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(54) Title: DYNAMIC AMELIORATION OF MISREGISTRATION MEASUREMENT

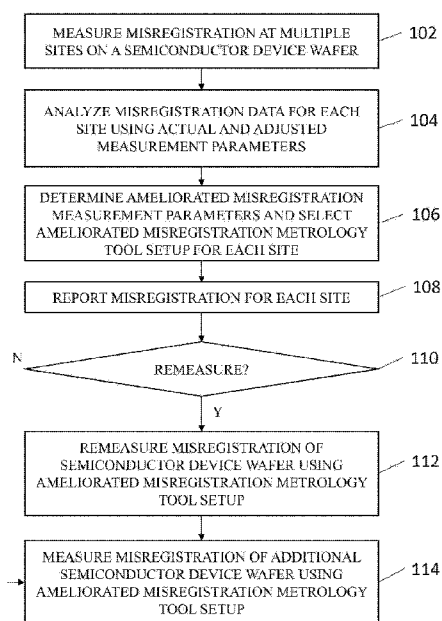


FIG. 1

(57) **Abstract:** A dynamic misregistration measurement amelioration method including taking at least one misregistration measurement at multiple sites on a first semiconductor device wafer, which is selected from a batch of semiconductor device wafers intended to be identical, analyzing each of the misregistration measurements, using data from the analysis of each of the misregistration measurements to determine ameliorated misregistration measurement parameters at each one of the multiple sites, thereafter ameliorating misregistration metrology tool setup for ameliorated misregistration measurement at the each one of the multiple sites, thereby generating an ameliorated misregistration metrology tool setup and thereafter measuring misregistration at multiple sites on a second semiconductor device wafer, which is selected from the batch of semiconductor device wafers intended to be identical, using the ameliorated misregistration metrology tool setup.

DYNAMIC AMELIORATION OF MISREGISTRATION MEASUREMENT

REFERENCE TO RELATED APPLICATIONS

5 Reference is made to U.S. Provisional Patent Application Serial No. 62/815,990, filed March 8, 2019 and entitled IMPROVE OVERLAY RESULTS BY DYNAMIC MEASUREMENTS, the disclosure of which is hereby incorporated by reference and priority of which is hereby claimed.

10 FIELD OF THE INVENTION

The present invention relates to the field of metrology, and more particularly, to metrology recipe setup and measurement procedures.

15 BACKGROUND OF THE INVENTION

Various types of devices and procedures for metrology and metrology recipe setup are known.

20 SUMMARY OF THE INVENTION

The present invention seeks to provide improved methods and systems for metrology.

25 There is thus provided in accordance with a preferred embodiment of the present invention a dynamic misregistration measurement amelioration method including taking at least one misregistration measurement at multiple sites on a first semiconductor device wafer, which is selected from a batch of semiconductor device wafers intended to be identical, analyzing each of the misregistration measurements, using data from the
30 analysis of each of the misregistration measurements to determine ameliorated misregistration measurement parameters at each one of the multiple sites, thereafter ameliorating misregistration metrology tool setup for ameliorated misregistration

measurement at the each one of the multiple sites, thereby generating an ameliorated misregistration metrology tool setup and thereafter measuring misregistration at multiple sites on a second semiconductor device wafer, which is selected from the batch of semiconductor device wafers intended to be identical, using the ameliorated misregistration metrology tool setup.

In accordance with a preferred embodiment of the present invention the misregistration measurements are taken with an imaging misregistration metrology tool. Additionally, the misregistration metrology tool setup includes at least one of the following: a region of interest in a metrology target, a wavelength of light used in misregistration measurement, a polarization of light used in misregistration measurement and a numerical aperture.

In accordance with a preferred embodiment of the present invention the misregistration measurements are taken with a scatterometry misregistration metrology tool. Additionally, the misregistration metrology tool setup includes at least one of the following: a polarization of light used in misregistration measurement, a diffraction mask used in misregistration measurement and a diffraction aperture used in misregistration measurement.

Preferably, the method does not decrease processing throughput.

In accordance with a preferred embodiment of the present invention the dynamic misregistration measurement amelioration method also includes recalculating results of the at least one misregistration measurement using the ameliorated misregistration measurement parameters at the each one of multiple sites.

In accordance with a preferred embodiment of the present invention the first semiconductor device wafer and the second semiconductor device wafer are the same semiconductor device wafer.

Preferably, the misregistration metrology tool setup is selected based on at least one of: increased contrast precision of results of the misregistration measurements, improved residual values of results of the misregistration measurements, better correlation between results of the misregistration measurements and electron beam measurements, improved device yield, improved precision of results of the misregistration measurements, reduced tool-induced-shift of results of the misregistration measurements, improved sensitivity of results of the misregistration measurements,

improved throughput of the misregistration measurements, improved matching of results of the misregistration measurements to results of misregistration measurements taken by other misregistration metrology tools and decreased fluctuations in results of the misregistration measurements with process variations.

5 There is also provided in accordance with a preferred embodiment of the present invention a dynamic misregistration measurement amelioration system including a misregistration metrology tool operative to perform the dynamic optimization misregistration method.

10 There is further provided in accordance with yet another preferred embodiment of the present invention a dynamic misregistration measurement amelioration method including taking at least one misregistration measurement at multiple sites on a semiconductor device wafer, which is selected from a batch of semiconductor device wafers intended to be identical, analyzing each of the misregistration measurements, using data from the analysis of each of the misregistration
15 measurements to determine ameliorated site-specific misregistration parameters each one of multiple sites, thereafter ameliorating a setup for misregistration measurement at the each one of multiple sites, thereby generating an ameliorated misregistration metrology tool setup and thereafter remeasuring misregistration of the semiconductor device wafer, which is selected from a batch of semiconductor device wafers intended to be identical,
20 using the ameliorated misregistration metrology tool setup.

 In accordance with a preferred embodiment of the present invention the misregistration measurements are taken with an imaging misregistration metrology tool. Additionally, the misregistration metrology tool setup includes at least one of the following: a region of interest in metrology target, a wavelength of light used in
25 misregistration measurement, a polarization of light used in misregistration measurement and a numerical aperture.

 In accordance with a preferred embodiment of the present invention the misregistration measurements are taken with a scatterometry misregistration metrology tool. Additionally, the misregistration metrology tool setup includes at least one of the
30 following: a polarization of light used in misregistration measurement, a diffraction mask used in misregistration measurement and a diffraction aperture used in misregistration measurement.

Preferably, the method does not decrease processing throughput.

In accordance with a preferred embodiment of the present invention the dynamic misregistration measurement amelioration method also includes recalculating results of the at least one misregistration measurement using the ameliorated
5 misregistration measurement parameters at the each one of multiple sites.

In accordance with a preferred embodiment of the present invention the dynamic misregistration measurement amelioration method also includes measuring misregistration at multiple sites on a second semiconductor device wafer, which is selected from the batch of semiconductor device wafers intended to be identical, using
10 the ameliorated misregistration metrology tool setup.

Preferably, the misregistration metrology tool setup is selected based on at least one of: increased contrast precision of results of the misregistration measurements, improved residual values of results of the misregistration measurements, better correlation between results of the misregistration measurements and electron beam
15 measurements, improved device yield, improved precision of results of the misregistration measurements, reduced tool-induced-shift of results of the misregistration measurements, improved sensitivity of results of the misregistration measurements, improved throughput of the misregistration measurements, improved matching of results of the misregistration measurements to results of misregistration measurements taken by
20 other misregistration metrology tools and decreased fluctuations in results of the misregistration measurements with process variations.

There is also provided in accordance with a preferred embodiment of the present invention a dynamic misregistration measurement amelioration system including a misregistration metrology tool operative to perform the dynamic optimization
25 misregistration method.

BRIEF DESCRIPTION OF THE DRAWINGS

The present invention will be understood and appreciated more fully from the following detailed description, taken in conjunction with the drawings in which:

5 Fig. 1 is a simplified flowchart illustrating a dynamic misregistration measurement amelioration method; and

 Fig. 2 is a simplified schematic pictorial illustration of a dynamic misregistration measurement amelioration system useful in performing the method of Fig. 1.

10 DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

Reference is now made to Fig. 1, which is a simplified flowchart illustrating a dynamic misregistration measurement amelioration method. As seen at a first step 102, misregistration is measured at multiple sites on a semiconductor device wafer, which is selected from a batch of semiconductor device wafers intended to be identical. The number of sites measured on a semiconductor device wafer can range from 15 2 – 4,000 sites.

It is appreciated that misregistration measurements at each of the multiple sites taken at step 102 may consist either of a single grab or of multiple grabs. It is further appreciated that misregistration measurements taken at each of the multiple sites at step 20 102 may be measured using a single misregistration metrology tool setup, or multiple alternative misregistration metrology tool setups.

At step 102, misregistration may be measured using any suitable misregistration metrology tool, including, inter alia, an imaging misregistration metrology tool or a scatterometry misregistration metrology tool. A typical imaging 25 misregistration metrology tool useful in step 102 is an Archer™ 600, commercially available from KLA-Tencor Corporation of Milpitas, CA, USA. A typical scatterometry metrology tool useful in step 102 is an ATL™ 100, commercially available from KLA-Tencor Corporation of Milpitas, CA, USA.

30 At a next step 104, the misregistration data for each site measured at step 102 is analyzed. The analysis of step 104 may include analysis based both on

misregistration measurement parameters used in the measurements taken at step 102 and on adjusted misregistration measurement parameters.

Adjusted misregistration measurement parameters include at least one measurement parameter that is different from misregistration measurement parameters used in the measurements taken at step 102. For example, measurements may be analyzed based both on the entire region of interest (ROI) used in the measurements taken at step 102, and on sub-sections of the ROI used in the measurements taken at step 102.

Based on the analysis at step 104, at a next step 106, ameliorated misregistration measurement parameters are selected for each one of multiple sites measured at step 102 and an ameliorated misregistration metrology tool setup is selected for each measurement site. It is appreciated that an ameliorated misregistration metrology tool setup can be selected to satisfy various criteria, including, inter alia, increased contrast precision of results of misregistration measurements, improved residual values of results of misregistration measurements, better correlation between results of misregistration measurements and electron beam measurements; improved device yield, improved precision of results of misregistration measurements, reduced tool-induced-shift of results of misregistration measurements, improved sensitivity of results of misregistration measurements, improved throughput of misregistration measurements, improved matching of results of misregistration measurements to results of misregistration measurements taken by other misregistration metrology tools and decreased fluctuations in results of misregistration measurements with process variations.

In a preferred embodiment of the present invention, ameliorated misregistration measurement parameters include fewer variations than misregistration measurement parameters used in the measurements taken at step 102. For example, measurements may be taken at step 102 with multiple wavelengths of light, only one of which is included in the adjusted misregistration measurement parameters. Similarly, measurements may be taken at step 102 with multiple polarizations of light, only one of which is included in the adjusted misregistration measurement parameters. Similarly, measurements may be taken at step 102 with multiple numerical apertures, only one of which is included in the adjusted misregistration measurement parameters.

Additionally, ameliorated misregistration measurement parameters may be different than misregistration measurement parameters used in the measurements taken

at step 102. For example, measurements may be taken at step 102 using a relatively large ROI, and the ameliorated misregistration measurement parameters may include only certain sub-sections of the ROI used in the measurements taken at step 102.

If an imaging misregistration metrology tool is employed, misregistration measurement parameters adjusted between step 102 and step 106 may include, inter alia, a region of interest in a metrology target, a wavelength of light used in a misregistration measurement, polarization of light used in misregistration measurement and numerical aperture.

If a scatterometry misregistration metrology tool is employed, misregistration measurement parameters adjusted between step 102 and step 106 may include, inter alia, polarization of light used in misregistration measurement, diffraction mask used in misregistration measurement and diffraction aperture used in misregistration measurement.

As seen at a next step 108, a misregistration value is obtained for each site measured at step 102. In a preferred embodiment of the present invention, step 108 uses the ameliorated misregistration measurement parameters for each site selected at step 106 to calculate misregistration values for each site measured at step 102. For example, misregistration measurements taken at step 102 using a relatively large ROI may be recalculated using the ameliorated ROI selected at step 106.

As seen at a next step 110, it is ascertained whether the semiconductor device wafer whose misregistration was measured at step 102 should be remeasured using the ameliorated misregistration metrology tool setup selected at step 106. If the previously measured semiconductor device wafer should be remeasured, for example if the previously measured semiconductor device wafer was measured at relatively few sites at step 102, in a next step 112 the same semiconductor device wafer whose misregistration was measured at step 102 is remeasured using the ameliorated misregistration metrology tool setup selected at step 106.

Following step 112, or directly following step 110 if the semiconductor device wafer whose misregistration was measured at step 102 does not require remeasurement, in a further step 114, misregistration is measured at multiple sites on at least one other semiconductor device wafer, which is selected from the same batch of semiconductor device wafers from which the semiconductor device wafer whose

misregistration was measured at step 102 was selected. It is a particular feature of an embodiment of the present invention that misregistration measured at step 114 is measured using the ameliorated misregistration metrology tool setup selected at step 106.

It is a particular feature of an embodiment of the present invention that measurements analyzed at step 104 and used for amelioration of misregistration metrology tool setup are measurements that would ordinarily be taken in the course of ascertaining the misregistration of various semiconductor device wafers in the batch of semiconductor device wafers which are designed to be identical. Thus, the method of the present invention does not decrease processing throughput.

Reference is now made to Fig. 2, which is a simplified schematic pictorial illustration of a dynamic misregistration measurement amelioration system 200 useful in performing the method described hereinabove with reference to Fig. 1. As seen in Fig. 2, dynamic misregistration measurement amelioration system 200 includes a multi-site misregistration measurement stage 210, operative to measure misregistration at multiple sites on a semiconductor device wafer.

Multi-site misregistration measurement stage 210 may include any suitable misregistration metrology tool, including, inter alia, an imaging misregistration metrology tool or a scatterometry misregistration metrology tool. A typical imaging misregistration metrology tool useful in multi-site misregistration measurement stage 210 is an Archer™ 600, commercially available from KLA-Tencor Corporation of Milpitas, CA, USA. A typical scatterometry metrology tool useful in multi-site misregistration measurement stage 210 is an ATL™ 100, commercially available from KLA-Tencor Corporation of Milpitas, CA, USA.

Multi-site misregistration measurement stage 210 is operative to communicate results of misregistration measurements to multi-site misregistration measurement analyzer 220. Multi-site misregistration measurement analyzer 220 is operative to analyze misregistration data provided by multi-site misregistration measurement stage 210 based both on misregistration measurement parameters used in the measurements taken by multi-site misregistration measurement stage 210 and on adjusted misregistration measurement parameters.

Adjusted misregistration measurement parameters include at least one measurement parameter that is different from misregistration measurement parameters

used in the measurements taken by multi-site misregistration measurement stage 210. For example, measurements may be analyzed based both on the entire ROI used in the measurements taken by multi-site misregistration measurement stage 210, and on sub-sections of the ROI used in the measurements taken by multi-site misregistration measurement stage 210.

Multi-site misregistration measurement analyzer 220 is further operative to communicate the results of its analysis to multi-site misregistration measurement parameter setup engine 230. Multi-site misregistration measurement parameter setup engine 230 is operative to select ameliorated misregistration measurement parameters for each one of multiple sites measured by multi-site misregistration measurement stage 210 and to select an ameliorated misregistration metrology tool setup for each measurement site. Multi-site misregistration measurement parameter setup engine 230 is further operative to communicate the ameliorated misregistration metrology tool setup to multi-site misregistration measurement stage 210.

The ameliorated misregistration metrology tool setup selected by multi-site misregistration measurement parameter setup engine 230 may satisfy various criteria, including, inter alia, increased contrast precision of results of misregistration measurements, improved residual values of results of misregistration measurements, better correlation between results of misregistration measurements and electron beam measurements; improved device yield, improved precision of results of misregistration measurements, reduced tool-induced-shift of results of misregistration measurements, improved sensitivity of results of misregistration measurements, improved throughput of misregistration measurements, improved matching of results of misregistration measurements to results of misregistration measurements taken by other misregistration metrology tools and decreased fluctuations in results of misregistration measurements with process variations.

In a preferred embodiment of the present invention, ameliorated misregistration measurement parameters include fewer variations than misregistration measurement parameters used initially in the measurements taken by multi-site misregistration measurement stage 210. For example, measurements may initially be taken by multi-site misregistration measurement stage 210 with multiple wavelengths of light, only one of which is included in the adjusted misregistration measurement

parameters selected by multi-site misregistration measurement parameter setup engine 230.

Similarly, measurements may initially be taken by multi-site misregistration measurement stage 210 with multiple polarizations of light, only one of which is included in the adjusted misregistration measurement parameters selected by multi-site misregistration measurement parameter setup engine 230. Similarly, measurements may initially be taken by multi-site misregistration measurement stage 210 with multiple numerical apertures, only one of which is included in the adjusted misregistration measurement parameters selected by multi-site misregistration measurement parameter setup engine 230.

Additionally, ameliorated misregistration measurement parameters selected by multi-site misregistration measurement parameter setup engine 230 may be different than misregistration measurement parameters used in the initial measurements taken by multi-site misregistration measurement stage 210. For example, measurements may initially be taken by multi-site misregistration measurement stage 210 using a relatively large ROI, and the ameliorated misregistration measurement parameters selected by multi-site misregistration measurement parameter setup engine 230 may include only certain sub-sections of the ROI used in the measurements initially taken by multi-site misregistration measurement stage 210.

If multi-site misregistration measurement stage 210 includes an imaging misregistration metrology tool, misregistration measurement parameters adjusted by multi-site misregistration measurement parameter setup engine 230 may include, inter alia, a region of interest in a metrology target, a wavelength of light used in a misregistration measurement, polarization of light used in misregistration measurement and numerical aperture.

If multi-site misregistration measurement stage 210 includes a scatterometry misregistration metrology tool, misregistration measurement parameters adjusted by multi-site misregistration measurement parameter setup engine 230 may include, inter alia, polarization of light used in misregistration measurement, diffraction mask used in misregistration measurement and diffraction aperture used in misregistration measurement.

Multi-site misregistration measurement analyzer 220 is further operative to communicate the results of its analysis to multi-site misregistration measurement reporter 240. Multi-site misregistration measurement reporter 240 is operative to output a misregistration value for each site measured by multi-site misregistration measurement stage 210.

In a preferred embodiment of the present invention, multi-site misregistration measurement reporter 240 uses the ameliorated misregistration measurement parameters for each site selected by multi-site misregistration measurement parameter setup engine 230 to calculate misregistration values for each site measured by multi-site misregistration measurement stage 210. For example, misregistration measurements taken by multi-site misregistration measurement stage 210 using a relatively large ROI may be recalculated using the ameliorated ROI selected by multi-site misregistration measurement parameter setup engine 230.

It will be appreciated by persons skilled in the art that the present invention is not limited to what has been particularly shown and described hereinabove. The scope of the present invention includes both combinations and sub combinations of various features described hereinabove as well as modifications thereof, all of which are not in the prior art.

CLAIMS

1. A dynamic misregistration measurement amelioration method comprising:
taking at least one misregistration measurement at multiple sites on a first
5 semiconductor device wafer, which is selected from a batch of semiconductor device
wafers intended to be identical;
analyzing each of said misregistration measurements;
using data from said analysis of each of said misregistration measurements
to determine ameliorated misregistration measurement parameters at each one of said
10 multiple sites;
thereafter ameliorating misregistration metrology tool setup for
ameliorated misregistration measurement at said each one of said multiple sites, thereby
generating an ameliorated misregistration metrology tool setup; and
thereafter measuring misregistration at multiple sites on a second
15 semiconductor device wafer, which is selected from said batch of semiconductor device
wafers intended to be identical, using said ameliorated misregistration metrology tool
setup.
2. A dynamic misregistration measurement amelioration method according
20 to claim 1 and wherein said misregistration measurements are taken with an imaging
misregistration metrology tool.
3. A dynamic misregistration measurement amelioration method according
to claim 2 and wherein said misregistration metrology tool setup comprises at least one
25 of the following:
a region of interest in a metrology target;
a wavelength of light used in misregistration measurement;
a polarization of light used in misregistration measurement; and
a numerical aperture.

30

4. A dynamic misregistration measurement amelioration method according to claim 1 and wherein said misregistration measurements are taken with a scatterometry misregistration metrology tool.
5. A dynamic misregistration measurement amelioration method according to claim 4 and wherein said misregistration metrology tool setup comprises at least one of the following:
- a polarization of light used in misregistration measurement;
 - a diffraction mask used in misregistration measurement; and
 - a diffraction aperture used in misregistration measurement.
6. A dynamic misregistration measurement amelioration method according to any of claims 1 – 5 and wherein said method does not decrease processing throughput.
7. A dynamic misregistration measurement amelioration method according to any of claims 1 – 6 and also comprising recalculating results of said at least one misregistration measurement using said ameliorated misregistration measurement parameters at said each one of multiple sites.
8. A dynamic misregistration measurement amelioration method according to any of claims 1 – 7 and wherein said first semiconductor device wafer and said second semiconductor device wafer are the same semiconductor device wafer.
9. A dynamic misregistration measurement amelioration method according to any of claims 1 – 8 and wherein said misregistration metrology tool setup is selected based on at least one of:
- increased contrast precision of results of said misregistration measurements;
 - improved residual values of results of said misregistration measurements;
 - better correlation between results of said misregistration measurements and electron beam measurements;
 - improved device yield;

- improved precision of results of said misregistration measurements;
reduced tool-induced-shift of results of said misregistration measurements;
improved sensitivity of results of said misregistration measurements;
improved throughput of said misregistration measurements;
5 improved matching of results of said misregistration measurements to
results of misregistration measurements taken by other misregistration metrology tools;
and
decreased fluctuations in results of said misregistration measurements with
process variations.

10

10. A dynamic misregistration measurement amelioration system comprising
a misregistration metrology tool operative to perform the dynamic optimization
misregistration method according to any of claims 1 – 9.

- 15 11. A dynamic misregistration measurement amelioration method comprising:
taking at least one misregistration measurement at multiple sites on a
semiconductor device wafer, which is selected from a batch of semiconductor device
wafers intended to be identical;

- analyzing each of said misregistration measurements;
20 using data from said analysis of each of said misregistration measurements
to determine ameliorated site-specific misregistration parameters each one of multiple
sites;

- thereafter ameliorating a setup for misregistration measurement at said
each one of multiple sites, thereby generating an ameliorated misregistration metrology
25 tool setup; and

- thereafter remeasuring misregistration of said semiconductor device
wafer, which is selected from a batch of semiconductor device wafers intended to be
identical, using said ameliorated misregistration metrology tool setup.

- 30 12. A dynamic misregistration measurement amelioration method according
to claim 11 and wherein said misregistration measurements are taken with an imaging
misregistration metrology tool.

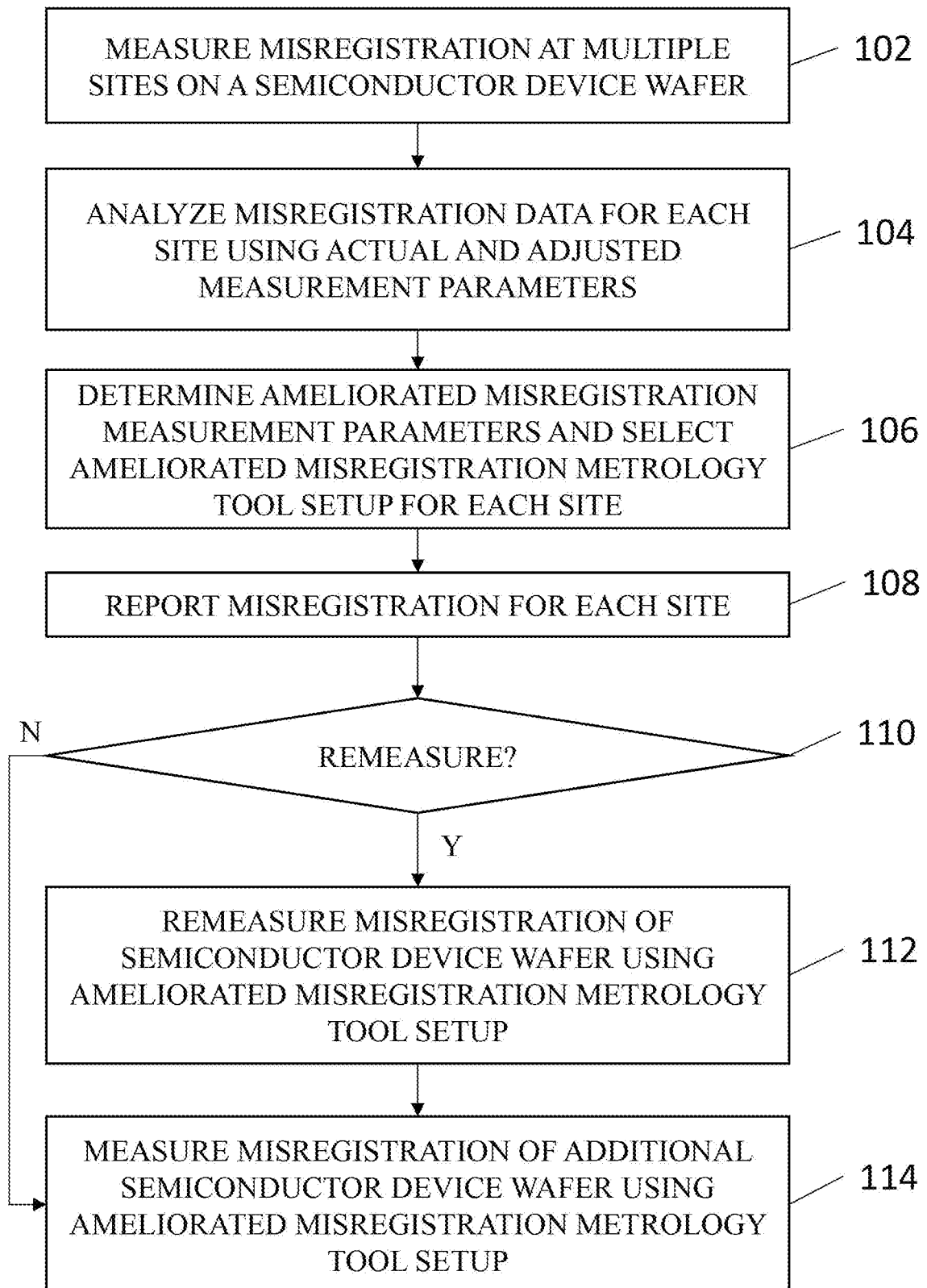
13. A dynamic misregistration measurement amelioration method according to claim 12 and wherein said misregistration metrology tool setup comprises at least one of the following:
- 5 a region of interest in a metrology target;
a wavelength of light used in misregistration measurement;
a polarization of light used in misregistration measurement; and
a numerical aperture.
- 10 14. A dynamic misregistration measurement amelioration method according to claim 11 and wherein said misregistration measurements are taken with a scatterometry misregistration metrology tool.
- 15 15. A dynamic misregistration measurement amelioration method according to claim 14 and wherein said misregistration metrology tool setup comprises at least one of the following:
- a polarization of light used in misregistration measurement;
a diffraction mask used in misregistration measurement; and
a diffraction aperture used in misregistration measurement.
- 20 16. A dynamic misregistration measurement amelioration method according to any of claims 11 – 15 and wherein said method does not decrease processing throughput.
- 25 17. A dynamic misregistration measurement amelioration method according to any of claims 11 – 16 and also comprising recalculating results of said at least one misregistration measurement using said ameliorated misregistration measurement parameters at said each one of multiple sites.
- 30 18. A dynamic misregistration measurement amelioration method according to any of claims 11 – 17 and also comprising measuring misregistration at multiple sites on a second semiconductor device wafer, which is selected from said batch of

semiconductor device wafers intended to be identical, using said ameliorated misregistration metrology tool setup.

19. A dynamic misregistration measurement amelioration method according to any of claims 11 – 18 and wherein said misregistration metrology tool setup is selected based on at least one of:

- increased contrast precision of results of said misregistration measurements;
- improved residual values of results of said misregistration measurements;
- 10 better correlation between results of said misregistration measurements and electron beam measurements;
- improved device yield;
- improved precision of results of said misregistration measurements;
- reduced tool-induced-shift of results of said misregistration measurements;
- 15 improved sensitivity of results of said misregistration measurements;
- improved throughput of said misregistration measurements;
- improved matching of results of said misregistration measurements to results of misregistration measurements taken by other misregistration metrology tools;
- and
- 20 decreased fluctuations in results of said misregistration measurements with process variations.

20. A dynamic misregistration measurement amelioration system comprising a misregistration metrology tool operative to perform the dynamic optimization misregistration method according to any of claims 10 – 19.

1/2**FIG. 1**

2/2

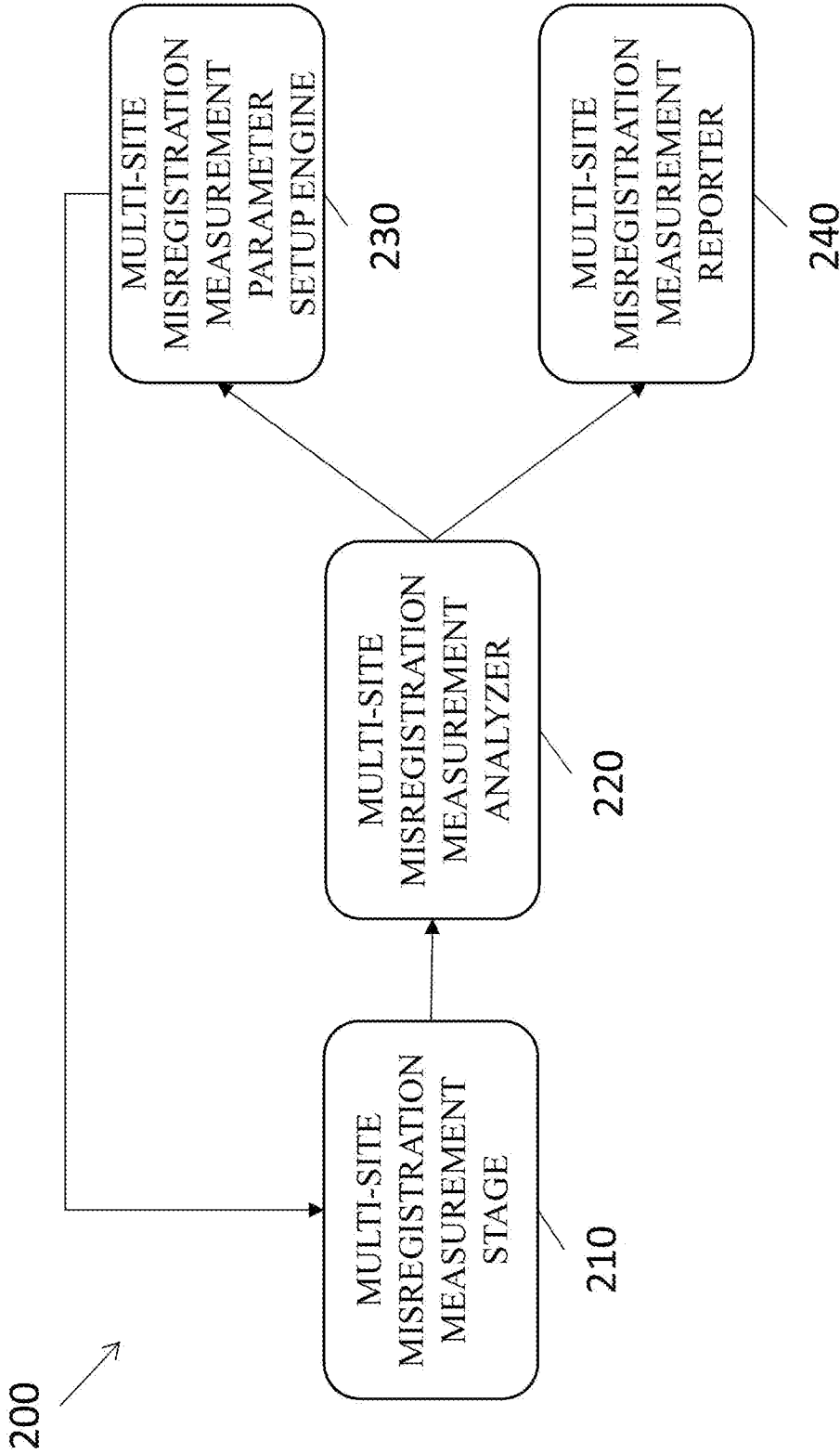


FIG. 2

A. CLASSIFICATION OF SUBJECT MATTER**H01L 21/66(2006.01)i, H01L 21/67(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; G01B 11/02; G01B 11/14; G01B 21/04; G03F 1/08; G03F 7/20; G05B 21/02; G06T 11/20; H01L 23/544; H01L 21/67

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: misregistration, amelioration, measurement, metrology tool, scatterometry

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2014-0060148 A1 (KLA-TENCOR CORPORATION) 06 March 2014 See paragraphs [0005]–[0046] and claims 1, 6, 12.	1–6, 11–16
A	US 2011-0051150 A1 (DONGSUB CHOI et al.) 03 March 2011 See paragraphs [0035]–[0041].	1–6, 11–16
A	US 2017-0256501 A1 (MICRON TECHNOLOGY, INC.) 07 September 2017 See paragraphs [0044]–[0054].	1–6, 11–16
A	US 2017-0255188 A1 (KLA-TENCOR CORPORATION) 07 September 2017 See paragraphs [0011], [0082] and claim 1.	1–6, 11–16
A	JP 4620048 B2 (TOPPAN PHOTOMASKS, INC.) 26 January 2011 See paragraphs [0023]–[0032] and figures 2, 3.	1–6, 11–16



Further documents are listed in the continuation of Box C.



See patent family annex.

* Special categories of cited documents:

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"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

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Name and mailing address of the ISA/KR

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INTERNATIONAL SEARCH REPORT

Information on patent family members

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PCT/US2019/033019

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
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International application No.

PCT/US2019/033019

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2019/033019**Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)**

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:
2. ☐ Claims Nos.:
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:
3. ☒ Claims Nos.: 7-10,17-20
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.
2. ☐ As all searchable claims could be searched without effort justifying an additional fees, this Authority did not invite payment of any additional fees.
3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:
4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

- ☐ The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.
- ☐ The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.
- ☐ No protest accompanied the payment of additional search fees.