the top surface of the fluid handling structure 12. The supply opening 20 and recovery opening 21 can have their function swapped (i.e. the flow direction of liquid is reversed). This allows the direction of flow to be changed depending upon the relative motion of the fluid handling structure 12 and substrate W.

[0048] Additionally or alternatively, immersion liquid may be recovered from under the fluid handling structure 12 through a recovery opening 25 formed in its bottom surface. The recovery opening 25 may serve to hold a meniscus 33 of the immersion liquid to the fluid handling structure 12. The meniscus 33 forms between the fluid handling structure 12 and the facing surface and it serves as border between the liquid space and the gaseous external environment. The recovery opening 25 may be a porous plate which may recover the immersion liquid in a single phase flow. The recovery opening in the bottom surface may be a series of pinning openings 32 through which the immersion liquid is recovered. The pinning openings 32 may recover the immersion liquid in a two phase flow.

[0049] Optionally radially outward, with respect to the inner-surface of the fluid handling structure 12, is a gas knife opening 26. Gas may be supplied through the gas knife opening 26 at elevated speed to assist liquid confinement of the immersion liquid in the immersion space 11. The supplied gas may be humidified and it may contain substantially carbon dioxide. Radially outward of the gas knife opening 26 is a gas recovery opening 28 for recovering the gas supplied through the gas knife opening 26.

[0050] Further openings, for example open to atmosphere or to a gas source or to a vacuum, may be present in the bottom surface of the fluid handling structure 12, i.e. in the surface of the fluid handling structure 12 facing the substrate W. An example of such an optional further opening 50 is shown in dashed lines on the right hand side of Figure 2a. As shown, the further opening 50 may be a supply or extraction member, which is indicated by the double-headed arrow. For example, if configured as a supply, the further opening 50 may be connected to a liquid supply or a gas supply as with any of the supply members. Alternatively, if configured as an extraction, the further opening 50 may be used to extract fluid, and may for example, be connected to atmosphere or to a gas source or to a vacuum. For example, the at least one further opening 50 may be present between gas knife opening 26 and gas recovery opening 28, and/or between pinning openings 32 and gas knife opening 26. In an alternative arrangement, the fluid handling structure 12 may contain the pinning opening 32, gas knife opening 26 and optionally the under supply opening 23. The supply opening 20 or recovery opening 21 may be formed in the inner surface of the fluid handling structure 12.

[0051] The two different versions of the fluid handling structure 12 of the left and right sides of Figure 2a pin the meniscus 33. The version of the fluid handling structure 12 on the right hand side of Figure 2a may pin the meniscus 33 at a position that is substantially fixed with respect to the final element 100, due to the fixed position of the pinning opening 32. The version of the fluid handling structure 12 on the left hand side of Figure 2a may pin the meniscus 33 below the recovery opening 25, and thus the meniscus 33 may move along the length and/or width of the recovery opening 25. For the radiation beam B to be directed to a full side of the substrate W under exposure, the substrate support WT supporting the substrate W is moved relative to the projection system PS. To maximize the output of substrates W exposed by the lithographic apparatus, the substrate support WT (and so substrate W) is moved as fast as possible. However, there is a critical relative speed (often referred to as a critical scan speed) above which the meniscus 33 between the fluid handling structure 12 and the substrate W becomes unstable. An unstable meniscus 33 has a greater risk of losing immersion liquid, for example in the form of one or more droplets. Furthermore, an unstable meniscus 33 has a greater risk of resulting in the inclusion of gas bubbles in the immersion liquid, especially when the confined immersion liquid crosses the edge of the substrate W.

[0052] A droplet present on the surface of the substrate W may apply a thermal load and may be a source of defectivity. The droplet may evaporate leaving a drying stain, it may move transporting contamination such as a particle, it may collide with a larger body of immersion liquid introducing a bubble of gas into the larger body and it may evaporate, applying the thermal heat load to the surface on which it is located. Such a thermal load could be a cause of distortion and/or a source of a positioning error if the surface is associated with positioning of components of the lithographic apparatus relative to the substrate W being imaged. A formation of a droplet on a surface is therefore is undesirable. To avoid formation of such a droplet, the speed of the substrate support WT is thus limited to the critical scan speed at which the meniscus 33 remains stable. This limits the throughput of the lithographic apparatus.

[0053] The left hand side of the fluid handling system in Figure 2a may comprise a spring 60. The spring 60 may be an adjustable passive spring configured to apply a biasing force to the fluid handling structure 12 in the direction of the substrate W. Thus, the spring 60 can be used to control the height of the fluid handling structure 12 above the substrate W. Such adjustable passive springs are described in US 7,199,874 which is herein incorporated by reference in its entirety. Other bias devices may also be appropriate, for example, using an electromagnetic force. Although the spring 60 is shown with the left hand side of Figure 2a, it is optional and does not need to be included with the other features of the left hand side of Figure 2a. The spring 60 is not shown on any of the other figures, but could also be included with the other variations of the fluid handling system described in relation to Figures 2a, 2b, 2c, or 2d.

[0054] Figure 2b shows two different versions of the fluid handling structure 12 on its left side and on its right side, which allow movement of the meniscus 33 with respect to the final element 100. The meniscus 33 may move in the direction of the moving substrate W. This decreases the relative speed between the meniscus 33 and the moving substrate W, which may result in improved stability and a reduced risk of breakdown of the meniscus 33. The speed of the substrate W at which the meniscus 33 breaks down is increased so as to allow faster movement of the substrate W under the projection system PS. Throughput is thus increased.

[0055] Features shown in Figure 2b which are common to Figure 2a share the same reference numbers. The fluid handling structure 12 has an inner surface which complements the conical surface of the frusto-conical shape. The bottom surface of the fluid handling structure 12 is closer to the facing surface than the bottom planar surface of the frusto-conical shape.

[0056] Immersion liquid is supplied to the immersion space 11 through supply openings 34 formed in the inner surface of the fluid handling structure 12. The supply openings 34 are located towards the bottom of the inner surface, perhaps below the bottom surface of the frusto-conical shape. The supply openings 34 are located around the inner surface, spaced apart around the path of the radiation beam B.

[0057] Immersion liquid is recovered from the immersion space 11 through recovery openings 25, in the bottom surface of the fluid handling structure 12. As the facing surface moves under the fluid handling structure 12, the meniscus 33 may migrate over the surface of the recovery opening 25 in the same direction as the movement of the facing surface. The recovery openings 25 may be formed of a porous member. The immersion liquid may be recovered in single phase. The immersion liquid may be recovered in a two phase flow. The two phase flow is received in a chamber 35 within the fluid handling structure 12 where it is separated into liquid and gas. The liquid and gas are recovered through separate channels 36, 38 from the chamber 35.

[0058] An inner periphery 39 of the bottom surface of fluid handling structure 12 extends into the immersion space 11 away from the inner surface to form a plate 40. The inner periphery 39 forms a small aperture which may be sized to match the shape and size of the radiation beam B. The plate 40 may serve to isolate the immersion liquid at either side of it. The supplied immersion liquid flows inwards towards the aperture, through the inner aperture and then under the plate 40 radially outwardly towards the surrounding the recovery openings 25.

[0059] The fluid handling structure 12 may be in two parts as shown on the right hand side of Figure 2b: an inner part 12a and an outer part 12b. The inner part 12a and the outer part 12b may move relatively to each other, mainly in a plane parallel to facing surface. The inner part 12a may have the supply openings 34 and it may have the overflow recovery 24. The outer part 12b may have the plate 40 and the recovery opening 25. The inner part 12a may have an intermediate recovery 42 for recovering the immersion liquid which flows between the inner part 12a and the outer part 12b.

[0060] The two different versions of the fluid handling structure of Figure 2b thus allow for movement of the meniscus 33 in the same direction as the substrate W, enabling faster scan speeds and increased throughput of the lithographic apparatus. However, the migration speed of meniscus 33 over the surface of the recovery opening 25 in the fluid handling structure 12 of the left side of Figure 2b may be slow. The fluid handling structure 12 of the right side of Figure 2b allows for quicker movement of the meniscus 33, by moving the outer part 12b with respect to the inner part 12a and the final element 100. However, it may be difficult to control the intermediate recovery 42 so as to ensure that enough immersion liquid is provided between the inner part 12a and the outer part 12b to prevent contact therebetween. Implementations may also include a liquid supply being provided in the moving outer part 12b.

[0061] Figure 2c shows two different versions of the fluid handling structure 12 on its left side and on its right side, which may be used to pin the meniscus 33 of the immersion liquid to the fluid handling structure 12 as described above in relation to Figures 2a and/or 2b. Features shown in Figure 2c which are common to Figures 2a and/or 2b share the same reference numbers.

[0062] The fluid handling structure 12 has an inner surface which compliments the conical surface of the frusto-chronical shape. The bottom surface of the fluid handling structure 12 is closer to the facing surface than the bottom planar surface of the frusto-chronical shape. Immersion liquid is supplied to the immersion space 11 delivered through an opening formed in a surface of the fluid handling structure 12. The immersion liquid may be supplied through a supply opening 34 in the inner surface of the fluid structure 12. Alternatively or additionally, the immersion liquid may be supplied through a supply opening 20 in the inner surface of the fluid structure 12. Alternatively or additionally, the immersion liquid is supplied through the under supply opening 23. The immersion liquid may be recovered via an extraction member, for example, via recovery opening 21 formed in the inner-surface and/or overflow recovery 24 and/or one or more openings in a surface of the fluid handling structure 12 as described below.

[0063] The two different versions of the fluid handling structure 12 of the left and right sides of Figure 2c pin the meniscus 33. The version of the fluid handling structure 12 on the right hand side of Figure 2c may pin the meniscus 33 at a position that is substantially fixed with respect to the final element 100, due to the fixed position of the recovery opening 32a. The version of the fluid handling structure 12 on the left hand side of Figure 2c may pin the meniscus 33 below the recovery opening 25, and thus the meniscus 33 may move along the length and/or width of the recovery opening 25.

[0064] As described above in relation to figure 2b, an inner periphery of the bottom surface of fluid handling structure 12 may extends into the immersion space 11 away from the inner surface to form a plate 40 as shown on the left hand side. As described above, this may form a small aperture, and may isolate the immersion liquid at either side and/or cause immersion liquid to flow inwards towards the aperture, through the inner aperture and then under the plate 40 radially outwardly towards the surrounding the recovery openings 25. Although this features is shown on the left hand side in Figure 2c, it is optional in combination with the other features shown. Preferably, as shown on the left hand side, immersion liquid is supplied to the immersion space 11 through supply openings 34 formed in the inner surface of the fluid handling structure 12. The supply openings 34 are located towards the bottom of the inner surface, perhaps below the bottom surface of the frusto-conical shape. The supply openings 34 are located around the inner surface, spaced apart around the path of the radiation beam B. Alternatively or additionally, the immersion liquid may be supplied through a supply opening 20 in the inner surface of the fluid structure 12. Alternatively or additionally, the immersion liquid is supplied through the under supply opening 23. Although the supply openings 34 are the preferred liquid supply, any combination of supply openings 34, supply openings 20 and/or under supply openings 23 may be provided.

[0065] As shown on the left hand side of Figure 2c, a fluid handling system may comprise the fluid handling structure 12 as described above and a further device 3000. The fluid handling structure 12 may have an extraction member, such as recovery opening 25, and a liquid supply opening, such as the under supply opening 23. It will be understood that the fluid handling structure 12 may comprise any configuration as disclosed in relation to the left hand of Figure 2a, the right hand side of Figure 2a, the left hand side of Figure 2b, the right hand side of Figure 2b or (as described below) the right hand side of Figure 2c, in combination with the further device 3000.

[0066] The further device 3000 may otherwise be referred to as a droplet catcher. The further device 3000 is provided to reduce occurrence of liquid on the surface of the substrate W after the fluid handling structure 12 has moved over the surface. The further device 3000 may comprise a liquid supply member 3010 and at least one extraction member 3020. The at least one extraction member 3020 may be formed in a shape surrounding the at least one supply member 3010 in plan. The at least one liquid supply member 3010 may be configured to provide a further liquid to a space 3110 between at least a part of the further device 3000 and the surface of the substrate W. The further device 3000 may be configured to recover at least some of the liquid via the at least one extraction member 3020. The further device 3000 may be used to incorporate any liquid left on the surface of the substrate W with the liquid in the space 3110 and then use the further device 3000 to extract the liquid such that the amount of liquid remaining on the surface of the substrate W is reduced.

[0067] The further device 3000 is shown as a separate device from the fluid handling structure 12 in Figure 2c. The further device 3000 may be positioned adjacent to the fluid handling structure 12. Alternatively, the further device 3000 may be part of, i.e. integral to, the fluid handling structure 12 (as in Figure 2d, however, either arrangement can be selected).

[0068] The further device 3000 may be configured to provide a liquid to the space 3110 which is separate from the liquid provided by the fluid handling structure 12.

[0069] Additionally or alternatively, the fluid handling structure 12 may have the components as shown on the right hand side of Figure 2c. More specifically, the fluid handling structure 12 may comprise the at least one liquid supply member, two extraction members (e.g., recovery openings 32a and 32b) and two gas supply members (e.g., gas supply openings 27a and 27b) formed on the surface of the fluid handling structure 12. Gas supply opening 27a can be omitted, i.e. is optional. The at least one liquid supply member may be the same as the under supply opening 23 in the bottom surface of the fluid handling structure 12 described above or the supply opening 20 or liquid supply openings 34 formed on the inner surface of the fluid handling structure 12 described in relation to left hand side of Figure 2b. The liquid supply member, the extraction members and the gas supply members may be formed on the surface of the fluid handling structure 12. Specifically, these components may be formed on a surface of the fluid handling structure 12 facing the substrate W, i.e. the bottom surface of the fluid handling structure 12.

[0070] At least one of the two extraction members may comprise a porous material 37 therein. The porous material 37 may be provided within an opening, e.g., recovery opening 32a through which fluid handling structure 12 extracts fluid from below the fluid handling structure 12 and may recover the immersion liquid in a single phase flow. The other of the two extraction members, e.g., recovery opening 32b may recover the immersion fluid as a dual phase extractor. The porous material 37 does not need to be flush with the bottom surface of the fluid handling structure 12.

[0071] Specifically, the fluid handling structure 12 may comprise the liquid supply member (e.g., under supply opening 23), with a first extraction member (e.g., recovery opening 32a) radially outwards of the liquid supply member, and a first gas supply member (e.g., gas supply opening 27a) radially outwards of the first extraction member, and the second extraction member (e.g., recovery opening 32b) radially outwards of the first gas supply member, and a second gas supply member (e.g., gas supply opening 27b) radially outwards of the second extraction member. Similar to Figure 2a, further openings, for example open to atmosphere or to a gas source or to a vacuum, may be present in the bottom surface of the fluid handling structure 12 as described previously (in relation to the fluid handling structure 12).

[0072] For example, at least one further opening (not shown) may be provided in the bottom surface of the fluid handling structure 12. The further opening is optional. The further opening may be arranged between the first extraction member (e.g., recovery opening 32a) and the first gas supply member (e.g., gas supply opening 27a) as described in the arrangement above. Alternatively or additionally, the further opening may be arranged between the second extraction member (e.g., recovery opening 32b) and the second gas supply member (e.g., gas supply opening 27b) as described in the arrangement above. The further opening may be the same as further opening 50 described above.

[0073] Optionally, the fluid handling structure 12 comprises a recess 29. The recess 29 may be provided between the recovery opening 32a and recovery opening 32b or gas supply opening 27a and recovery opening 32b. The shape of the recess 29 may be uniform around the fluid handling structure 12 and may optionally contain an inclined surface. In the case of the recess 29 provided between the recovery opening 32a and recovery opening 32b, the gas supply opening 27b may be provided on the inclined surface as shown in Figure 2c. In the case of the recess 29 provided between the supply opening 27a and recovery opening 32b, the gas supply opening 27b may be provided on the inclined surface or a part of the bottom surface of the fluid handling structure 12 which is parallel to the surface of the substrate W. Alternatively, the shape of the recess 29 may vary around the circumference of the fluid handling structure 12. The shape of the recess 29 may be varied to alter the impact of gas supplied from the gas supply members on the fluid below the fluid handling structure 12. The recess 29 may alternatively be a negative recess, i.e. a protruding structure, that narrows the separation between the fluid handling structure 12 and the substrate W.

[0074] Figure 2d shows, in its left and right halves, two different versions of the fluid handling structure 12. The fluid handling structure 12 of the left half of Figure 2d has a liquid injection buffer 41a, which holds a buffer amount of immersion liquid, and liquid injection holes 41 which supply immersion liquid from the liquid injection buffer to the space 11. Outwardly of the liquid injection holes 41 are inner liquid recovery apertures 43 for conducting liquid to an inner recovery buffer 43a which is provided with a porous member. A recess 29 similar to that described relating to Figure 2c is provided outward of the inner liquid recovery apertures 43. Outward of the recess 29, in the lower face of the fluid handling structure 12 is a gas guiding groove 44 into which open outer recovery holes 44a. The outer recovery holes 44a lead a two-phase recovery flow to outer recovery buffer 44b which is also provided with a porous member. Outermost are gas sealing holes 45 which communicate between a gas sealing buffer volume 45a and the space underneath the fluid handling structure 12 to provide a gas flow to contain the immersion liquid. In the above-described implementations, the meniscus 33 may to pinned to the recovery opening 32a or it may be moveable.

[0075] The fluid handling structure 12 of the right half of Figure 2d has a liquid supply opening 20 in the inner inclined face thereof. In the underside of the fluid handling structure 12 there are (from inner side to outer side) an extraction opening 25 provided with a porous member 37; a first gas knife opening 26a, a second gas knife opening 26b and a third gas knife opening 26c. Each of these openings opens into a groove in the underside of the fluid handling structure 12 that provides a buffer volume. The outermost part of the fluid handling structure 12 is stepped so as to provide a greater separation between the fluid handling structure 12 and the substrate W.

[0076] Figures 2a to 2d show examples of different configurations which can be used as part of a fluid handling system. It will be understood that the examples provided above refer to specific extraction members and recovery members, but it is not necessary to use the exact type of extraction member and/or recovery member. In some cases different terminology is used to indicate the position of the member, but the same functional features may be provided. Examples of the extraction member referred to above include recovery opening 21, overflow recover 24, recovery opening 25 (possibly comprising a porous plate and/or the chamber 35), gas recovery opening 28, pinning opening 32, recovery opening 32a, recovery opening 32b and/or the intermediate recovery 42. Examples of the supply member referred to above include supply opening 20, under supply opening 23, gas knife opening 26, gas supply opening 27a, gas supply opening 27b, and/or supply openings 34. In general, an extraction member used to extract/recover fluid, liquid or gas is interchangeable with at least any of the other examples used which extract/recover fluid, liquid or gas respectively. Similarly, a supply member used to supply fluid, liquid or gas is interchangeable with at least any of the other examples used which supply fluid, liquid or gas respectively. The extraction member may extract/recover fluid, liquid or gas from a space by being connected to an underpressure which draws the fluid, liquid or gas into the extraction member. The supply member may supply fluid, liquid or gas to the space by being connected to a relevant supply.

[0077] As described earlier, the immersion liquid may be extracted from the immersion space 11, which is also referred to herein as a liquid confinement space 11, by an extraction member. As shown in Figures 2a, 2c and 2d, the extraction member may be a recovery opening 21. The extraction member may be located on the opposite side of the supply opening 20, when viewed in plan. The extraction member may extract both liquid and gas. The supply opening 20 may supply liquid. Both the extraction member and the supply opening 20 may be provided in an inner-surface, that is a wall, that faces towards the conical surface of the frusto-conical shape of the final element 100. There may therefore be a continuous flow of water through the liquid confinement space 11 around the final element 100.

[0078] As described earlier, the fluid handling system may comprise the fluid handling structure 12 and/or the further device 3000. The fluid handling system generally comprises at least one bottom surface that is substantially planar and in use the at least one bottom surface may be parallel with the facing surface of the substrate support WT and/or substrate W. Thus, the at least one bottom surface of the fluid handling system may be referred to as a substrate facing surface 200 of the fluid handling system. The substrate facing substrate 200 may be a surface of the fluid handling structure 12. The substrate facing substrate 200 may be a surface of the further device 3000. The substrate facing substrate 200 may be any other surface of the fluid handling system facing the substrate W. Furthermore, the substrate facing surface 200 may be a combination of surfaces of the fluid handling system facing the substrate". For example, the substrate facing surface 200 may comprise one or more surfaces of the fluid handling structure 12 and one or more surfaces of the further device 3000.

[0079] As illustrated in the configurations of Figures 2a to 2d, the substrate facing surface 200 may be provided with one or more openings. The one or more openings may include, but are not limited to, a fluid supply member and/or a fluid extraction member. Examples of the fluid extraction member include, but are not limited to, recovery opening 25, gas recovery opening 28, pinning opening 32, recovery opening 32a, recovery opening 32b, extraction member 3020, liquid recovery aperture 43 and/or outer recovery hole 44a. The fluid extraction member may further be any other opening that is used to extract/recover fluid, liquid, and/or gas. Examples of the fluid supply member include under supply opening 23, gas knife opening 26, gas supply opening 27a, gas supply opening 27b, liquid supply member 3010 and/or liquid injection hole 41b. The fluid supply member may further be any other opening that is used to supply fluid, liquid, and/or gas. The one or more openings in the substrate facing surface 200 may alternatively or additionally include other openings, such as further opening 50 and/or gas sealing hole 45. The one or more openings in the substrate facing surface 200 may include openings for single-phase or two-phase flow of fluid.

[0080] The one or more openings in the substrate facing surface 200 may serve to provide immersion fluid to the immersion space 11, remove immersion fluid from the immersion space 11, and/or maintain the immersion fluid in the immersion space 11. The ability of the one or more openings to fulfil or achieve one or more of these purposes may be adversely affected by manufacturing defects, blockages, contamination and/or any other defects of the opening. For example, a blockage of an immersion fluid supply member may reduce the incoming flow rate of immersion liquid to the immersion space 11, which may lead to a lack of immersion fluid in the immersion space 11. As another example, a blockage of an immersion fluid extraction member may reduce the extraction capabilities of the immersion fluid extraction member, which may lead to an overflow of immersion fluid in the immersion space 11. As yet another example, a blockage of a gas knife opening 26 may reduce pressure in the gas seal used to retain the immersion fluid in the immersion space 11, which may lead to immersion fluid escaping from the immersion space 11.

[0081] Any defect of the one or more openings in the substrate facing surface 200 may thus adversely affect the performance of the fluid handling system, and in turn may adversely affect the performance of the lithographic apparatus.

[0082] As described above, a fluid handling system may comprise a fluid handling structure 12 that comprises openings in a substrate facing surface. The fluid handling structure 12 may also be referred to as an immersion hood (IH). When the fluid handling structure 12 becomes subject to a defect, such as a blockage of one or more openings in its substrate facing surface, the fluid handling structure 12 needs to be taken out of operation. It is known for the fluid handling structure 12 to then be sent back to its supplier. The supplier of the fluid handling structure 12 may perform a full repair and requalification of the fluid handling structure 12 before sending it back to its place of use. This is a highly inefficient and slow process, especially since the supplier may be located on the other side of the world from the place of use of the fluid handling structure 12. Furthermore, most fluid handling structures 12 that are taken out of service only require cleaning and/or minor repairs.

[0083] Embodiments improve on known techniques by providing a stand-alone conditioning system for reconditioning a fluid handling structure close to its place of use. Embodiments of the conditioning system may perform a number of processes for cleaning and/or repairing a fluid handling structure.

[0084] The conditioning system according to embodiments may be located within the same clean room that a lithographic apparatus is located in. The conditioning system may be a stand-alone system that is operated independently from the lithographic apparatus. When a determination is made to recondition a fluid handling structure comprised by the lithographic apparatus, the fluid handling structure may be moved to the conditioning system where it is reconditioned. The fluid handling structure may be replaced in the lithographic apparatus after it has been reconditioned. Alternatively, a different fluid handling structure, that was stored within the conditioning system, may be installed in the lithographic apparatus. The downtime of the lithographic apparatus is thereby substantially less than with known techniques. The downtime may be minimised.

[0085] Figure 3 schematically shows a conditioning system 301 according to a first embodiment.

[0086] The conditioning system 301 of the first embodiment may comprise a receptacle for receiving a fluid handling structure 304. The fluid handling structure 304 may be the fluid handling structure 12 as described in Figures 2a-2d. The conditioning system 301 may comprise a conditioning device 307 for conditioning the fluid handling structure 304 that is held by the receptacle. The conditioning system 301 may comprise an inspection system that may inspect at least part of the fluid handling structure 304. The inspection system may determine one or more different types of conditioning to be performed on the fluid handling structure 304. The conditioning device 307 may then automatically perform processes for cleaning and/or repairing the fluid handling structure 304.

[0087] The conditioning system 301 may comprise a fluid inlet manifold 302 for providing a flow of fluid to the fluid handling structure 304 that is held by the receptacle. The provided fluid may be a liquid flow, such as an ultra-pure water flow. The conditioning system 301 may also comprise a fluid outlet manifold 303 for receiving a flow of fluid that has flowed through the fluid handling structure 304 that is held by the receptacle. There may be a fluid recirculation system that provides a flow path 309 for recirculating the flow of fluid through the fluid handling structure 304. Within the flow path 309, there may be a filter 308 that may capture, i.e. collect, any particles in the recirculated fluid. The particles may be analysed by the conditioning system 301 and/or provided to a different apparatus for analysing the particles. Although not shown in Figure 3, the fluid recirculation system may also comprise a pump and any other devices required for its operation.

[0088] The conditioning system 301 may comprise a light emitter 305, that may be a laser light emitter, that may illuminate the fluid handling structure 304. The laser light emitter may emit scattered light. The conditioning system 301 may comprise a light receiver 306, that may be a laser light receiver, for detecting the light.

[0089] The conditioning system 301, and operation of the conditioning system 301, according to embodiments is described in more detail below.

[0090] The fluid handling structure 304 may have a major surface that is the surface of the fluid handling structure 304 that faces a substrate W when the fluid handling structure 304 is used in a lithographic apparatus. The major surface of the fluid handling structure 304 may comprise openings for the supply and/or extraction of fluid and may be the part of the fluid handling structure 304 that most frequently requires cleaning and/or repair.

[0091] The conditioning device 307 may be arranged so that it is located below the fluid handling structure 304 that is received by the receptacle of the conditioning system 301. The conditioning device 307 may comprise a major surface, that may be referred to as an active surface, that faces the major surface of the fluid handling structure 304.

[0092] The inspection system may be configured to inspect the fluid handling structure 304 prior to the conditioning device 307 performing any conditioning processes on the fluid handling structure 304. The inspection system may comprise processor for controlling the inspection processes and receiving, generating and transmitting data related to the inspection processes. In particular, the inspection system may generate and/or receive inspection data in dependence on the inspection of the fluid handling structure 304. The processor may automatically determine one or more different types of conditioning processes to be performed on the fluid handling structure 304 in dependence on the inspection data. The inspection system may automatically generate and send instructions for performing the determined one or more conditioning processes to the conditioning device 307. For example, the instructions may be for a specific type of cleaning to be performed on all of the major surface of the fluid handling structure 304 and also for only a specific part of the major surface to be repaired.

[0093] The inspection system may comprise one or more cameras for generating images and/or video of all, or part, of at least the major surface of the fluid handling structure 304. The inspection system may analyse the images and/or video to generate inspection data.

[0094] The inspection system may control the light emitter 305 so that it illuminates the major surface of the fluid handling structure 304 and/or shines light through fluid that has flowed through the fluid handling structure 304. The inspection system may generate inspection data in dependence on the light detected by the light receiver 306. For example, the inspection system may use the detected light by the light receiver 306 to inspect all, or part, of at least the major surface of the fluid handling structure 304. In particular, the light emitter 305, that may be a laser light emitter, may illuminate some, or all, of the major surface of the fluid handling structure 304 with scattered light. The inspection system may generate inspection data in dependence on the pattern of light detected by the light receiver 306. The inspection data may include measured dimensions of features, such as openings, of the fluid handling structure 304. The measured dimensions may include one of more of the diameters, shapes and sizes of the openings. The inspection system may compare the measured dimensions to reference data, that may comprise historical, data so as to detect any changes of the dimensions. For example, a comparison to historical data may detect a drift in the diameter of an opening.

[0095] The inspection system may comprise a particle analyser that is arranged to generate inspection data in dependence on an analysis of particles collected by the filter 308. The presence and types of any contaminant particles, that have come from within the internal flow paths of the fluid handling structure 304, may thereby be detected. The types of contaminant particles may include fibres, metal and organic particles. The determined one or more types of conditioning to be performed may therefore be dependent on the type, or types, of detected contaminant particle.

[0096] The inspection system may be configured to inspect the fluid handling structure 304 whilst conditioning processes are being performed on the fluid handling structure 304 by the conditioning device 307. The inspection system may generate and display, in real time, an indication of the progress of conditioning processes. The inspection system may determine when the conditioning of the fluid handling structure 304 is completed and the fluid handling structure 304 is ready for use in the lithographic apparatus. The inspection system may generate and display a notification when the conditioning of the fluid handling structure 304 is completed. The determination that the conditioning of the fluid handling structure 304 is completed may be according to a scenario that is pre-defined by a user.

[0097] The conditioning device 307 may be able to perform a number of different types of processes for reconditioning the fluid handling structure 304. Each conditioning process performed by the conditioning device 307 on the fluid handling structure 304 may be performed locally or globally. That is to say, each conditioning process may be performed on only one or more parts of the major surface of the fluid handling structure 304, or on the entire major surface of the fluid handling structure 304.

[0098] The types of reconditioning processes that the conditioning device 307 may perform may include one or more of: a repair process; a polishing process; a coating process; and a process for applying an additive to the fluid handling structure 304.

[0099] The conditioning device 307 may comprise a polishing pad for polishing out scratches on the major surface of the fluid handling structure.

[0100] The conditioning device 307 may comprise a laser for cutting, removing, reshaping and/or mechanically retouching parts of the fluid handling structure 304. The conditioning device 307 may use the laser to change the shape of some of the openings. The conditioning device 307 may use the laser, or another device, to unblock openings in the fluid handling structure 304.

[0101] The conditioning device 307 may perform an ion deposition to fill in cracks in the major surface of the fluid handling structure 304. The conditioning device 307 may apply an additive to the major surface of the fluid handling structure 304. The additive may be a plastic or a metallic material.

[0102] The fluid handling structure 304 may be modular. A repair process performed by the conditioning device 307 may include replacing one or modules of the fluid handling structure 304.

[0103] The conditioning system 301 may comprise a mechanical device (not shown in Figure 3) arranged to hit the fluid handling structure 304. This may generate a shock wave in the fluid handling structure 304 that dislodges any components of the fluid handling structure 304 that are stuck together. This may aid the inspection and conditioning processes.

[0104] Although not shown in Figure 3, the fluid recirculation system may comprise a fluid temperature control system. The fluid temperature control system may monitor the temperature of the fluid recirculated by the fluid recirculation system and, if necessary, heat or cool the fluid so that it is maintained at, or changed to, a desired temperature. The fluid temperature control system may be provided in the flow path 309.

[0105] Although not shown in Figure 3, the fluid recirculation system may comprise a fluid flow control system. The fluid flow control system may control the flow rate of fluid in the fluid recirculation system. The fluid flow control system may rapidly stop and start the flow of fluid so as to generate a pressure wave is the fluid. The pressure wave may dislodge parts of the fluid handling structure 304 that are stuck together and thereby aid the inspection and/or conditioning processes of the fluid handling structure 304. The fluid flow control system may be provided in the flow path 309

[0106] The conditioning system 301 may further comprise a temperature control system for controlling the temperature of the fluid handling structure 304. The temperature of the fluid handling structure 304 may be changed to, and maintained at, an appropriate temperature for each inspection and conditioning process.

[0107] The conditioning system 301 may further comprise one or more storage sections (not shown in Figure 3) for storing a plurality of fluid handling structures 304. There may be a first storage section for storing a plurality of fluid handling structures 304 that require reconditioning by the conditioning device 307. There may be a second storage section for storing a plurality of fluid handling structures 304 that have been reconditioned by the conditioning device 307. The conditioning system 301 may automatically select a fluid handling structure 304 in the first storage section for reconditioning, recondition the selected fluid handling structure 304, and then store the reconditioned fluid handling structure 304 in the second storage section. The conditioning system 301 may determine the sequence in which the fluid handling structures 304 are reconditioned and then sequentially recondition the fluid handling structures 304. Advantageously, the second storage section provides a store of one or more fluid handling structures 304 that are ready for use. When the fluid handling structure 304 of a lithographic apparatus needs reconditioning, the fluid handling structure 304 may be quickly removed from the lithographic apparatus and replaced with another the fluid handling structure 304 that is ready for use.

[0108] As described earlier, the conditioning system 301 may be located in the same clean room as a lithographic apparatus. The conditioning system 301 is a stand-alone system that operates independently from the lithographic apparatus.

[0109] The conditioning system 301 may comprise a conveyor system (not shown in Figure 3) for automatically transferring a fluid handling structure 304 that requires reconditioning from the lithographic apparatus to the conditioning system 301. The conveyor system may also automatically transfer a fluid handling structure 304 that has been reconditioned and is ready for use from the conditioning system 301 to the lithographic apparatus. Alternatively, a fluid handling structure 304 may be manually transferred between the lithographic apparatus and the conditioning system 301.

[0110] The fluid recirculation system of the conditioning system 301 may be provided and operated completely independently from the fluid flow system of the lithographic apparatus.

[0111] For providing and controlling the inspection system and conditioning device 307, the conditioning system 301 may include a computer, server, mainframe host, terminals, personal computer, any kind of mobile computing devices, and the like, or a combination thereof.

[0112] A non-transitory computer readable medium may be provided that stores instructions for a processor of a controller of the inspection system and the conditioning device 307. Common forms of non-transitory media include, for example, a floppy disk, a flexible disk, hard disk, solid state drive (SSD), magnetic tape, or any other magnetic data storage medium, a Compact Disc Read Only Memory (CD-ROM), any other optical data storage medium, any physical medium with patterns of holes, a Random Access Memory (RAM), a Programmable Read Only Memory (PROM), and Erasable Programmable Read Only Memory (EPROM), a FLASH-EPROM or any other flash memory, Non-Volatile Random Access Memory (NVRAM), a cache, a register, any other memory chip or cartridge, and networked versions of the same.

[0113] Rouging is a type of corrosion layer that may form on the internal and external surfaces of the fluid handling structure 12 that have contact with water. Rouging increases the risk of particles being generated in the immersion fluid and also worsens the appearance on the fluid handling structure 12. When fluid handling structures 12 become rouged, they are currently scrapped.

[0114] According to a second embodiment, a conditioning system is provided for derouging fluid handling structures. Derouging is a process of removing the effects of rouging so as to return a rouged fluid handling structure 12 substantially back to a state as if the rouging had not occurred. The fluid handling structures are derouged by flowing acid over the rouged surfaces. The derouged fluid handling structures may then be re-used in a lithographic apparatus.

[0115] Figure 4 schematically shows a conditioning system 401 according to the second embodiment. The conditioning system 401 of the second embodiment may comprise both a fluid supply system 402 and a derouging system 403. The fluid supply system 402 generates different fluid flows that are supplied to the derouging system 403. The derouging system 403 receives a fluid handling structure 418 with rouged surfaces and is arranged to use fluids received from the fluid supply system 402 to derouge the rouged surfaces of the fluid handling structure 418. The fluid handling structure 418 may be the fluid handling structure 12 as described in Figures 2a-2d.

[0116] The fluid supply system 402 comprises an acid supply 406, a dilution liquid supply 407, an ultra-pure water (UPW) supply 404, an extreme clean dry air (XCDA) supply 405, an acid supply pump 412, a heater 411, a dilution liquid supply regulator 413, a pH meter 414, an UPW supply valve 408, an XCDA supply valve 409, an acid supply valve 410, and a fluid supply 415. Although not shown in Figure 4, there may also be a control system for automatically controlling the operation of at least the dilution liquid supply regulator 413, the UPW supply valve 408, the XCDA supply valve 409, and the acid supply valve 410.

[0117] The fluid supply 415 is a fluid output of the fluid supply system 402. The fluid supply system 402 is controllable so that the fluid output through the fluid supply 415 is acid, UPW, XCDA, or for there to be no fluid output through the fluid supply 415.

[0118] To provide an acid in the fluid supply 415, acid is output from the acid supply 406. The pH meter 414 may measure the pH of the acid. If it is necessary to change the pH of the acid, the dilution liquid supply regulator 413 may be automatically controlled so that the acid is mixed in an appropriate ratio with a dilution liquid, such as water, from the dilution liquid supply 407. The acid supply pump 412 may pressurise the acid and the heater 411 may heat the acid to an appropriate temperature for derouging. The acid supply valve 410 may be automatically controlled so that the acid flows into the fluid supply 415 at an appropriate rate. The UPW supply valve 408 and the XCDA supply valve 409 may be closed so that only acid is supplied to the fluid supply 415.

[0119] To provide UPW in the fluid supply 415, the UPW supply valve 408 is controlled so that UPW flows from the UPW supply 404 to the fluid supply 415 at an appropriate rate. The acid supply valve 410 and the XCDA supply valve 409 may be closed so that only UPW is supplied to the fluid supply 415.

[0120] To provide XCDA in the fluid supply 415, the XCDA supply valve 409 is controlled so that XCDA flows from the XCDA supply 405 to the fluid supply 415 at an appropriate rate. The acid supply valve 410 and the UPW supply valve 408 may be closed so that only XCDA is supplied to the fluid supply 415.

[0121] When the UPW supply valve 408, the XCDA supply valve 409, and the acid supply valve 410 are all closed, there is no fluid supplied to the fluid supply 415.

[0122] The derouging system 403 comprises a derouging table 419, a liquid bath 420, a stirring fan 417, one or more o-rings 416, a cover 424, a suction line 421, a drain pump 422, and a drain 423. The derouging system 403 is arranged to receive a rouged fluid handling structure, i.e. a fluid handling structure 418 with rouged surfaces. The derouging system 403 is arranged to receive fluid from the fluid supply 415 of the fluid supply system 402. Although not shown in Figure 4, there may also be a control system for automatically controlling the operation of the derouging system 403. The same control system may automatically control the operation of both the fluid supply system 402 and the derouging system 403.

[0123] A rouged fluid handling structure 418 may positioned on one or more o-rings 416 on an upper surface of the derouging table 419. The liquid bath 420 is a region that acid, and other fluids, may be supplied to and is at least partially bounded by some of external surfaces of the fluid handling structure 418, the upper surface of the derouging table 419 and the one or more o-rings 416. The acid, and other fluids, may flow into a channel between the lower surface of the fluid handling structure 418 and the upper surface of the derouging table 419. The ends of the channel may be bounded by the one or more o-rings 416. The cover 424 may be positioned over the main opening through the fluid handling structure 418 so that the region that acid, and other fluids, may flow to is closed. The cover 424 may prevent acid from flowing to some surfaces of the fluid handling structure 418 that should be protected from the acid. Some surfaces of the fluid handling structure 418 may comprise glues, and/or other materials, that would be damaged if contacted by acid. The cover 424 prevents the acid from reaching, and thereby damaging, such surfaces of the fluid handling structure 418. The stirring fan 417 may be arranged to generate a turbulent flow when there is a liquid in the liquid bath 420. Although not shown in Figure 4, the derouging table 419 may be mounted on a dynamic platform. The dynamic platform may be able to rotate in both directions on all of three orthogonal axes, such as the x-axis, y-axis and z-axis. The rotations may only be partial rotations about each axis, not full rotations. The dynamic platform may be used to shake the fluid handling structure 418 so as to increase the turbulence in the fluid flow. Turbulence in the fluid flow may increase all of the extent that the fluid reaches all of the rouged surfaces of the fluid handling structure 418, the detachment of particles by the fluid, and the mixing of the fluid. Turbulence may also prevent released particles from resettling in the fluid handling structure 418. Acid, and other fluids, may flow out of the liquid bath 420 through the suction line 421. Fluid may be extracted into the suction line 421 by the drain pump 422. The fluid in the suction line 421 may flow to the drain 423.

[0124] The conditioning system 401 of the second embodiment may automatically perform processes for derouging the fluid handling structure 418. The conditioning system 401 may operate as described below.

[0125] A rouged fluid handling structure 418 may be positioned in the derouging system 403. The fluid supply system 402 may generate an acid for supplying to the derouging system 403. The acid from the acid supply 406 may be mixed with a dilution liquid, such as water, from the dilution liquid supply 407 so that it has an appropriate pH. The acid may be pressurised to an appropriate pressure by the acid supply pump 412. The acid may be heated, by the heater 411, so that it is at an appropriate temperature for the derouging. The acid may then be supplied to the derouging system 403 via the fluid supply 415.

[0126] The derouging system 403 may receive the acid from the fluid supply 415. The received acid may be supplied to some, and preferably all, of the surfaces of the fluid handling structure 418 where rouging may occur. These are the surfaces that contact water. In particular, the acid may be supplied to the conduits of the fluid handling structure 418 where rouging may occur. This includes all of the fluid supply conduits and fluid extraction conduits. The acid may flow through the conduits and into the liquid bath 420. The acid may flow to some, and preferably all, of the external surfaces of the fluid handling structure 418 where rouging may occur, such as damper surfaces, i.e., underside or bottom surfaces of the fluid handling structure 418. Acid may be supplied so that the acid reaches substantially all of the surfaces that it may flow to. The stirring fan 417 and/or dynamic platform may be operated so as to generate turbulence in the acid flow. The acid may continuously flow into the derouging system 403, through the fluid handling structure 418 and to the drain 423. Alternatively, the flow to the drain 423 may be temporarily stopped so that acid that has flowed into the fluid handling structure 418 is temporarily retained within the fluid handling structure 418. The time that acid is allowed to contact each surface may be about, or less than 120 seconds, and preferably less than 60 seconds. After the acid has been allowed to remain in contact with the surfaces that it may reach for the desired length of time, all of the acid may flow to the drain 423.

[0127] When acid is supplied to the derouging system 403, the inlets and outlets of the conduits of the fluid handling structure 418 that are not designed to support a liquid flow when they are used, such as conduits that only support a gas flow when used, may be sealed so that no acid flows into them. Rouging is not expected to occur in such conduits due to there being no liquid flow.

[0128] The fluid supply system 402 may then generate a flow of UPW that is supplied to the derouging system 403 through the fluid supply 415. The UPW may wash any remaining acid from all of the surfaces that the acid contacted. The stirring fan 417 and/or dynamic platform may be operated so as to generate turbulence in the UPW flow. The UPW may flow to the drain 423.

[0129] The fluid supply system 402 may then generate a flow of XCDA that is supplied to the derouging system 403 through the fluid supply 415. The XCDA may dry out any remaining water from all of the surfaces that the water contacted. The stirring fan 417 and/or dynamic platform may be operated so as to generate turbulence in the XCDA flow. The XCDA may flow to the drain 423.

[0130] The fluid handling structure 418 may then be removed from the derouging system 403 and re-used in a lithographic apparatus.

[0131] Advantageously, the conditioning system 401 of the second embodiment may automatically perform processes for derouging a rouged fluid handling structure 418.

[0132] In an implementation of the second embodiment, the pH of the acid may be varied throughout the acid supply process. In particular, acid with a low pH may be used at the start of the acid supply process so that fast removal of the rouging occurs. The pH of the acid may then be increased so that the rouging removal rate is slowed down to increase the control of the rouging removal. The pH value of the acid may be controlled by changing the ratio that the acid from the acid supply 406 is mixed with dilution liquid from the dilution liquid supply 407.

[0133] In another implementation of the second embodiment, there may be more than one acid supply 406 and each acid supply 406 may comprise a different acid. A control system may then select an acid to use for a specific purpose. For example, a first acid may be used to remove some resist and a second acid may then be used to remove rouging.

[0134] In another implementation of the second embodiment, the pH value of the acid may be set in dependence on a determination, or measurement, by a separate system (not shown) from the conditioning system 401. This allows an operator of the conditioning system 401 to manually set the pH value.

[0135] In another implementation of the second embodiment, detectors or sensors (not shown) may measure the rouging and/or contamination level on a surface of the fluid handling structure 418. The derouging process may be controlled in dependence on the measured rouging and/or contamination. The detectors may be, for example, optical detectors such as cameras.

[0136] In another implementation of the second embodiment, pH sensors or meters (not shown) may measure the pH of the acid in the fluid supply 415 and the acid in the suction line 421. The acid supply process may be controlled in dependence on the measurements by the pH sensors or meters. In particular, the derouging process may be continued until the pH of the acid in the suction line 421 is substantially the same as the pH of the acid in the fluid supply 415.

[0137] In another implementation of the second embodiment, acid that has flowed through the derouging system 403 may be filtered and supplied back to the fluid supply system 402, similar to the fluid recirculation system described in the first embodiment. The acid may then be resupplied to the derouging system 403.

[0138] Any two or more of the above-described implementations of the second embodiment may be used in conjunction with each other.

[0139] The conditioning system 401 of the second embodiment may be a stand-alone conditioning system that is separate from the conditioning system 301 of the first embodiment. Alternatively, the conditioning system 401 of the second embodiment may be integrated with the conditioning system 301 of the first embodiment.

[0140] Embodiments include a number of modifications and variations to the above-described techniques.

[0141] Although the second embodiment has been described as a conditioning system 401 for derouging a fluid handling structure 418, the second embodiment more generally includes a conditioning system 401 for derouging a fluid handling system 418. The conditioning system 401 may also be used to derouge other types of rouged structures and systems.

[0142] Embodiments may be used to recondition any of a number of known types of fluid handling structures of fluid handling systems, such as those shown in Figures 2a to 2d. Embodiments are not limited to the reconditioning of specific arrangements of features of a fluid handling system or of the substrate facing surface thereof. Embodiments may be used to recondition all, or part of, any fluid handling system.

[0143] Although specific reference may have been made above to the use of embodiments of the invention in the context of reconditioning a fluid handling system, embodiments of the invention are not limited to this. Embodiments include reconditioning any other component of a lithographic apparatus. Embodiments may also be used to recondition devices other than those comprised by a lithographic apparatus, such as components of a mask inspection apparatus, a metrology apparatus, or any apparatus that measures or processes an object such as a wafer (or other substrate) or mask (or other patterning device). These apparatus may be generally referred to as lithographic tools. Such a lithographic tool may use ambient (non-vacuum) conditions.

[0144] Although specific reference has been made in this text to the use of an immersion lithographic apparatus, it should be understood that embodiments of the invention is not limited to this type of lithographic apparatus. Embodiments, for example, include reconditioning of devices comprised by an extreme ultra-violet (EUV) lithographic apparatus.

[0145] Although specific reference may be made in this text to the use of a lithographic apparatus in the manufacture of ICs, it should be understood that the lithographic apparatus described herein may have other applications. Possible other applications include the manufacture of integrated optical systems, guidance and detection patterns for magnetic domain memories, flat-panel displays, liquid-crystal displays (LCDs), thin-film magnetic heads, etc.

[0146] Where the context allows, embodiments of the invention may be implemented in hardware, firmware, software, or any combination thereof. Embodiments of the invention may also be implemented by instructions stored on a machine-readable medium, which may be read and executed by one or more processors. A machine-readable medium may include any mechanism for storing or transmitting information in a form readable by a machine (e.g., a computing device). For example, a machine-readable medium may include read only memory (ROM); random access memory (RAM); magnetic storage media; optical storage media; flash memory devices; electrical, optical, acoustical or other forms of propagated signals (e.g. carrier waves, infrared signals, digital signals, etc.), and others. Further, firmware, software, routines, instructions may be described herein as performing certain actions. However, it should be appreciated that such descriptions are merely for convenience and that such actions in fact result from computing devices, processors, controllers, or other devices executing the firmware, software, routines, instructions, etc. and in doing that may cause actuators or other devices to interact with the physical world.

[0147] Although specific reference may be made in this text to embodiments of the invention in the context of a lithographic apparatus, embodiments of the invention may be used in other apparatus. Embodiments of the invention may form part of a mask inspection apparatus, a metrology apparatus, or any apparatus that measures or processes an object such as a wafer (or other substrate) or mask (or other patterning device). These apparatus may be generally referred to as lithographic tools. Such a lithographic tool may use ambient (non-vacuum) conditions.

[0148] Although specific reference may have been made above to the use of embodiments of the invention in the context of optical lithography, it will be appreciated that the invention, where the context allows, is not limited to optical lithography.

[0149] Embodiments include the following numbered clauses:

1. A stand-alone conditioning system for a fluid handling structure of a lithographic apparatus, comprising:

an inspection system configured to inspect the fluid handling structure and to determine one or more different types of conditioning to be performed on a major surface of the fluid handling structure; and

a conditioning device configured to perform the determined one or more different types of conditioning on the major surface of the fluid handling structure.

2. The conditioning system according to clause 1, wherein the inspection system is configured to inspect the conditioning process and generate an indication of the progress of conditioning process in real time.

3. The conditioning system according to clause 1 or 2, wherein the inspection system is configured to determine when the conditioning of the fluid handling structure is completed and ready for use according to a user pre-defined scenario.

4. The conditioning system according to any preceding clause, wherein the inspection system is configured to generate a notification when the conditioning of the fluid handling structure is completed.

5. The conditioning system according to any preceding clause, wherein, when the fluid handling structure is in use in a lithographic apparatus, the major surface of the fluid handling structure is a substrate facing surface.

6. The conditioning system according to any preceding clause, wherein the conditioning device comprises a major surface; and

the conditioning device is configured such that, when the fluid handling structure is received by the conditioning system, the major surface of the conditioning device faces the major surface of the fluid handling structure.

7. The conditioning system according to clause 6, wherein the conditioning device is configured such that, when the fluid handling structure is received by the conditioning system, the major surface of the conditioning device is below the major surface of the fluid handling structure.

8. The conditioning system according to any preceding clause, wherein the types of conditioning that the conditioning device is configured to perform on the fluid handling structure include one or more of:

a repair process;

a polishing process;

a coating process;

a process for applying an additive to the fluid handling structure;

a process for replacing a modular component of the fluid handling structure; and

a process for derouging at least part of the fluid handling structure.

9. The conditioning system according to any preceding clause, further comprising a fluid recirculation system;

wherein, when the fluid handling structure is received by the conditioning system, the fluid recirculation system is configured to recirculate a flow of fluid through the fluid handling structure; and

the inspection system is configured to perform an analysis on the recirculated fluid and to determine one or more types of conditioning to be performed in dependence on the analysis.

10. The conditioning system according to clause 9, wherein the fluid recirculation system comprises a filter, arranged in a fluid flow path thereof, for collecting contaminants in the fluid; and

the inspection system is configured to analyse the collected contaminants by the filter such that the determined one or more types of conditioning to be performed are dependent on the type, or types, of contaminant.

11. The conditioning system according to clause 9 or 10, further comprising a fluid temperature control system configured to control the temperature of the fluid recirculated by the fluid recirculation system.

12. The conditioning system according to any of clauses 9 to 11, further comprising a fluid flow control system configured to control the flow of fluid in the fluid recirculation system such that a pressure wave is created in the fluid.

13. The conditioning system according to any preceding clause, further comprising a temperature control system for controlling the temperature of the fluid handling structure.

14. The conditioning system according to any preceding clause, further comprising a mechanical device arrange to generate a shock wave in the fluid handling structure.

15. The conditioning system according to any preceding clause, wherein the inspection system further comprises:

a light emitter configured to illuminate the major surface of the fluid handling structure and/or fluid that has flowed through the fluid handling structure; and

a light receiver configured to detect light from the illumination;

wherein the inspection system is configured to determine one or more types of conditioning to be performed in dependence on the received light.

16. The conditioning system according to any preceding clause, wherein the light emitted is configured to emit scattered light.

17. The conditioning system according to any preceding clause, wherein the inspection system is configured to measure dimensions of features of the fluid handling structure and to compare the measured dimensions to reference data.

18. The conditioning system according to clause 17, wherein the features include openings and the measured dimensions include one of more of the diameters, shapes and sizes of the openings.

19. The conditioning system according to any preceding clause, further comprising a storage section for storing a plurality of fluid handling structures.

20. The conditioning system according to any preceding clause, wherein the conditioning system is configured to automatically condition a plurality of fluid handling structures sequentially.

21. The conditioning system according to any preceding clause, wherein the conditioning system comprises:

a fluid supply system; and

a derouging system;

wherein the derouging system is configured to receive acid from the fluid supply system and to derouge at least part of the fluid handling structure with the received acid.

22. A conditioning system and a fluid handling structure; wherein:

the conditioning system is according to any preceding clause; and

the fluid handling structure is received by the conditioning system.

23. An arrangement in a clean room comprising:

a lithographic apparatus; and

a conditioning system according to any of clauses 1 to 21.

24. The arrangement according to clause 23, further comprising a conveyor system for automatically transferring a fluid handling structure from the lithographic apparatus to the conditioning system.

25. The arrangement according to clause 24, further comprising a fluid handling structure;

wherein the fluid handling structure is received by the conditioning system.

26. A method for reconditioning a fluid handling structure of a lithographic apparatus, the method comprising:

removing a fluid handling structure from a lithographic apparatus;

providing the fluid handling structure to a stand-alone conditioning system;

inspecting the fluid handling structure to determine one or more different types of conditioning to be performed on a major surface of the fluid handling structure; and

performing the determined one or more different types of conditioning on the major surface of the fluid handling structure.

27. The method according to clause 26, wherein the conditioning system is according to any of clauses 1 to 21.

28. The method according to clause 26 or 27, wherein the conditioning system and the lithographic apparatus are located in the same clean room.

[0150] While specific embodiments of the invention have been described above, it will be appreciated that the invention may be practiced otherwise than as described. The descriptions above are intended to be illustrative, not limiting. Thus it will be apparent to one skilled in the art that modifications may be made to the invention as described without departing from the scope of the claims set out below.

CLAIMS

1. A stand-alone conditioning system for a fluid handling structure of a lithographic apparatus, comprising:

an inspection system configured to inspect the fluid handling structure and to determine one or more different types of conditioning to be performed on a major surface of the fluid handling structure; and

a conditioning device configured to perform the determined one or more different types of conditioning on the major surface of the fluid handling structure.

2. The conditioning system according to claim 1, wherein the inspection system is configured to inspect the conditioning process and generate an indication of the progress of conditioning process in real time, and/or wherein the inspection system is configured to determine when the conditioning of the fluid handling structure is completed and ready for use according to a user pre-defined scenario, and/or wherein the inspection system is configured to generate a notification when the conditioning of the fluid handling structure is completed, and/or wherein the inspection system is configured to measure dimensions of features of the fluid handling structure and to compare the measured dimensions to reference data, and/or wherein, when the fluid handling structure is in use in a lithographic apparatus, the major surface of the fluid handling structure is a substrate facing surface.

3. The conditioning system according to claim 2, wherein the features include openings and the measured dimensions include one of more of the diameters, shapes and sizes of the openings..

4. The conditioning system according to claim 1, 2 or 3, wherein the conditioning device comprises a major surface; and

the conditioning device is configured such that, when the fluid handling structure is received by the conditioning system, the major surface of the conditioning device faces the major surface of the fluid handling structure, and/or

wherein the conditioning system is configured to automatically condition a plurality of fluid handling structures sequentially.

5. The conditioning system according to claim 4, wherein the conditioning device is configured such that, when the fluid handling structure is received by the conditioning system, the major surface of the conditioning device is below the major surface of the fluid handling structure.

6. The conditioning system according to any of the preceding claims, wherein the types of conditioning that the conditioning device is configured to perform on the fluid handling structure include one or more of:

a repair process;
a polishing process;
a coating process;
a process for applying an additive to the fluid handling structure;
a process for replacing a modular component of the fluid handling structure; and
a process for derouging at least part of the fluid handling structure.

7. The conditioning system according to any of the preceding claims, further comprising a fluid recirculation system;

wherein, when the fluid handling structure is received by the conditioning system, the fluid recirculation system is configured to recirculate a flow of fluid through the fluid handling structure; and

the inspection system is configured to perform an analysis on the recirculated fluid and to determine one or more types of conditioning to be performed in dependence on the analysis.

8. The conditioning system according to claim 7, wherein the fluid recirculation system comprises a filter, arranged in a fluid flow path thereof, for collecting contaminants in the fluid; and

the inspection system is configured to analyse the collected contaminants by the filter such that the determined one or more types of conditioning to be performed are dependent on the type, or types, of contaminant, and/or further comprising a fluid temperature control system configured to control the temperature of the fluid recirculated by the fluid recirculation system, and/or further comprising a fluid flow control system configured to control the flow of fluid in the fluid recirculation system such that a pressure wave is created in the fluid, and/or further comprising a temperature control system for controlling the temperature of the fluid handling structure, and/or further comprising a temperature control system for controlling the temperature of the fluid handling structure, and/or further comprising a temperature control system for controlling the temperature of the fluid handling structure, and/or further comprising a storage section for storing a plurality of fluid handling structures.

9. The conditioning system according to any of the preceding claims, wherein the inspection system further comprises:

a light emitter configured to illuminate the major surface of the fluid handling structure and/or fluid that has flowed through the fluid handling structure; and

a light receiver configured to detect light from the illumination;

wherein the inspection system is configured to determine one or more types of conditioning to be performed in dependence on the received light.

10. The conditioning system according to claim 9, wherein the light emitted is configured to emit scattered light.

11. The conditioning system according to any of the preceding claims, wherein the conditioning system comprises:

a fluid supply system; and
a derouging system;

wherein the derouging system is configured to receive acid from the fluid supply system and to derouge at least part of the fluid handling structure with the received acid.

12. A conditioning system and a fluid handling structure; wherein:

the conditioning system is according to any of the preceding claims; and
the fluid handling structure is received by the conditioning system.

13. An arrangement in a clean room comprising:

a lithographic apparatus; and
a conditioning system according to any of claims 1 to 11.

14. The arrangement according to claim 13, further comprising a conveyor system for automatically transferring a fluid handling structure from the lithographic apparatus to the conditioning system, and/or further comprising a fluid handling structure;

wherein the fluid handling structure is received by the conditioning system.

15. A method for reconditioning a fluid handling structure of a lithographic apparatus, the method comprising:

removing a fluid handling structure from a lithographic apparatus;

providing the fluid handling structure to a stand-alone conditioning system;

inspecting the fluid handling structure to determine one or more different types of conditioning to be performed on a major surface of the fluid handling structure; and

performing the determined one or more different types of conditioning on the major surface of the fluid handling structure.

Fig. 1

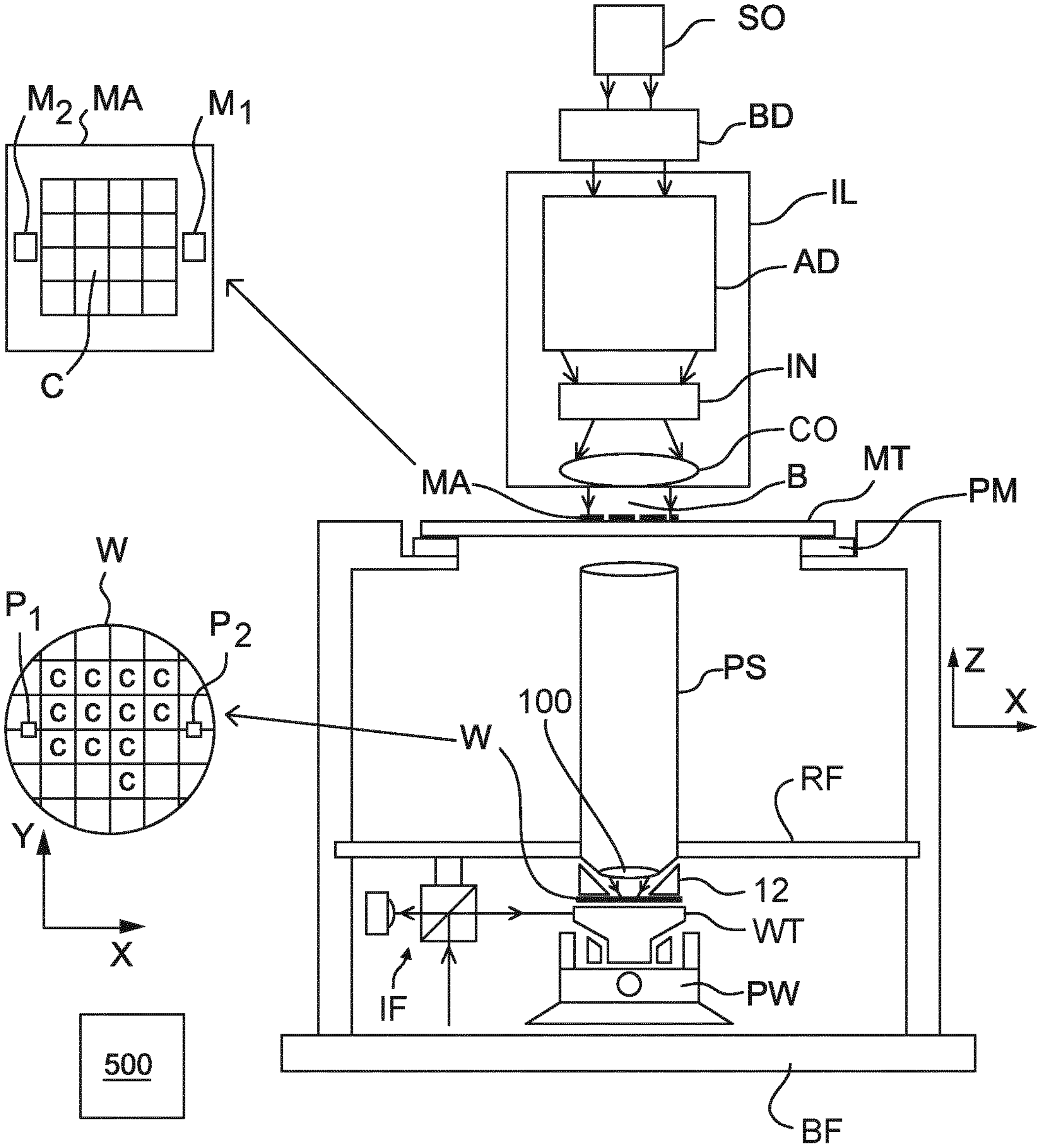
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Fig. 2a

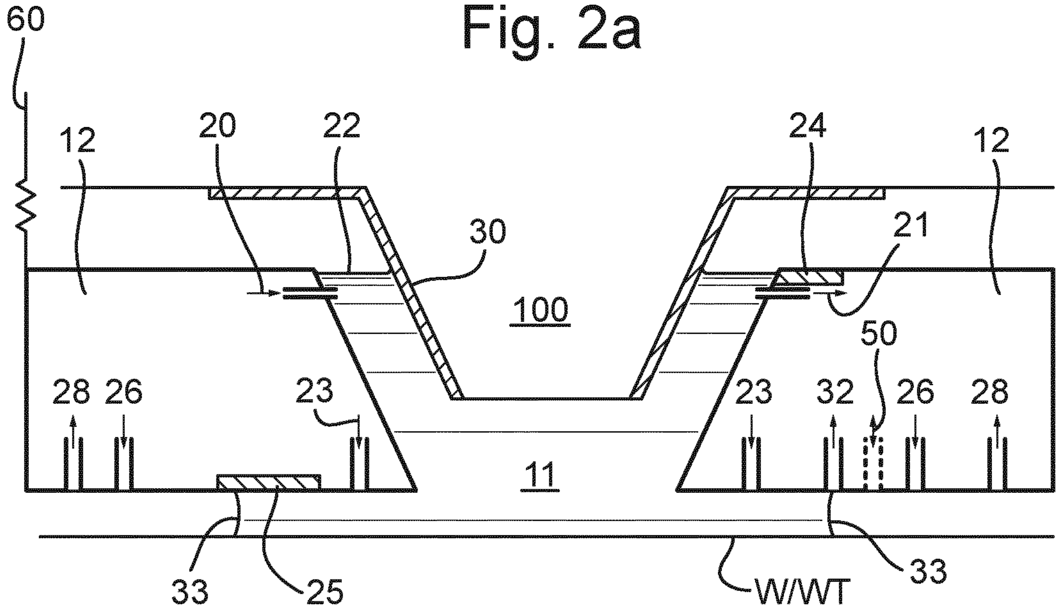
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Fig. 2b

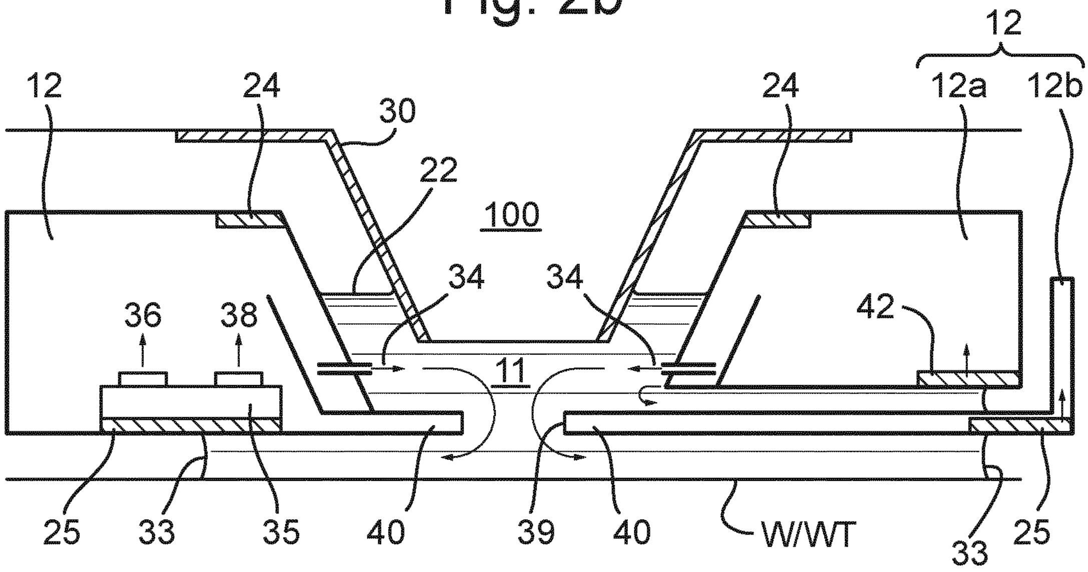
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Fig. 2c

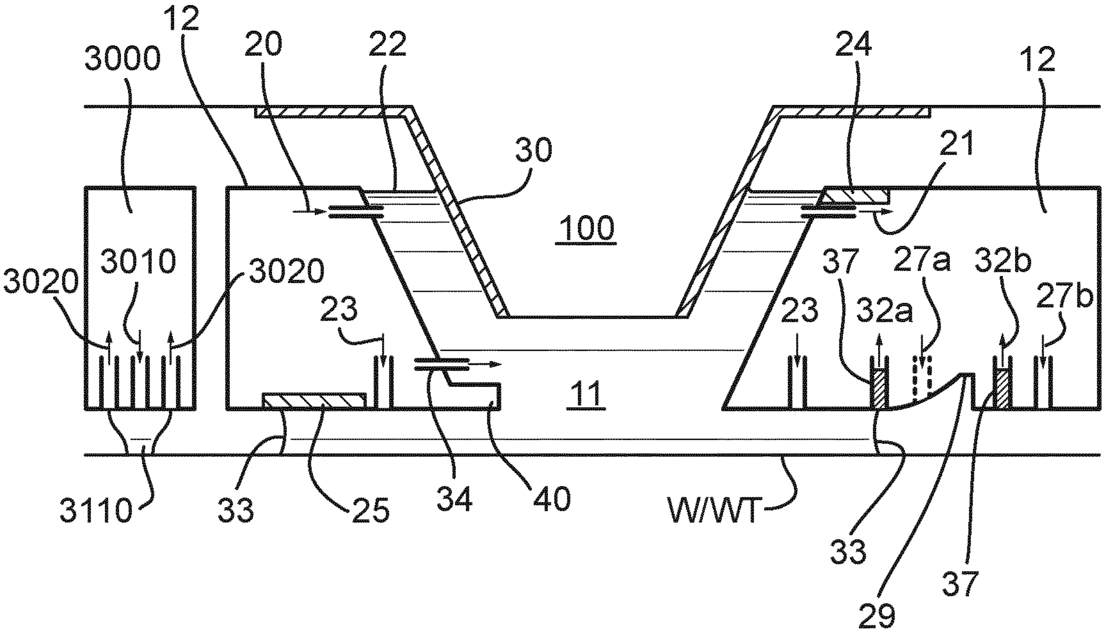
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Fig. 2d

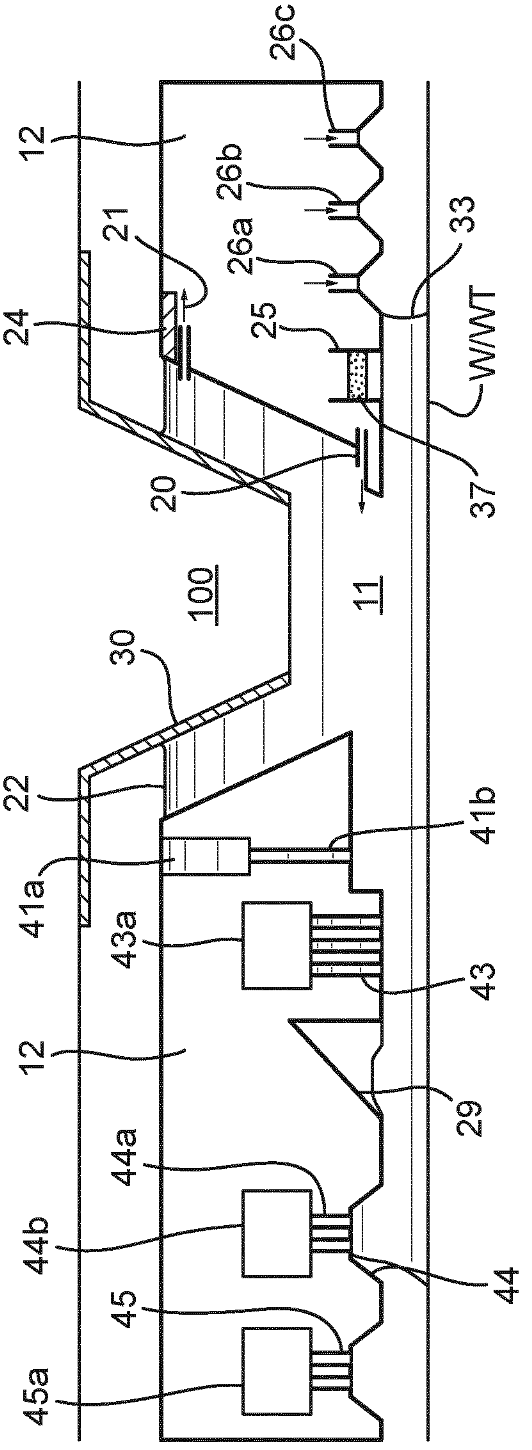
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Fig. 3

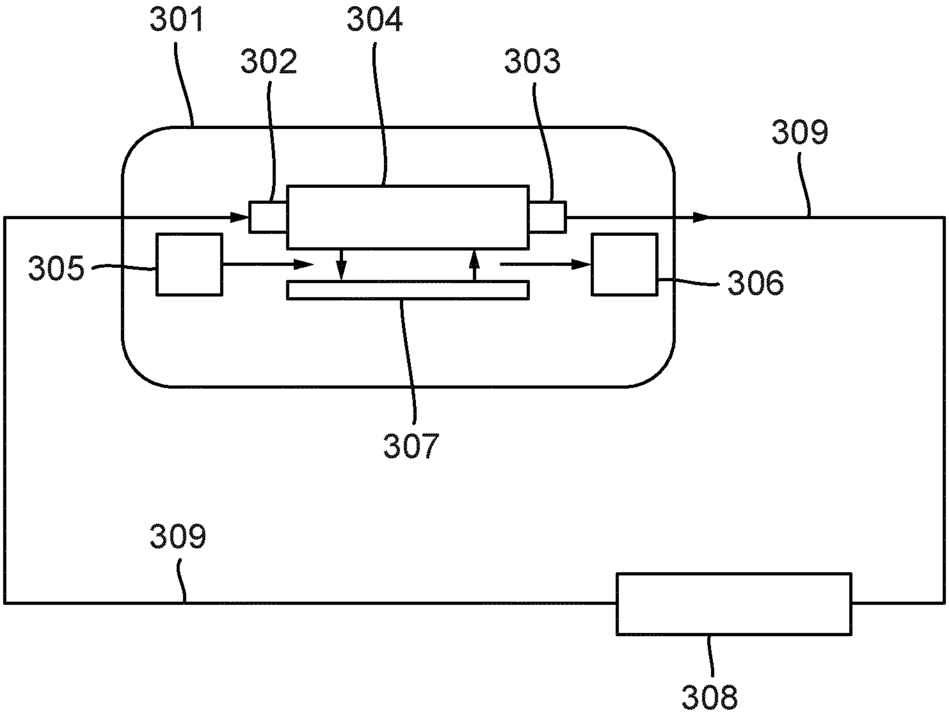
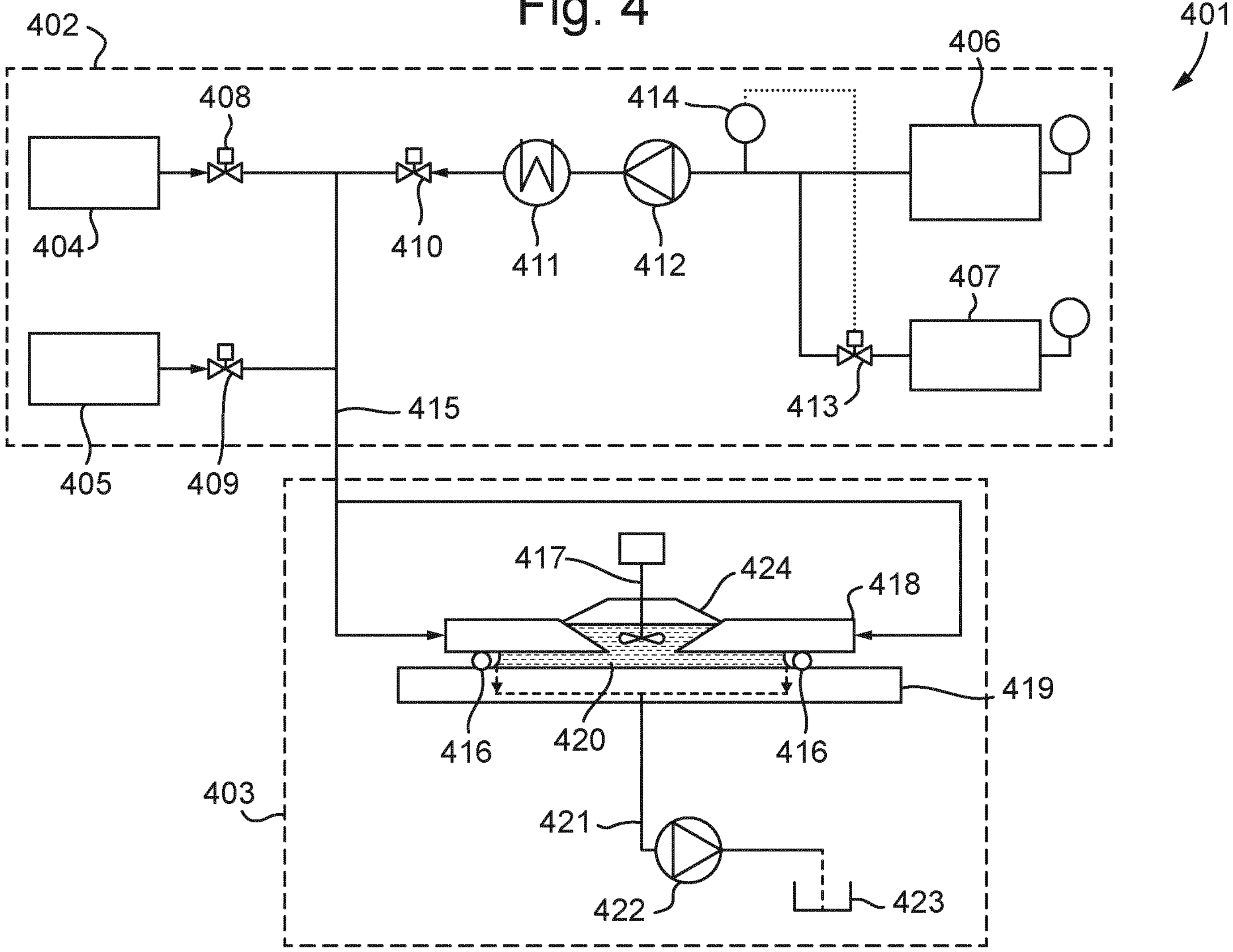


Fig. 4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INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2023/069502

A. CLASSIFICATION OF SUBJECT MATTER
INV. G03F7/00
ADD.

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
G03F

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPO-Internal, WPI Data, INSPEC

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y A	US 2009/015805 A1 (JANSEN BAUKE [NL] ET AL) 15 January 2009 (2009-01-15) paragraphs [0083], [0085]; figures 6,7 -----	1-10, 12-15 11
Y A	EP 2 042 930 A2 (ASML NETHERLANDS BV [NL]) 1 April 2009 (2009-04-01) paragraphs [0121] - [0133] -----	1-10, 12-15 11
A	EP 1 783 821 A1 (NIKON CORP [JP]) 9 May 2007 (2007-05-09) paragraphs [0143] - [0157] -----	1-15

☐ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

* Special categories of cited documents :

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"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance;; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance;; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search 9 October 2023	Date of mailing of the international search report 17/10/2023
Name and mailing address of the ISA/ European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Authorized officer Eisner, Klaus

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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/EP2023/069502

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