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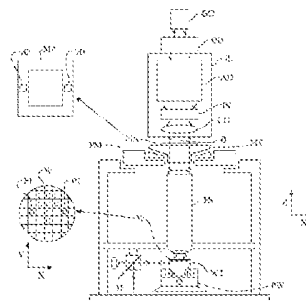
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A vibration isolation system to support a structure, a lithographic apparatus and device manufacturing method.

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The invention relates to a vibration isolation system to support a structure on a basis. The vibration isolation system being provided with a low frequency support . The vibration isolation system comprises:
a force sensor to provide a force signal representative of the force;
an internal force actuator for applying an internal force in parallel to the force; and, an internal force controller operably connected to the force sensor and the internal force actuator and the internal force controller is configured to control the internal force actuator on the basis of the force signal.



A VIBRATION ISOLATION SYSTEM TO SUPPORT A STRUCTURE, A LITHOGRAPHIC APPARATUS AND DEVICE MANUFACTURING METHOD

BACKGROUND

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Field of the Invention

The present invention relates to a vibration isolation system configured to at least partially support a structure, the vibration isolation system being provided with a low frequency support such as an airmount, the support being arranged to apply a force to the structure. The present invention also relates to a lithographic apparatus comprising:

an illumination system configured to condition a radiation beam;

a patterning device support constructed to support a patterning device, the patterning device being capable of imparting the radiation beam with a pattern in its cross-section to form a patterned radiation beam;

15 a substrate table constructed to hold a substrate; and

a projection system configured to project the patterned radiation beam onto a target portion of the substrate. The invention further relates to a method for manufacturing a device.

Description of the Related Art

20 A lithographic apparatus is a machine that applies a desired pattern onto a substrate, usually onto a target portion of the substrate. A lithographic apparatus can be used, for example, in the manufacture of integrated circuits (ICs). In such a case, a patterning device, which is alternatively referred to as a mask or a reticle, may be used to generate a circuit pattern to be formed on an individual layer of the IC. This pattern can be transferred onto a target portion (e.g. including part of, one, or several dies) on a substrate (e.g. a silicon wafer). Transfer of the pattern is typically via imaging onto a layer of radiation-sensitive material (resist) provided on the substrate. In general, a single substrate will contain a network of adjacent target portions that are successively patterned. Conventional lithographic apparatus include so-called steppers, in which each target portion is irradiated by exposing an entire pattern onto the target portion at once, 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

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scanning the substrate parallel or anti-parallel to this direction. It is also possible to transfer the pattern from the patterning device to the substrate by imprinting the pattern onto the substrate.

During the transfer of the pattern vibrations may deteriorate the transferred image. It is therefore important that the vibration sensitive lithographic apparatus or a vibration sensitive part thereof are supported on a basis by a vibration isolation system which isolates the sensitive part from base vibrations.

SUMMARY

10 It is desirable to provide an improved vibration isolation system.

According to an embodiment of the invention, there is provided a vibration isolation system configured to at least partially support a structure, the vibration isolation system being provided with a low frequency support, the low frequency support being arranged to apply a force to the structure; wherein the vibration isolation system comprises: a force sensor to provide a force signal representative of the force;

15 an internal force actuator for applying an internal force in parallel to the force; and,

an internal force controller operably connected to the force sensor and the internal force actuator and the internal force controller is configured to control the internal force actuator on the basis of the force signal.

20 By having an internal force actuator controlled by an internal force controller connected to a force sensor it becomes possible to compensate with the internal force actuator for small fluctuations in the force exerted by the low frequency support as measured with the internal force sensor. The transmission of vibrations between a base supporting the low frequency support and the structure through the low frequency support is thus minimized.

25 In an embodiment, the low frequency support comprises an airmount.

In another embodiment of the invention, there is provided a lithographic apparatus comprising:

the vibration isolation system for supporting the apparatus or a portion of the apparatus on a basis.

30 According to an embodiment of the invention, there is provided a device manufacturing method comprising projecting a patterned beam of radiation onto a substrate, wherein the method

comprises using the vibration isolation system.

BRIEF DESCRIPTION OF THE DRAWINGS

5 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:

- Figure 1 depicts a lithographic apparatus which may use a vibration isolation system according to an embodiment of the invention;

10 - Figure 2 depicts a vibration isolation system according to a first embodiment of the invention;

- Figure 3 depicts a vibration isolation system according to a second embodiment of the invention;

15 - Figures 4a, 4b, 4c depict how the vibration isolation system behaves with a feedback loop formed by a force sensor, an internal force controller and an internal force actuator;

- Figures 5a, 5b, 5c depict how the vibration isolation system behaves with the feedback loop formed by the force sensor, the internal force controller and the internal force actuator closed and a absolute motion sensor operably connected to the internal force controller; and,

20 - Figures 6a, 6b, 6c depict how the vibration isolation system behaves with the feedback loop formed by the force sensor, the internal force controller and the internal force actuator closed and with the absolute motion sensor operably connected to an external force controller controlling the external actuator.

DETAILED DESCRIPTION

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Figure 1 schematically depicts a lithographic apparatus for using a vibration isolation system according to an embodiment of the invention. The apparatus includes an illumination system (illuminator) IL configured to condition a radiation beam B (e.g. UV radiation or any other suitable radiation), a patterning device (e.g. a mask) support structure (e.g. a mask table)

30 MT constructed to support a patterning device (e.g. a mask) MA and connected to a first positioning device PM configured to accurately position the patterning device in accordance with

certain parameters. The apparatus also includes a substrate table (e.g. a wafer table) WT or "substrate support" constructed to hold a substrate (e.g. a resist-coated wafer) W and connected to a second positioning device PW configured to accurately position the substrate in accordance with certain parameters. The apparatus further includes 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. including one or more dies) of the substrate W.

The mask support structure supports, i.e. bears the weight of, the patterning device. It holds the patterning device in a manner that depends on the orientation of the patterning device, the design of the lithographic apparatus, and other conditions, such as for example whether or not the patterning device is held in a vacuum environment. The mask support structure can use mechanical, vacuum, electrostatic or other clamping techniques to hold the patterning device. The mask support structure may be a frame or a table, for example, which may be fixed or movable as required. The mask support structure may ensure that the patterning device is at a desired position, for example with respect to the projection system. Any use of the terms "reticle" or "mask" herein may be considered synonymous with the more general term "patterning device."

The term "projection system" used herein should be broadly interpreted as encompassing any type of projection system, including refractive, reflective, catadioptric, magnetic, electromagnetic and electrostatic optical systems, or any combination thereof, as appropriate for the exposure radiation being used, 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".

As here depicted, the apparatus is of a transmissive type (e.g. employing a transmissive mask). Alternatively, the apparatus may be of a reflective type (e.g. employing a programmable mirror array of a type as referred to above, or employing a reflective mask).

The lithographic apparatus may be of a type having two (dual stage) or more substrate tables or "substrate supports" (and/or two or more mask tables or "mask supports"). In such "multiple stage" machines the additional tables or supports may be used in parallel, or preparatory steps may be carried out on one or more tables or supports while one or more other tables or supports are being used for exposure.

The lithographic apparatus may also be of a type wherein at least a portion of the substrate may be covered by a liquid having a relatively high refractive index, e.g. water, so as to fill a space between the projection system and the substrate. An immersion liquid may also be applied to other spaces in the lithographic apparatus, for example, between the mask and the projection system. Immersion techniques can be used to increase the numerical aperture of projection systems. The term "immersion" as used herein does not mean that a structure, such as a substrate, must be submerged in liquid, but rather only means that a liquid is located between the projection system and the substrate during exposure.

The radiation beam B is incident on the patterning device (e.g., mask MA), which is held on the mask support structure (e.g., mask table MT), and is patterned by the patterning device. 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 positioning device PW and position sensor IF (e.g. an interferometric device, linear encoder or capacitive sensor), the substrate table WT can be moved accurately, e.g. so as to position different target portions C in the path of the radiation beam B. Similarly, the first positioning device PM and another position sensor (which is not explicitly depicted in Figure 1) can be used to accurately position the mask MA with respect to the path of the radiation beam B, e.g. after mechanical retrieval from a mask library, or during a scan. In general, movement of the mask table MT may be realized with the aid of a long-stroke module (coarse positioning) and a short-stroke module (fine positioning), which form part of the first positioning device PM. Similarly, movement of the substrate table WT or "substrate support" may be realized using a long-stroke module and a short-stroke module, which form part of the second positioner PW. In the case of a stepper (as opposed to a scanner) the mask table MT may be connected to a short-stroke actuator only, or may be fixed. Mask MA and substrate W may be aligned using mask alignment marks M1, M2 and substrate alignment marks P1, P2. Although the substrate alignment marks as illustrated occupy dedicated target portions, they may be located in spaces between target portions (these are known as scribe-lane alignment marks). Similarly, in situations in which more than one die is provided on the mask MA, the mask alignment marks may be located between the dies.

The depicted apparatus could be used in at least one of the following modes:

1. In step mode, the mask table MT or "mask support" and the substrate table WT or

"substrate support" are kept essentially stationary, while an entire pattern imparted to the radiation beam is projected onto a target portion C at one time (i.e. a single static exposure). The substrate table WT or "substrate support" is then shifted in the X and/or Y direction so that a different target portion C can be exposed. In step mode, the maximum size of the exposure field limits the size of the target portion C imaged in a single static exposure.

2. In scan mode, the mask table MT or "mask support" and the substrate table WT or "substrate support" are scanned synchronously while a pattern imparted to the radiation beam is projected onto a target portion C (i.e. a single dynamic exposure). The velocity and direction of the substrate table WT or "substrate support" relative to the mask table MT or "mask support" may be determined by the (de-)magnification and image reversal characteristics of the projection system PS. In scan mode, the maximum size of the exposure field limits the width (in the non-scanning direction) of the target portion in a single dynamic exposure, whereas the length of the scanning motion determines the height (in the scanning direction) of the target portion.

3. In another mode, the mask table MT or "mask support" is kept essentially stationary holding a programmable patterning device, and the substrate table WT or "substrate support" is moved or scanned while a pattern imparted to the radiation beam is projected onto a target portion C. In this mode, generally a pulsed radiation source is employed and the programmable patterning device is updated as required after each movement of the substrate table WT or "substrate support" or in between successive radiation pulses during a scan. This mode of operation can be readily applied to maskless lithography that utilizes programmable patterning device, such as a programmable mirror array of a type as referred to above.

Combinations and/or variations on the above described modes of use or entirely different modes of use may also be employed.

Figure 2 depicts a support according to a first embodiment of the invention. It depicts a vibration isolation system to support at least partially a structure MF on a basis BF, the vibration isolation system being provided with low frequency support. In the embodiment as shown, the low frequency support comprises an airmount AM. The vibration isolation system according to the present invention comprises a low frequency support for applying a force, e.g. a support force, to the structure MF. Within the meaning of the present invention, 'low frequency support' is used to denote any type of support, either passive or active, that may be applied to support, at least partially, a structure MF of a lithographic apparatus. Examples of such supports may e.g.

include passive springs, magnetic support systems, electro-magnetic support systems, hydraulic or pneumatic support systems. A well-known example of the latter support system is an airmount. In a lithographic environment, e.g. in a lithographic apparatus, such a support system may be used to provide a vibration isolation, i.e. ensuring that vibrations of the basis BF are not transmitted to the structure MF or at least attenuated. In an embodiment, the low frequency support may be configured to attenuate vibrations in a comparatively large frequency range, starting at a comparatively low frequency, e.g. 3 Hz or less.

Although below description refers to an airmount AM as the low frequency support, it should be noted that the vibration isolation system according to the present invention may also make use of alternative low frequency supports such as the support systems mentioned above. As such, whenever below description refers to an airmount, an alternative support system may be considered as well.

The supported structure MF may be a part of a lithographic apparatus, for example a metrology frame carrying the projection system PL or a complete lithographic apparatus. The basis BF may be a floor on which the lithographic projection apparatus is positioned or a base frame of the lithographic projection apparatus it self.

The airmount AM may have a housing (not depicted) forming a pressure chamber, a moveable member moveable in said pressure chamber, and, a gas supply to supply gas to said pressure chamber, said gas in use acting between said moveable member and the housing to at least partially counteract a force due to a gravitational load of the structure MF. Fluctuations in the pressure of the gas provided to the airmount AM may cause vibrations in the airmount which are unwanted. More information with respect to airmounts can be gleaned from US7170582 incorporated herein by reference.

The vibration isolation system may therefore have:

a force sensor FS to provide a force signal representative of the force and any disturbances travelling towards the structure MF via the air mount AM, such as vibrational disturbances caused by gas pressure fluctuations, base vibrations, and/or airmount structural resonances;
an internal force actuator IFA for applying an internal force in parallel to the force; and,
an internal force controller IFC operably connected to the force sensor FS and the internal force actuator IFA and the internal force controller IFC is configured to control the internal force actuator on the basis of the force signal.

The internal force controller may be configured to control the internal force actuator on the basis of the force measured by the force sensor in an internal feed back loop. By having an internal force actuator IFA controlled by an internal force controller IFC connected to a force sensor FS it becomes possible to compensate with the internal force actuator for small

5 fluctuations in the force exerted by the airmount AM as measured with the internal force sensor. The small fluctuations in the force may be caused by fluctuations in the pressure of the gas provided to the airmount. The force sensor FS may be a piezoelectric sensor which is a compact solution for measuring the force. Alternatively, a strain gauge may be used. The internal force actuator may be a Lorentz motor which is contactless and has a low parasitic stiffness.

10 Disturbances measured with the force sensor FS may be used at the internal force controller IFC to calculate a force for the internal force actuator IFA to counteract the disturbance.

As depicted the force sensor FS may be positioned in between the airmount AM and the structure MF. The force sensor FS may measure a force due to the gravitational load of the structure on the airmount and any disturbances traveling to the structure MF through the AM.

15 Alternatively the force sensor may be positioned in between the airmount AM and the basis BF to measure the force due to the gravitational load of the structure on the airmount AM.

Optionally, the vibration isolation system may be provided with an absolute motion sensor ACM, such as a displacement, a velocity (e.g. a geophone) or an acceleration sensor for measuring a change of the motion of the structure MF, for example, in a Z-direction being in

20 parallel to the gravitational direction. The absolute motion sensor ACM may be operably connected to the internal force controller IFC to control the internal force actuator IFA via a force calculator AFC which calculates a force as a function of the absolute motion measurement of the absolute motion sensor ACM. For example, it may calculate a compensation force to counteract a certain absolute motion change, a velocity or an acceleration of the structure MF in

25 the inertial feed back loop. The absolute motion change may for example be caused by a movement of a part in the structure MF changing the weight balance in the structure MF.

Compensation forces calculated by controller AFC are exerted on the isolated structure MF by internal actuator IFA. The force sensor FS provides a measurement of the actuated force to the internal force feedback controller IFC, which in response will calculate a force that negates

30 the applied force by controller AFC. To prevent this effect, the output of controller AFC, representing the required force to reduce motion sensed by sensor ACM, is subtracted from the

output of force sensor FS, before being this is input to controller IFC. This correction ensures that controller IFC does not act against the force generated by controller AFC.

Also forces in the horizontal plane perpendicular to the Z-direction may be measured. The force sensor FS may therefore comprise a force sensor (X, Y force sensor) for measuring a force
5 between the airmount AM and the structure MF in a horizontal plane perpendicular to the Z-direction. The X, Y force sensor may be operably connected to the internal force controller IFC. The internal force actuator IFA may comprise an internal force actuator (X, Y internal force actuator) acting in the horizontal plane and controlled by the internal force controller on the basis of the X, Y force sensor to counteract any forces in the horizontal plane.

10 The absolute motion sensor ACM may be an X, Y absolute motion sensor, such as a X, Y-displacement, a X, Y-velocity or an X, Y-acceleration sensor for measuring an absolute motion change of the position of the structure in a horizontal plane perpendicular to the Z-direction. The X, Y-absolute motion sensor may be operably connected to the internal force controller to control the X, Y-internal force actuator to counteract any absolute motion changes of the
15 structure in the horizontal plane.

Figure 3 depicts a vibration isolation system according to a second embodiment of the invention. In this embodiment the internal feedback loop formed by the force sensor FS, the internal force controller IFC and the internal force actuator IFA is uncoupled of the inertial feedback loop with the absolute motion sensor ACM. The internal feedback loop formed by the
20 force sensor FS, the internal force controller IFC and the internal force actuator IFA may have the same components as the first embodiment. The vibration isolation system is additionally provided with an external force actuator EFA for exerting a force between the basis BF and the structure MF and the absolute motion sensor ACM is operably connected to an external force controller EFC controlling the external actuator EFA to counteract any absolute motion changes
25 of the structure MF as measured with the absolute motion sensor ACM. The external force actuator EFA may work in a Z-direction being in parallel to the gravitational direction or in a horizontal direction perpendicular thereto. For the internal force feedback loop, it may be essential that the internal force actuator IFA acts on the force sensor FS. The internal force controller IFC then takes care that the sum of the disturbance force applied by the air mount AM,
30 and the force applied by the internal force actuator IFA, may be minimized. This way the transmissibility, or the transmission of vibrations from the basis BF to the structure MF, is

minimized. For the inertial feedback loop making use of absolute motion sensor ACM and absolute force controller AFC, it is essential that the force applied by the external force actuator EFA acts directly on the supported structure MF instead of on the force sensor FS. Otherwise, the force generated in external force actuator EFA would be cancelled by the internal feedback loop.

The external force actuator EFA may comprise an external X, Y-force actuator for exerting a force between the basis BM and the structure MF in a horizontal plane perpendicular to gravity. The external force controller EFC may control the external X, Y-force actuator and the X, Y-absolute motion sensor may be operably connected to the external force controller.

An advantage of the second embodiment over the first embodiment is that the control is more simple at the cost of an extra actuator.

Figures 4a, 4b and 4c depict in Bode plots how the vibration isolation system behaves. A Bode plot is a graph of a transfer function of a linear, time-invariant system versus frequency, plotted with a log-frequency axis, to show the system's frequency response. The Bode magnitude plot expresses the magnitude of the frequency response, and the Bode phase plot expresses the phase shift of the response. The Bode plots show how the vibration isolation system behaves with the internal feedback loop formed by the force sensor FS (see figure 2), the internal force controller IFC and the internal force actuator IFA closed or open (CL vs. OL).

Figure 4a depicts the open loop of the controller, indicated by the line 'OL'. The line 'CL' indicates the closed-loop response. The magnitude/phase behavior of the open loop is such that the closed loop is stable and robust. An open loop gain of 12 dB with a proper phase leads to a disturbance reduction of a factor of 4. Figure 4b depicts how the transmissibility of disturbances from the basis of the vibration isolation system to the structure MF is improved from open loop to closed loop. The line of the closed loop is lower than the line of the open loop indicating a larger suppression of vibrations from the basis to the structure. Again, a difference of 12 dB indicates an improvement of a factor of 4. Figure 4c depicts that the compliance of the vibration isolation system (how the vibration isolation system reacts on external disturbance to the supported structure) is not improved with the closed loop. The low stiffness support of the air mount makes the vibration isolation system sensitive to external disturbances to the structure.

To improve the compliance an absolute motion sensor ACM may be operably connected to the internal force controller IFC to control the internal force actuator IFA via a force calculator

AFC which calculates a force as a function of the absolute motion measurement of the absolute motion sensor ACM. In this way a compensation force to counteract a certain absolute motion change, a velocity or an acceleration of the structure MF may be applied.

5 Figures 5a, 5b and 5c depict in Bode plots how the vibration isolation system behaves. The line OL is without any force compensation. The line IFF CL IFA is with the internal feedback loop formed by the force sensor FS, the internal force controller IFC and the internal force actuator IFA closed and with inertial feedback by the absolute motion sensor ACM operably connected to the internal force controller via a force calculator. When using the same actuator IFA for the internal feedback loop as for the inertial feedback from the absolute motion sensor
10 the force required for the inertial feedback is considered a disturbance to the internal feedback loop. The internal feedback loop therefore degrades the inertial feedback loop. In Figure 5a it is shown that the gain of the line IFF CL IFA is reduced with respect to the open loop OL line. This effect reduces the attainable performance of the inertial feedback loop, and corresponds to the interaction between the two control loops as explained above. To avoid the degradation of the inertial feedback by the internal feedback loop the signal of the force calculator AFC may be subtracted from the force measured by the force sensor FS while the signal of the force calculator AFC is being added to the force exerted by the internal force actuator IFA (see figure 2). The latter resulting in the lines IFF CL IFA C in Figure 5a and IFF + IFB CL in Figure 5b and 5c.
15 Figure 5a shows that the gain with line IFF CL IFA C is restored. Figure 5b depicts that the transmissibility of disturbances from the basis of the vibration isolation system is improved from open loop to closed loop (OL to IFF CL) and from closed loop to closed loop with correction for inertial feedback degradation (IFF CL IFA C). Figure 5c depicts that the compliance of the vibration isolation system (how the vibration isolation system reacts on external disturbance to the supported structure) is also improved for the closed loop with correction for inertial feedback
20 degradation (IFF CL IFA C).
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Figures 6a, 6b and 6c depict in Bode plots how the vibration isolation system behaves with an external force actuator EFA. The line OL is without any force compensation. The line IFF CL IFA is with the internal feedback loop formed by the force sensor FS, the internal force controller IFC and the internal force actuator IFA closed and with inertial feedback by the
30 absolute motion sensor ACM operably connected to the internal force controller via a force calculator. When using the same actuator IFA for the internal feedback loop as for the inertial

feedback from the absolute motion sensor the force required for the inertial feedback is considered a disturbance to the internal feedback loop. The internal feedback loop therefore degrades the inertial feedback loop. In Figure 6a it is shown that the gain of the line IFF CL IFA is reduced with respect to the open loop OL line similar to that in Figure 5a. To avoid the degradation of the inertial feedback by the internal feedback loop the vibration isolation system may be provided with an external force actuator EFA for exerting a force between the basis BF and the structure MF and the absolute motion sensor ACM may be operably connected to an external force controller EFC controlling the external actuator EFA to counteract any absolute motion changes of the structure MF as measured with the absolute motion sensor ACM (see figure 3). The latter resulting in the lines IFF CL EFA in Figure 6a and IFF + IFB CL in Figure 6b and 6c. Figure 6a shows that the gain with line IFF CL EFA is restored. Figure 6b depicts that the transmissibility of disturbances from the basis of the vibration isolation system is improved from open loop to closed loop (OL to IFF CL) and from closed loop to closed loop with an external actuator (IFF + IFB CL). Figure 6c depicts that the compliance of the vibration isolation system (how the vibration isolation system reacts on external disturbance to the supported structure) is also improved for the closed loop with external actuator (IFF + IFB CL).

Although specific reference may be made in this text to the use of lithographic apparatus in the manufacture of ICs, it should be understood that the lithographic apparatus described herein may have other applications, such as 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. The skilled artisan will appreciate that, in the context of such alternative applications, any use of the terms “wafer” or “die” herein may be considered as synonymous with the more general terms “substrate” or “target portion”, respectively. The substrate referred to herein may be processed, before or after exposure, in for example a track (a tool that typically applies a layer of resist to a substrate and develops the exposed resist), a metrology tool and/or an inspection tool. Where applicable, the disclosure herein may be applied to such and other substrate processing tools. Further, the substrate may be processed more than once, for example in order to create a multi-layer IC, so that the term substrate used herein may also refer to a substrate that already contains multiple processed layers.

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 may be

used in other applications, for example imprint lithography, and where the context allows, is not limited to optical lithography. In imprint lithography a topography in a patterning device defines the pattern created on a substrate. The topography of the patterning device may be pressed into a layer of resist supplied to the substrate whereupon the resist is cured by applying electromagnetic radiation, heat, pressure or a combination thereof. The patterning device is moved out of the resist leaving a pattern in it after the resist is cured.

The terms “radiation” and “beam” used herein encompass all types of electromagnetic radiation, including ultraviolet (UV) radiation (e.g. having a wavelength of or about 365, 248, 193, 157 or 126 nm) and extreme ultra-violet (EUV) radiation (e.g. having a wavelength in the range of 5-20 nm), as well as particle beams, such as ion beams or electron beams.

The term “lens”, where the context allows, may refer to any one or combination of various types of optical components, including refractive, reflective, magnetic, electromagnetic and electrostatic optical components.

While specific embodiments of the invention have been described above, it will be appreciated that the invention may be practiced otherwise than as described. For example, the invention may take the form of a computer program containing one or more sequences of machine-readable instructions describing a method as disclosed above, or a data storage medium (e.g. semiconductor memory, magnetic or optical disk) having such a computer program stored therein.

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 clauses set out below. Other aspects of the invention are set out as in the following numbered clauses:

1. A vibration isolation system configured to at least partially support a structure, the vibration isolation system being provided with a low frequency support, the low frequency support being arranged to apply a force to the structure; wherein the vibration isolation system comprises:

a force sensor to provide a force signal representative of the force;

an internal force actuator for applying an internal force in parallel to the force; and,

an internal force controller operably connected to the force sensor and the internal force actuator and the internal force controller is configured to control the internal force actuator on

the basis of the force signal.

2 The vibration isolation system according to clause 1, wherein the force sensor is positioned in between the low frequency support and the structure.

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3 The vibration isolation system according to clause 1, wherein the force sensor is positioned in between the low frequency support and a basis for supporting the low frequency suspension support.

10 4. The vibration isolation system according to any of clauses 1 to 3, wherein the force is due to a gravitational load of the structure on the low frequency support.

5. The vibration isolation system according to any of the preceding clauses, wherein the vibration isolation system is provided with an absolute motion sensor, such as a displacement, a
15 velocity or a acceleration sensor for providing an absolute motion measurement signal representative of a motion of the structure and wherein the absolute motion sensor is operably connected to the internal force controller to control the internal force actuator.

6. The vibration isolation system according to clause 5, wherein the vibration isolation system
20 is provided with an external force actuator for applying an external force between a basis for supporting the low frequency support and the structure wherein the absolute motion sensor is operably connected to an external force controller configured to control the external force actuator on the basis of the absolute motion measurement signal.

25 7. The vibration isolation system according to any of the preceding clauses, wherein the internal force actuator and/or the external force actuator is a Lorentz motor.

8. The vibration isolation system according to any of the preceding clauses, wherein the force sensor is a piezoelectric sensor.

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9.. The vibration isolation system according to any of clauses 1 to 5, wherein the force sensor

provides a force signal representative for a force on the low frequency support in a horizontal plane perpendicular to a gravitational direction, and the internal force actuator is constructed and arranged for applying an internal force to the structure in the horizontal plane controlled by the internal force controller.

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10. The vibration isolation system according to clause 9, wherein the vibration isolation system is provided with an absolute motion sensor, such as a displacement, a velocity or an acceleration sensor for providing an absolute motion measurement signal representative for a horizontal absolute motion of the structure.

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11. The vibration isolation system according clause 10, wherein the absolute motion sensor is horizontally orientated and operably connected to the internal force controller to control the internal force actuator acting in the horizontal plane.

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12. The vibration isolation system according to clause 11, wherein the vibration isolation system comprises:

an external force actuator for exerting a force between the structure and a basis which supports the low frequency support; and,

an external force controller controlling the external force actuator; the absolute motion sensor is operably connected to the external force controller.

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13. The vibration isolation system according to any of the preceding clauses in which the internal force controller is programmed and arranged to counteract a change of force measured with the force sensor with the internal force actuator.

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14. The vibration isolation system according to any of the preceding clauses, wherein the low frequency support comprises an airmount.

15. A lithographic apparatus comprising:

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a vibration isolation system according to any of the clauses 1 to 14 for supporting the apparatus or a part of the apparatus.

CONCLUSIE

Een lithografieinrichting omvattende: een belichtinginrichting ingericht voor het leveren van een stralingsbundel; een drager geconstrueerd voor het dragen van een patroneerinrichting, 5 welke patroneerinrichting in staat is een patroon aan te brengen in een doorsnede van de stralingsbundel ter vorming van een gepatroneerde stralingsbundel; 5 een substraattafel geconstrueerd om een substraat te dragen; en een projectieinrichting ingericht voor het projecteren van de gepatroneerde stralingsbundel op een doelgebied van het substraat, met het kenmerk, dat de substraattafel is ingericht voor het positioneren van het doelgebied van het 10 substraat in een brandpuntsvlak van de projectieinrichting.

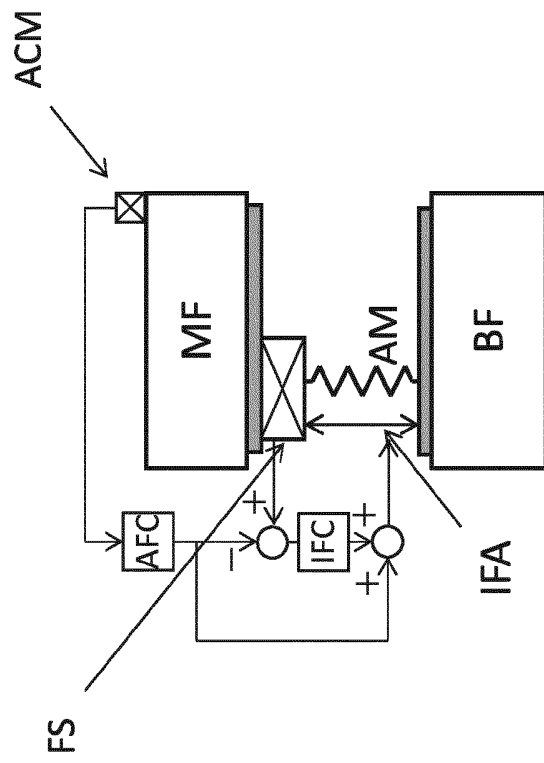


Fig. 2

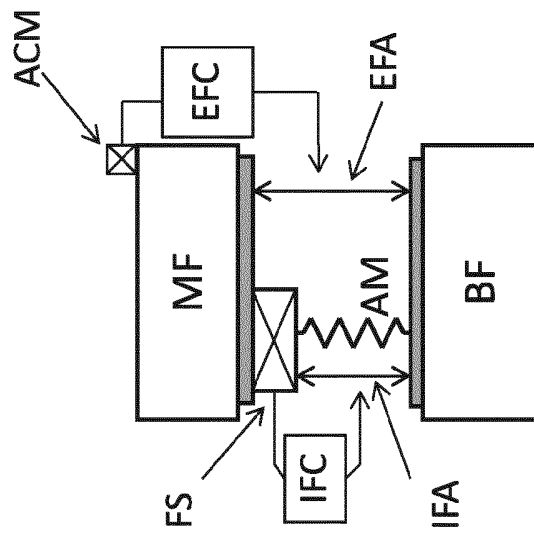


Fig. 3

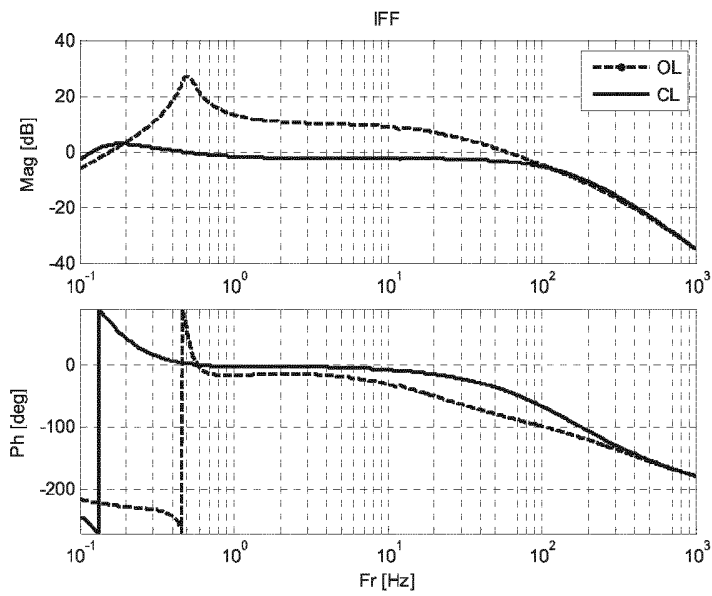


Fig.4a

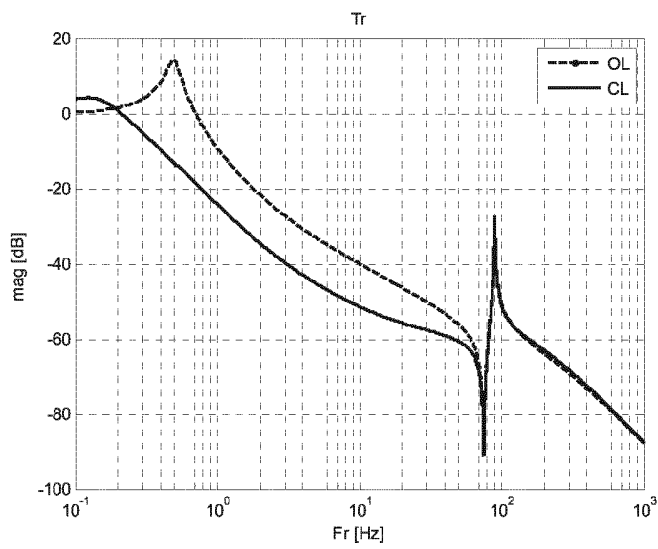


Fig. 4b

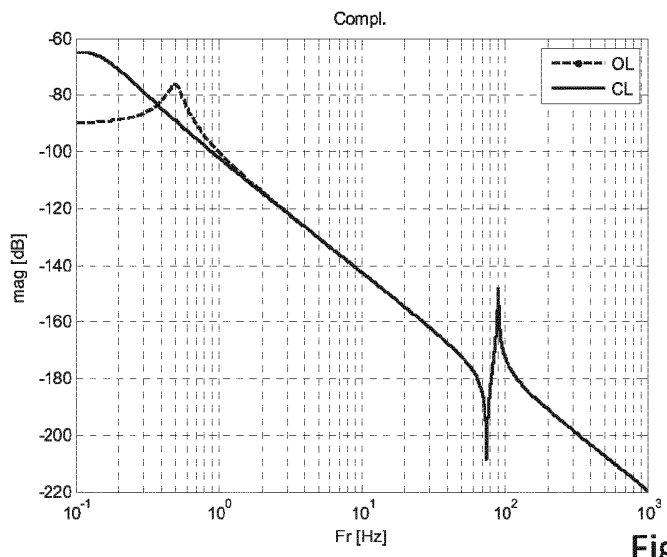


Fig. 4c

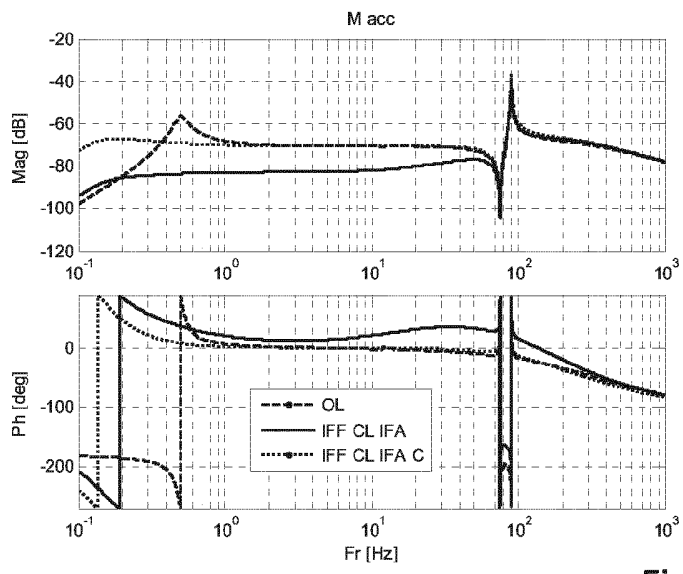


Fig.5a

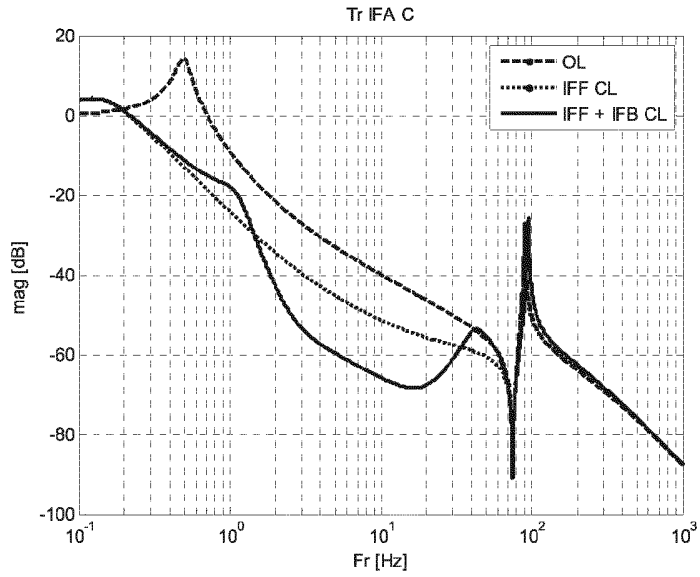


Fig. 5b

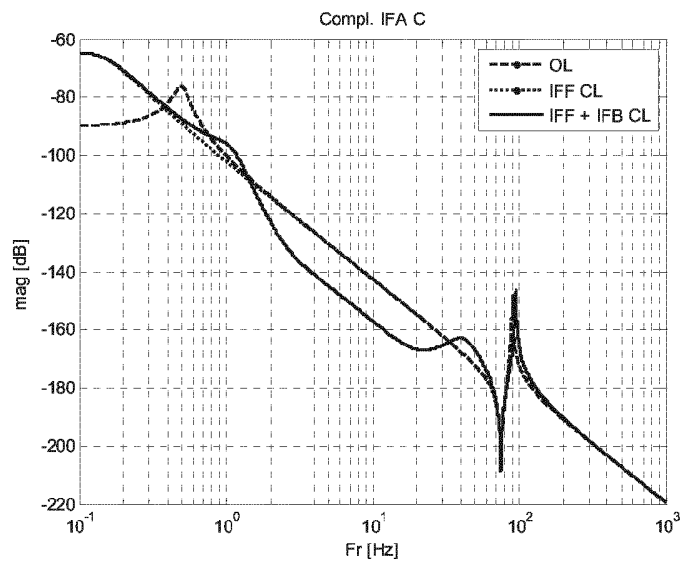


Fig. 5c

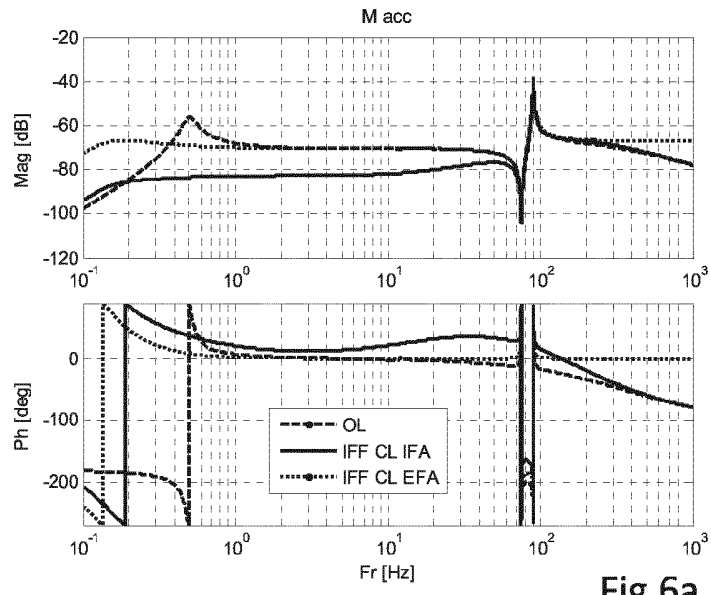


Fig.6a

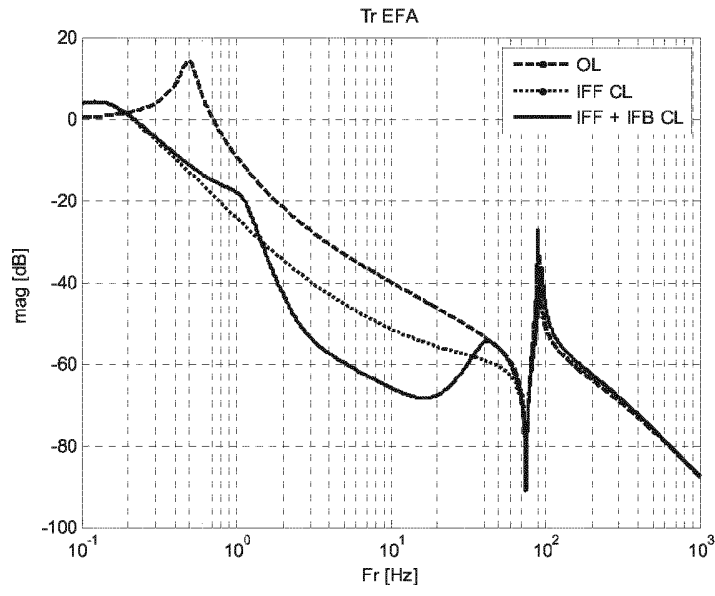
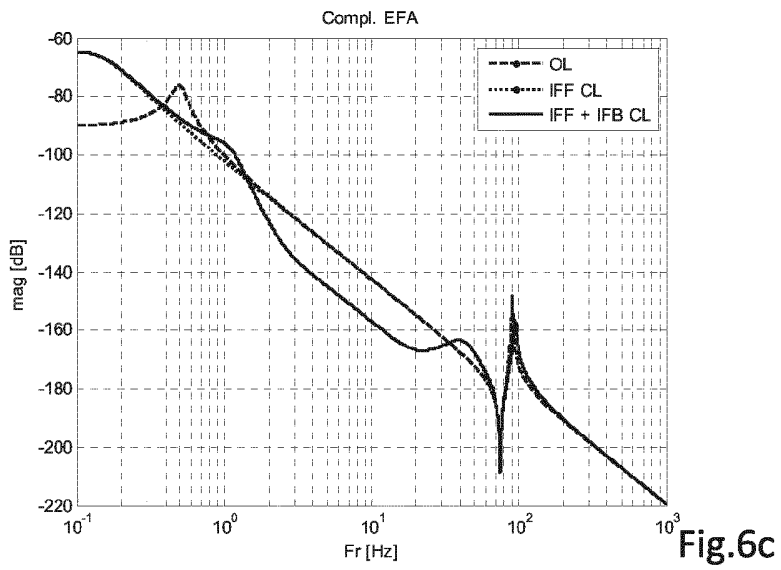


Fig.6b



ABSTRACT

The invention relates to a vibration isolation system to support a structure on a basis. The vibration isolation system being provided with a low frequency support . The vibration isolation

5 system comprises:

a force sensor to provide a force signal representative of the force;

an internal force actuator for applying an internal force in parallel to the force; and,

an internal force controller operably connected to the force sensor and the internal force actuator and the internal force controller is configured to control the internal force actuator on

10 the basis of the force signal.