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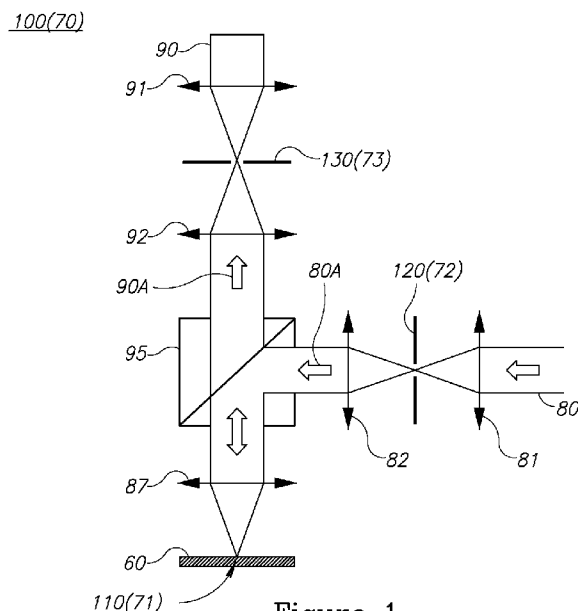


Figure 1

(57) Abstract: Scatterometry metrology systems, targets and methods are provided, which reduce or remove edge diffractions from target diffraction signals. Boundaries of field stops and/or of targets may be designed to be slanted with respect to the measurement directions, to cause edge diffraction to propagate obliquely and thus reduce or remove its effects on the measured target diffraction signals.

ROTATED BOUNDARIES OF STOPS AND TARGETS

CROSS REFERENCE TO RELATED APPLICATIONS

[0001] This application claims the benefit of U.S. Provisional Patent Application No. 62/016,267 filed on June 24, 2014, which is incorporated herein by reference in its entirety.

BACKGROUND OF THE INVENTION

1. TECHNICAL FIELD

[0002] The present invention relates to the field of metrology, and more particularly, to scatterometry metrology optical systems and targets.

2. DISCUSSION OF RELATED ART

[0003] Overlay offset measurement is implemented by an angle resolved scatterometry technology, such as the 4-cell measurement technology. In this arrangement, an illumination radiation is incident on a “grating on grating” target. The target scatters the illumination radiation to form a scattered radiation. A part of the scattered radiation undergoes diffraction by the target. The resulting scattered radiation pattern consists of several diffracted orders, according to the grating equation. This scattered radiation is then collected and analyzed, where the spatial and/or angular distribution of the diffracted light is used to estimate the overlay offset between the layers of the “grating over grating” target.

SUMMARY OF THE INVENTION

[0004] One aspect of the present invention provides a scatterometry metrology system, configured to measure diffraction signals from at least one target having respective at least one measurement direction, the scatterometry metrology system having at least one field stop having edges which are slanted with respect to the at least one measurement direction.

[0005] These, additional, and/or other aspects and/or advantages of the present invention are set forth in the detailed description which follows; possibly inferable from the detailed description; and/or learnable by practice of the present invention.

BRIEF DESCRIPTION OF THE DRAWINGS

[0006] For a better understanding of embodiments of the invention and to show how the same may be carried into effect, reference will now be made, purely by way of example, to the accompanying drawings in which like numerals designate corresponding elements or sections throughout.

[0007] In the accompanying drawings:

[0008] **Figure 1** is a high level illustration of scatterometry metrology system, according to some embodiments of the invention.

[0009] **Figure 2A** is a schematic representation of incoming radiation as viewed at a field equivalent plane at illumination field stop according to the prior art, while **Figure 2B** is a schematic representation of incoming radiation as viewed at a field equivalent plane at the illumination field stop, according to some embodiments of the invention.

[0010] **Figure 3A** is a schematic representation of incident radiation as viewed at the pupil in systems according to the prior art, while **Figure 3B** is a schematic representation of incident radiation as viewed at the pupil in systems according to some embodiments of the invention.

[0011] **Figure 4A** is a schematic representation of radiation incident on target (at a field equivalent plane) in systems according to the prior art, while **Figure 4B** is a schematic representation of radiation incident on targets (at a field equivalent plane) in systems according to some embodiments of the invention.

[0012] **Figure 5A** is a schematic representation of scattered radiation (at a pupil equivalent plane) in systems according to the prior art, while **Figure 5B** is a schematic representation of scattered radiation (at a pupil equivalent plane) in systems according to some embodiments of the invention.

[0013]Figure 6A is a schematic representation of scattered radiation as viewed at a field equivalent plane at the collection field stop according to the prior art, while **Figure 6B** is a schematic representation of scattered radiation as viewed at a field equivalent plane at the collection field stop, according to some embodiments of the invention.

[0014]Figure 7A is a schematic representation of the diffraction signal (at the pupil plane) in systems according to the prior art, while **Figure 7B** is a schematic representation of the diffraction signal (at the pupil plane) in systems according to some embodiments of the invention.

[0015]Figure 8A is a schematic illustration of a target with superimposed edges of a field stop, according to some embodiments of the invention. **Figure 8B** is a schematic illustration of targets according to some embodiments of the invention.

[0016]Figures 9A and 9B schematically illustrates field stop configurations, according to some embodiments of the invention.

[0017]Figure 10 is a high level schematic flowchart illustrating a method, according to some embodiments of the invention.

DETAILED DESCRIPTION OF THE INVENTION

[0018]Prior to the detailed description being set forth, it may be helpful to set forth definitions of certain terms that will be used hereinafter.

[0019]The terms "metrology target", "scatterometry target" or "target" as used herein in this application, are defined as structures designed or produced on a wafer which are used for metrological purposes such as scatterometry overlay (SCOL) measurements. The terms "metrology measurement" or "measurement" as used herein in this application, are defined as any metrology procedure used to extract information such as diffraction signals from metrology targets. The term "periodic structure" as used in this application refers to any kind of designed or produced structure in at least one layer which exhibits some periodicity. The term "measurement direction" as used in this application refers to the direction along which the periodic structure is periodic. For example, the measurement direction

of a grating as the periodic structure is perpendicular to the target elements which constitute the grating. Targets may have more than one measurement direction, for example two perpendicular measurement directions

[0020] With specific reference now to the drawings in detail, it is stressed that the particulars shown are by way of example and for purposes of illustrative discussion of the preferred embodiments of the present invention only, and are presented in the cause of providing what is believed to be the most useful and readily understood description of the principles and conceptual aspects of the invention. In this regard, no attempt is made to show structural details of the invention in more detail than is necessary for a fundamental understanding of the invention, the description taken with the drawings making apparent to those skilled in the art how the several forms of the invention may be embodied in practice.

[0021] Before at least one embodiment of the invention is explained in detail, it is to be understood that the invention is not limited in its application to the details of construction and the arrangement of the components set forth in the following description or illustrated in the drawings. The invention is applicable to other embodiments or of being practiced or carried out in various ways. Also, it is to be understood that the phraseology and terminology employed herein is for the purpose of description and should not be regarded as limiting.

[0022] Scatterometry metrology systems, targets and methods are provided, which reduce or remove edge diffractions from target diffraction signals. Boundaries of field stops and/or of targets may be designed to be slanted with respect to the measurement directions, to cause edge diffraction to propagate obliquely and thus reduce or remove its effects on the measured target diffraction signals.

[0023] Embodiments of the disclosed invention overcome the following limitations of the prior art. As actual targets are finite, the incident illumination is diffracted by both the grating structure (grating diffraction) and by the boundaries of the grating structure (edge diffraction). Grating diffraction is desired, as it

provides information on the grating, while edge diffraction is undesired because it interferes with the grating diffraction and decreases the usable grating diffraction signal. The mechanism of performance deterioration is as follows: Edge diffraction manifests itself in the pupil plane, as a convolution of the grating-diffracted light with a pattern associated with the edge diffraction. The effects of all the edge diffraction in the optical system contributes to the system's Point Spread Function (PSF) and specifically may make PSF more spatially extended. Effectively this means that some of the grating diffracted radiation is further diffracted by the edge diffraction, possibly overlapping with different orders of the grating diffracted radiation. This phenomenon degrades the performance of an angle resolved scatterometer.

[0024] Furthermore, the edge diffraction mixes light from different orders of the grating diffraction pattern. The details of this mixing depend strongly on measurement parameters (such as element position, target orientation etc.). It follows then that measurement instabilities result in stronger loss of repeatability when edge diffraction is present. Additionally, the edge diffraction can be asymmetric with respect to the target grating. As a scatterometry overlay measurement makes use of symmetry properties of the target and the tool, such an asymmetric contribution will result in an accuracy error.

[0025] Specifically in overlay measurements, edge diffraction may lead to loss of performance and accuracy by any of the following mechanisms: (i) Mixing light from different orders, which is not accounted for by the overlay algorithm; (ii) mixing the light in an asymmetric way, which can register as an overlay; (iii) the overlay 's high sensitivity to position leads through positioning variation to loss in repeatability; and (iv) specifically in 4-cell scatterometry, diffraction mixes zero order into the first order light in two ways, namely a DC contribution proportional to the intensity of the zero order and an AC contribution proportional to both to the zero order field amplitude, and the first order field amplitude.

[0026] As different diffraction orders "cross-talk" by diffraction, providing a source of performance and accuracy loss, and as the diffraction is primarily from the

edge of the target (e.g., the edge of a target cell), field stops and pupil stops in the optical path in the tool, the present invention which changes, or rotates, the diffracting elements (cell boundaries, field stops and pupil stops), directs thereby the diffraction away from regions of interest and reduce the interruptions to accurate measurement of the diffraction signal originating from the actual target. It is emphasized that embodiments may modify at least one of the target edges, edges of any of the field stops in the system and edges pupil stops (at an incoming radiation pupil plane and/or at a scattered radiation pupil plane), either of the latter by modifying corresponding apertures.

[0027]Figure 1 is a high level illustration of scatterometry metrology system **100**, according to some embodiments of the invention. The illustration concentrates on the optics and target in system **100** and is non-limiting with respect to other parts of system **100** (e.g., light sources and detectors) nor with respect to the specifically illustrated elements. **Figure 1** illustrates field stops **120**, **130** and target **110** as exemplary elements at the field plane of the system's optics, yet the invention may be extended to other elements located at the field plane of system **100**. Prior art optical systems **70** are characterized by prior art field stops **72**, **73** (at optical positions which are equivalent to field stops **120**, **130**) and targets **71**.

[0028]Figure 1 is a schematic of the optical head of an angle resolved scatterometer as a non-limiting example for scatterometry metrology system **100**. Collimated incoming radiation **80** is focused by a lens **81** to an illumination field stop **120** and then collimated by a lens **82** and directed as incident radiation **80A** by a beam splitter **95** over a focusing lens **87** to a field target **110** on a wafer 60. The scattered light from target **110** is collected by lens **87**, directed by beam splitter **95** as outgoing radiation **90A** and focused by a lens **92** to a collection field stop **130**, and then collimated again by lens **91** to form the scattered radiation **90** collected by the sensor (as an example for pupil plane imaging used in scatterometry). It is noted that illumination field stop **120**, target **110** and collection field stop **130** are all in field planes, while the incoming radiation **80**

and scattered radiation **90** may be handled with respect to a pupil plane in each corresponding section. Specifically, diffraction by field stops **120**, **130** and by target **110** spatially translates scattered radiation **90** in the pupil plane.

[0029] The inventors note that as the optical field stops limit the spatial extent of the radiation in the field planes. The target has a finite extent and a border to separate it from its surroundings. Both the optical field stops and the target introduce edge diffraction which are undesirable. The inventors have found out that certain arrangements of the field stops and/or of the target edges reduce the interruptions caused by edge diffraction.

[0030] In certain embodiments, in optical stop arrangements, e.g., having opaque optical stop with a square radiation transmission area, the square opening may be rotated relative to the grating direction. In general, the term “edge diffraction” is used to refer to diffraction come from either step-like edges, or from smooth, or gradual edges. Disclosed embodiments may be applicable to any type of edge and the examples given for step-like edge are not limiting in this sense, but are used merely as they are visualized better. Certain embodiments may be applied to soft edges which introduce a few more degrees of freedom (e.g., the direction and steepness of the edge gradient) which may be taken into account in the reconfiguration of the corresponding stop edges according to the disclosed principle that light diffracts stronger along the direction in which it is stronger constrained.

[0031] It is noted that certain embodiments comprise, in addition or in place of reducing the effects of edge diffraction for a given stop area, decreasing the stop area while keeping the edge diffraction fixed (with reference to one or more stops in the system). For example, the target itself, acting as a stop; the collection field stop may be made smaller to block more undesired light, like ghost images, from being collected; and the illumination field stop may be made smaller to eliminate unwanted light, like ghost images, from being directed to the target.

[0032] In order to exemplify, in a non-limiting manner, the structure and functioning of certain embodiments, the following pairs of figures illustrate a comparison

between prior art systems **70** and system **100** at different locations along the optical path of the radiation.

[0033] **Figure 2A** is a schematic representation of incoming radiation **80** as viewed at a field equivalent plane at illumination field stop **72** according to the prior art, while **Figure 2B** is a schematic representation of incoming radiation **80** as viewed at a field equivalent plane at illumination field stop **120**, according to some embodiments of the invention. In a non-limiting manner, **Figure 2B** illustrates a square optical field stop which is rotated with respect to prior art field stops, causing edge diffractions to propagate at an angle with respect to the horizontal and vertical axes of the pupil plane which are the target measurement directions.

[0034] Certain embodiments comprise a scatterometry metrology system **100**, configured to measure diffraction signals **90** from at least one target **71** and/or **110** having respective at least one measurement direction (e.g., x , y). While in prior art systems **70**, illumination field stop **72** has edges **75** which are perpendicular to target **71**'s measurement directions (x , y), scatterometry metrology system **100** has at least one field stop (e.g., illumination field stop **120**) having edges **121**, **122** which are slanted (e.g., x_1 , y_1) with respect to the at least one measurement direction (x , y).

[0035] **Figure 3A** is a schematic representation of incident radiation **80A** as viewed at the pupil plane (objective pupil, log intensity, simulated radiation intensity pattern) in systems **70** according to the prior art, while **Figure 3B** is a schematic representation of incident radiation **80A** as viewed at the pupil plane (objective pupil, log intensity, simulated radiation intensity pattern) in systems **100**, according to some embodiments of the invention. It is noted that while in prior art systems **70** edge diffraction patterns **83** are formed perpendicularly to stop edges **75** in measurement directions (x, y), in systems **100** edge diffraction patterns **118** are slanted with respect to measurement directions (x, y) as they are perpendicular to slanted stop edges **121**, **122** and hence at directions (x_1, y_1) for rectangular stops **120** (as a non-limiting example).

[0036] **Figure 4A** is a schematic representation of radiation **80A** incident on target **71** (at a field equivalent plane) in systems **70** according to the prior art, while **Figure 4B** is a schematic representation of radiation **80A** incident on target **71** or **110** (at a field equivalent plane) in systems **100**, according to some embodiments of the invention. In the illustrated non-limiting example, target **71** or **110** comprises a periodic structure in one direction (x) having a corresponding measurement direction. Edges **75** of illumination stop **72** and edges **121**, **122** of illumination stop **120** determine the spatial extent of incident illumination **80A**, and emphasize the oblique configuration of edge verticals x_1 , y_1 with respect to target measurement direction's x , y .

[0037] **Figure 5A** is a schematic representation of scattered radiation **90A** (at a pupil equivalent plane) in systems **70** according to the prior art, while **Figure 5B** is a schematic representation of scattered radiation **90A** (at a pupil equivalent plane) in systems **100**, according to some embodiments of the invention. It is clear that while in prior art systems **70** edge diffraction patterns **73** in measurement direction x interfere with a diffraction signal **76** from target **71** (e.g., shown are diffractions orders 0 , ± 1), in systems **100** edge diffraction patterns **113** are slanted (in directions x_1 , y_1) with respect to measurement direction x and interfere more weakly with a diffraction signal **116** from target **71** or **110** (e.g., shown are diffractions orders 0 , ± 1). Clearly, similar considerations are applicable to targets **71**, **110** with two (or more) measurement directions x , y .

[0038] **Figure 6A** is a schematic representation of scattered radiation **90A** as viewed at a field equivalent plane at collection field stop **73** according to the prior art, while **Figure 6B** is a schematic representation of scattered radiation **90A** as viewed at a field equivalent plane at collection field stop **130**, according to some embodiments of the invention.

[0039] Certain embodiments comprise a scatterometry metrology system **100**, configured to measure diffraction signals **90** from at least one target **71** and/or **110** having respective at least one measurement direction (e.g., x , y). While in prior art systems **70**, collection field stop **73** has edges **74** which are

perpendicular to target **71**'s measurement directions (x, y) , scatterometry metrology system **100** has at least one field stop (e.g., collection field stop **130**) having edges **131**, **132** which are slanted (e.g., x_2, y_2) with respect to the at least one measurement direction (x, y) . Edges **131**, **132** of collection field stop **130** may be slanted similarly to edges **121**, **122** of illumination field stop **120** ($x_1, y_1 = x_2, y_2$) or stop edges may be slanted differently ($x_1, y_1 \neq x_2, y_2$). It is noted that edges of either or both stops **120**, **130** may be slanted (**Figure 6B** illustrates the latter case in as a non-limiting example).

[0040] **Figure 7A** is a schematic representation of diffraction signal **90** (at the pupil plane) in systems **70** according to the prior art, while **Figure 7B** is a schematic representation of diffraction signal **90** (at the pupil plane) in systems **100**, according to some embodiments of the invention. While in prior art systems **70** edge diffraction patterns **79** in measurement direction x interfere with a diffraction signal **76** from target **71** (e.g., shown are diffractions orders $0, \pm 1$), in systems **100** edge diffraction patterns **119** are slanted (in directions $x_1, y_1 = x_2, y_2$ in the illustrated example, possibly in other patterns when edge directions differ) with respect to measurement direction x and interfere more weakly with a diffraction signal **116** from target **71** or **110** (e.g., shown are diffractions orders $0, \pm 1$). Clearly, similar considerations are applicable to targets **71**, **110** with two (or more) measurement directions x, y , as seen in **Figure 7B** at the vertical measurement direction (y) with respect to diffraction signals **116**.

[0041] It is noted that the rotated square stop may be implemented in the illumination path of the measurement device and/or in the collection path of the measurement device. Both implementations are independently beneficial, and the combination of the two rotated square stops (illumination and collection field stops) combines the benefits of the individual implementations.

[0042] The angle between field stop edges (any of **121**, **122**, **131**, **132**) and the measurement directions (any of x, y) may be between 30° - 60° , and in certain embodiments, such as rotated rectangular stops for measuring targets with two perpendicular measurement directions, may comprise 45° . It is noted that for

small illumination radii and/or for larger distances between orders than illustrated, smaller angles than 30° or larger angles than 60° may suffice to reduce or remove the effects of edge diffraction on the measured target diffraction signals by propagating the edge diffraction obliquely. For example, angles as small as 20° , 10° , 5° or in certain cases even 1° , as well as intermediate values and complementary values to 90° (i.e., 70° , 80° , 85° , 89°) may be applied to edged elements in the optical system.

[0043] **Figure 8A** is a schematic illustration of target **71** with superimposed edges of a field stop **120** and/or **130**, according to some embodiments of the invention. The field stop is slanted, or rotated, with respect to the direction of spatial periodicity of target **71**, i.e., measurement direction x . **Figure 8B** is a schematic illustration of target **110**, according to some embodiments of the invention. While the direction of spatial periodicity of target **110**, i.e., measurement direction x , is horizontal in **Figure 8B**, target edges **111**, **112** are slanted (along directions x_3 , y_3) with respect to measurement direction x . Certain embodiments of scatterometry metrology target **110** have at least one periodic structure along at least one respective measurement direction, wherein edges **111**, **112** of target **110** are slanted with respect to the at least one measurement direction. For example, target edges **111**, **112** may form a rectangle rotated at 30° - 60° from the at least one measurement direction (x and/or y). In a non-limiting example, target edges **111**, **112** may form a rectangle rotated at 45° from the at least one measurement direction. As explained above, depending on the configuration of the illumination spots and diffraction orders, rotations may be carried out at a wider range of angles, eventually extending between 1° - 89° .

[0044] Target edges **111**, **112** may be slanted at a same or at a different angle to the measurement direction(s) as edges **121**, **122** of illumination pupil **120** and/or edges **131**, **132** of collection pupil **130** ($x_3, y_3 =$ or $\neq x_1, y_2$ and/or x_2, y_2). Target boundaries may be arranged, relative to the grating direction, such that diffraction from the target edges, which propagates to a region of interest in the pupil plane, is diminished. For example, target boundaries may be rotated with respect to the

grating measurement directions. As the edge diffraction is directed in perpendicular to the target edges, and extends further in that direction, for targets with rotated edges, the edge diffractions propagate at an angle to the x and y axes of the pupil plane. The effect thus created is similar to the effects of rotated field stop illustrated in **Figure 3B**, **5B** and **7B** and may, furthermore, enhanced thereby. The implementations of the rotated square stop as an optical field stop and the rotated target boundary as the target boundary may be realized independently. Both implementations are independently beneficial, and the combination of rotated square stops (at illumination and/or collection field stops **120**, **130** respectively) and the rotated target boundary combines the benefits of the individual implementations.

[0045] Certain embodiments comprise scatterometry metrology system **100** wherein edges of at least one target **110** are slanted with respect to the at least one measurement direction. Certain embodiments comprise target design files of scatterometry metrology targets **110** described herein. Certain embodiments comprise scatterometry metrology measurements by scatterometry metrology system **100** described herein and/or scatterometry metrology measurements of scatterometry metrology targets **110** described herein.

[0046] In certain embodiments, scatterometry metrology system **100** may comprise a correction module (not shown) configured to correct measured scatterometry signals from at least one target **110** using measured diffraction signals of at least one field stop **120**, **130**.

[0047] Edges **121**, **122**, **131**, **132** of stops **120**, **130** (respectively) may be configured to limit illumination **80** to target boundaries **111**, **112**. In certain embodiments, stops **120**, **130** and target **110** may have congruent edges (when considering the intermediate optical elements such as lenses **82**, **87**, **92**).

[0048] **Figures 9A** and **9B** schematically illustrates field stop configurations, according to some embodiments of the invention. **Figure 9A** schematically illustrates an opaque disc with a rotated square aperture **125** and respective X and Y cross sections illustrating the maximal extent of aperture **125** in

measurement directions x, y. **Figure 9B** schematically illustrates a mirror **126** which may be shaped as a rotated square and positioned to reflect a portion of incoming radiation **80** to yield incident radiation **80A** as a formed beam similar to one passing through aperture **125** and having boundaries as disclosed herein. Other, not illustrated embodiments of stops **120**, **130** comprise a diffracting element arranged such that a straight edge is directed at an angle relative to the direction to the center of a region of interest (e.g., with a rectangular effective aperture shape).

[0049] **Figure 10** is a high level schematic flowchart illustrating a method **200**, according to some embodiments of the invention.

[0050] Method **200** may comprise a scatterometry metrology method comprising designing, in a scatterometry metrology system for measuring at least one scatterometry metrology target having at least one periodic structure along at least one respective measurement direction, edges of at least one of: at least one field stop in the system and the at least one target, to be slanted with respect to the at least one measurement direction. Method **200** may comprise designing field stop edge(s) to be slanted with respect to measurement direction(s) (stage **210**) and/or designing target edge(s) to be slanted with respect to measurement direction(s) (stage **250**).

In certain embodiments, method **200** comprises designing the field stop(s) edges to be rotated at 30°-60° (e.g., 45°) from the at least one measurement direction, e.g., to form a rectangle (stage **220**). In certain embodiments, method **200** comprises designing the target circumference to be rotated at 30°-60° (e.g., 45°) from the at least one measurement direction, e.g., to form a rectangle (stage **260**), specifically, while maintaining the target's measurement direction(s) (directions of periodicity) (stage **280**). As explained above, depending on the configuration of the illumination spots and diffraction orders, rotations may be carried out at a wider range of angles, eventually extending between 1°-89°.

[0051] Method **200** may further comprise producing and/or using the field stop(s) in a scatterometry metrology system (stage **230**) and/or producing and/or using the target for scatterometry metrology measurements (stage **270**).

[0052] Method **200** may further comprise measuring scatterometry signals of the at least one scatterometry metrology target by the scatterometry metrology system (stage **290**) and/or measuring diffraction signals of the at least one field stop and correcting the measured scatterometry signals accordingly (stage **300**).

[0053] The inventors note, that rotating the target boundaries while maintaining the spatial periodicity direction of the target and hence measurement direction, is different from prior art proposals such as disclosed in U.S. Patent Publication No. 2011/0194092, which rotate the actual target grating and raise thus a large number of applicative problems. In contrast to U.S. Patent Publication No. 2011/0194092, embodiments of the present invention maintain the direction target periodicity and modify field stop boundaries and/or target boundaries rather than the target periodicity itself. The inventors have found out that the proposed approach is at least as effective and much more practicable. Specifically, in modern lithography processes the optimal direction of the grating is dictated by the lithography illumination pattern. Typically a dipole or quadupole illumination is used to minimize the critical dimension of the structures, and the grating direction is fixed by the choice of illumination. Hence, as the disclosed invention does not alter the grating direction, but instead modifies the target boundaries, it is therefore, unlike the prior art, process-compatible and results in better produced grating targets while mitigating the effect of target and stops edge diffractions.

[0054] In the above description, an embodiment is an example or implementation of the invention. The various appearances of "one embodiment", "an embodiment", "certain embodiments" or "some embodiments" do not necessarily all refer to the same embodiments.

[0055] Although various features of the invention may be described in the context of a single embodiment, the features may also be provided separately or in any

suitable combination. Conversely, although the invention may be described herein in the context of separate embodiments for clarity, the invention may also be implemented in a single embodiment.

[0056] Certain embodiments of the invention may include features from different embodiments disclosed above, and certain embodiments may incorporate elements from other embodiments disclosed above. The disclosure of elements of the invention in the context of a specific embodiment is not to be taken as limiting their use in the specific embodiment alone.

[0057] Furthermore, it is to be understood that the invention can be carried out or practiced in various ways and that the invention can be implemented in certain embodiments other than the ones outlined in the description above.

[0058] The invention is not limited to those diagrams or to the corresponding descriptions. For example, flow need not move through each illustrated box or state, or in exactly the same order as illustrated and described.

[0059] Meanings of technical and scientific terms used herein are to be commonly understood as by one of ordinary skill in the art to which the invention belongs, unless otherwise defined.

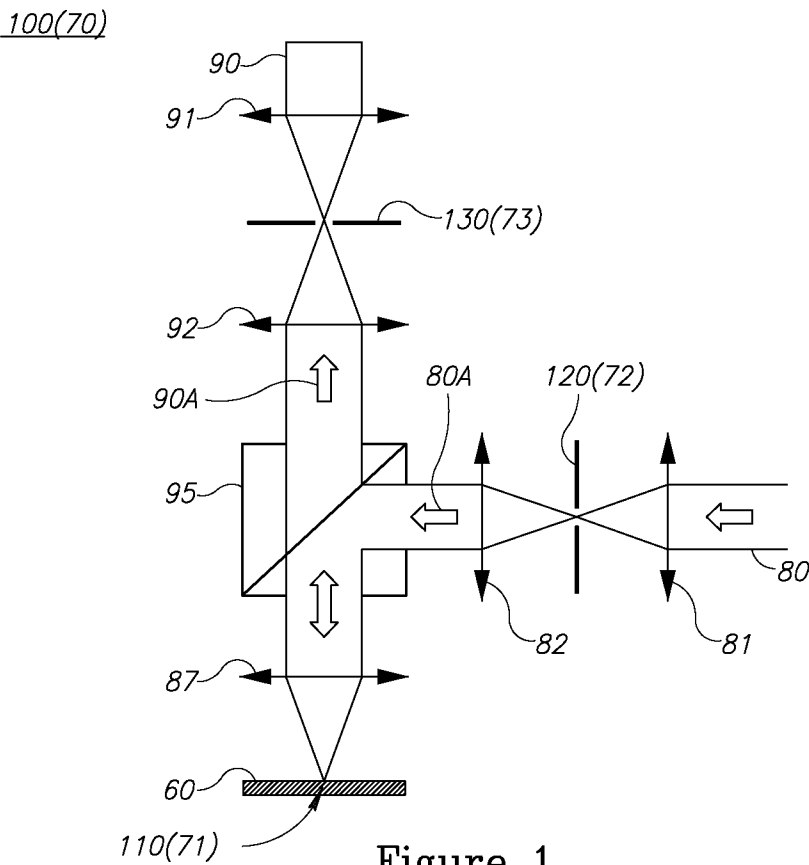
[0060] While the invention has been described with respect to a limited number of embodiments, these should not be construed as limitations on the scope of the invention, but rather as exemplifications of some of the preferred embodiments. Other possible variations, modifications, and applications are also within the scope of the invention. Accordingly, the scope of the invention should not be limited by what has thus far been described, but by the appended claims and their legal equivalents.

CLAIMS

What is claimed is:

1. A scatterometry metrology system, configured to measure diffraction signals from at least one target having respective at least one measurement direction, the scatterometry metrology system having at least one field stop having edges which are slanted with respect to the at least one measurement direction.
2. The scatterometry metrology system of claim 1, wherein the at least one field stop comprises at least one of an illumination field stop and a collection field stop.
3. The scatterometry metrology system of claim 1, wherein the edges of the at least one field stop form a rectangle rotated at 30° - 60° from the at least one measurement direction.
4. The scatterometry metrology system of claim 1, wherein the edges of the at least one field stop form a rectangle rotated at 45° from the at least one measurement direction.
5. The scatterometry metrology system of claim 1, wherein edges of the at least one target are slanted with respect to the at least one measurement direction.
6. The scatterometry metrology system of claim 1, further comprising a correction module configured to correct measured scatterometry signals from the at least one target using measured diffraction signals of the at least one field stop.
7. Scatterometry metrology measurements by the scatterometry metrology system of any one of claims 1-6.
8. A scatterometry metrology target having at least one periodic structure along at least one respective measurement direction, wherein edges of the target are slanted with respect to the at least one measurement direction.
9. The scatterometry metrology target of claim 8, wherein the target edges form a rectangle rotated at 30° - 60° from the at least one measurement direction.

10. The scatterometry metrology target of claim 8, wherein the target edges form a rectangle rotated at 45° from the at least one measurement direction.
11. Target design files of the scatterometry metrology targets of any one of claims 8-10.
12. Scatterometry metrology measurements of the scatterometry metrology target of any one of claims 8-10.
13. A scatterometry metrology method comprising designing, in a scatterometry metrology system for measuring at least one scatterometry metrology target having at least one periodic structure along at least one respective measurement direction, edges of at least one of: at least one field stop in the system and the at least one target, to be slanted with respect to the at least one measurement direction.
14. The method of claim 13, further comprising designing the edges to form a rectangle rotated at 30° - 60° from the at least one measurement direction.
15. The method of claim 13, further comprising designing the edges to form a rectangle rotated at 45° from the at least one measurement direction.
16. The method of claim 13, further comprising measuring scatterometry signals of the at least one scatterometry metrology target by the scatterometry metrology system.
17. The method of claim 16, further comprising measuring diffraction signals of the at least one field stop and correcting the measured scatterometry signals accordingly.



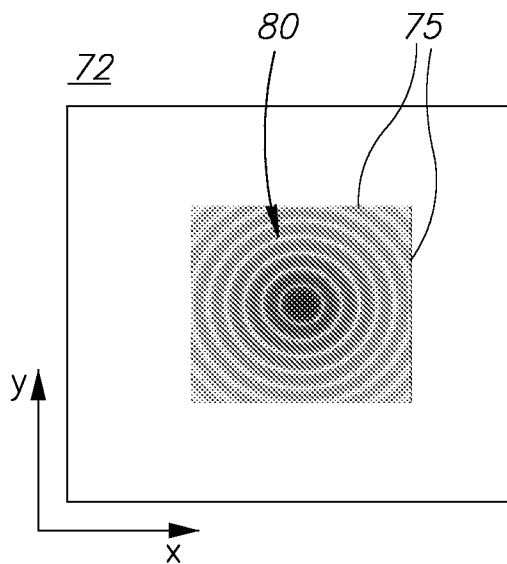


Figure 2A

PRIOR ART

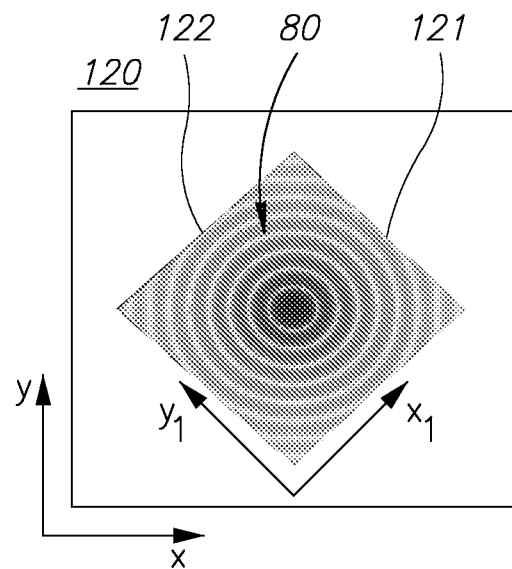


Figure 2B

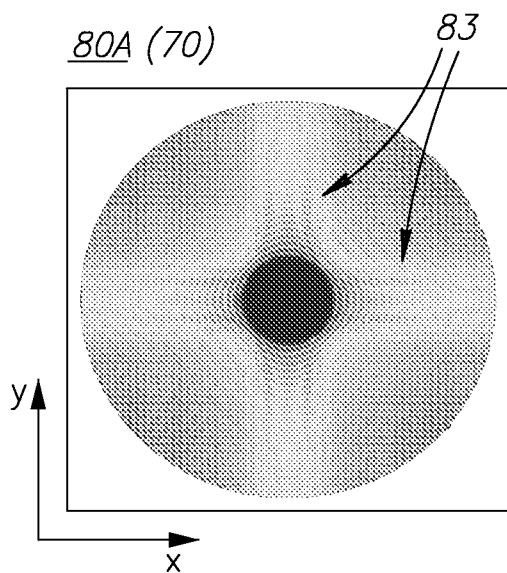


Figure 3A

PRIOR ART

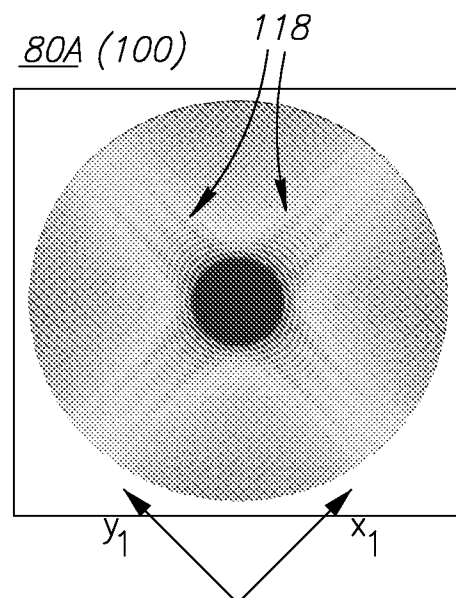


Figure 3B

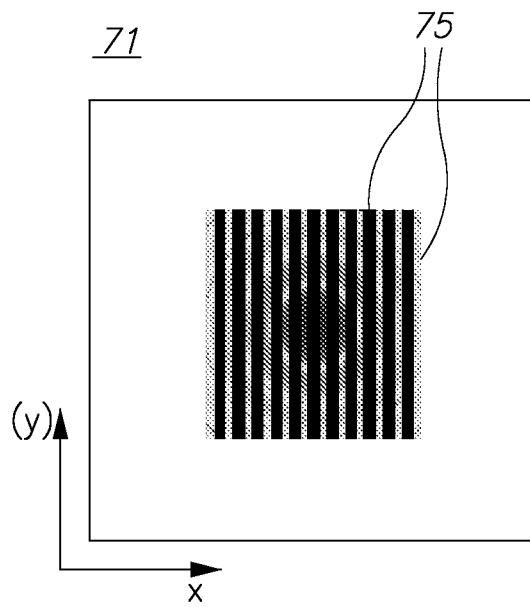


Figure 4A
PRIOR ART

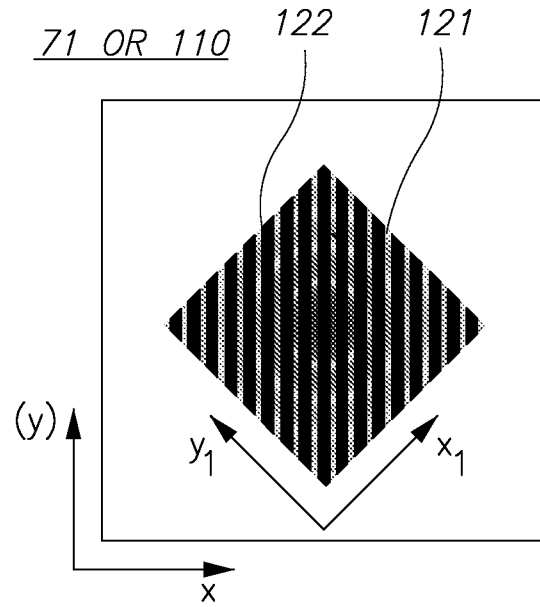


Figure 4B

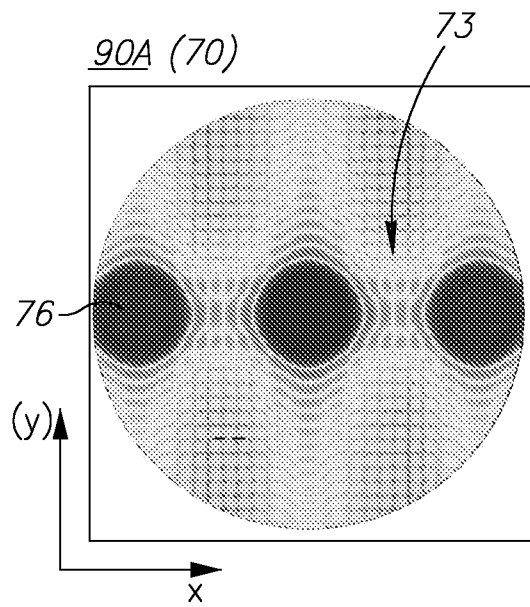


Figure 5A
PRIOR ART

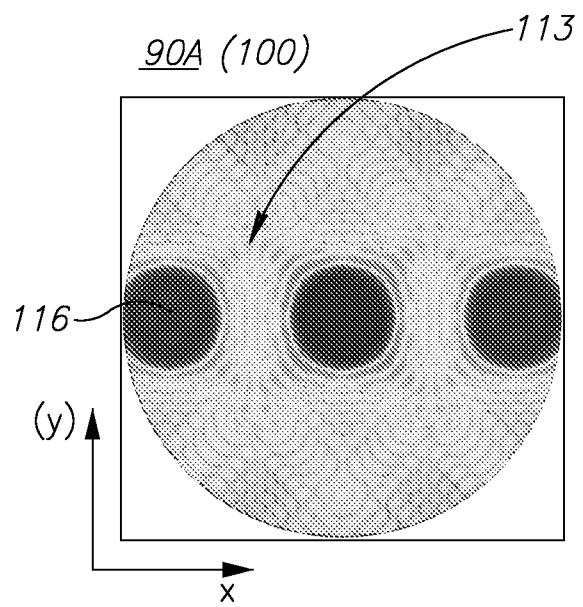


Figure 5B

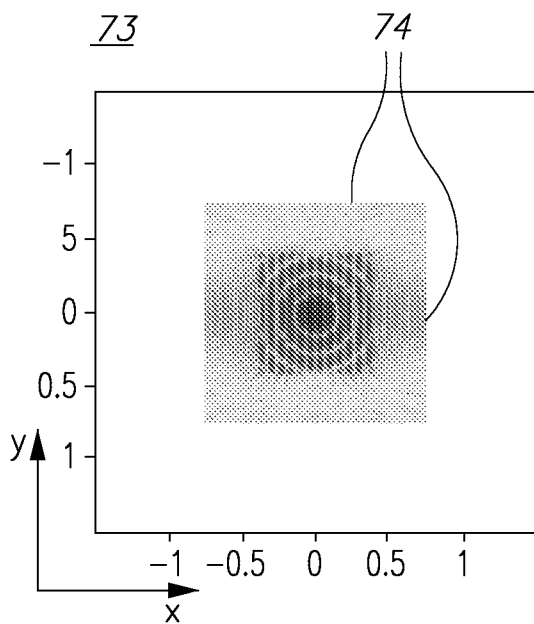


Figure 6A

PRIOR ART

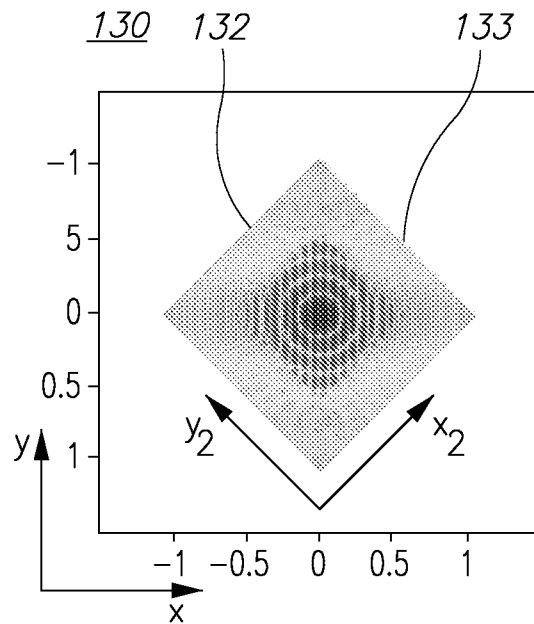


Figure 6B

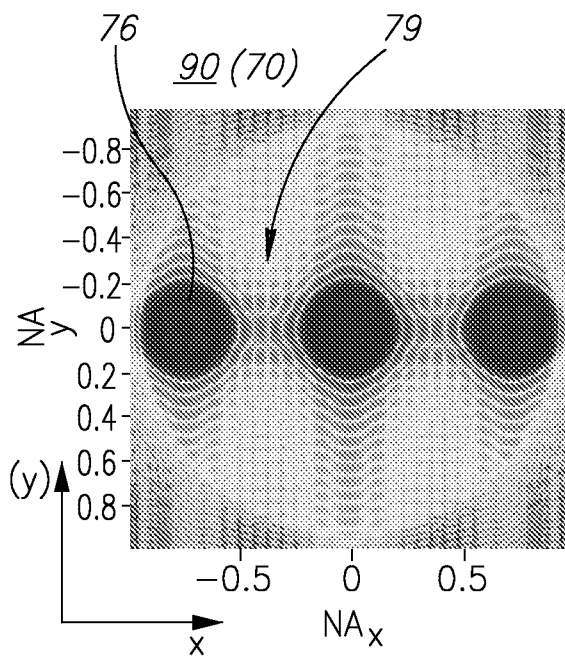


Figure 7A

PRIOR ART

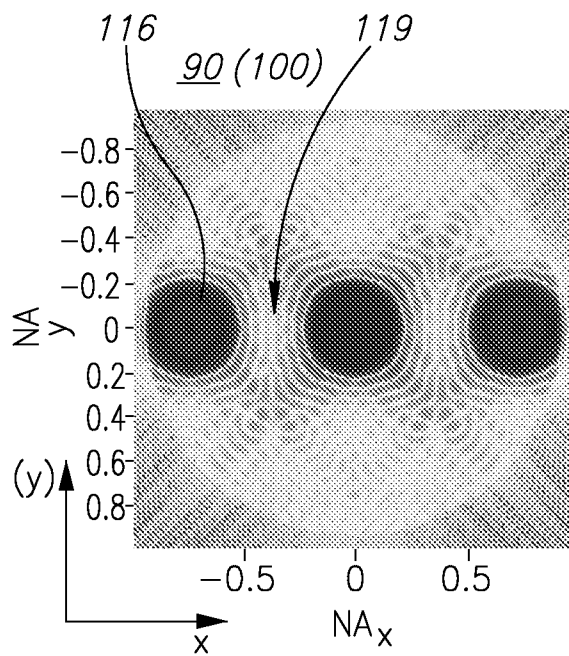


Figure 7B

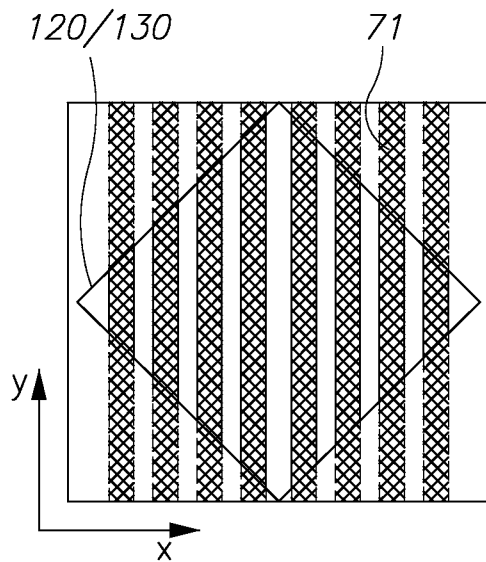


Figure 8A

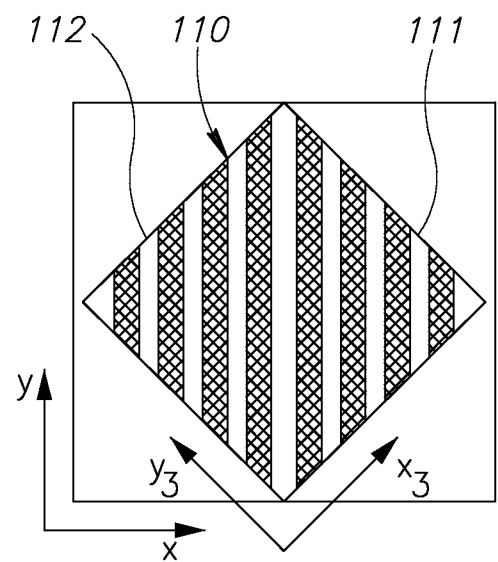


Figure 8B

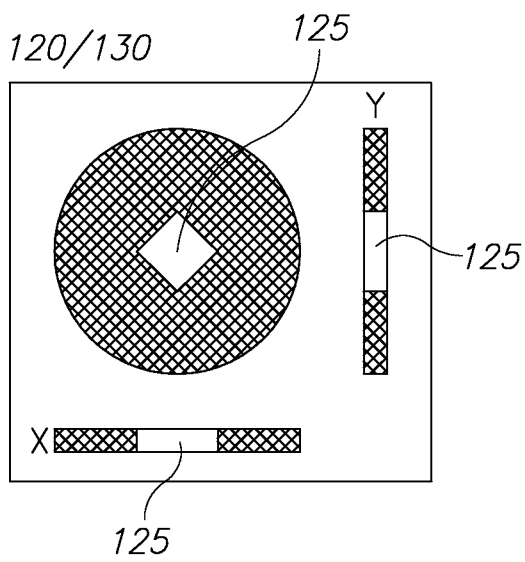


Figure 9A

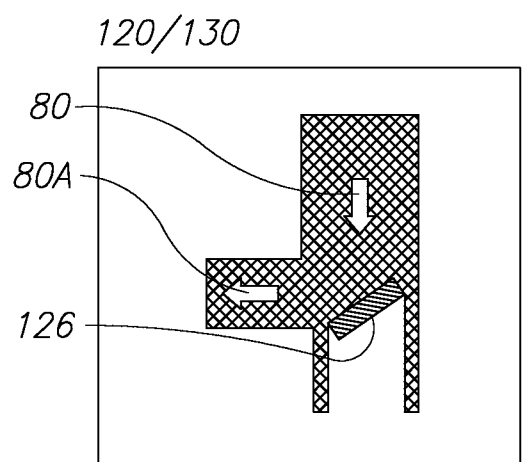


Figure 9B

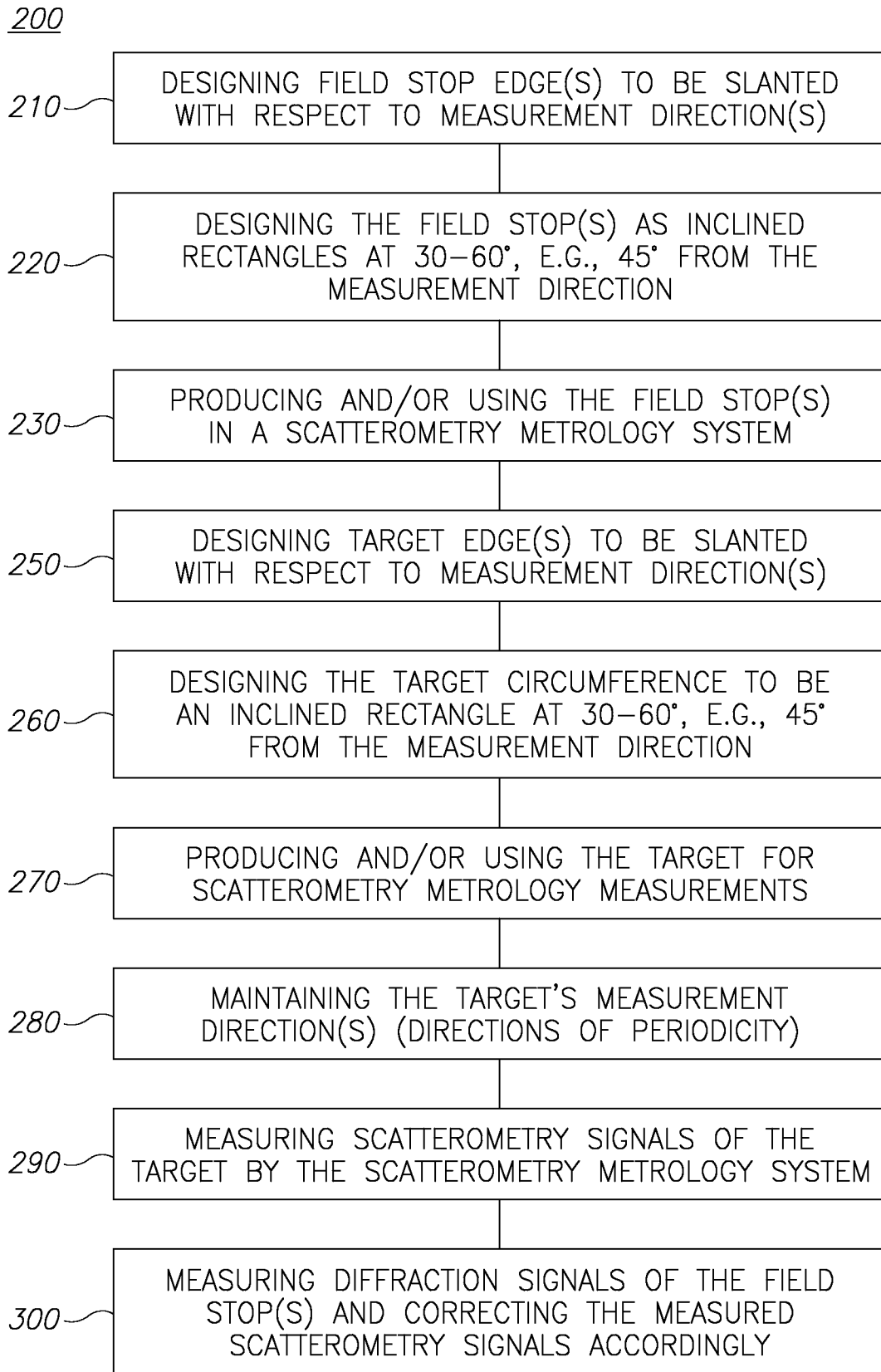


Figure 10

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2015/037167**A. CLASSIFICATION OF SUBJECT MATTER****H01L 21/66(2006.01)i**

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)

H01L 21/66; H01L 21/027; G03F 1/08; G01B 11/02; G02B 5/18; G02B 5/23; H05K 3/00; G01B 11/00

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

Korean utility models and applications for utility models

Japanese utility models and applications for utility models

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

eKOMPASS(KIPO internal) & Keywords: scatterometry, target, field stop, slant

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2002-0060793 A1 (TATSUO FUKUI) 23 May 2002	1-4, 6-7
Y	See abstract, paragraphs [0034]-[0066] and figures 1-4B.	5, 13-17
X	JP 2005-175270 A (NIKON CORP.) 30 June 2005	8-12
Y	See abstract, paragraphs [0013]-[0043] and figures 1-6.	5, 13-17
A	US 2009-0262362 A1 (PETER DE GROOT et al.) 22 October 2009	1-17
	See abstract, paragraphs [0054]-[0077] and figures 1-7B.	
A	US 2009-0279091 A1 (VLADIMIR LEVINSKI et al.) 12 November 2009	1-17
	See abstract, paragraphs [0034]-[0065] and figures 1A-7.	
A	US 2011-0075238 A1 (HARRY SEWELL et al.) 31 March 2011	1-17
	See abstract, paragraphs [0055]-[0060] and figure 2A-2E.	



Further documents are listed in the continuation of Box C.



See patent family annex.

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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

14 October 2015 (14.10.2015)

Date of mailing of the international search report

14 October 2015 (14.10.2015)

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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.

PCT/US2015/037167

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US 2011-0075238 A1	31/03/2011	JP 2010-251746 A JP 4943530 B2 NL 2004365 A US 8625096 B2	04/11/2010 30/05/2012 12/10/2010 07/01/2014