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(71) Applicant: ASML NETHERLANDS B.V. [NL/NL]; P.O. Box 324, 5500 AH Veldhoven (NL).

(72) Inventors: SCHASFOORT, Gerard, Frans, Jozef; P.O. Box 324, 5500 AH Veldhoven (NL). DE GROOT, Pieter; P.O. Box 324, 5500 AH Veldhoven (NL). SLADKOV, Maksym, Yuriiovich; P.O. Box 324, 5500 AH Veldhoven (NL). DIKKERS, Manfred, Petrus, Johannes, Maria; P.O. Box 324, 5500 AH Veldhoven (NL). FINDERS, Jozef, Maria; P.O. Box 324, 5500 AH Veldhoven (NL). VAN ZWOL, Pieter-Jan; P.O. Box 324, 5500 AH Veldhoven (NL). BASELMANS, Johannes, Jacobus, Matheus; P.O. Box 324, 5500 AH Veldhoven (NL). BAUMER, Stefan; P.O. Box 324, 5500 AH Veldhoven (NL). DE WINTER, Laurentius, Cornelius; P.O. Box 324, 5500 AH Veldhoven (NL). ENGELLEN, Wouter, Joep; P.O. Box 324, 5500 AH Veldhoven (NL). VAN DE KERKHOF, Marcus, Adrianus; P.O. Box 324, 5500 AH Veldhoven (NL). VOOGD, Robbert Jan; P.O. Box 324, 5500 AH Veldhoven (NL).

(74) Agent: SLENDERS, Peter; ASML Netherlands B.V., P.O. Box 324, 5500 AH Veldhoven (NL).

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(54) Title: PATTERNING DEVICE

(57) Abstract: A patterning device comprising a reflective marker, wherein the marker comprises: a plurality of reflective regions configured to preferentially reflect radiation having a given wavelength; and a plurality of absorbing regions configured to preferentially absorb radiation having the given wavelength; wherein the absorbing and reflective regions are arranged to form a patterned radiation beam reflected from the marker when illuminated with radiation, and wherein the reflective regions comprise a roughened reflective surface, the roughened reflective surface being configured to diffuse radiation reflected from the reflective regions, and wherein the roughened reflective surface has a root mean squared roughness of about an eighth of the given wavelength or more.



INTERNATIONAL SEARCH REPORT

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A. CLASSIFICATION OF SUBJECT MATTER		
INV.	G03F1/24 G03F9/00	G03F1/42 G03F1/44 G02B5/02 G03F7/20
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) G03F G02B		
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, INSPEC, WPI Data		
C. DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	Jianglei Niu: "Investigation of the Reflectivity Uniformity for EUV lithography", 31 August 2013 (2013-08-31), XP055411632, Retrieved from the Internet: URL:https://pure.tue.nl/ws/files/46940704/760230-1.pdf [retrieved on 2017-10-02] page 8 - page 9 -----	1,2,5,6
X	EP 1 403 714 A2 (ASML NETHERLANDS BV [NL]) 31 March 2004 (2004-03-31) paragraph [0033] - paragraph [0051]; claims 1-18; figures 2,3 -----	1,2,9, 11,13 12,14,15
A	-/--	
☒ Further documents are listed in the continuation of Box C. ☒ See patent family annex.		
* Special categories of cited documents : "A" document defining the general state of the art which is not considered to be of particular relevance "E" earlier application or patent but published on or after the international filing date "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified) "O" document referring to an oral disclosure, use, exhibition or other means "P" document published prior to the international filing date but later than the priority date claimed "T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention "X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone "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		
Date of the actual completion of the international search 12 January 2018		Date of mailing of the international search report 19/01/2018
Name and mailing address of the ISA/ European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016		Authorized officer Angioni, Catherine

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Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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A	paragraphs [0051] - [0057], [0071] - [0085]; claims 4,5; figure 5 -----	12,14,15
Y	US 2002/160545 A1 (ANDERSON ERIK [US] ET AL) 31 October 2002 (2002-10-31)	1-11,13
A	paragraph [0031]; claims 16-20 -----	12,14,15
A	US 2005/275841 A1 (HEERENS GERT-JAN [NL] ET AL) 15 December 2005 (2005-12-15) the whole document -----	1-15
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International application No

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Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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X	US 2012/262688 A1 (DE VRIES GOSSE CHARLES [NL] ET AL) 18 October 2012 (2012-10-18) figures 5,7,12,13,15 -----	27,28, 31,33
A	EP 1 717 639 A2 (CANON KK [JP]) 2 November 2006 (2006-11-02) figures 1,10,11 -----	27-33
A	US 2009/268188 A1 (KATO SEIMA [JP] ET AL) 29 October 2009 (2009-10-29) figures 1-12 -----	27-33
X	US 2012/075610 A1 (DIERICHS MARCEL MATHIJS THEODORE MARIE [NL] ET AL) 29 March 2012 (2012-03-29) figures 2,5-7 -----	27,28,31
A	MINORU SUGAWARA ET AL: "Impact of slanted absorber side wall on printability in EUV lithography", PROCEEDINGS VOLUME 9025IS&T/SPIE ELECTRONIC IMAGING 2-6 FEBRUARY 2014INTELLIGENT ROBOTS AND COMPUTER VISION XXXI: ALGORITHMS AND TECHNIQUES, vol. 5992, 21 October 2005 (2005-10-21), page 59923V, XP055412436, US ISSN: 0277-786X, DOI: 10.1117/12.632419 ISBN: 978-1-5106-1354-6 the whole document -----	12,14,15
A	US 2004/227922 A1 (DIERICHS MARCEL MATHIJS THEODO [NL] ET AL) 18 November 2004 (2004-11-18) the whole document -----	27-33

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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.:
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: 1-15

The subject-matter of independent claims 1, 4 and 14 relates to a patterning device with a reflective marker comprising reflective regions and absorbing regions which are arranged to form a patterned radiation beam reflected from the marker when illuminated with radiation, and wherein the reflective regions act as a reflective diffuser. In particular, in claims 1 and 4, diffusion is obtained with a roughened reflective surface, while in claim 14, diffusion is obtained by providing absorbing portions with an asymmetric height profile.

2. claims: 16-26

The subject-matter of independent claims 16 and 21 relates to an EUV transmissive diffuser. The subject-matter of claim 22 relates to an optical apparatus for controlling the angular distribution of a beam, the apparatus comprising a first and a second material of different refractive indices and an array of lens formed in the second material. Claim 22 is so broadly formulated that it encompasses, e.g., standard mounted microlens arrays. In view of the dependent claim 23, it appears that the optical apparatus is meant to operate in transmission mode at EUV wavelength.

3. claims: 27-33

The subject-matter of independent claim 27 relates to an illumination system comprising a source to produce a radiation beam and a pair of reflective optical elements altering an angular distribution of the radiation beam, each reflective optical element being movable to a position such that the radiation beam is incident on the second reflective optical element and the radiation reflected from the second reflective element is incident on the first reflective optical element. The subject-matter of independent claim 31 relates to a lithographic apparatus comprising the illumination system according to claim 27.

INTERNATIONAL SEARCH REPORT

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International application No

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