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Published:

— with international search report (Art. 21(3))

[Continued on next page]

(54) Title: GERMANIUM PHOTODETECTOR

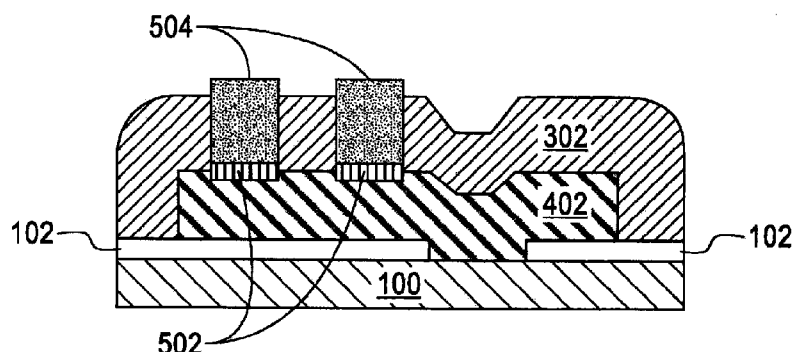


FIG. 5

(57) Abstract: A method for forming a photodetector device includes forming an insulator layer on a substrate, forming a germanium (Ge) layer on the insulator layer and a portion of the substrate, forming a second insulator layer on the Ge layer, implanting n-type ions in the Ge layer, patterning the n-type Ge layer, forming a capping insulator layer on the second insulator layer and a portion of the first insulator layer, heating the device to crystallize the Ge layer resulting in an single crystalline n-type Ge layer, and forming electrodes electrically connected to the single crystalline n-type Ge layer.

— *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))*

(88) Date of publication of the international search report:
1 March 2012

INTERNATIONAL SEARCH REPORT

International application No

PCT/EP2011/060377

A. CLASSIFICATION OF SUBJECT MATTER
 INV. H01L31/102 H01L31/18
 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)

H01L G01T

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 , INSPEC

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	ASSEFA S ET AL: "CMOS-integrated 40GHz germanium waveguide photodetector for on-chip optical interconnects" , OPTICAL FIBER COMMUNICATION - INCLUDES POST DEADLINE PAPERS, 2009. OFC 2009. CONFERENCE ON, IEEE, PISCATAWAY, NJ, USA, 22 March 2009 (2009-03-22) , pages 1-3 , XP031467714, ISBN: 978-1-4244-2606-5	1,20
Y	the whole document	2-4
X	Wo 2009/052479 A2 (BAE SYSTEMS INFORMATION [US] ; CAROTHERS DANIEL N [US] ; HILL CRAIG M [U] 23 April 2009 (2009-04-23)	20
Y	page 5, line 1 - page 8, line 10	2-4
A		1
	----- -/- .	



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 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

11 October 2011

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Name and mailing address of the ISA/

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INTERNATIONAL SEARCH REPORT

International application No

PCT/EP2011/060377

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	VU V A ET AL: "PIN Germani um Photodetector Fabri cati on Issues and Manufacturabi li ty" , IEEE TRANSACTIONS ON SEMICONDUCTOR MANUFACTURING, IEEE SERVICE CENTER, PISCATAWAY, NJ , US, vol . 23, no. 3, 20 May 2010 (2010-05-20) , pages 411-418, XP011309606, ISSN: 0894-6507	20
Y	page 412-413 , chapter 'I I. Photodetector	2-4
A	Fabri cati on Process ' figures 1, 2, 5, 6	1
X	US 2007/004067 AI (HSU SHENG T [US] ET AL HSU SHENG TENG [US] ET AL) 4 January 2007 (2007-01-04)	20
A	paragraph [0048] - paragraph [0055] figure 7	1-4
A	SOLOMON ASSEFA ET AL: "CMOS-Integrated Opti cal Recei vers for On-Chi p Interconnects" , IEEE JOURNAL OF SELECTED TOPICS IN QUANTUM ELECTRONICS, IEEE SERVICE CENTER, PISCATAWAY, NJ , US, vol . 16, no. 5, 7 June 2010 (2010-06-07) , pages 1376-1385 , XP011310935 , ISSN: 1077-260X pages 1379-1380, chapter 'I I I . B. Ge Integrati on ' pages 1381-1883 , chapter 'IV. Monol i thi c Integrati on w i t h CMOS '	1-4,20
A	WOLF S ET AL: "Ion Impantati on for VLSI " , 1 January 1986 (1986-01-01) , SI LICON PROCESSING FOR THE VLSI ERA. VOLUME 1: PROCESS TECHNOLOGY, LATTICE PRESS, SUNSET BEACH, CALI FORNIA, USA, PAGE(S) 280 - 330, XP008095222 , ISBN: 978-0-9616721-3-3 pages 323-325 , chapter ' Impl anti ng Through Surface Layers '	1

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/EP2011/060377

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
WO 2009052479 A2	23-04-2009	US 2010029033 A1	04-02-2010
		WO 2009052479 A2	23-04-2009

US 2007004067 A1	04-01-2007	US 2007004067 A1	04-01-2007
		US 2007290288 A1	20-12-2007

INTERNATIONAL SEARCH REPORT

International application No.
PCT/EP2011/060377

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. :

1-4, 20

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, 20

A method comprising a growth process with a single common crystallization and activation heat treatment step.

1.1. claim: 20

A device comprising a n-type doped Ge layer, an insulator and a pair of electrodes .

2. claims: 5-10

A method comprising a growth process with a separate crystallization heat treatment and a separate activation heat treatment.

3. claims: 11-14

A method comprising an epitaxial n-type deposition process .

4. claims: 15-19

A method comprising an epitaxial deposition process with a separate n-type implant/activation heat treatment step.
