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(54) **Title**: POSITION DETERMINATION IN A LITHOGRAPHY SYSTEM USING A SUBSTRATE HAVING A PARTIALLY REFLECTIVE POSITION MARK

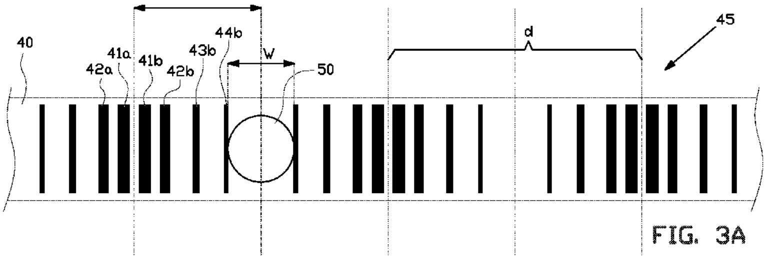

FIG. 3A

(57) **Abstract**: The invention relates to a substrate for use in a lithography system, said substrate being provided with an at least partially reflective position mark comprising an array of structures, the array extending along a longitudinal direction of the mark, characterized in that said structures are arranged for varying a reflection coefficient of the mark along the longitudinal direction, wherein said reflection coefficient is determined for a predetermined wavelength. In an embodiment a specular reflection coefficient varies along the substrate, wherein high order diffractions are substantially absorbed by the substrate. A position of a beam on a substrate can thus be determined based on the intensity of its reflection in the substrate. The invention further relates to a positioning device and lithography system for cooperation with the substrate, and a method of manufacture of the substrate.

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AMENDED CLAIMS

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1. Lithography system for processing a target, such as a wafer, comprising a substrate, said substrate being provided with an at least partially reflective position mark comprising an array of structures, the array extending along a longitudinal direction of the mark, wherein said structures are arranged for varying a reflection coefficient of the mark along the longitudinal direction, wherein said reflection coefficient is determined for a predetermined wavelength, said system comprising:

an alignment beam source arranged for providing an alignment beam of said predetermined wavelength;

an alignment beam intensity detector arranged for determining an intensity of a reflected alignment beam, wherein said reflected alignment beam is generated by reflection of the beam on said position mark;

an optical system arranged for focusing the alignment beam on the position mark and for guiding the reflected alignment beam on the alignment beam intensity detector,

wherein said alignment beam intensity detector is arranged for detecting an alignment beam intensity of the zeroth order reflection of the reflected alignment beam.

2. Lithography system according to claim 1, said lithography system comprising said substrate, wherein a pitch between a first structure of the array and a second structure of the array neighboring said first structure is different from a pitch between said second structure and a third structure of the array neighboring said second structure.

3. Lithography system as claimed in claim 1 or 2, wherein the pitch between neighboring structures along the longitudinal direction follows a sinusoid function of the position of said structures along the longitudinal

direction.

4. Lithography system according to any one of the preceding claims, wherein said structures are arranged for varying a specular, i.e. zero-th order, reflection coefficient of the mark along the longitudinal direction.

5. Lithography system according to any one of the preceding claims, wherein said structures are adapted for substantially absorbing higher order diffractions by multiple reflection of said higher order diffractions within the mark.

6. Lithography system according to any one of the preceding claims, wherein said structures each have a width along the longitudinal direction, said width being less than said predetermined wavelength, and wherein a distance between neighboring structures along the longitudinal direction is less than said predetermined wavelength.

7. Lithography system according to any one of the preceding claims, wherein said substrate comprises a wafer, preferably wherein the position mark is provided on one or more scribe lines of said wafer.

8. Lithography system according to any one of the preceding claims, wherein the structures are aligned on points which are equidistantly spaced along the longitudinal direction.

9. Lithography system according to claim 6, wherein a first structure of said structures has a different width along the longitudinal direction than a second structure of said structures.

10. Lithography system according to any one of the claims 1-8, wherein said structures have substantially identical dimensions, said structures preferably having rectangular shapes.

11. Lithography system according to claim 10, wherein the distance between neighboring structures along the longitudinal direction of the mark is substantially equal to a width of a structure.

12. Lithography system according to claim 11, wherein a maximum distance between neighboring structures along the longitudinal direction is at most 610 nm, preferably within a range of 590 nm to 610 nm, preferably substantially equal to 600 nm.

13. Lithography system according to any one of the preceding claims, adapted for emitting a light beam onto the substrate for generating a beam spot on said substrate, wherein the light beam has a wavelength equal to the predetermined wavelength, wherein a maximum distance between neighboring structures along the longitudinal direction is at most equal to the diameter of the beam spot.

14. Lithography system according to claim 13, wherein said light beam has a substantially Gaussian profile.

15. Lithography system according to any one of the preceding claims, wherein said structures form a periodic pattern of structures repeating along said longitudinal direction, and wherein the period of said pattern is larger than said diameter of the beam spot, preferably at least twice as large.

16. Lithography system according to claim 15, wherein the periodic pattern of structures has a period of 2 micron.

17. Lithography system according to any one of the claims 13-16, wherein the pitch between neighboring structures is less than or equal to diameter of the beam spot.

18. Lithography system according to claim any one of the claims 13-17, wherein the structures are dimensioned and arranged for varying the reflection coefficient as a sinusoidal function of the position of beam spot on the position mark along the longitudinal direction.

19. Lithography system according to any one of the preceding claims, wherein said substrate is formed as an integrated unit from a single material.

20. Lithography system according to any one of the claims 1-18, wherein a first of said structures comprises a first material and a second of said structures comprises a second material having a different reflection coefficient than said first material.

21. Lithography system according to any one of the preceding claims, wherein a maximum reflection coefficient of an area of the position mark for said wavelength is substantially equal to 1.

22. Lithography system as claimed in any one of the preceding claims, wherein the structures comprise sub-wavelength structures.

23. Lithography system according to any one of the preceding claims, further comprising:

a target carrier, adapted for moving the target relative to the optical system along the longitudinal direction, wherein said substrate is provided on the target carrier and/or on the target,

a processing unit adapted for determining an alignment and/or position of the substrate relative to the optical system based on the detected intensity of the reflected alignment beam.

24. Lithography system according to claim 23, wherein the substrate is provided on an edge of said target carrier for determining and/or aligning the position of the beam spot on the target carrier.

25. Lithography system according to claim 23 or 24, further comprising:

an optical column adapted for projecting one or more exposure beams on the target, wherein the optical system is attached to the optical column.

26. Lithography system according to claim 25, wherein the optical column is adapted for projecting a multitude of charged particle exposure beams onto the target, and wherein said optical system is mounted on or near a downstream portion of the optical column, preferably within a distance of 100 micron to an outer exposure beam

thereof.

27. Lithography system according to any one of the claims 21-26, wherein, at least during use the optical system is arranged at a distance of 2 mm or less from the substrate.

28. Lithography system according to any one of the claims 21-27, wherein the optical system is arranged for projecting said alignment beam onto the substrate substantially perpendicular on said substrate.

29. Position device arranged for determining a position of the alignment beam on the position mark of the substrate in the lithography system according to any one of the preceding claims, said position device comprising:

the alignment beam source arranged for providing the alignment beam of said predetermined wavelength;

the alignment beam intensity detector arranged for determining the intensity of the reflected alignment beam, wherein the reflected alignment beam is generated by reflection of the alignment beam on said position mark;

the optical system arranged for focusing the alignment beam on the position mark and for guiding the reflected alignment beam on the alignment beam intensity detector,

wherein said alignment beam intensity detector is arranged for detecting a beam intensity for the zeroth order reflection of the reflected alignment beam and adapted for providing a signal representative of the detected alignment beam intensity.

30. Substrate for use in the lithography system according to any one of claims 1 to 28.

31. Substrate according to claim 30, the substrate comprising a partially reflective surface, said surface having a substantially constant reflection coefficient and being provided with alignment beam absorbing structures for varying a reflection coefficient of the mark along the longitudinal direction.

32. Substrate according to claim 31, wherein the

distance between neighboring alignment beam absorbing structures along the longitudinal direction of the mark is substantially equal to a width of a structure.

33. Substrate according to claim 31 or 32, wherein said beam absorbing structures have substantially identical dimensions, said structures preferably having rectangular shapes.

34. Substrate according to any one of claims 31-33, wherein the beam alignment absorbing structures comprise sub-wavelength structures.

35. Substrate as claimed in claim 30, the substrate being provided with an at least partially reflective position mark comprising an array of structures, the array extending along a longitudinal direction of the mark, wherein said structures are arranged for varying a reflection coefficient of the mark along the longitudinal direction, wherein said reflection coefficient is determined for a predetermined wavelength.

36. Substrate according to claim 35, wherein a pitch between a first structure of the array and a second structure of the array neighboring said first structure is different from a pitch between said second structure and a third structure of the array neighboring said second structure.

37. Substrate according to claim 35 or 36, wherein the pitch between neighboring structures along the longitudinal direction follows a sinusoid function of the position of said structures along the longitudinal direction.

38. Substrate according to any one of claims 35-37, wherein the structures comprise sub-wavelength structures.

39. Substrate according to claim 37 or 38, wherein said structures are arranged for smoothly varying the reflection coefficient of the position mark along the longitudinal direction.

40. Method for alignment and/or position

determination of a beam spot on a substrate in a lithography system according to any one of the claims 1-27, said method comprising:

illuminating the substrate with a light beam for generating the beam spot on said substrate,

detecting an intensity of a zeroth order reflection of said light beam,

determining, based on said detected intensity, a position and/or alignment of substrate relative to the beam spot.

41. Method according to claim 40, further comprising a step of

measuring a position of the substrate using a further measurement system,

wherein the position and/or alignment of the substrate is further determined based on the measurement by the further measurement system.

42. Method according to claim 40 or 41, wherein a diameter of the beam spot is larger than or equal to a maximum distance between neighboring structures along the longitudinal direction.

Statement under Art. 19 PCT

Claim 1 discloses a lithography system in which an alignment beam which has a predetermined wavelength is directed onto a partially reflective position mark which has a varying reflection coefficient along its longitudinal direction, wherein an intensity of a zero-th order reflection of the alignment beam in the position mark is used to determine a relative position of the alignment beam on the position mark. The invention allows the position of the beam spot of the alignment beam on the position mark to be determined substantially independent of a position of a beam sensor for detecting the intensity of the reflected alignment beam. Based on the position of the alignment beam on the position mark, a position of the position mark in the lithography system may be determined.

The cited prior art EP 1 148 390 A2 does not disclose measuring an intensity of a zero-th order reflected beam to determine a position of the beam on a position mark, but instead discloses measuring an intensity of an interference pattern for determining whether a mark is aligned with respect to an alignment sensor. Because an interference pattern is formed, any changes in focus distance or tilt of the alignment mark 18 shown in figure 1 of EP 1 148 390 A2 relative to the alignment sensor 10 will substantially affect the measured degree of alignment. Moreover, the system of EP 1 148 390 A2 is not suitable for measuring a position of an alignment beam when the beam spot is projected on the position mark anywhere along the length of the position mark, and the substrate of EP 1 148 390 A2 is not adapted for smoothly varying a reflection coefficient along the length of the substrate.

In contrast, the present invention allows position determination of the position of an alignment beam spot on a position mark, along the length of the position mark. This position determination is substantially less sensitive to errors in focus of the alignment beam or tilt of the position mark relative to the alignment beam than the prior art system or other systems which measure interference patterns and/or higher order diffractions of an alignment beam to determine a position of an alignment beam on a position mark. Advantageously, the present invention allows said position determination to be performed using relatively low-cost off the shelf components, such as DVD-heads, for determining the intensity of the specularly (i.e. zero-th order) reflected alignment beam, and thus the position of the alignment beam spot on the position mark.