

CLAIMS

1. A method for quantifying sensitivity of metrology to process variation comprising:
- 5 performing metrology, by a metrology tool, on at least one metrology target located at at least one site on a semiconductor wafer, thereby generating a metrology landscape; and
- calculating a sensitivity metric directly based on said metrology landscape, said sensitivity metric quantifying a sensitivity of said metrology landscape to process
- 10 variation involved in manufacture of said semiconductor wafer.
2. The method according to claim 1, wherein:
- said performing metrology on at least one metrology target comprises performing metrology on a plurality of metrology targets,
- 15 said calculating a sensitivity metric comprises calculating a sensitivity metric for each of said plurality of metrology targets; and
- said method also comprises comparing said sensitivity metrics calculated for each of said plurality of metrology targets and selecting a selected metrology target of said plurality of metrology targets as an optimum metrology target having least sensitivity
- 20 to said process variation in comparison to other ones of said plurality of metrology targets, based on a value of said sensitivity metric of said selected metrology target being lower than values of said sensitivity metric of said other ones of said plurality of metrology targets.
- 25 3. The method according to claim 2 and also comprising, following said selecting a selected metrology target:
- further performing metrology on said semiconductor wafer by said metrology tool, utilizing said selected metrology target, thereby generating an additional metrology landscape;
- 30 decomposing said additional metrology landscape at least into components thereof arising from systematic and non-systematic errors therein;

quantifying a contribution of at least one of said components to said additional metrology landscape; and

correcting said additional metrology landscape by removing therefrom said contribution, as found by said quantifying.

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4. The method according to claim 1 or claim 2, and also comprising correcting said metrology landscape for errors therein arising from said process variation, based on a value of said sensitivity metric.

10 5. The method according to claim 1, wherein said performing metrology comprises performing metrology over a multiplicity of wavelengths, said metrology landscape measuring variation of a metrology measurement as a function of said multiplicity of wavelengths.

15 6. The method according to claim 5, wherein said metrology measurement comprises measurement of misregistration between layers of said semiconductor wafer.

7. The method according to claim 6, and also comprising:

20 selecting an optimum wavelength of said multiplicity of wavelengths having least sensitivity to process variation in comparison to other wavelengths of said multiplicity of wavelengths, based on correlating values of said sensitivity metric to ones of said multiplicity of wavelengths, and

further performing metrology on said semiconductor wafer by said metrology tool, utilizing said optimum wavelength.

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8. The method according to claim 1, and also comprising performing said metrology under a plurality of conditions, calculating said sensitivity metric for each of said plurality of conditions and optimizing said performance of said metrology in accordance with a condition of said plurality of conditions having a lowest sensitivity
30 metric value calculated therefor.

9. The method according to claim 5, wherein said sensitivity metric is calculated in accordance with $S_{metric} = \chi \cdot \sqrt{\frac{\sum_{i=1}^N w_i (MIS_i - \langle MIS \rangle)^2}{\sum w_i}}$ wherein S_{metric} is said

sensitivity metric, N is a number of said multiplicity of wavelengths over which a part of interest of said metrology landscape is measured, i is a wavelength index, MIS_i is a misregistration measurement at wavelength i of said multiplicity of wavelengths N , w_i is a wavelength weight, and $\langle MIS \rangle$ is a weighted average misregistration across said
 5 landscape, given by $\langle MIS \rangle = \frac{\sum w_i MIS_i}{\sum w_i}$ and χ may take the value of +1 or -1.

10. A system for quantifying sensitivity of metrology to process variation comprising:

a metrology tool operative to perform metrology on at least one metrology
 10 target located at at least one site on a semiconductor wafer, said metrology tool generating a metrology landscape; and

a sensitivity metric calculator operative to receive said metrology landscape and to calculate a sensitivity metric directly based on said metrology landscape, said sensitivity metric quantifying a sensitivity of said metrology landscape to process
 15 variation involved in manufacture of said semiconductor wafer.

11. The system according to claim 10, wherein said metrology tool is operative to perform said metrology over a multiplicity of wavelengths, said metrology landscape measuring variation of a metrology measurement as a function of said
 20 multiplicity of wavelengths, and to select an optimum wavelength of said multiplicity of wavelengths having least sensitivity to process variation in comparison to other wavelengths of said multiplicity of wavelengths, based on correlating values of said sensitivity metric to ones of said multiplicity of wavelengths,

said metrology tool being operative to perform additional metrology on
 25 said semiconductor wafer, utilizing said optimum wavelength, thereby generating an additional metrology landscape.

12. The system according to claim 10 or claim 11, wherein said metrology tool is operative to perform said metrology on a plurality of metrology targets and said
 30 sensitivity metric calculator is operative to calculate a sensitivity metric for each of said plurality of metrology targets,

said sensitivity metric calculator being additionally operative to compare said sensitivity metrics calculated for each of said plurality of metrology targets and to select a selected metrology target of said plurality of metrology targets as an optimum metrology target having least sensitivity to said process variation in comparison to other ones of said plurality of metrology targets, based on a value of said sensitivity metric of said selected metrology target being lower than values of said sensitivity metric of said other ones of said plurality of metrology targets.

13. The system according to claim 10, wherein said metrology tool is operative to perform said metrology under a plurality of conditions, and said sensitivity metric calculator is operative to calculate said sensitivity metric for each of said plurality of conditions, performance of said metrology being optimized in accordance with a condition of said plurality of conditions having a lowest sensitivity metric value calculated therefor.

14. The system according to claim 11, wherein said sensitivity metric is calculated in accordance with $S_{metric} = \chi \cdot \sqrt{\frac{\sum_{i=1}^N w_i (MIS_i - \langle MIS \rangle)^2}{\sum w_i}}$ wherein S_{metric} is said sensitivity metric, N is a number of said multiplicity of wavelengths over which a part of interest of said metrology landscape is measured, i is a wavelength index, MIS_i is a misregistration measurement at wavelength i of said multiplicity of wavelengths N, w_i is a wavelength weight, and $\langle MIS \rangle$ is a weighted average misregistration across said landscape, given by $\langle MIS \rangle = \frac{\sum w_i MIS_i}{\sum w_i}$ and χ may take the value of +1 or -1.

15. The system according to claim 11, and also comprising a landscape decomposer operative to:

decompose said additional metrology landscape at least into components thereof arising from systematic and non-systematic errors therein;

quantify a contribution of at least one of said components to said additional metrology landscape; and

correct said additional metrology landscape by removing therefrom said contribution.

16. A method for quantifying components of metrology, comprising:
decomposing a metrology landscape at least into components thereof
arising from systematic and non-systematic errors therein;
quantifying a contribution of at least one of said components to said
5 metrology landscape; and
correcting said metrology landscape by removing therefrom said
contribution, as found by said quantifying.
17. The method according to claim 16, wherein said decomposing is carried
10 out by principle component analysis of said metrology landscape.
18. The method according to claim 16 or claim 17, wherein said decomposing
is performed on at least one of a raw inaccuracy level, a modeled inaccuracy level and a
residual inaccuracy level.
- 15 19. The method according to claim 16, and also comprising, prior to said
decomposing, performing metrology, by a metrology tool, on at least one metrology target
located at at least one site on a semiconductor wafer, thereby generating said metrology
landscape, and
20 calculating a sensitivity metric directly based on said metrology landscape,
said sensitivity metric quantifying a sensitivity of said metrology landscape to process
variation involved in manufacture of said semiconductor wafer.
20. A system for quantifying components of metrology, comprising:
25 a metrology tool operative to perform metrology on a semiconductor wafer
and to output a metrology landscape; and
a landscape decomposer operative to decompose said metrology landscape
at least into components thereof arising from systematic and non-systematic errors, to
quantify a contribution of at least one of said components to said metrology landscape
30 and to correct said metrology landscape by removing therefrom said contribution.

21. The system according to claim 20, wherein said landscape decomposer is operative to perform principle component analysis on said metrology landscape in order to decompose said metrology landscape into said components thereof.

5 22. The system according to claim 20 or claim 21, wherein said landscape decomposer is operative to decompose said metrology landscape on at least one of a raw inaccuracy level, a modelled inaccuracy level and a residual inaccuracy level.

23. The system according to claim 20, and also comprising a sensitivity metric
10 calculator operative to receive said metrology landscape and to calculate a sensitivity metric directly based on said metrology landscape, said sensitivity metric quantifying a sensitivity of said metrology landscape to process variation involved in manufacture of said semiconductor wafer.

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