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[Continued on next page]

(54) Title: EXTREME ULTRAVIOLET LIGHT SOURCE

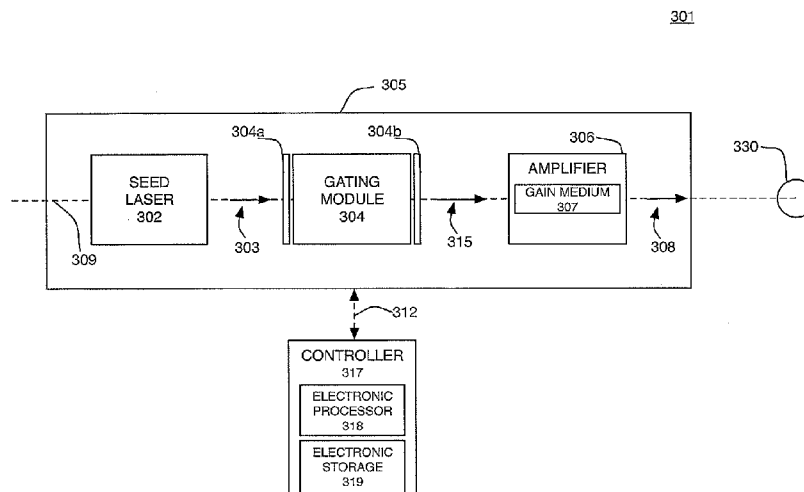


FIG. 3A

(57) Abstract: An initial pulse of radiation is generated; a section of the initial pulse of radiation is extracted to form a modified pulse of radiation, the modified pulse of radiation including a first portion and a second portion, the first portion being temporally connected to the second portion, and the first portion having a maximum energy that is less than a maximum energy of the second portion; the first portion of the modified pulse of radiation is interacted with a target material to form a modified target; and the second portion of the modified pulse of radiation is interacted with the modified target to generate plasma that emits extreme ultraviolet (EUV) light.

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- *with international search report (Art. 21(3))*
- *before the expiration of the time limit for amending the claims and to be republished in the event of receipt of amendments (Rule 48.2(h))*

## INTERNATIONAL SEARCH REPORT

International application No.

PCT/US 15/37799

## A. CLASSIFICATION OF SUBJECT MATTER

IPC(8) - G21B 1/00, G03F 7/20, G21K 5/08, H05G 2/00 (2015.01)

CPC - G21K 5/04, H05G 2/008, H05G 2/006, H05G 2/001, H05G 2/003, H05G 2/005

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)

CPC - G21K5/04, H05G2/008, H05G2/006, H05G2/001, H05G2/003, H05G2/005

IPC(8) - G21B1/00, G03F7/20, G21K5/08, H05G2/00 (2015.01)

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

CPC - G21K5/04, H05G2/008, H05G2/006, H05G2/001, H05G2/003, H05G2/005

IPC(8) - G21B1/00, G03F7/20, G21K5/08, H05G2/00 (2015.01); USPC - 315/111.81

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

Patbase; Google Scholar, FreePatentsonline

Search terms used: extreme ultraviolet uv euv pulse target light laser portion part first second temporal time amplifier gain medium modify split

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X --- Y --- A	US 2005/0258768 A1 (GAEBEL et al.) 24 November 2005 (24.11.2005), Fig 2; para [0010], [0012], [0051], [0053], [0056], [0060]	1, 4, 7 ----- 5, 6, 10, 12, 13 ----- 2, 3, 9, 11
X --- A	US 2013/0327963 A1 (LAMBERT et al.) 12 December 2013 (12.12.2013), Fig 1; para [0006], [0020]-[0026], [0048], [0051]	1, 4, 7, 8 ----- 2, 3, 9, 11
Y	US 2012/0243566 A1 (HORI et al.) 27 September 2012 (27.09.2012), para [0009], [0210], [0211], para [0160], [0162]; claim 28	5, 6, 10, 12, 13
A	US 2007/0291350 A1 (ERSHOV et al.) 20 December 2007 (20.12.2007), para [0002], [0007], [0038]	2, 3, 9, 11
A	US 2012/0229889 A1 (SUGANUMA et al) 13 September 2012 (13.09.2012), entire document	1-13
A	US 2013/0148674 A1 (NOWAK et al.) 13 June 2013 (13.06.2013), entire document	1-13

 Further documents are listed in the continuation of Box C.

\* 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

"&amp;" document member of the same patent family

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26 October 2015 (26.10.2015)

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**INTERNATIONAL SEARCH REPORT**

International application No.

PCT/US 15/37799

**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:

This application contains the following inventions or groups of inventions which are not so linked as to form a single general inventive concept under PCT Rule 13.1. In order for all inventions to be examined, the appropriate additional examination fees must be paid.

Group I: Claims 1-13 drawn to method comprising generating an initial pulse of radiation.

Group II: Claims 14-16, drawn to a method of generating extreme ultraviolet (EUV) light.

Group III: Claims 17-23, drawn to an extreme ultraviolet (EUV) system.

-- see extra 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 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.:  
1-13

**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.

INTERNATIONAL SEARCH REPORT

International application No.

PCT/US 15/37799

Continuation of Box No. III -- Observations where unity of invention is lacking

The inventions listed as Groups I through III do not relate to a single general inventive concept under PCT Rule 13.1 because, under PCT Rule 13.2, they lack the same or corresponding special technical features for the following reasons:

**Special Technical Features**

Group I includes the special technical feature of the first portion having maximum energy that is less than a maximum energy of the second portion, not included in the other groups.

Group II includes the special technical feature of the target being expanded spatially prior to reaching the target location, not included in the other groups.

Group III includes the special technical feature of a modulator configured to receive the beam of light emitted from the light source, not included in the other groups.

**Common Technical Features:**

The only technical features shared by Groups I-III that would otherwise unify the groups, are a pulse of radiation, directing a pulse of radiation toward the target location, the pulse of radiation comprising a first portion and a second portion being temporally related; interacting the first portion of the modified pulse of radiation with a target material to form a modified target; and interacting the second portion of the pulse of radiation with the modified target to generate plasma that emits EUV light. However, these shared technical features do not represent a contribution over prior art, because the shared technical features are disclosed by US 2005/0258768 A1 to Gaebel et al. (hereinafter Gaebel)

Gaebel discloses a pulse of radiation (para [0010], a pulsed high-energy beam), directing a pulse of radiation toward the target location, the pulse of radiation comprising a first portion and a second portion being temporally related; interacting the first portion of the modified pulse of radiation with a target material to form a modified target (para [0010], [0012], a target flow that is provided in a reproducible manner are made to interact with a pulsed high-energy beam...an additional energy beam is directed on the target flow spatially in advance of its interaction with the high-energy beam...The additional energy beam is advantageously split off from the high-energy beam); and interacting the second portion of the pulse of radiation with the modified target to generate plasma that emits EUV light.(para [0010], generation of extreme ultraviolet (EUV) radiation...the target flow is excited at an interaction point...by the high-energy beam for generating a hot, radiating plasma).

As the technical features were known in the art at the time of the invention, these cannot be considered special technical features that would otherwise unify the groups.

Therefore, Groups I-III lack unity under PCT Rule 13.