[0013] Figures 3A-3B are high level schematic illustrations of a corresponding optical system, according to some embodiments of the invention.

[0014] Figures 4A-4C are high level schematic illustrations of optical systems for simultaneous measurement of multiple focus positions, according to some embodiments of the invention.

[0015] Figure 5A is a high level schematic illustration of polarization control targets, according to some embodiments of the invention.

[0016] Figure 5B is a high level schematic illustration of an optical system, according to some embodiments of the invention.

[0017] Figure 6 is a high level schematic illustration of an optical system, according to some embodiments of the invention.

[0018] Figure 7 is a high level schematic illustration of contrast functions as criteria for topographic phase control, according to some embodiments of the invention.

[0019] Figure 8 is a high level schematic illustration of diffraction orders in typical diffraction based overlay (DBO) metrology, according to some embodiments of the invention.

[0020] Figure 9 is a high level schematic illustration of a SCOL target with auxiliary cells, measured by a metrology tool, according to some embodiments of the invention.

Figure 10 is a high level flowchart illustrating a method for an optical system, according to some embodiments of the invention.

DETAILED DESCRIPTION OF THE INVENTION

[0021] In the following description, various aspects of the present invention are described. For purposes of explanation, specific configurations and details are set forth in order to provide a thorough understanding of the present invention. However, it will also be apparent to one skilled in the art that the present invention may be practiced without the specific details presented herein. Furthermore, well known features may have been omitted or simplified in order not to obscure the present invention. With specific reference to the drawings, it is stressed that the particulars shown are by way of example and for purposes of illustrative discussion 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

and sufficiently narrow illumination bandwidth, the cancelation of topographic phases that are responsible for sensitivity of the measurements to process variations.

[0053] **Figures 4A-4C** are high level schematic illustrations of optical systems **110** for simultaneous measurement of multiple focus positions, according to some embodiments of the invention. **Figure 4A** is a high level schematic illustration of an imaging metrology tool **85** having optical system **110** and a calibration module **112** associated therewith, and possibly operated by one or more processor(s) (see **Figure 9**).

[0054] Calibration module **112** may be configured to derive a dependency of an overlay error magnification on a level of defocusing and optical system **110** may be configured to operate at a narrow spectral range, $\Delta\lambda \leq 10$nm, at a narrow illumination numerical aperture, $NA \leq 0.1$, and at a focus position that corresponds to zero overlay error magnification according to the derived dependency (see approach (ii) above).

[0055] Optical system **110** may be, alternatively or complementarily, configured to grab a plurality of metrology target images at a corresponding plurality of focus positions, and calibration module **112** may be configured to estimate an inaccuracy magnification factor of the grabbed images and determine a best contrast position by identifying a sign change of the inaccuracy magnification factor with respect to the focus positions, with imaging metrology tool **85** being re-configured to be operated at the determined best contrast position (see approach (iii) above). Calibration module **112** may be configured to operate on-the-fly during regular metrology tool operation.

[0056] Optical systems **110** may be configured to enable simultaneous measurement of target **90** in multiple de-foci (focus locations), while calibration module **112** in metrology tool **85** (**Figure 4A**) may be configured to provide a particular per-layer grab centering without risk of compromised precision (see approach (iv) above).

[0057] Optical system **110** may have a first detection focus location **131C** of a collection path **79** (schematically illustrated by objective **83** and optics **84**) in metrology tool **85** and comprise at least two beam splitting elements **132**, **134** along collection path **79** which are positioned to provide at least two corresponding additional focus locations **131A**, **131B** having different collection path lengths than first detection focus location **131C**.

[0058] For example, optical system **110** may comprise (**Figure 4B**) an optical assembly **130** comprising beam splitters **132**, **134** (e.g., BS 30/70 and BS 50/50 respectively)

processor, e.g., in a metrology module. Certain embodiments comprise computer program products comprising a computer readable storage medium having computer readable program embodied therewith and configured to carry out of the relevant stages of method **200**. Certain embodiments comprise target design files of respective targets designed by embodiments of method **200**.

[0099] These method stages are described in more detail with respect to the systems and tools described above and optionally configured to implement method **200**. Method stages of different aspects of the invention may be combined according to specified requirements.

[00100] Method **200** may comprise deriving, in an optical system of an imaging metrology tool, a dependency of an overlay error magnification on a level of defocusing (stage **210**), and operating the optical system at a narrow spectral range, $\Delta\lambda \leq 10$nm, at a narrow illumination numerical aperture, $NA \leq 0.1$, and at a focus position that corresponds to zero overlay error magnification according to the derived dependency (stage **220**).

[00101] Method **200** may comprise grabbing a plurality of metrology target images at a corresponding plurality of focus positions (stage **230**), estimating an inaccuracy magnification factor of the grabbed images (stage **250**), determining a best contrast position by identifying a sign change of the inaccuracy magnification factor with respect to the focus positions (stage **260**), and operating the metrology tool at the determined best contrast position (stage **270**). Grabbing **230** may be is carried out simultaneously (stage **240**) and simultaneous grabbing **240** may be carried out by positioning at least two beam splitting elements along a collection path of the metrology tool (stage **242**) to provide the plurality of focus positions having different collection path lengths (stage **244**). In certain embodiments, method **200** further comprises using a reticle at a field plane of the metrology tool, configured as a reference for target images at the focus locations (stage **246**).

[00102] Method **200** may comprise deriving a dependency of a topographic phase of an imaging metrology target on a measurement wavelength (stage **280**), adjusting the measurement wavelength to make the topographic phase an integer multiple of π (stage **290**), e.g., in a range of ± 10 nm, and carrying out imaging metrology measurements of the imaging metrology target at the adjusted measurement wavelength (stage **300**).

CLAIMS

1. An imaging metrology tool comprising:

a calibration module configured to derive a dependency of an overlay error magnification on a level of defocusing, and

an optical system configured to operate at a narrow spectral range, $\Delta\lambda \leq 10$nm, at a narrow illumination numerical aperture, NA ≤ 0.1, and at a focus position that corresponds to zero overlay error magnification according to the derived dependency.

2. An imaging metrology tool comprising:

an optical system configured to grab a plurality of metrology target images at a corresponding plurality of focus positions, and

a calibration module configured to estimate an inaccuracy magnification factor of the grabbed images and determine a best contrast position by identifying a sign change of the inaccuracy magnification factor with respect to the focus positions,

wherein the imaging metrology tool re-configured to be operated at the determined best contrast position.

3. An optical system having a first detection focus location of a collection path in a metrology tool, the optical system comprising at least two beam splitting elements along the collection path which are positioned to provide at least two corresponding additional focus locations having different collection path lengths than the first detection focus location.

4. A metrology tool comprising the optical system of claim 3, further comprising an on-the-fly calibration module configured to provide a particular per-layer grab centering.

5. The optical system of claim 3, further comprising a reticle at a field plane thereof, configured as a reference for target images at the focus locations.

6. An imaging metrology target comprising at least one periodic structure having elements at a pitch p along a measurement direction, wherein the elements are segmented at an unresolved pitch along a direction perpendicular to the measurement direction, the unresolved pitch selected to provide a topographic phase of the target which is an integer multiple of π.

7. An optical system in an imaging metrology tool, the optical system comprising an adjustable reference path having a reference signal integrated in the collection path thereof, wherein the reference path is configured to provide an adjustable phase of the reference signal and the optical system is configured to adjust the phase of the reference signal to modify a topographic phase of an imaging metrology target to be an integer multiple of π.

8. The optical system of claim 7, comprising the adjustable reference path as a Linnik interferometer with a reference objective identical to an objective of the imaging metrology optical system and an adjustable mirror.

9. An optical system in an imaging overlay metrology tool, the optical system comprising an illumination path, a main objective and a collection path, wherein the optical system further comprises a reference path having a reference signal with controllable amplitude and phase which are configured to minimize a difference of topographic phases between zeroth and first order diffraction signals from at least two target layers.

10. The optical system of claim 9, wherein the reference path is incorporated in the optical system in a Linnik interferometer configuration.

11. The optical system of claim 9, wherein the minimization is carried out according to Equation 12.

12. A scatterometry metrology target comprising:

at least two cells, each having at least two target layers with periodic structures having a pitch p and shifted with respect to each other by an opposite offsets in the at least two cells, and

at least two auxiliary cells having the periodic structures shifted by ±p/4 with respect to each other, at the respective at least two auxiliary cells.

13. A metrology tool comprising an optical system and a calibration module configured to derive, through the optical system, a contrast function of an imaging target, and adjust measurement conditions of the optical system to modify the derived contrast function to have a single peak, wherein the metrology tool is configured to carry out imaging metrology measurement at the adjusted measurement conditions.

14. A metrology optical system configured for carrying out high topography stack measurements wherein collection and illumination numerical apertures (NA's) of the metrology optical system are selected to have a sum smaller than $2\lambda/P$, and/or the metrology optical system is configured integrate multiple images captured thereby over multiple focal positions thereof, to average out non-symmetric contributions.