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(54) Title: CHARGED PARTICLE MULTI-BEAM SYSTEM AND METHOD

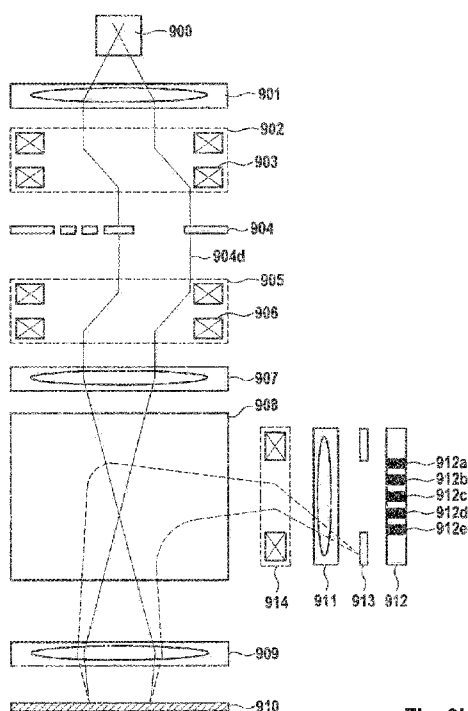


Fig. 9b

(57) Abstract: The present invention relates to a multi beam charged particle beam inspection system and a method of operating the system in two modes. More particular, the present invention relates to compensating charging of a sample 910 during inspection in the multi beam system.



INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2019/054393

A. CLASSIFICATION OF SUBJECT MATTER
INV. H01J37/244 H01J37/28
ADD.

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)
H01J

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

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

EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2017/084424 A1 (MASNAGHETTI DOUG K [US] ET AL) 23 March 2017 (2017-03-23) abstract paragraphs [0002], [0026] - [0089]; figures 1A,4B,6,7,9-11 -----	1,2,7,12
X Y	US 2014/224985 A1 (RODGERS STEVEN R [IL] ET AL) 14 August 2014 (2014-08-14) abstract paragraphs [0010], [0036] - [0113]; claim 21; figures 1,9-14,20 -----	1,2,7, 12,18 18
X	JP 2002 245960 A (NIKON CORP; EBARA CORP) 30 August 2002 (2002-08-30) abstract paragraphs [0018] - [0077]; figure 1 ----- -/--	1-4,7,12



Further documents are listed in the continuation of Box C.



See patent family annex.

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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

"&" document member of the same patent family

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INTERNATIONAL SEARCH REPORT

International application No
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C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2011/272576 A1 (OTAKI HIROKI [JP] ET AL) 10 November 2011 (2011-11-10)	1-7, 10-12, 23-26,28
Y	abstract paragraphs [0001], [0012] - [0016], [0037] - [0100]; figures 1,3,5,6,8,12 -----	13,14, 17,18, 22,27
X	US 2010/133433 A1 (TANIMOTO SAYAKA [JP] ET AL) 3 June 2010 (2010-06-03)	1-7, 12-14, 17,18, 22-28
	abstract paragraphs [0002], [0038] - [0128]; claims 1-4,10,12; figures 1,2,4,5,7-10,14,17,20-23 -----	
X	US 9 165 742 B1 (SIMMONS RICHARD [US] ET AL) 20 October 2015 (2015-10-20)	23-27
Y	abstract column 1, line 29 - column 2, line 2 column 2, line 50 - column 3, line 25 column 5, line 5 - column 12, line 11; claims 1,5-7,15,32; figures 1,5-8 -----	13,14, 17,22,27
A	US 2007/194229 A1 (OKUDA HIROHITO [US] ET AL) 23 August 2007 (2007-08-23)	13,14
	abstract paragraphs [0037] - [0093]; figures 3-18 -----	
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A	US 2017/316912 A1 (ZEIDLER DIRK [DE] ET AL) 2 November 2017 (2017-11-02)	1,23
	cited in the application abstract paragraphs [0045] - [0095]; figures 1-5,10-15 -----	

INTERNATIONAL SEARCH REPORT

International application No.
PCT/EP2019/054393

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.:
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:

see additional sheet

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 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.:
1-7, 10-14, 18, 22-28(completely); 17(partially)
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.

FURTHER INFORMATION CONTINUED FROM PCT/ISA/ 210

This International Searching Authority found multiple (groups of) inventions in this international application, as follows:

1. claims: 1-4, 7, 12, 18

A charged particle beam system comprising:
 at least a first charged particle source configured to generate a first charged particle beam,
 a multi beam generator configured to generate a plurality of charged particle beamlets from the incoming first charged particle beam,
 an objective lens,
 a projective system,
 a sample stage
 a detector system comprising a plurality of individual detectors, and
 a control configured to control the operation of the multi beam generator, the objective lens and the projective system,
 wherein in a first mode of operation the control controls the multi beam generator to be configured that each individual beamlet of the plurality of charged particle beamlets is spatially separated from other beamlets of the plurality of charged particle beamlets, the objective lens to be configured to focus incoming charged particle beamlets in a first plane in a manner that a first region in which a first individual beamlet of the plurality of charged particle beamlets impinges in the first plane is spatially separated from a second region in which a second individual beamlet of the plurality of charged particle beamlets impinges in the first plane, the projective system to be configured to image interaction products leaving the first region within the first plane due to impinging charged particles onto a first one of the plurality of individual detectors and to image interaction products leaving the second region in the first plane due to impinging charged particles onto a second one of the plurality of individual detectors, and
 wherein in a second mode of operation the control controls the operation of the multi beam generator in combination with the objective lens to be configured that a single or plural defocused charged particle beam(s) is/are provided in the first plane (claim 1);
 further comprising a voltage supply configured to supply a variable voltage to the sample stage, wherein in the first mode of operation the control controls the objective lens and/or a voltage supply of the sample stage in a manner that the charged particles of the charged particle beamlets have a first average kinetic energy in the first plane, and
 wherein the control controls the objective lens and/or the voltage supply of the sample stage in the second mode in a manner that the charged particles have a second average kinetic energy in the first plane that is different from the first average kinetic energy (claims 3-4).

FURTHER INFORMATION CONTINUED FROM PCT/ISA/ 210

2. claims: 5, 6, 23-28

The charged particle beam system of claim 1, wherein in the second mode of operation the defocused charged particle beam has a second diameter in the first plane, wherein in the first mode of operation a minimum diameter of a circle surrounding an area onto which the plurality of charged particle beamlets impinge in the first plane has a first diameter, and wherein the second diameter is at least 1.2 times the first diameter, more preferable at least 2 times the first diameter, even more preferable at least 5 times the first diameter, even more preferable at least 10 times the first diameter, and most preferable at least 50 times the first diameter (claim 5); or wherein in the second mode of operation the defocused charged particle beam illuminates a surface in the first plane having a second surface area, wherein in the first mode of operation a minimum surface area within which all beamlets of the plurality of charged particle beamlets impinge in the first plane has a first area, and wherein the second surface area is at least 1.5 times, more preferable 4 times, even more preferable 10 times, even more preferable 100 times, and most preferable 200 times the first surface area (claim 6); or

A method of operating a charged particle beam system, comprising the steps:
 in a first mode of operation, forming a plurality of charged particle beamlets of a multi beam charged particle beam system, scanning a sample with the charged particle beamlets and detecting interaction products leaving the sample due to the impinging plurality of charged particles beamlets, and
 in a second mode of operation, flooding the sample with a defocused charged particle beam,
 switching between the first mode of operation and the second mode of operation several times while recording an image of the sample, and
 changing at least one of the parameters of landing energy, focus, stage position and
 beam deflection of the charged particle beam system when switching between the first mode of operation and the second mode of operation (claims 23-28).

3. claims: 8, 9

The charged particle beam system of claim 1, the multi beam generator comprising at least a first multi aperture plate, wherein the first multi aperture plate comprises a plurality of holes for forming the plurality of charged particle beamlets (claim 7), wherein the holes in first multi aperture plate have a first hole diameter, and wherein the first multi aperture plate has at least one second hole having a second hole diameter, and wherein the second hole diameter is at least 5 times the first hole diameter (claims 8-9).

FURTHER INFORMATION CONTINUED FROM PCT/ISA/ 210

4. claims: 10, 11, 13, 14, 22(completely); 17(partially)

The charged particle beam system of claim 7, wherein the charged particle beam system further comprises a first single or double deflection system arranged between the charged particle source and the first multi aperture plate, and a second single or double deflection system arranged between the first multi aperture plate and the objective lens (claims 10-11); or the charged particle beam system of claim 1, further comprising a second charge particle source providing a second charged particle beam, a deflection system and a beam stop, wherein the control is configured control the deflection system to direct the second charged particle beam onto the beam stop in the first mode of operation and to direct the second charged particle beam to pass the beam stop in the second mode of operation (claims 13-14; 17 when dependent on 14); or further comprising an projective beam stop between the first plane and the detector system and a deflection system between the first plane and the detector system, wherein the control is configured to control the deflection system to direct emission products form the charged particle beamlets to impinge onto the detector system in the first mode of operation and to direct the emission products of the second charged particle beamlets to the beam stop in the second mode or operation (claim 22).

5. claims: 15, 16, 19-21(completely); 17(partially)

The charged particle beam system of claim 1, wherein the projective system comprises a first subcomponent providing low-frequency adjustments and a second subcomponent providing a high frequency adjustments (claims 15-16, 17 when dependent thereon; 19-21).

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/EP2019/054393

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US 2017084424	A1	23-03-2017	NONE
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