

PATENT COOPERATION TREATY

From the
INTERNATIONAL SEARCHING AUTHORITY

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PCT

WRITTEN OPINION OF THE
INTERNATIONAL SEARCHING AUTHORITY

(PCT Rule 43bis.1)

Date of mailing
(day/month/year)

17 SEP 2018

Applicant's or agent's file reference
101879.000065

FOR FURTHER ACTION

See paragraph 2 below

International application No.
PCT/US18/39541

International filing date (day/month/year)
26 June 2018 (26.06.2018)

Priority date (day/month/year)
26 June 2017 (26.06.2017)

International Patent Classification (IPC) or both national classification and IPC

IPC - G02B 5/18, 6/10, 6/12, 6/124, 6/13, 3/136, 6/30 (2018.01)

CPC - G02B 5/18, 5/1819, 5/1828, 5/1847, 5/1857, 5/1861, 5/1866, 6/0016, 6/0038, 6/0065, 6/124, 6/136, 6/30

Applicant **The Trustees of Columbia University in the City of New York**

1. This opinion contains indications relating to the following items:

- Box No. I Basis of the opinion
- Box No. II Priority
- Box No. III Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
- Box No. IV Lack of unity of invention
- Box No. V Reasoned statement under Rule 43bis.1(a)(i) with regard to novelty, inventive step and industrial applicability; citations and explanations supporting such statement
- Box No. VI Certain documents cited
- Box No. VII Certain defects in the international application
- Box No. VIII Certain observations on the international application

2. **FURTHER ACTION**

If a demand for international preliminary examination is made, this opinion will be considered to be a written opinion of the International Preliminary Examining Authority ("IPEA") except that this does not apply where the applicant chooses an Authority other than this one to be the IPEA and the chosen IPEA has notified the International Bureau under Rule 66.1bis(b) that written opinions of this International Searching Authority will not be so considered.

If this opinion is, as provided above, considered to be a written opinion of the IPEA, the applicant is invited to submit to the IPEA a written reply together, where appropriate, with amendments, before the expiration of 3 months from the date of mailing of Form PCT/ISA/220 or before the expiration of 22 months from the priority date, whichever expires later.

For further options, see Form PCT/ISA/220.

Name and mailing address of the ISA/US
Mail Stop PCT, Attn: ISA/US
Commissioner for Patents
P.O. Box 1450, Alexandria, Virginia 22313-1450
Facsimile No. 571-273-8300

Date of completion of this opinion
23 August 2018 (23.08.2018)

Authorized officer
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Box No. I Basis of this opinion

1. With regard to the language, this opinion has been established on the basis of:
- the international application in the language in which it was filed.
 - a translation of the international application into _____ which is the language of a translation furnished for the purposes of international search (Rules 12.3(a) and 23.1(b)).
2. This opinion has been established taking into account the **rectification of an obvious mistake** authorized by or notified to this Authority under Rule 91 (Rule 43*bis*.1(a)).
3. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, this opinion has been established on the basis of a sequence listing:
- a. forming part of the international application as filed:
 - in the form of an Annex C/ST.25 text file.
 - on paper or in the form of an image file.
 - b. furnished together with the international application under PCT Rule 13*ter*.1(a) for the purposes of international search only in the form of an Annex C/ST.25 text file.
 - c. furnished subsequent to the international filing date for the purposes of international search only:
 - in the form of an Annex C/ST.25 text file (Rule 13*ter*.1(a)).
 - on paper or in the form of an image file (Rule 13*ter*.1(b) and Administrative Instructions, Section 713).
4. In addition, in the case that more than one version or copy of a sequence listing has been filed or furnished, the required statements that the information in the subsequent or additional copies is identical to that forming part of the application as filed or does not go beyond the application as filed, as appropriate, were furnished.
5. Additional comments:

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Box No. III Non-establishment of opinion with regard to novelty, inventive step and industrial applicability

The questions whether the claimed invention appears to be novel, to involve an inventive step (to be non obvious), or to be industrially applicable have not been examined in respect of:

the entire international application.

claims Nos. 6-8 & 13-20

because:

the said international application, or the said claims Nos. _____ relate to the following subject matter which does not require an international search (*specify*):

the description, claims or drawings (*indicate particular elements below*) or said claims Nos. 6-8 & 13-20 are so unclear that no meaningful opinion could be formed (*specify*):

because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

the claims, or said claims Nos. _____ are so inadequately supported by the description that no meaningful opinion could be formed (*specify*):

no international search report has been established for said claims Nos. 6-8 & 13-20

a meaningful opinion could not be formed without the sequence listing; the applicant did not, within the prescribed time limit:

furnish a sequence listing in the form of an Annex C/ST.25 text file, and such listing was not available to the International Searching Authority in the form and manner acceptable to it; or the sequence listing furnished did not comply with the standard provided for in Annex C of the Administrative Instructions.

furnish a sequence listing on paper or in the form of an image file complying with the standard provided for in Annex C of the Administrative Instructions, and such listing was not available to the International Searching Authority in the form and manner acceptable to it; or the sequence listing furnished did not comply with the standard provided for in Annex C of the Administrative Instructions.

pay the required late furnishing fee for the furnishing of a sequence listing in response to an invitation under Rule 13ter.1(a) or (b).

See Supplemental Box for further details.

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Box No. V Reasoned statement under Rule 43bis.1(a)(i) with regard to novelty, inventive step and industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty (N)	Claims	NONE	YES
	Claims	1-5 & 9-12	NO
Inventive step (IS)	Claims	NONE	YES
	Claims	1-5 & 9-12	NO
Industrial applicability (IA)	Claims	1-5 & 9-12	YES
	Claims	NONE	NO

2. Citations and explanations:

Claims 1-4, 5/1-5/2, 9-11 & 12/8-12/11 lack novelty under PCT Article 33(2) as being anticipated by US 2009/0290837 A1 to CHEN, X et al. (hereinafter "Chen").

As per claim 1, Chen discloses a millimeter scale weak grating coupler (optical device comprising a grating structure for coupling of light; abstract; figures 1A-2; paragraph [0040]) comprising a waveguide having a plurality of bars of overlay material of length (a) disposed periodically at a period (Λ) adjacent the waveguide (waveguiding layer 100 includes waveguide grating 110 having a length (a) and a period Λ disposed on the topside of waveguide; figures 1A-2; paragraphs [0023 & 0028-0040]).

As per claim 2, Chen discloses the grating coupler of claim 1. Chen further discloses wherein a duty cycle of (a/Λ) is uniform along the top of the waveguide (grating duty cycle of grating section 112 of grating 110 may be uniform; figures 1A-2; paragraphs [0033-0037]).

As per claim 3, Chen discloses the grating coupler of claim 1. Chen further discloses wherein a duty cycle of (a/Λ) is varied along the top of the waveguide (grating duty cycle of grating section 111 of grating 110 may be chirped (varied); figures 1A-2; paragraphs [0031-0033]).

As per claim 4, Chen discloses the grating coupler of claim 3. Chen further discloses wherein the duty cycle increases along the waveguide as a grating strength decreases (grating duty cycle of grating section 111 of grating 110 may be chirped (duty cycle increases along the waveguide as a grating strength decreases duty cycle increases along the silicon waveguide as a grating strength decreases); figures 1A-2; paragraphs [0031-0033]).

As per claims 5/1-5/4, Chen discloses the grating coupler of claims 1-4 respectively. Chen further discloses a stop layer disposed between the overlay material and the waveguide (buried oxide layer 210 (stop layer) between the waveguiding layer 100 and silicon substrate 220; figure 2; paragraph [0040]).

As per claim 9, Chen discloses a method of forming a grating coupler (optical device comprising a grating structure for coupling of light and manufacture thereof; abstract; figures 1A-2; paragraph [0040]) comprising: a. depositing on a wafer a stop layer (buried oxide layer 210 disposed on silicon wafer 220; figure 2; paragraph [0040]); b. depositing a grating layer on the stop layer (waveguiding layer 100 disposed on buried oxide layer 210; figure 2; paragraph [0040]); c. patterning desired gratings (waveguiding layer 100 is masked into the pattern of grating 110; figures 1A-2; paragraphs [0005 & 0022]); and d. etching, based on the patterning, the grating layer to create the desired gratings (waveguiding layer 100 with mask thereon is etched into the desired pattern of grating 110; figures 1A-2; paragraphs [0005 & 0022]), whereby bars of the remaining grating layer of width "w" and length "a" are disposed periodically at a period " Λ " on the wafer (waveguiding layer 100 includes waveguide grating 110 having a width (w), a length (a) and a period Λ disposed on the topside of waveguide; figures 1A-2; paragraphs [0023, 0026 & 0028-0040]).

As per claim 10, Chen discloses the method of claim 9. Chen further discloses wherein a duty cycle of (a/Λ) is uniform along the top of the wafer (grating duty cycle of grating section 112 of grating 110 may be uniform; figures 1A-2; paragraphs [0033-0037]).

As per claim 11, Chen discloses the method of claim 9. Chen further discloses wherein a duty cycle of (a/Λ) is varied along the top of the wafer (grating duty cycle of grating section 111 of grating 110 may be chirped (varied); figures 1A-2; paragraphs [0031-0033]).

As per claims 12/9-12/11, Chen discloses the method of claims 9-11 respectively. Chen further discloses patterning and etching a waveguide from the wafer whereby the duty cycle of a/Λ increases along the waveguide moving away from a light source (waveguiding layer 100 with mask thereon is etched into grating section 111 of grating 110 wherein the duty cycle of grating section 111 may be chirped; figures 1A-2; paragraphs [0005 & 0022]).

Claims 1-5 & 9-12 have industrial applicability as defined by PCT Article 33(4) because the subject matter can be made or used in industry.

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Box No. VIII Certain observations on the international application

The following observations on the clarity of the claims, description, and drawings or on the question whether the claims are fully supported by the description, are made:

Claims 1 and 4 are objected to under PCT Rule 66.2(a)(v) as lacking clarity under PCT Article 6 because claims 1 and 4 are indefinite for the following reason(s):

Claims 1 and 4 contain the language "the silicon waveguide" which lacks antecedent basis. For the purpose of this opinion "the silicon waveguide" is interpreted as "the waveguide".