

(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau



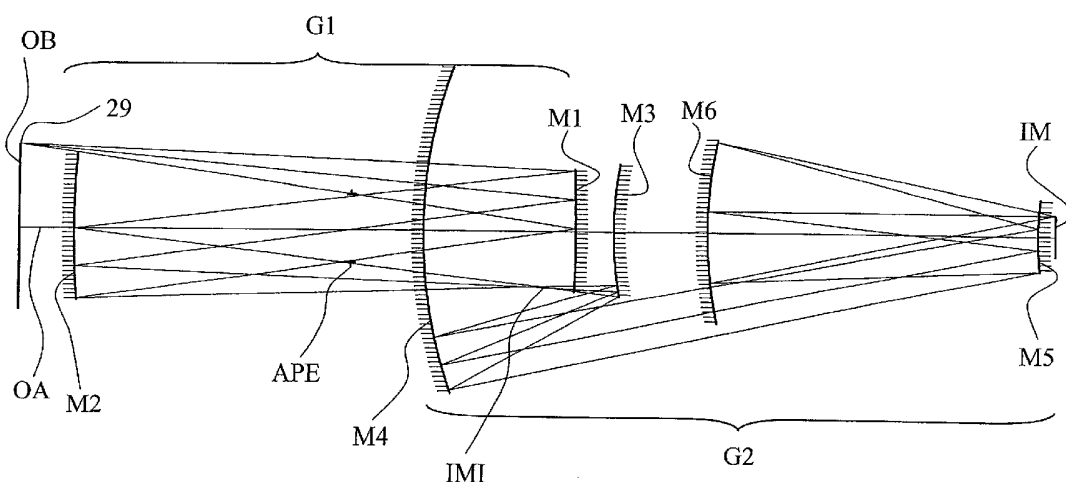
(43) International Publication Date
20 June 2002 (20.06.2002)

PCT

(10) International Publication Number
WO 02/048796 A3

- (51) International Patent Classification⁷: **G03F 7/20** (74) Agent: **MÜLLER-RISSMANN, Werner**; c/o Carl Zeiss, Patentabteilung, Carl-Zeiss-Strasse, 73446 Oberkochen (DE).
- (21) International Application Number: PCT/EP01/14301
- (22) International Filing Date: 6 December 2001 (06.12.2001) (81) Designated States (*national*): JP, KR, US.
- (25) Filing Language: English (84) Designated States (*regional*): European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE, TR).
- (26) Publication Language: English
- (30) Priority Data:
60/255,161 12 December 2000 (12.12.2000) US
Declaration under Rule 4.17:
— of inventorship (Rule 4.17(iv)) for US only
- (71) Applicant (*for all designated States except US*): **CARL ZEISS SEMICONDUCTOR MANUFACTURING** [DE/DE]; Technologies AG, Carl-Zeiss-Strasse, 73446 Oberkochen (DE).
- Published:
— with international search report
- (72) Inventors; and (88) Date of publication of the international search report:
23 January 2003
- (75) Inventors/Applicants (*for US only*): **MANN, Hans-Jürgen** [DE/DE]; Katzenbachstrasse 49, 73447 Oberkochen (DE). **HUDYMA, Russell** [US/US]; 218 Eastridge Drive, San Ramon, CA 84583-4905 (US).
- For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.*

(54) Title: PROJECTION SYSTEM FOR EUV LITHOGRAPHY



(57) Abstract: An EUV optical projection system includes at least six reflecting surfaces for imaging an object (OB) on an image (IM). The system is preferably configured to form an intermediate image (IMI) along an optical path from the object (OB) to the image (IM) between a secondary mirror (M2) and a tertiary mirror (M3), such that a primary mirror (M1) and the secondary mirror (M2) form a first optical group (G1) and the tertiary mirror (M3), a fourth mirror (M4), a fifth mirror (M5) and a sixth mirror (M6) form a second optical group (G2). The system also preferably includes an aperture stop (APE) located along the optical path from the object (OB) to the image (IM) between the primary mirror (M1) and the secondary mirror (M2). The secondary mirror (M2) is concave, and the tertiary mirror (M3) is convex. Each of the six reflecting surfaces preferably receives a chief ray (CR) from a central field point at an incidence angle of less than substantially 15°.

WO 02/048796 A3

INTERNATIONAL SEARCH REPORT

International Application No

EP 01/14301

A. CLASSIFICATION OF SUBJECT MATTER

IPC 7 G03F7/20

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)

IPC 7 G03F

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 practical, search terms used)

EPO-Internal, WPI Data, PAJ, INSPEC

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	DE 199 48 240 A (CARL ZEISS) 24 August 2000 (2000-08-24) claims 1,2,4,9-11,13,19,26; figure 1 ---	1-29
Y	WO 99 57606 A (KONINKLIJKE PHILIPS ELECTRONICS N.V.) 11 November 1999 (1999-11-11) claims 1,2,5,6; figures 1,2 ---	1-29
A	EP 0 779 528 A (SVG LITHOGRAPHIC SYSTEMS, INC.) 18 June 1997 (1997-06-18) cited in the application claims 1,12; figures 1,2 ---	1-29
E	EP 1 178 356 A (CARL ZEISS) 6 February 2002 (2002-02-06) claims 1,13,14,21,23,24; figures 4,5 -----	1-29



Further documents are listed in the continuation of box C.



Patent family members are listed in 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 document 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

16 July 2002

Date of mailing of the international search report

10.10.02

Name and mailing address of the ISA

European Patent Office, P.B. 5818 Patentlaan 2
NL - 2280 HV Rijswijk
Tel. (+31-70) 340-2040, Tx. 31 651 epo nl,
Fax: (+31-70) 340-3016

Authorized officer

Thiele, N

INTERNATIONAL SEARCH REPORT

International application No.
PCT/EP 01/14301

Box I Observations where certain claims were found unsearchable (Continuation of item 1 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 II Observations where unity of invention is lacking (Continuation of item 2 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 fee, this Authority did not invite payment of any additional fee.
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.:

1-29

Remark on Protest

- ☐ The additional search fees were accompanied by the applicant's protest.
- ☐ 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: 1-29

EUV optical projection system with six mirrors, wherein the first two mirrors and mirrors 3 to 6 form an optical group respectively, wherein the second mirror is concave and the third mirror is convex, and wherein an intermediate image is formed between the second and the third mirror; the numerical aperture should be greater than 0.18, an aperture stop should be between the first two mirrors, and a chief ray should diverge away from the optical axis between mirrors 2 and 3.

2. Claims: 30,31

EUV optical projection system with six mirrors, wherein no optical groups of mirrors are defined, and wherein the second mirror does not need to be concave and the third mirror does not need to be convex; an aperture stop is foreseen between mirrors 1 and 2, and a chief ray converges toward the optical path between mirrors 2 and 3.

INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No

EP 01/14301

Patent document cited in search report		Publication date	Patent family member(s)	Publication date
DE 19948240	A	24-08-2000	DE 19948240 A1	24-08-2000
			EP 1035445 A2	13-09-2000
			JP 2000235144 A	29-08-2000
			TW 464768 B	21-11-2001
			US 6353470 B1	05-03-2002

WO 9957606	A	11-11-1999	EP 1004057 A1	31-05-2000
			WO 9957606 A1	11-11-1999
			JP 2002509654 T	26-03-2002
			US 6255661 B1	03-07-2001

EP 779528	A	18-06-1997	US 5815310 A	29-09-1998
			CA 2192604 A1	13-06-1997
			EP 0779528 A2	18-06-1997
			JP 9211332 A	15-08-1997

EP 1178356	A	06-02-2002	DE 10037870 A1	14-02-2002
			EP 1178356 A2	06-02-2002
			JP 2002107630 A	10-04-2002
			US 2002056815 A1	16-05-2002
