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(54) **Inspection Apparatus, Lithographic Apparatus and Method of Measuring a Property of a Substrate.**

(57) The invention relates to a scatterometer. In a scatterometer a polarizer is used to split a radiation beam in a first beam of polarized radiation in a first polarization direction and a second beam of polarized radiation in a second polarization direction orthogonally to the first polarization direction. According to the invention the scatterometer is provided with a Glan-laser polarizer. The use of Glan-laser polarizers as described generally results in an improved extinction ratio and use over a greater range of wavelengths when compared with dielectric polarizers.

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Inspection Apparatus, Lithographic Apparatus and Method of Measuring a Property of a Substrate

FIELD

[0001] The present invention relates to methods of inspection usable, for example, in the manufacture of devices by lithographic techniques and to methods of manufacturing devices using lithographic techniques.

BACKGROUND

[0002] 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 that instance, 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., comprising 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. 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. It is also possible to transfer the pattern from the patterning device to the substrate by imprinting the pattern onto the substrate.

[0003] In order to monitor the lithographic process, it is necessary to measure parameters of the patterned substrate, for example the overlay error between successive layers formed in or on it. There are various techniques for making measurements of the microscopic structures formed in lithographic processes, including the use of scanning electron microscopes and various specialized tools. One form of specialized inspection tool is a scatterometer in which a beam of radiation is directed onto a target on the surface of the substrate and properties of the scattered or reflected beam are measured. By comparing the properties of the beam before and after it has been reflected or scattered by the substrate, the properties of the substrate can be determined. This can be done, for example, by comparing the reflected beam with data stored in a library of known measurements associated with known substrate properties. Two main types of scatterometer are known. Spectroscopic scatterometers direct a broadband radiation beam onto the substrate and measure the spectrum (intensity as a function of wavelength) of the radiation scattered into a particular narrow angular range. Angularly resolved scatterometers use a monochromatic radiation beam and measure the intensity of the scattered radiation as a function of angle.

[0004] Scatterometers often use polarized radiation as the different polarizations can be scattered differently. Thus the radiation is often passed through a polarizer, in which radiation polarized in one direction is transmitted and radiation in a second direction is not. Such a polarizer is shown in Figure 5 of the accompanying Figures and comprises two polarizers 17a and 17b joined together. Polarization of the incident radiation is performed by a polarizing optical (dielectric) coating, which in this case is located on the hypotenuses of beam splitters 17a and 17b. Two polarizing cube beam splitters can be cemented together, or made out of three sub components. Two orthogonal polarized beams having identical optical axes can be created with this beam splitter lay out. Two incident unpolarized beams are partially reflected and transmitted. The reflected portion has polarization state 1; here called vertical or s-polarization. The transmitted portion has polarization state 2, which is orthogonal with respect to polarization state 1, called horizontal or p-polarization. Since only the orthogonally polarized beams with the same optical axis as the input side of beam splitter are used the radiation emerging in the two other directions remain unused. To prevent stray light inside the scatterometer, neutral density filters 28a, 28b can be added to the beam splitter design. These filters absorb unwanted radiation up to a factor of 10^{-4} or even more.

[0005] Extinction ratio is defined as the purity of polarization. A theoretical perfect polarizer transmits 100% of the desired polarization and 0% (fully blocks) the undesired polarization. The ratio between the undesired polarization and desired polarization is called extinction ratio. Creating a broad wavelength band polarizing (dielectric) coating having a high extinction ratio is difficult. Furthermore, an optical (dielectric) coating to create a high extinction ratio over a broad wavelength range mostly has a large (dielectric) coating thickness which might introduce intensity in-homogeneities. These intensity profile inhomogeneities might have negative impact on scatterometer performance.

[0006] Furthermore, polarizers used in present scatterometers are often only effective over a narrow range of wavelengths, limiting the use of the apparatus.

SUMMARY

[0007] It is desirable to provide an inspection apparatus with a polarizer with a low extinction ratio which operates over a wider range of wavelengths.

[0008] According to an aspect of the invention, there is provided an inspection apparatus configured to measure a property of a substrate, the apparatus comprising:

- an illumination system configured to condition a radiation beam;
- a radiation projector configured to project radiation onto said substrate;
- a high numerical aperture lens;
- a detector configured to detect the radiation beam reflected from a surface of the substrate; and
- a polarizing device configured to polarize said radiation beam,

wherein said polarizing device comprises a Glan-laser polarizer.

[0009] According to a further aspect of the invention there is provided an apparatus configured to project an image of a substrate, the apparatus comprising:

- a radiation projector configured to project radiation onto said substrate;
- a high numerical aperture lens through which said radiation is projected; and
- a polarizing device configured to polarize said radiation beam,

wherein said polarizing device comprises a Glan-laser polarizer.

[0010] According to a further aspect of the invention there is provided a method of measuring a property of a substrate comprising:

- projecting radiation onto a substrate using a radiation projector;
- detecting said radiation reflected from said substrate, the reflected radiation being indicative of the properties to be measured; and
- polarizing said radiation by transmitting said radiation through a Glan-laser polarizer.

BRIEF DESCRIPTION OF THE DRAWINGS

[0011] 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:

[0012] - Figure 1 depicts a lithographic apparatus;

[0013] - Figure 2 depicts a lithographic cell or cluster;

[0014] - Figure 3 depicts a first scatterometer;

[0015] - Figure 4 depicts a second scatterometer;

[0016] - Figure 5 depicts a polarizer according to the prior art;

[0017] - Figure 6 depicts a polarizer according to the present invention; and

[0018] - Figures 7a and 7b depict a Glan-laser polarizer.

DETAILED DESCRIPTION

[0019] Figure 1 schematically depicts a lithographic apparatus. The apparatus comprises:

- an illumination system (illuminator) IL configured to condition a radiation beam B (e.g., UV radiation or DUV radiation).
- a support structure (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 in accordance with certain parameters;
- a substrate table (e.g., a wafer 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 in accordance with certain parameters; and
- a projection system (e.g., a refractive projection lens system) PL 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.

[0020] The illumination system may include various types of optical components, such as refractive, reflective, magnetic, electromagnetic, electrostatic or other types of optical components, or any combination thereof, for directing, shaping, or controlling radiation.

[0021] The 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 support structure can use mechanical, vacuum, electrostatic or other clamping techniques to hold the patterning device. The support structure may be a frame or a table, for example, which may be fixed or movable as required. The 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."

[0022] The term "patterning device" used herein should be broadly interpreted as referring to any device that can be used to impart a radiation beam with a pattern in its cross-section such as to create a pattern in a target portion of the substrate. It should be noted that the pattern imparted to the radiation beam may not exactly correspond to the desired pattern in the target portion of the substrate, for example if the pattern includes phase-shifting features or so called assist features. Generally, the pattern imparted to the radiation beam will correspond to a particular functional layer in a device being created in the target portion, such as an integrated circuit.

[0023] The patterning device may be transmissive or reflective. Examples of patterning devices include masks, programmable mirror arrays, and programmable LCD panels. Masks are well known in lithography, and include mask types such as binary, alternating phase-shift, and attenuated phase-shift, as well as various hybrid mask types. An example of a programmable mirror array employs a matrix arrangement of small mirrors, each of which can be individually tilted so as to reflect an incoming radiation beam in different directions. The tilted mirrors impart a pattern in a radiation beam, which is reflected by the mirror matrix.

[0024] 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".

[0025] 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).

[0026] The lithographic apparatus may be of a type having two (dual stage) or more substrate tables (and/or two or more mask tables). In such "multiple stage" machines the additional tables may be used in parallel, or preparatory steps may be carried out on one or more tables while one or more other tables are being used for exposure.

[0027] 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 are well known in the art for increasing 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 liquid is located between the projection system and the substrate during exposure.

[0028] Referring to Figure 1, the illuminator IL receives a radiation beam from a radiation source SO. The source and the lithographic apparatus may be separate entities, for example when the source is an excimer laser. In such cases, the source is not considered to form part of the lithographic apparatus and the radiation beam is passed from the source SO to the illuminator IL with the aid of a beam delivery system BD comprising, for example, suitable directing mirrors and/or a beam expander. In other cases the source may be an integral part of the lithographic apparatus, for example when the source is a mercury lamp. The source SO and the illuminator IL, together with the beam delivery system BD if required, may be referred to as a radiation system.

[0029] The illuminator IL may comprise an adjuster AD for adjusting the angular intensity distribution of the radiation beam. Generally, at least the outer and/or inner radial extent (commonly referred to as σ-outer and σ-inner, respectively) of the intensity distribution in a pupil plane of the illuminator can be adjusted. In addition, the illuminator IL may comprise various other components, such as an integrator IN and a condenser CO. The illuminator may be used to condition the radiation beam, to have a desired uniformity and intensity distribution in its cross-section.

[0030] The radiation beam B is incident on the patterning device (e.g., mask MA), which is held on the 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 PL, which focuses the beam onto a target portion C of the substrate W. With the aid of the second positioner PW and position sensor IF (e.g., an interferometric device, linear encoder, 2-D 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 positioner 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 positioner PM. Similarly, movement of the substrate table WT 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.

[0031] The depicted apparatus could be used in at least one of the following modes:

[0032] 1. In step mode, the mask table MT and the substrate table WT 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 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.

[0033] 2. In scan mode, the mask table MT and the substrate table WT 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 relative to the mask table MT may be determined by the (de-)magnification and image reversal characteristics of the projection system PL. 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.

[0034] 3. In another mode, the mask table MT is kept essentially stationary holding a programmable patterning device, and the substrate table WT 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 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.

[0035] Combinations and/or variations on the above described modes of use or entirely different modes of use may also be employed.

[0036] As shown in Figure 2, the lithographic apparatus LA forms part of a lithographic cell LC, also sometimes referred to a lithocell or cluster, which also includes apparatus to perform pre- and post-exposure processes on a substrate. Conventionally these include spin coaters SC to deposit resist layers, developers DE to develop exposed resist, chill plates CH and bake plates BK. A substrate handler, or robot, RO picks up substrates from input/output ports I/O1, I/O2, moves them between the different process apparatus and delivers then to the loading bay LB of the lithographic apparatus. These devices, which are often collectively referred to as the track, are under the control of a track control unit TCU which is itself controlled by the supervisory control system SCS, which also controls the lithographic apparatus via lithography control unit LACU. Thus, the different apparatus can be operated to maximize throughput and processing efficiency.

[0037] In order that the substrates that are exposed by the lithographic apparatus are exposed correctly and consistently, it is desirable to inspect exposed substrates to measure properties such as overlay errors between subsequent layers, line thicknesses, critical dimensions (CD), etc. If errors are detected, adjustments may be made to exposures of subsequent substrates, especially if the inspection can be done soon and fast enough that other substrates of the same batch are still to be exposed. Also, already exposed substrates may be stripped and reworked – to improve yield – or discarded – thereby avoiding performing exposures on substrates that are known to be faulty. In a case where only some target portions of a substrate are faulty, further exposures can be performed only on those target portions which are good.

[0038] An inspection apparatus is used to determine the properties of the substrates, and in particular, how the properties of different substrates or different layers of the same substrate vary from layer to layer. The inspection apparatus may be integrated into the lithographic apparatus LA or the lithocell LC or may be a stand-alone device. To enable most rapid measurements, it is desirable that the inspection apparatus measure properties in the exposed resist layer immediately after the exposure. However, the latent image in the resist has a very low contrast – there is only a very small difference in refractive index between the parts of the resist which have been exposed to radiation and those which have not – and not all inspection apparatus have sufficient sensitivity to make useful measurements of the latent image. Therefore measurements may be taken after the post-exposure bake step (PEB) which is customarily the first step carried out on exposed substrates and increases the contrast between exposed and unexposed parts of the resist. At this stage, the image in the resist may be referred to as semi-latent. It is also possible to make measurements of the developed resist image – at which point either the exposed or unexposed parts of the resist have been removed – or after a pattern transfer step such as etching. The latter possibility limits the possibilities for rework of faulty substrates but may still provide useful information.

[0039] Figure 3 depicts a scatterometer which may be used in the present invention. It comprises a broadband (white light) radiation projector 2 which projects radiation onto a substrate W. The reflected radiation is passed to a spectrometer detector 4, which measures a spectrum 10 (intensity as a function of wavelength) of the specular reflected radiation. From this data, the structure or profile giving rise to the detected spectrum may be reconstructed by processing unit PU, e.g., by Rigorous Coupled Wave Analysis and non-linear regression or by comparison with a library of simulated spectra as shown at the bottom of Figure 3. In general, for the reconstruction the general form of the structure is known and some parameters are assumed from knowledge of the process by which the structure was made, leaving only a few parameters of the structure to be determined from the scatterometry data. Such a scatterometer may be configured as a normal-incidence scatterometer or an oblique-incidence scatterometer.

[0040] Another scatterometer that may be used with the present invention is shown in Figure 4. In this device, the radiation emitted by radiation source 2 is focused using lens system 12 through interference filter 13 and polarizer 17, reflected by partially reflected surface 16 and is focused onto substrate W via a microscope objective lens 15, which has a high numerical aperture (NA), for example at least 0.9 and more particularly at least 0.95. Immersion scatterometers may even have lenses with numerical apertures over 1. The reflected radiation then transmits through partially reflective surface 16 into a detector 18 in order to have the scatter spectrum detected. The detector may be located in the back-projected pupil plane 11, which is at the focal length of the lens system 15, however the pupil plane may instead be re-imaged with auxiliary optics (not shown) onto the detector. The pupil plane is the plane in which the radial position of radiation defines the angle of incidence and the angular position defines azimuth angle of the radiation. In an embodiment, the detector is a two-dimensional detector so that a two-dimensional angular scatter spectrum of a substrate target 30 can be measured. The detector 18 may be, for example, an array of CCD or CMOS sensors, and may use an integration time of, for example, 40 milliseconds per frame.

[0041] A reference beam is often used for example to measure the intensity of the incident radiation. To do this, when the radiation beam is incident on the beam splitter 16 part of it is transmitted through the beam splitter as a reference beam towards a reference mirror 14. The reference beam is then projected onto a different part of the same detector 18.

[0042] A set of interference filters 13 is available to select a wavelength of interest in the range of, say, 405 - 790 nm or even lower, such as 200 - 300 nm. The interference filter may be tunable rather than comprising a set of different filters. A grating could be used instead of interference filters.

[0043] The detector 18 may measure the intensity of scattered light at a single wavelength (or narrow wavelength range), the intensity separately at multiple wavelengths or integrated over a wavelength range. Furthermore, the detector may separately measure the intensity of transverse magnetic- and transverse electric-polarized light and/or the phase difference between the transverse magnetic- and transverse electric-polarized light.

[0044] Using a broadband light source (i.e., one with a wide range of light frequencies or wavelengths – and therefore of colors) is possible, which gives a large etendue, allowing the mixing of multiple wavelengths. The plurality of wavelengths in the broadband each has a bandwidth of $\delta\omega$ and a spacing of at least 2 $\delta\omega$ (i.e., twice the bandwidth). Several "sources" of radiation can be different portions of an extended radiation source which have been split using fiber bundles. In this way, angle resolved scatter spectra can be measured at multiple wavelengths in parallel. A 3-D spectrum (wavelength and two different angles) can be measured, which contains more information than a 2-D spectrum. This allows more information to be measured which increases metrology process robustness. This is described in more detail in EP1,628,164A.

[0045] The target 30 on substrate W may be a grating, which is printed such that after development, the bars are formed of solid resist lines. The bars may alternatively be etched into the substrate. This pattern is sensitive to chromatic aberrations in the lithographic projection apparatus, particularly the projection system PL, and illumination symmetry and the presence of such aberrations will manifest themselves in a variation in the printed grating. Accordingly, the scatterometry data of the printed gratings is used to reconstruct the gratings. The parameters of the grating, such as line widths and shapes, may be input to the reconstruction process, performed by processing unit PU, from knowledge of the printing step and/or other scatterometry processes.

[0046] According to an embodiment of the invention two Glan-laser polarizers 27a, 27b are used in place of the conventional polarizers using optical coatings. As discussed above, these are arranged in the path of the radiation beam, usually after the interference filter 13 and before the partially reflective surface 16. As can be seen from Figure 6 the Glan-laser polarizers 27a, 27b are usually joined together, and can conveniently be cemented together. According to the arrangement of the scatterometer as a whole the optical axes of the Glan-laser polarizers are arranged to be parallel such that the incoming radiation beam is parallel to the transmitted radiation beam. The unwanted radiation can be absorbed by a neutral density filter 28.

[0047] Glan-laser polarizers are often made from two calcite (or other birefringent material) prisms between which is a small air space (not depicted) and which may be mounted in a black anodized housing. A Glan-laser polarizer is shown in more detail in Figures 7a and 7b and Figure 7a depicts an end view showing a clear aperture 31, around which is arranged the black anodized housing 32. As can be seen from Figure 7b radiation of one polarization is refracted at a different angle from radiation at another polarization. This results in different angles of incidence of the o-rays and e-rays on the air space. The polarizer is arranged such that the e-ray is incident on the air interface at an angle below Brewster's angle and is thus transmitted. However, the polarizer is arranged such that the o-ray is incident on the air interface at an angle above Brewster's angle and is reflected. The o-ray may be reflected into either the black anodized housing 32 or windows 33 cut into the black anodized housing. Although only one window 33 is depicted many may be present. Rather than using a polarization coating, as in conventional polarizers, this results in an extinction ratio of up to 10^{-6}. Furthermore, a Glan-laser polarizer is usable over a wide wavelength range of 350-2000nm or even larger. Each polarizer is composed of two mounted air-spaced calcite prisms which might be uncoated or have a broadband antireflection coating.

[0048] Although the description above refers to a Glan-laser polarizer for use in each polarizer, one, three or more could equally be used and should be arranged such that the transmitted radiation is suitable for the scatterometer.

[0049] 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.

[0050] 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.

[0051] 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, 355, 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.

[0052] 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.

[0053] 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.

[0054] 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 clausess set out below. Other Aspects of the invention are set out as in the following clauses:

1. An inspection apparatus configured to measure a property of a substrate, the apparatus comprising:

   an illumination system configured to condition a radiation beam;

   a radiation projector configured to project radiation onto said substrate;

   a high numerical aperture lens;

   a detector configured to detect the radiation beam reflected from a surface of the substrate; and

   a polarizer configured to polarize said radiation beam, the polarizer comprising a Glan-laser polarizer.

2. An apparatus according to clauses 1 wherein said polarizer comprises two Glan-laser polarizers.

3. An apparatus according to clauses 2 wherein said two Glan-laser polarizers are joined together.

4. An apparatus according to clauses 2 wherein optical axes of each Glan-laser polarizer are parallel.

5. An apparatus according to clauses 1 wherein said Glan-laser polarizer comprises a birefringent material.

6. An apparatus according to clauses 5, wherein the birefringent material comprises calcite.

7. A lithographic apparatus comprising:

an illumination system configured to condition a radiation beam;

a 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;

a substrate table constructed to hold a substrate;

a projection system configured to project the patterned radiation beam onto a target portion of the substrate; and

an inspection apparatus comprising:

an illumination system configured to condition a radiation beam;

a radiation projector configured to project radiation onto said substrate;

a high numerical aperture lens;

a detector configured to detect the radiation beam reflected from a surface of the substrate; and

a polarizer configured to polarize said radiation beam, the polarizer comprising a Glan-laser polarizer.

8. An apparatus configured to project an image of a substrate, the apparatus comprising:

a radiation projector configured to project radiation onto said substrate;

a high numerical aperture lens through which said radiation is projected; and

a polarizer configured to polarize said radiation beam, the polarizer comprising a Glan-laser polarizer.

9. A method of measuring a property of a substrate comprising:

projecting radiation onto a substrate using a radiation projector;

detecting said radiation reflected from said substrate, the reflected radiation being indicative of the properties to be measured; and

polarizing said radiation by transmitting said radiation through a Glan-laser polarizer.

CONCLUSIE

1. Een lithografieinrichting omvattende:

een belichtinginrichting ingericht voor het leveren van een stralingsbundel;

een drager geconstrueerd voor het dragen van een patroneerinrichting, welke patroneerinrichting in staat is een patroon aan te brengen in een doorsnede van de stralingsbundel ter vorming van een gepatroneerde stralingsbundel;

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 substraat in een brandpuntsvlak van de projectieinrichting.

Fig. 1

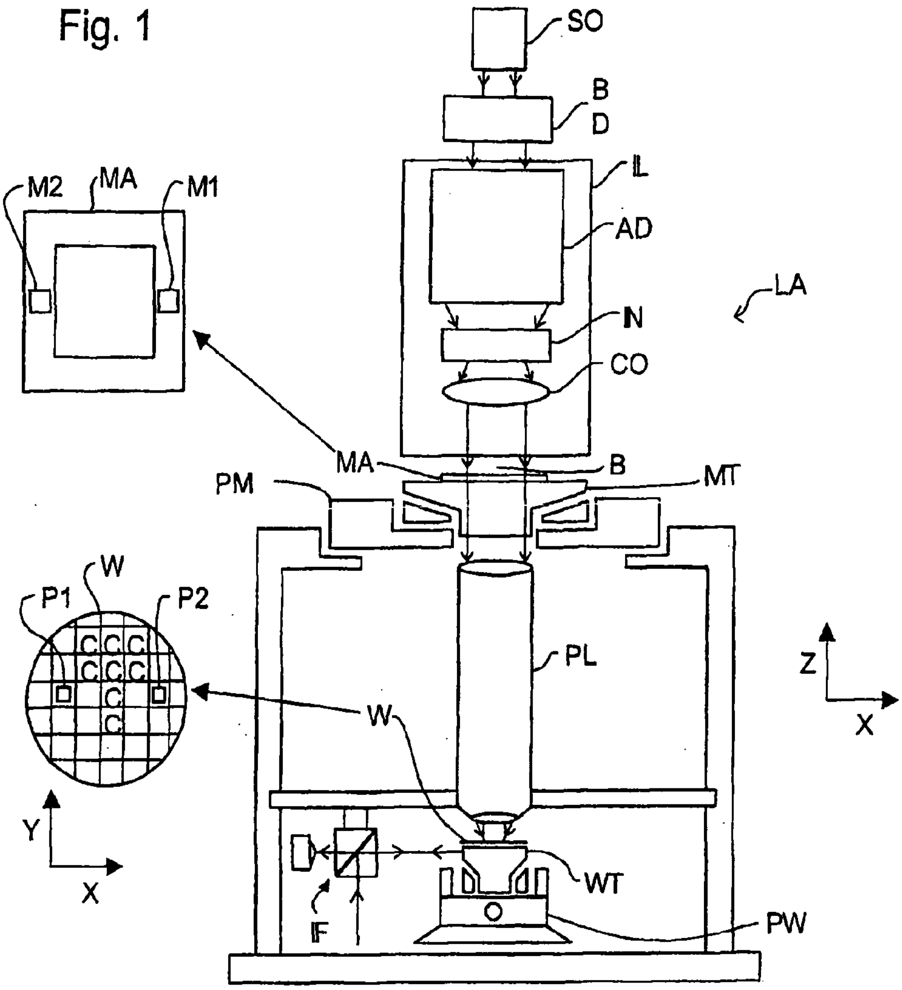

Fig. 2

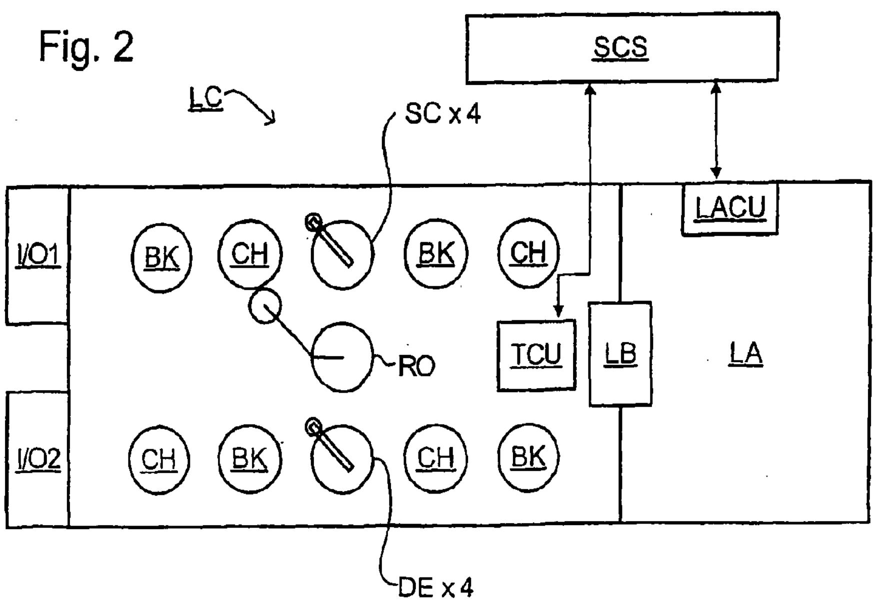

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Fig. 3

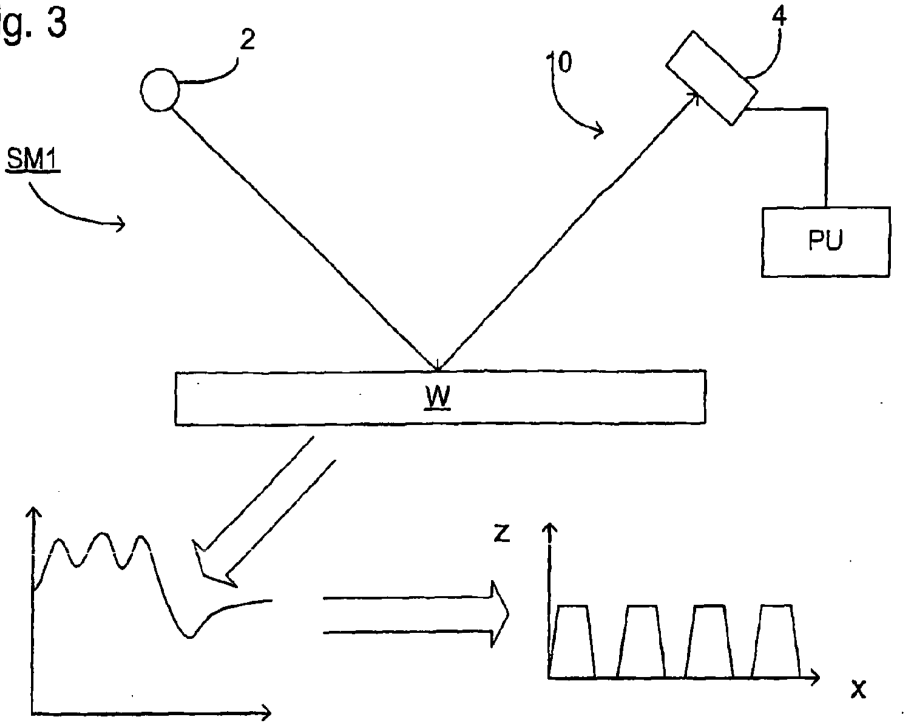

Fig. 4

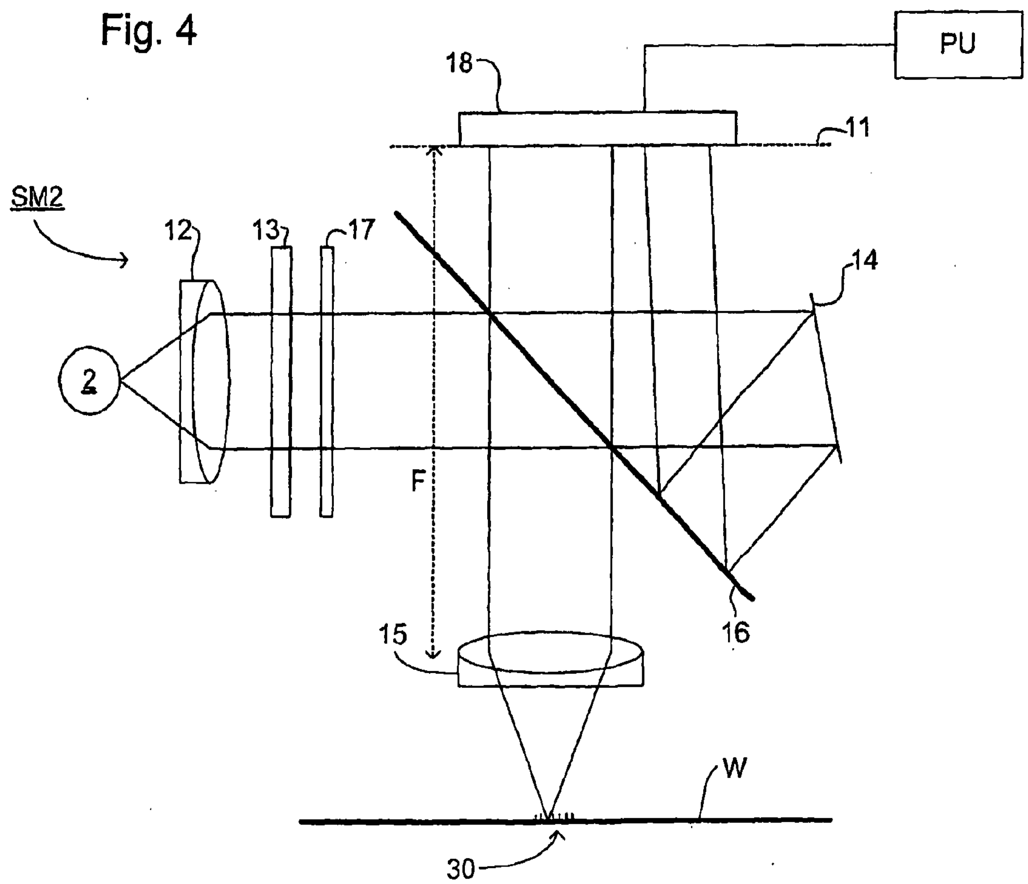

Fig. 5

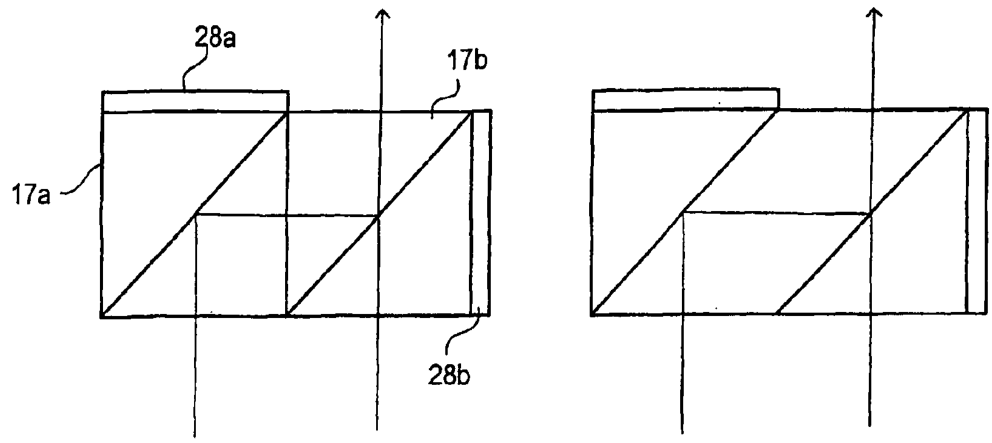

Fig. 6

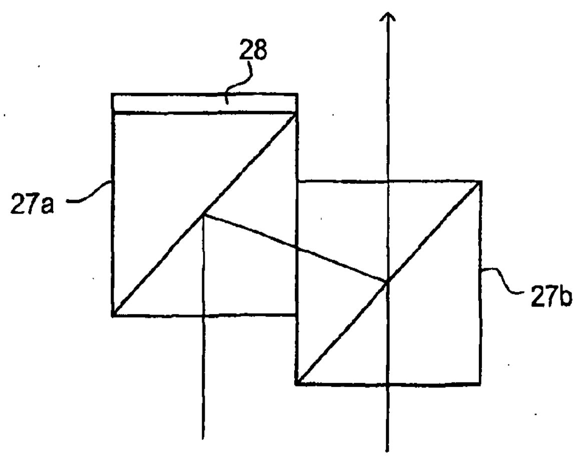

Fig. 7a

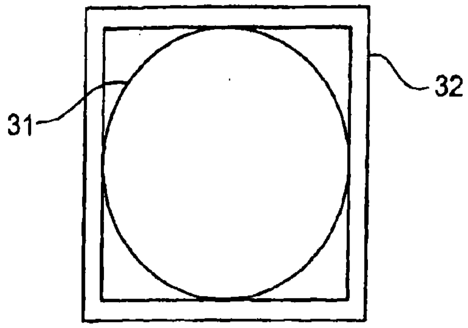

Fig. 7b