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P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NO.	ISSUE DATE	PATENT NO.	ATTORNEY DOCKET NO.	CONFIRMATION NO.
15/137,823	08/07/2018	10042116	PAT260-018US	2275

27543 7590 07/18/2018
APPLIED OPTOELECTRONICS, INC.
13115 JESS PIRTLE BLVD.
SUGAR LAND, TX 77478

ISSUE NOTIFICATION

The projected patent number and issue date are specified above.

Determination of Patent Term Adjustment under 35 U.S.C. 154 (b) (application filed on or after May 29, 2000)

The Patent Term Adjustment is 0 day(s). Any patent to issue from the above-identified application will include an indication of the adjustment on the front page.

If a Continued Prosecution Application (CPA) was filed in the above-identified application, the filing date that determines Patent Term Adjustment is the filing date of the most recent CPA.

Applicant will be able to obtain more detailed information by accessing the Patent Application Information Retrieval (PAIR) WEB site (<http://pair.uspto.gov>).

Any questions regarding the Patent Term Extension or Adjustment determination should be directed to the Office of Patent Legal Administration at (571)-272-7702. Questions relating to issue and publication fee payments should be directed to the Application Assistance Unit (AAU) of the Office of Data Management (ODM) at (571)-272-4200.

APPLICANT(s) (Please see PAIR WEB site <http://pair.uspto.gov> for additional applicants):

I-Lung HO, Sugar Land, TX;
Applied Optoelectronics, Inc., Sugar Land, TX;
Zhengyu MIAO, Sugar Land, TX;
Qin LI, Houston, TX;

The United States represents the largest, most dynamic marketplace in the world and is an unparalleled location for business investment, innovation, and commercialization of new technologies. The USA offers tremendous resources and advantages for those who invest and manufacture goods here. Through SelectUSA, our nation works to encourage and facilitate business investment. To learn more about why the USA is the best country in the world to develop technology, manufacture products, and grow your business, visit SelectUSA.gov.

PART B - FEE(S) TRANSMITTAL

Complete and send this form, together with applicable fee(s), to: **Mail** **Mail Stop ISSUE FEE**
Commissioner for Patents
P.O. Box 1450
Alexandria, Virginia 22313-1450
or Fax **(571)-273-2885**

INSTRUCTIONS: This form should be used for transmitting the ISSUE FEE and PUBLICATION FEE (if required). Blocks 1 through 5 should be completed where appropriate. All further correspondence including the Patent, advance orders and notification of maintenance fees will be mailed to the current correspondence address as indicated unless corrected below or directed otherwise in Block 1, by (a) specifying a new correspondence address; and/or (b) indicating a separate "FEE ADDRESS" for maintenance fee notifications.

CURRENT CORRESPONDENCE ADDRESS (Note: Use Block 1 for any change of address)

27543 7590 06/04/2018
APPLIED OPTOELECTRONICS, INC.
13115 JESS PIRTLE BLVD.
SUGAR LAND, TX 77478

Note: A certificate of mailing can only be used for domestic mailings of the Fee(s) Transmittal. This certificate cannot be used for any other accompanying papers. Each additional paper, such as an assignment or formal drawing, must have its own certificate of mailing or transmission.

Certificate of Mailing or Transmission

I hereby certify that this Fee(s) Transmittal is being deposited with the United States Postal Service with sufficient postage for first class mail in an envelope addressed to the Mail Stop ISSUE FEE address above, or being facsimile transmitted to the USPTO (571) 273-2885, on the date indicated below.

April Davis	(Depositor's name)
<i>April Davis</i>	(Signature)
July 5, 2018	(Date)

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
15/137,823	04/25/2016	I-Lung HO	PAT260-018US	2275

TITLE OF INVENTION: TECHNIQUES FOR DIRECT OPTICAL COUPLING OF PHOTODETECTORS TO OPTICAL DEMULTIPLEXER OUTPUTS AND AN OPTICAL TRANSCIVER USING THE SAME

APPLN. TYPE	ENTITY STATUS	ISSUE FEE DUE	PUBLICATION FEE DUE	PREV. PAID ISSUE FEE	TOTAL FEE(S) DUE	DATE DUE
nonprovisional	UNDISCOUNTED	\$1000	\$0	\$0	\$1000	09/04/2018

EXAMINER	ART UNIT	CLASS-SUBCLASS
PHAN, HANH	2636	398-087000

1. Change of correspondence address or indication of "Fee Address" (37 CFR 1.363).
☐ Change of correspondence address (or Change of Correspondence Address form PTO/SB/122) attached.
☐ "Fee Address" indication (or "Fee Address" Indication form PTO/SB/47; Rev 03-02 or more recent) attached. **Use of a Customer Number is required.**

2. For printing on the patent front page, list
 (1) The names of up to 3 registered patent attorneys or agents OR, alternatively,
 (2) The name of a single firm (having as a member a registered attorney or agent) and the names of up to 2 registered patent attorneys or agents. If no name is listed, no name will be printed.

1 Grossman Tucker Perreault
 2 & Pflieger, PLLC
 3 Norman S. Kinsella

3. ASSIGNEE NAME AND RESIDENCE DATA TO BE PRINTED ON THE PATENT (print or type)

PLEASE NOTE: Unless an assignee is identified below, no assignee data will appear on the patent. If an assignee is identified below, the document has been filed for recordation as set forth in 37 CFR 3.11. Completion of this form is NOT a substitute for filing an assignment.

(A) NAME OF ASSIGNEE

Applied Optoelectronics, Inc.

(B) RESIDENCE: (CITY and STATE OR COUNTRY)

Sugar Land, Texas

Please check the appropriate assignee category or categories (will not be printed on the patent): ☐ Individual ☒ Corporation or other private group entity ☐ Government

4a. The following fee(s) are submitted:

☒ Issue Fee
☐ Publication Fee (No small entity discount permitted)
☐ Advance Order - # of Copies _____

4b. Payment of Fee(s): (Please first reapply any previously paid issue fee shown above)

☐ A check is enclosed.
☐ Payment by credit card. Form PTO-2038 is attached.
☒ The director is hereby authorized to charge the required fee(s), any deficiency, or credits any overpayment, to Deposit Account Number 50-1705 (enclose an extra copy of this form).

5. Change in Entity Status (from status indicated above)

☐ Applicant certifying micro entity status. See 37 CFR 1.29
☐ Applicant asserting small entity status. See 37 CFR 1.27
☐ Applicant changing to regular undiscounted fee status

NOTE: Absent a valid certification of Micro Entity Status (see forms PTO/SB/15A and 15B), issue fee payment in the micro entity amount will not be accepted at the risk of application abandonment.

NOTE: If the application was previously under micro entity status, checking this box will be taken to be a notification of loss of entitlement to micro entity status.

NOTE: Checking this box will be taken to be a notification of loss of entitlement to small or micro entity status, as applicable.

NOTE: This form must be signed in accordance with 37 CFR 1.31 and 1.33. See 37 CFR 1.4 for signature requirements and certifications.

Authorized Signature _____
 Typed or printed name **Kevin J. Carroll**

Date **July 5, 2018**
 Registration No. **36,384**

Electronic Patent Application Fee Transmittal				
Application Number:		15137823		
Filing Date:		25-Apr-2016		
Title of Invention:		TECHNIQUES FOR DIRECT OPTICAL COUPLING OF PHOTODETECTORS TO OPTICAL DEMULTIPLEXER OUTPUTS AND AN OPTICAL TRANSCEIVER USING THE SAME		
First Named Inventor/Applicant Name:		I-Lung HO		
Filer:		Kevin J. Carroll/April Davis		
Attorney Docket Number:		PAT260-018US		
Filed as Large Entity				
Filing Fees for Utility under 35 USC 111(a)				
Description	Fee Code	Quantity	Amount	Sub-Total in USD(\$)
Basic Filing:				
Pages:				
Claims:				
Miscellaneous-Filing:				
Petition:				
Patent-Appeals-and-Interference:				
Post-Allowance-and-Post-Issuance:				
UTILITY APPL ISSUE FEE	1501	1	1000	1000

Description	Fee Code	Quantity	Amount	Sub-Total in USD(\$)
Extension-of-Time:				
Miscellaneous:				
Total in USD (\$)				1000

Electronic Acknowledgement Receipt

EFS ID:	33096870
Application Number:	15137823
International Application Number:	
Confirmation Number:	2275
Title of Invention:	TECHNIQUES FOR DIRECT OPTICAL COUPLING OF PHOTODETECTORS TO OPTICAL DEMULTIPLEXER OUTPUTS AND AN OPTICAL TRANSCEIVER USING THE SAME
First Named Inventor/Applicant Name:	I-Lung HO
Customer Number:	27543
Filer:	Kevin J. Carroll/April Davis
Filer Authorized By:	Kevin J. Carroll
Attorney Docket Number:	PAT260-018US
Receipt Date:	05-JUL-2018
Filing Date:	25-APR-2016
Time Stamp:	15:37:47
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	DA
Payment was successfully received in RAM	\$ 1000
RAM confirmation Number	070618INTEFSW00002008501705
Deposit Account	501705
Authorized User	April Davis

The Director of the USPTO is hereby authorized to charge indicated fees and credit any overpayment as follows:

37 CFR 1.16 (National application filing, search, and examination fees)

37 CFR 1.17 (Patent application and reexamination processing fees)

IPR2025-00435, Exhibit 1002, Page 5

37 CFR 1.19 (Document supply fees)
 37 CFR 1.20 (Post Issuance fees)
 37 CFR 1.21 (Miscellaneous fees and charges)

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Issue Fee Payment (PTO-85B)	IssueFee_Transmittal.pdf	102555	no	1
			be645dd04844189c123ff4289c4138a1f1f12110		

Warnings:

Information:

2	Fee Worksheet (SB06)	fee-info.pdf	30407	no	2
			55f959417367c9afde2dd60d36b2c8aaa401477a		

Warnings:

Information:

Total Files Size (in bytes):			132962
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This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

New Applications Under 35 U.S.C. 111

If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371

If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office

If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.



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NOTICE OF ALLOWANCE AND FEE(S) DUE

27543 7590 06/04/2018
APPLIED OPTOELECTRONICS, INC.
13115 JESS PIRTLE BLVD.
SUGAR LAND, TX 77478

EXAMINER

PHAN, HANH

ART UNIT

PAPER NUMBER

2636

DATE MAILED: 06/04/2018

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
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15/137,823

04/25/2016

I-Lung HO

PAT260-018US

2275

TITLE OF INVENTION: TECHNIQUES FOR DIRECT OPTICAL COUPLING OF PHOTODETECTORS TO OPTICAL DEMULTIPLEXER OUTPUTS
AND AN OPTICAL TRANSCEIVER USING THE SAME

APPLN. TYPE	ENTITY STATUS	ISSUE FEE DUE	PUBLICATION FEE DUE	PREV. PAID ISSUE FEE	TOTAL FEE(S) DUE	DATE DUE
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nonprovisional

UNDISCOUNTED

\$1000

\$0

\$0

\$1000

09/04/2018

THE APPLICATION IDENTIFIED ABOVE HAS BEEN EXAMINED AND IS ALLOWED FOR ISSUANCE AS A PATENT. PROSECUTION ON THE MERITS IS CLOSED. THIS NOTICE OF ALLOWANCE IS NOT A GRANT OF PATENT RIGHTS. THIS APPLICATION IS SUBJECT TO WITHDRAWAL FROM ISSUE AT THE INITIATIVE OF THE OFFICE OR UPON PETITION BY THE APPLICANT. SEE 37 CFR 1.313 AND MPEP 1308.

THE ISSUE FEE AND PUBLICATION FEE (IF REQUIRED) MUST BE PAID WITHIN THREE MONTHS FROM THE MAILING DATE OF THIS NOTICE OR THIS APPLICATION SHALL BE REGARDED AS ABANDONED. THIS STATUTORY PERIOD CANNOT BE EXTENDED. SEE 35 U.S.C. 151. THE ISSUE FEE DUE INDICATED ABOVE DOES NOT REFLECT A CREDIT FOR ANY PREVIOUSLY PAID ISSUE FEE IN THIS APPLICATION. IF AN ISSUE FEE HAS PREVIOUSLY BEEN PAID IN THIS APPLICATION (AS SHOWN ABOVE), THE RETURN OF PART B OF THIS FORM WILL BE CONSIDERED A REQUEST TO REAPPLY THE PREVIOUSLY PAID ISSUE FEE TOWARD THE ISSUE FEE NOW DUE.

HOW TO REPLY TO THIS NOTICE:

I. Review the ENTITY STATUS shown above. If the ENTITY STATUS is shown as SMALL or MICRO, verify whether entitlement to that entity status still applies.

If the ENTITY STATUS is the same as shown above, pay the TOTAL FEE(S) DUE shown above.

If the ENTITY STATUS is changed from that shown above, on PART B - FEE(S) TRANSMITTAL, complete section number 5 titled "Change in Entity Status (from status indicated above)".

For purposes of this notice, small entity fees are 1/2 the amount of undiscounted fees, and micro entity fees are 1/2 the amount of small entity fees.

II. PART B - FEE(S) TRANSMITTAL, or its equivalent, must be completed and returned to the United States Patent and Trademark Office (USPTO) with your ISSUE FEE and PUBLICATION FEE (if required). If you are charging the fee(s) to your deposit account, section "4b" of Part B - Fee(s) Transmittal should be completed and an extra copy of the form should be submitted. If an equivalent of Part B is filed, a request to reapply a previously paid issue fee must be clearly made, and delays in processing may occur due to the difficulty in recognizing the paper as an equivalent of Part B.

III. All communications regarding this application must give the application number. Please direct all communications prior to issuance to Mail Stop ISSUE FEE unless advised to the contrary.

IMPORTANT REMINDER: Maintenance fees are due in utility patents issuing on applications filed on or after Dec. 12, 1980. It is patentee's responsibility to ensure timely payment of maintenance fees when due. More information is available at www.uspto.gov/PatentMaintenanceFees.

PART B - FEE(S) TRANSMITTAL

Complete and send this form, together with applicable fee(s), to: **Mail** **Mail Stop ISSUE FEE**
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P.O. Box 1450
Alexandria, Virginia 22313-1450
or Fax **(571)-273-2885**

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27543 7590 06/04/2018
APPLIED OPTOELECTRONICS, INC.
13115 JESS PIRTLE BLVD.
SUGAR LAND, TX 77478

Certificate of Mailing or Transmission

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(Depositor's name)
(Signature)
(Date)

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
15/137,823	04/25/2016	I-Lung HO	PAT260-018US	2275

TITLE OF INVENTION: TECHNIQUES FOR DIRECT OPTICAL COUPLING OF PHOTODETECTORS TO OPTICAL DEMULTIPLEXER OUTPUTS AND AN OPTICAL TRANSCIEVER USING THE SAME

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nonprovisional	UNDISCOUNTED	\$1000	\$0	\$0	\$1000	09/04/2018

EXAMINER	ART UNIT	CLASS-SUBCLASS
PHAN, HANH	2636	398-087000

1. Change of correspondence address or indication of "Fee Address" (37 CFR 1.363).

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- ☐ "Fee Address" indication (or "Fee Address" Indication form PTO/SB/47; Rev 03-02 or more recent) attached. **Use of a Customer Number is required.**

2. For printing on the patent front page, list

- (1) The names of up to 3 registered patent attorneys or agents OR, alternatively, 1 _____
- (2) The name of a single firm (having as a member a registered attorney or agent) and the names of up to 2 registered patent attorneys or agents. If no name is listed, no name will be printed. 2 _____
- 3 _____

3. ASSIGNEE NAME AND RESIDENCE DATA TO BE PRINTED ON THE PATENT (print or type)

PLEASE NOTE: Unless an assignee is identified below, no assignee data will appear on the patent. If an assignee is identified below, the document has been filed for recordation as set forth in 37 CFR 3.11. Completion of this form is NOT a substitute for filing an assignment.

(A) NAME OF ASSIGNEE

(B) RESIDENCE: (CITY and STATE OR COUNTRY)

Please check the appropriate assignee category or categories (will not be printed on the patent): ☐ Individual ☐ Corporation or other private group entity ☐ Government

4a. The following fee(s) are submitted:

- ☐ Issue Fee
- ☐ Publication Fee (No small entity discount permitted)
- ☐ Advance Order - # of Copies _____

4b. Payment of Fee(s): (Please first reapply any previously paid issue fee shown above)

- ☐ A check is enclosed.
- ☐ Payment by credit card. Form PTO-2038 is attached.
- ☐ The director is hereby authorized to charge the required fee(s), any deficiency, or credits any overpayment, to Deposit Account Number _____ (enclose an extra copy of this form).

5. Change in Entity Status (from status indicated above)

- ☐ Applicant certifying micro entity status. See 37 CFR 1.29
- ☐ Applicant asserting small entity status. See 37 CFR 1.27
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NOTE: Checking this box will be taken to be a notification of loss of entitlement to small or micro entity status, as applicable.

NOTE: This form must be signed in accordance with 37 CFR 1.31 and 1.33. See 37 CFR 1.4 for signature requirements and certifications.

Authorized Signature _____

Date _____

Typed or printed name _____

Registration No. _____



UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
15/137,823	04/25/2016	I-Lung HO	PAT260-018US	2275
27543 7590 06/04/2018 APPLIED OPTOELECTRONICS, INC. 13115 JESS PIRTLE BLVD. SUGAR LAND, TX 77478			EXAMINER PHAN, HANH	
			ART UNIT	PAPER NUMBER
			2636	
DATE MAILED: 06/04/2018				

Determination of Patent Term Adjustment under 35 U.S.C. 154 (b) (Applications filed on or after May 29, 2000)

The Office has discontinued providing a Patent Term Adjustment (PTA) calculation with the Notice of Allowance.

Section 1(h)(2) of the AIA Technical Corrections Act amended 35 U.S.C. 154(b)(3)(B)(i) to eliminate the requirement that the Office provide a patent term adjustment determination with the notice of allowance. See Revisions to Patent Term Adjustment, 78 Fed. Reg. 19416, 19417 (Apr. 1, 2013). Therefore, the Office is no longer providing an initial patent term adjustment determination with the notice of allowance. The Office will continue to provide a patent term adjustment determination with the Issue Notification Letter that is mailed to applicant approximately three weeks prior to the issue date of the patent, and will include the patent term adjustment on the patent. Any request for reconsideration of the patent term adjustment determination (or reinstatement of patent term adjustment) should follow the process outlined in 37 CFR 1.705.

Any questions regarding the Patent Term Extension or Adjustment determination should be directed to the Office of Patent Legal Administration at (571)-272-7702. Questions relating to issue and publication fee payments should be directed to the Customer Service Center of the Office of Patent Publication at 1-(888)-786-0101 or (571)-272-4200.

OMB Clearance and PRA Burden Statement for PTOL-85 Part B

The Paperwork Reduction Act (PRA) of 1995 requires Federal agencies to obtain Office of Management and Budget approval before requesting most types of information from the public. When OMB approves an agency request to collect information from the public, OMB (i) provides a valid OMB Control Number and expiration date for the agency to display on the instrument that will be used to collect the information and (ii) requires the agency to inform the public about the OMB Control Number's legal significance in accordance with 5 CFR 1320.5(b).

The information collected by PTOL-85 Part B is required by 37 CFR 1.311. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 12 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, Virginia 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, Virginia 22313-1450. Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number.

Privacy Act Statement

The Privacy Act of 1974 (P.L. 93-579) requires that you be given certain information in connection with your submission of the attached form related to a patent application or patent. Accordingly, pursuant to the requirements of the Act, please be advised that: (1) the general authority for the collection of this information is 35 U.S.C. 2(b)(2); (2) furnishing of the information solicited is voluntary; and (3) the principal purpose for which the information is used by the U.S. Patent and Trademark Office is to process and/or examine your submission related to a patent application or patent. If you do not furnish the requested information, the U.S. Patent and Trademark Office may not be able to process and/or examine your submission, which may result in termination of proceedings or abandonment of the application or expiration of the patent.

The information provided by you in this form will be subject to the following routine uses:

1. The information on this form will be treated confidentially to the extent allowed under the Freedom of Information Act (5 U.S.C. 552) and the Privacy Act (5 U.S.C. 552a). Records from this system of records may be disclosed to the Department of Justice to determine whether disclosure of these records is required by the Freedom of Information Act.
2. A record from this system of records may be disclosed, as a routine use, in the course of presenting evidence to a court, magistrate, or administrative tribunal, including disclosures to opposing counsel in the course of settlement negotiations.
3. A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.
4. A record in this system of records may be disclosed, as a routine use, to a contractor of the Agency having need for the information in order to perform a contract. Recipients of information shall be required to comply with the requirements of the Privacy Act of 1974, as amended, pursuant to 5 U.S.C. 552a(m).
5. A record related to an International Application filed under the Patent Cooperation Treaty in this system of records may be disclosed, as a routine use, to the International Bureau of the World Intellectual Property Organization, pursuant to the Patent Cooperation Treaty.
6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).
7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (i.e., GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.
8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspection or an issued patent.
9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

Notice of Allowability	Application No. 15/137,823	Applicant(s) HO ET AL.	
	Examiner HANH PHAN	Art Unit 2636	AIA (First Inventor to File) Status Yes

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address--

All claims being allowable, PROSECUTION ON THE MERITS IS (OR REMAINS) CLOSED in this application. If not included herewith (or previously mailed), a Notice of Allowance (PTOL-85) or other appropriate communication will be mailed in due course. **THIS NOTICE OF ALLOWABILITY IS NOT A GRANT OF PATENT RIGHTS.** This application is subject to withdrawal from issue at the initiative of the Office or upon petition by the applicant. See 37 CFR 1.313 and MPEP 1308.

1. ☒ This communication is responsive to amendment filed on 01/29/2018.
☐ A declaration(s)/affidavit(s) under **37 CFR 1.130(b)** was/were filed on _____.
2. ☐ An election was made by the applicant in response to a restriction requirement set forth during the interview on _____; the restriction requirement and election have been incorporated into this action.
3. ☒ The allowed claim(s) is/are 1-19. As a result of the allowed claim(s), you may be eligible to benefit from the **Patent Prosecution Highway** program at a participating intellectual property office for the corresponding application. For more information, please see http://www.uspto.gov/patents/init_events/pph/index.jsp or send an inquiry to PPHfeedback@uspto.gov.
4. ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

Certified copies:

a) ☐ All b) ☐ Some *c) ☐ None of the:

1. ☐ Certified copies of the priority documents have been received.
2. ☐ Certified copies of the priority documents have been received in Application No. _____.
3. ☐ Copies of the certified copies of the priority documents have been received in this national stage application from the International Bureau (PCT Rule 17.2(a)).

* Certified copies not received: _____.

Applicant has THREE MONTHS FROM THE "MAILING DATE" of this communication to file a reply complying with the requirements noted below. Failure to timely comply will result in ABANDONMENT of this application.
THIS THREE-MONTH PERIOD IS NOT EXTENDABLE.

5. ☐ CORRECTED DRAWINGS (as "replacement sheets") must be submitted.
☐ including changes required by the attached Examiner's Amendment / Comment or in the Office action of Paper No./Mail Date _____.

Identifying indicia such as the application number (see 37 CFR 1.84(c)) should be written on the drawings in the front (not the back) of each sheet. Replacement sheet(s) should be labeled as such in the header according to 37 CFR 1.121(d).

6. ☐ DEPOSIT OF and/or INFORMATION about the deposit of BIOLOGICAL MATERIAL must be submitted. Note the attached Examiner's comment regarding REQUIREMENT FOR THE DEPOSIT OF BIOLOGICAL MATERIAL.

Attachment(s) 1. ☐ Notice of References Cited (PTO-892) 2. ☒ Information Disclosure Statements (PTO/SB/08), Paper No./Mail Date _____ 3. ☐ Examiner's Comment Regarding Requirement for Deposit of Biological Material 4. ☐ Interview Summary (PTO-413), Paper No./Mail Date _____ . 5. ☒ Examiner's Amendment/Comment 6. ☒ Examiner's Statement of Reasons for Allowance 7. ☐ Other _____.	
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/HANH PHAN/ Primary Examiner, Art Unit 2636	
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EXAMINER'S AMENDMENT

1. An examiner's amendment to the record appears below. Should the changes and/or additions be unacceptable to applicant, an amendment may be filed as provided by 37 CFR 1.312. To ensure consideration of such an amendment, it MUST be submitted no later than the payment of the issue fee.

The application has been amended as follows:

Claim 20 is cancelled.

2. **REASONS FOR ALLOWANCE:**

Claims 1-19 are allowed.

The following is an examiner's statement of reasons for allowance:

Claims 1-11 are allowable because Bai (US Patent No. 7,532,783) fails to teach a tapered region disposed at the second end of the AWG chip configured to receive light via the plurality of output waveguides and reflect the same towards an exposed output interface region of the AWG chip, wherein the exposed output interface region emits the received light from the AWG chip on the same side as the substrate without passing the received light through the substrate.

Claims 12-19 are allowable because Dallesasse (US Patent No. 7,941,053) and Bai (US Patent No. 7,532,783) fails to teach a first end for coupling to an optical coupling receptacle to receive an optical signal comprising a plurality of channel

Art Unit: 2636

wavelengths, wherein the first end for coupling to the optical coupling receptacle includes an angled surface to reduce back reflections of an optical signal launched into the AWG chip.

Any comments considered necessary by applicant must be submitted no later than the payment of the issue fee and, to avoid processing delays, should preferably accompany the issue fee. Such submissions should be clearly labeled "Comments on Statement of Reasons for Allowance."

3. Any inquiry concerning this communication or earlier communications from the examiner should be directed to Hanh Phan whose telephone number is (571)272-3035.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Kenneth Vanderpuye, can be reached on (571)272-3078. The fax phone number for the organization where this application or proceeding is assigned is (571)273-8300.

Any inquiry of a general nature or relating to the status of this application or proceeding should be directed to the receptionist whose telephone number is (703)305-4700.

/HANH PHAN/

Primary Examiner, Art Unit 2636

Doc code: IDS

PTO/SB/08a (01-10)

Doc description: Information Disclosure Statement (IDS) Filed

Approved for use through 07/31/2012. OMB 0651-0031

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	First Named Inventor	HO	
	Art Unit	2636	
	Examiner Name	PHAN, Hanh	
	Attorney Docket Number	PAT260-018US	

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Examiner Initials*	Cite No	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc), date, pages(s), volume-issue number(s), publisher, city and/or country where published.	T ⁵
	1	US Office Action mailed April 13, 2018, received in US Application Serial No. 15/432,242, 28 pgs.	

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Examiner Signature	/HANH PHAN/	Date Considered	05/21/2018
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¹ See Kind Codes of USPTO Patent Documents at www.USPTO.GOV or MPEP 901.04. ² Enter office that issued the document, by the two-letter code (WIPO Standard ST.3). ³ For Japanese patent documents, the indication of the year of the reign of the Emperor must precede the serial number of the patent document. ⁴ Kind of document by the appropriate symbols as indicated on the document under WIPO Standard ST.16 if possible. ⁵ Applicant is to place a check mark here if English language translation is attached.

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OR

☐ That no item of information contained in the information disclosure statement was cited in a communication from a foreign patent office in a counterpart foreign application, and, to the knowledge of the person signing the certification after making reasonable inquiry, no item of information contained in the information disclosure statement was known to any individual designated in 37 CFR 1.56(c) more than three months prior to the filing of the information disclosure statement. See 37 CFR 1.97(e)(2).

See attached certification statement.

☒ The fee set forth in 37 CFR 1.17 (p) has been submitted herewith.

A certification statement is not submitted herewith.

SIGNATURE

A signature of the applicant or representative is required in accordance with CFR 1.33, 10.18. Please see CFR 1.4(d) for the form of the signature.

Signature	/Kevin J. Carroll/	Date (YYYY-MM-DD)	2018-04-16
Name/Print	Kevin J. Carroll	Registration Number	36384

This collection of information is required by 37 CFR 1.97 and 1.98. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 1 hour to complete, including gathering, preparing and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. **DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

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The information provided by you in this form will be subject to the following routine uses:

1. The information on this form will be treated confidentially to the extent allowed under the Freedom of Information Act (5 U.S.C. 552) and the Privacy Act (5 U.S.C. 552a). Records from this system of records may be disclosed to the Department of Justice to determine whether the Freedom of Information Act requires disclosure of these records.
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5. A record related to an International Application filed under the Patent Cooperation Treaty in this system of records may be disclosed, as a routine use, to the International Bureau of the World Intellectual Property Organization, pursuant to the Patent Cooperation Treaty.
6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).
7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (i.e., GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.
8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspections or an issued patent.
9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

Doc code: IDS

PTO/SB/08a (01-10)

Doc description: Information Disclosure Statement (IDS) Filed

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	Attorney Docket Number	PAT260-018US

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	1	PCT Search Report and Written Opinion mailed July 6, 2017, received in corresponding PCT Application No. PCT/US17/29350, 9 pgs.	

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Signature	/Kevin J. Carroll/	Date (YYYY-MM-DD)	2017-10-06
Name/Print	Kevin J. Carroll	Registration Number	36384

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	2	20040161186	A1	2004-08-19	CRAFTS ET AL	
	3	20160149662	A1	2016-05-26	SOLDANO ET AL	
	4	20160349451	A1	2016-12-01	SHEN ET AL	
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	1	US Office Action mailed August 29, 2017, received in US Application Serial No. 15/432,242, 15 pgs.	

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Signature	/Kenneth M. Thompson/	Date (YYYY-MM-DD)	2018-01-29
Name/Print	Kenneth M. Thompson	Registration Number	72001

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2. A record from this system of records may be disclosed, as a routine use, in the course of presenting evidence to a court, magistrate, or administrative tribunal, including disclosures to opposing counsel in the course of settlement negotiations.
3. A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.
4. A record in this system of records may be disclosed, as a routine use, to a contractor of the Agency having need for the information in order to perform a contract. Recipients of information shall be required to comply with the requirements of the Privacy Act of 1974, as amended, pursuant to 5 U.S.C. 552a(m).
5. A record related to an International Application filed under the Patent Cooperation Treaty in this system of records may be disclosed, as a routine use, to the International Bureau of the World Intellectual Property Organization, pursuant to the Patent Cooperation Treaty.
6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).
7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (i.e., GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.
8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspections or an issued patent.
9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

Issue Classification 	Application/Control No. 15137823	Applicant(s)/Patent Under Reexamination HO ET AL.	
	Examiner HANH PHAN	Art Unit 2636	

CPC						
Symbol				Type	Version	
G02B		6		12016	F	2013-01-01
H04J		14		02	I	2013-01-01
G02B		6		12011	I	2013-01-01
G02B		6		4292	I	2013-01-01
G02B		6		4246	I	2013-01-01
G02B		6		12019	I	2013-01-01

CPC Combination Sets					
Symbol		Type	Set	Ranking	Version

NONE		Total Claims Allowed:	
(Assistant Examiner)		19	
(Date)			
/HANH PHAN/		O.G. Print Claim(s)	O.G. Print Figure
Primary Examiner.Art Unit 2636		1	5A
(Primary Examiner)		(Date)	

Issue Classification 	Application/Control No. 15137823	Applicant(s)/Patent Under Reexamination HO ET AL.
	Examiner HANH PHAN	Art Unit 2636

☐ Claims renumbered in the same order as presented by applicant															
☐ CPA															
☐ T.D.															
☐ R.1.47															
Final	Original	Final	Original	Final	Original	Final	Original	Final	Original	Final	Original	Final	Original	Final	Original
1	1	17	17												
2	2	18	18												
3	3	19	19												
4	4		20												
5	5														
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7	9														
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11	11														
12	12														
13	13														
14	14														
15	15														
16	16														

NONE	Total Claims Allowed:	
(Assistant Examiner)	19	
(Date)		
/HANH PHAN/ Primary Examiner.Art Unit 2636	05/24/2018	O.G. Print Claim(s) 1
(Primary Examiner)	(Date)	O.G. Print Figure 5A

<i>Index of Claims</i> 	Application/Control No. 15137823	Applicant(s)/Patent Under Reexamination HO ET AL.
	Examiner HANH PHAN	Art Unit 2636

✓	Rejected	-	Cancelled	N	Non-Elected	A	Appeal
=	Allowed	÷	Restricted	I	Interference	O	Objected

☐ Claims renumbered in the same order as presented by applicant
☐ CPA
☐ T.D.
☐ R.1.47

CLAIM		DATE								
Final	Original	05/24/2018								
1	1	=								
2	2	=								
3	3	=								
4	4	=								
5	5	=								
6	6	=								
8	7	=								
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14	14	=								
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17	17	=								
18	18	=								
19	19	=								
	20	-								

EAST Search History

EAST Search History (Prior Art)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
L2	12	miao-zhengyu.in.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2018/05/25 20:47
L3	2382	li-qin.in.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2018/05/25 20:50
L4	2	li-qin.in. and AWG and ((angle\$3 adj surface) or exposed)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2018/05/25 20:51
L5	6	((("7532783") or ("8831433") or ("7376308")).PN.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2018/05/25 20:57
L6	20	((("7162124") or ("9341786") or ("20030174964") or ("20040161186") or ("20160149662") or ("20160349451") or ("20170168252") or ("5617234")).PN.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2018/05/25 21:05
L7	5545470	385/24, "37", "14".ccls. and AWG and ((angle\$3 adj surface) or exposed)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2018/05/25 21:11
L8	656	385/\$.ccls. and AWG and ((angle\$3 adj surface) or exposed)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2018/05/25 21:11
L9	103	398/\$.ccls. and AWG and ((angle\$3 adj surface) or exposed)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2018/05/25 21:33
L10	41	H04J14/\$.cpc. and AWG and	US-PGPUB;	OR	OFF	2018/05/25

		((angle\$3 adj surface) or exposed) and substrate and PLC	USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB			21:38
L11	36	H04B10/\$.cpc. and AWG and ((angle\$3 adj surface) or exposed) and substrate and PLC	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2018/05/25 22:02
L12	0	G02F6/\$.cpc. and AWG and ((angle\$3 adj surface) or exposed) and substrate and PLC	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2018/05/25 22:04
L13	170	G02B6/\$.cpc. and AWG and ((angle\$3 adj surface) or exposed) and substrate and PLC	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2018/05/25 22:04
S1	199	boduch-mark-e.in.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2018/05/25 13:27
S2	6	"7532783"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2018/05/25 19:13
S3	9	((("7532783") or ("7941053") or ("7058263") or ("20150249501")).PN.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2018/05/25 19:14
S4	0	("7532783").URPN.	USPAT	OR	OFF	2018/05/25 19:23
S5	4	("20040131302" "5617234" "6108472" "7050666").PN.	US-PGPUB; USPAT; USOCR	OR	OFF	2018/05/25 19:23
S6	106	ho-i-lung.in.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2018/05/25 19:42

5/ 25/ 2018 10:08:15 PM

Search Notes 	Application/Control No. 15137823	Applicant(s)/Patent Under Reexamination HO ET AL.
	Examiner HANH PHAN	Art Unit 2636

CPC- SEARCHED		
Symbol	Date	Examiner
H04J14/02, H04B10/40, H04J14/0282, H04j14/0221, H04j14/0202, H04B10/506, H04B10/503, H04B10/504, G02B6/4246, G02B6/4293, G02B6/4249	05/24/2018	HP

CPC COMBINATION SETS - SEARCHED		
Symbol	Date	Examiner

US CLASSIFICATION SEARCHED			
Class	Subclass	Date	Examiner
398	135, 136, 137, 138, 139, 79, 82, 158. 159, 85, 87, 84, 202, 208, 213, 214	05/24/2018	HP
385	24, 37, 14, 43	05/24/2018	HP
UPDATE SEARCH		05/24/2018	HP

* See search history printout included with this form or the SEARCH NOTES box below to determine the scope of the search.

SEARCH NOTES		
Search Notes	Date	Examiner
EAST SEARCH SEE ATTACHED PRINTOUT IN THE FILE	05/24/2018	HP
IEEE SEARCH	05/24/2018	HP
JPO SEARCH	05/24/2018	HP
CPC SEARCH PERFORMED IN EAST	05/24/2018	HP
PGPUB TEXT SEARCH SEE INTERFERENCE SEARCH PRINTOUT	05/24/2018	HP

INTERFERENCE SEARCH

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US Class/ CPC Symbol	US Subclass / CPC Group	Date	Examiner
398	135, 136, 137, 138, 139, 79, 82, 158. 159, 85, 87, 84, 202, 208, 213, 214	05/24/2018	HP
385	24, 37, 14, 43	05/24/2018	HP

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INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)	Application Number	15137823
	Filing Date	2016-04-25
	First Named Inventor	HO
	Art Unit	2636
	Examiner Name	PHAN, Hanh
	Attorney Docket Number	PAT260-018US

U.S.PATENTS							Remove	
Examiner Initial*	Cite No	Patent Number	Kind Code ¹	Issue Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear		
	1	7162124	B1	2007-01-09	GUNN, III ET AL			
	2	9341786	B1	2016-05-17	GAMACHE ET AL			
If you wish to add additional U.S. Patent citation information please click the Add button.							Add	
U.S.PATENT APPLICATION PUBLICATIONS							Remove	
Examiner Initial*	Cite No	Publication Number	Kind Code ¹	Publication Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear		
	1							
If you wish to add additional U.S. Published Application citation information please click the Add button.							Add	
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Examiner Initial*	Cite No	Foreign Document Number ³	Country Code ²ⁱ	Kind Code ⁴	Publication Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear	T ⁵
	1							
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INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)	Application Number		15137823
	Filing Date		2016-04-25
	First Named Inventor	HO	
	Art Unit	2636	
	Examiner Name	PHAN, Hanh	
	Attorney Docket Number	PAT260-018US	

Examiner Initials*	Cite No	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc), date, pages(s), volume-issue number(s), publisher, city and/or country where published.	T ⁵
	1	US Office Action mailed April 13, 2018, received in US Application Serial No. 15/432,242, 28 pgs.	

If you wish to add additional non-patent literature document citation information please click the Add button

EXAMINER SIGNATURE

Examiner Signature		Date Considered	
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*EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through a citation if not in conformance and not considered. Include copy of this form with next communication to applicant.

¹ See Kind Codes of USPTO Patent Documents at www.USPTO.GOV or MPEP 901.04. ² Enter office that issued the document, by the two-letter code (WIPO Standard ST.3). ³ For Japanese patent documents, the indication of the year of the reign of the Emperor must precede the serial number of the patent document. ⁴ Kind of document by the appropriate symbols as indicated on the document under WIPO Standard ST.16 if possible. ⁵ Applicant is to place a check mark here if English language translation is attached.

**INFORMATION DISCLOSURE
STATEMENT BY APPLICANT**
(Not for submission under 37 CFR 1.99)

Application Number	15137823
Filing Date	2016-04-25
First Named Inventor	HO
Art Unit	2636
Examiner Name	PHAN, Hanh
Attorney Docket Number	PAT260-018US

CERTIFICATION STATEMENT

Please see 37 CFR 1.97 and 1.98 to make the appropriate selection(s):

That each item of information contained in the information disclosure statement was first cited in any communication from a foreign patent office in a counterpart foreign application not more than three months prior to the filing of the information disclosure statement. See 37 CFR 1.97(e)(1).

OR

☐ That no item of information contained in the information disclosure statement was cited in a communication from a foreign patent office in a counterpart foreign application, and, to the knowledge of the person signing the certification after making reasonable inquiry, no item of information contained in the information disclosure statement was known to any individual designated in 37 CFR 1.56(c) more than three months prior to the filing of the information disclosure statement. See 37 CFR 1.97(e)(2).

See attached certification statement.

☒ The fee set forth in 37 CFR 1.17 (p) has been submitted herewith.

A certification statement is not submitted herewith.

SIGNATURE

A signature of the applicant or representative is required in accordance with CFR 1.33, 10.18. Please see CFR 1.4(d) for the form of the signature.

Signature	/Kevin J. Carroll/	Date (YYYY-MM-DD)	2018-04-16
Name/Print	Kevin J. Carroll	Registration Number	36384

This collection of information is required by 37 CFR 1.97 and 1.98. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 1 hour to complete, including gathering, preparing and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

Privacy Act Statement

The Privacy Act of 1974 (P.L. 93-579) requires that you be given certain information in connection with your submission of the attached form related to a patent application or patent. Accordingly, pursuant to the requirements of the Act, please be advised that: (1) the general authority for the collection of this information is 35 U.S.C. 2(b)(2); (2) furnishing of the information solicited is voluntary; and (3) the principal purpose for which the information is used by the U.S. Patent and Trademark Office is to process and/or examine your submission related to a patent application or patent. If you do not furnish the requested information, the U.S. Patent and Trademark Office may not be able to process and/or examine your submission, which may result in termination of proceedings or abandonment of the application or expiration of the patent.

The information provided by you in this form will be subject to the following routine uses:

1. The information on this form will be treated confidentially to the extent allowed under the Freedom of Information Act (5 U.S.C. 552) and the Privacy Act (5 U.S.C. 552a). Records from this system of records may be disclosed to the Department of Justice to determine whether the Freedom of Information Act requires disclosure of these records.
2. A record from this system of records may be disclosed, as a routine use, in the course of presenting evidence to a court, magistrate, or administrative tribunal, including disclosures to opposing counsel in the course of settlement negotiations.
3. A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.
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6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).
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9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

Electronic Patent Application Fee Transmittal				
Application Number:		15137823		
Filing Date:		25-Apr-2016		
Title of Invention:		TECHNIQUES FOR DIRECT OPTICAL COUPLING OF PHOTODETECTORS TO OPTICAL DEMULTIPLEXER OUTPUTS AND AN OPTICAL TRANSCEIVER USING THE SAME		
First Named Inventor/Applicant Name:		I-Lung HO		
Filer:		Kevin J. Carroll/April Davis		
Attorney Docket Number:		PAT260-018US		
Filed as Large Entity				
Filing Fees for Utility under 35 USC 111(a)				
Description	Fee Code	Quantity	Amount	Sub-Total in USD(\$)
Basic Filing:				
Pages:				
Claims:				
Miscellaneous-Filing:				
Petition:				
Patent-Appeals-and-Interference:				
Post-Allowance-and-Post-Issuance:				
Extension-of-Time:				

Description	Fee Code	Quantity	Amount	Sub-Total in USD(\$)
Miscellaneous:				
SUBMISSION- INFORMATION DISCLOSURE STMT	1806	1	240	240
Total in USD (\$)				240

Electronic Acknowledgement Receipt

EFS ID:	32353011
Application Number:	15137823
International Application Number:	
Confirmation Number:	2275
Title of Invention:	TECHNIQUES FOR DIRECT OPTICAL COUPLING OF PHOTODETECTORS TO OPTICAL DEMULTIPLEXER OUTPUTS AND AN OPTICAL TRANSCEIVER USING THE SAME
First Named Inventor/Applicant Name:	I-Lung HO
Customer Number:	27543
Filer:	Kevin J. Carroll/April Davis
Filer Authorized By:	Kevin J. Carroll
Attorney Docket Number:	PAT260-018US
Receipt Date:	16-APR-2018
Filing Date:	25-APR-2016
Time Stamp:	17:56:33
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	DA
Payment was successfully received in RAM	\$240
RAM confirmation Number	041718INTEFSW00005127501705
Deposit Account	501705
Authorized User	April Davis

The Director of the USPTO is hereby authorized to charge indicated fees and credit any overpayment as follows:

37 CFR 1.16 (National application filing, search, and examination fees)

37 CFR 1.17 (Patent application and reexamination processing fees)

37 CFR 1.19 (Document supply fees)
 37 CFR 1.20 (Post Issuance fees)
 37 CFR 1.21 (Miscellaneous fees and charges)

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Information Disclosure Statement (IDS) Form (SB08)	PAT260_018US_SUPP_IDS_041618.pdf	612032	no	4
			71c6754d981f9865bb9fd7aab97a20c0b88db2d8		
Warnings:					
Information:					
2	Other Reference-Patent/App/Search documents	AOIC006_OfficeAction_041318.pdf	1162759	no	28
			e49ae08e38bed24a53c457307d225b95455b5c56		
Warnings:					
Information:					
3	Fee Worksheet (SB06)	fee-info.pdf	30671	no	2
			c44668d3e90795fcc7fb77496395b9e5d60e7ad3		
Warnings:					
Information:					
Total Files Size (in bytes):			1805462		

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

New Applications Under 35 U.S.C. 111

If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371

If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office

If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

First Named Inventor: I-Lung HO

Examiner: Hanh, Phan

Serial No.: 15/137,823

Group Art Unit: 2636 Conf. No.: 2275

Filed: April 25, 2016

Docket: PAT260-018US

Title: TECHNIQUES FOR DIRECT OPTICAL COUPLING OF PHOTODETECTORS
TO OPTICAL DEMULTIPLEXER OUTPUTS AND AN OPTICAL TRANSCEIVER
USING THE SAME

AMENDMENT AND RESPONSE UNDER 37 C.F.R. § 1.111

This is in response to the Official Action in this case mailed August 21, 2017. Applicant's reply period was reset by Official Correspondence dated October 27, 2017 which set the three-month shortened statutory period of reply to January 28, 2018. Therefore, as this response is being filed within the three-month shortened statutory period of reply, no extension of time is believed necessary. However, Applicant conditionally petitions for an extension of time to provide for the possibility that the need for an extension has inadvertently been overlooked. As provided below, please charge Deposit Account No. 50-1705 for any required fee, or for any deficiency in the enclosed fee.

IN THE CLAIMS

1. (Currently Amended) An arrayed waveguide grating (AWG) chip comprising:
a first end for coupling to an optical coupling receptacle to receive an optical signal comprising a plurality of channel wavelengths;
a substrate;
a planar lightwave circuit (PLC) disposed on the substrate, the PLC coupled to the first end and configured to de-multiplex each channel wavelength of the plurality of channel wavelengths;
a plurality of output waveguides coupled to the PLC, each of the output waveguides configured to receive light corresponding to an associated de-multiplexed channel wavelength launched from the PLC and provide the light along a first light path that extends towards a second end of the AWG chip; and
a tapered region disposed at the second end of the AWG chip configured to receive light via the plurality of output waveguides and reflect the same towards an exposed output interface region of the AWG chip, wherein the exposed output interface region emits the received light from the AWG chip on the same side as the substrate without passing the received light through the substrate.
2. (Currently Amended) The AWG chip of claim 1, wherein the exposed output interface region is configured to pass the reflected light received via the plurality of output waveguides out of the AWG chip along a second light path that is substantially orthogonal to the first light path.
3. (Original) The AWG chip of claim 1, wherein the AWG chip defines a plurality of sidewalls extending longitudinally from the first end to the second end, and wherein the tapered region of the second end defines an angled surface that extends from a first sidewall of the plurality of sidewalls to a second sidewall of the plurality of sidewalls.

Serial Number: 15/137,823

Filing Date: April 25, 2016

Title: TECHNIQUES FOR DIRECT OPTICAL COUPLING OF PHOTODETECTORS TO OPTICAL DEMULTIPLEXER OUTPUTS AND AN OPTICAL TRANSCEIVER USING THE SAME

4. (Currently Amended) The AWG chip of claim 3, wherein the angled surface has an interior angle of about 41 to 45 degrees relative to the exposed output interface region.

5. (Original) The AWG chip of claim 3, wherein each of the output waveguides comprise a core material, and wherein a cladding material is disposed on the core material, the core material defining at least a portion of the plurality of sidewalls of the AWG chip.

6. (Original) The AWG chip of claim 5, wherein the core material of each of the plurality of output waveguides has a first index of refraction, and a medium external to and adjacent the tapered region has a second index of refraction, the first index of refraction being greater than the second index of refraction.

7. (Original) The AWG chip of claim 5, wherein the core material of each of the plurality of output waveguides provide a portion of the angled surface, and wherein the angled surface is configured to reflect incident light based on at least an interior angle of the angled surface.

8. (Original) The AWG chip of claim 5, wherein the core material comprises doped silica (SiO_2) having an index of refraction of about 1.45 to 1.50.

9. (Original) The AWG chip of claim 6, wherein the external medium comprises a material having an index of refraction of about 1.0.

10. (Original) The AWG chip of claim 1, wherein the AWG chip is configured as a 1xN demultiplexer device whereby a single optical input signal is de-multiplexed into N different channel wavelengths.

11. (Original) The AWG chip of claim 1, wherein the AWG chip is implemented in an AWG device package.

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12. (Currently Amended) An optical transceiver module comprising:
a transceiver housing;

a multi-channel receiver optical sub-assembly (ROSA) located in the transceiver housing and including an arrayed waveguide grating (AWG) chip, the AWG chip comprising:

a first end for coupling to an optical coupling receptacle to receive an optical signal comprising a plurality of channel wavelengths, wherein the first end for coupling to the optical coupling receptacle includes an angled surface to reduce back reflections of an optical signal launched into the AWG chip;

a planar lightwave circuit (PLC) coupled to the first end configured to demultiplex each channel wavelength of the plurality of channel wavelengths;

a plurality of output waveguides coupled to the PLC, each of the output waveguides configured to receive light corresponding to an associated demultiplexed channel wavelength launched from the PLC and provide the light along a first light path that extends towards a second end of the AWG chip; and

a tapered region disposed at the second end of the AWG chip configured to receive light via the plurality of output waveguides and reflect the same towards an output interface region of the AWG chip;

an array of detector devices disposed adjacent to the output interface region of the AWG chip; and

a multi-channel transmitter optical assembly (TOSA) including at least one laser package located in the transceiver housing for transmitting optical signals at different channel wavelengths.

13. (Currently Amended) The optical transceiver module of claim 12, wherein the output interface region of the AWG chip is an exposed region adjacent an air gap, and wherein ~~the~~ the air gap separates the output interface region of the AWG chip and the array of detector devices.

14. (Original) The optical transceiver module of claim 12, wherein the output interface region of the AWG chip is separated from the array of detector devices by about 50 microns.

15. (Original) The optical transceiver module of claim 12, wherein the AWG chip defines a plurality of sidewalls extending longitudinally from the first end to the second end, and wherein the tapered region of the second end defines an angled surface that extends from a first sidewall of the plurality of sidewalls to a second sidewall of the plurality of sidewalls.

16. (Original) The optical transceiver module of claim 15, wherein the angled surface has an interior angle of about 41 to 45 degrees relative to the output interface region.

17. (Original) The optical transceiver module of claim 15, wherein each of the output waveguides comprise a core material, and wherein a cladding material is disposed on the core material, the core material defining at least a portion of the plurality of sidewalls of the AWG chip.

18. (Original) The optical transceiver module of claim 17, wherein the core material of each of the plurality of output waveguides provide a portion of the angled surface, and wherein the angled surface is configured to reflect incident light based on at least an interior angle of the angled surface relative to the output interface of the AWG chip.

19. (Original) The optical transceiver of claim 12, wherein the transceiver is a Small Form-factor Pluggable (SFP) transceiver module and the ROSA is configured to receive at least four different channel wavelengths at transmission rates of at least about 25 Gbps per channel.

20. (Withdrawn) A method of forming an arrayed waveguide grating (AWG) comprising:

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depositing sequential layers of cladding and core material onto a substrate to form a planar lightwave circuit (PLC);

removing a portion of the substrate to expose an output interface region of the PLC; and

removing a portion of the PLC to provide a tapered region proximal to the output interface region of the PLC.

REMARKS

Please reconsider the application in view of the following remarks. Applicant submits that the claims, as presented, are in condition for allowance and respectfully requests the withdrawal of all pending rejections of the claims.

Status of Claims

Claims 1-19 were previously pending, with claim 20 having been previously withdrawn from consideration. Applicant herein amends independent claims 1, 12 and 13 herein, and claims 2 and 4 have been amended to be consistent with independent claim 1. Support for the amendments may be found at, for example, paras. 0021, 0041 and 0042 of Applicant's originally-filed disclosure. No claims are cancelled, and no new claims are added at this time. Accordingly, claims 1-19 remain pending for examination with claims 1 and 12 being independent claims.

Rejections Under 35 U.S.C. § 102

Claims 1-11 were rejected under 35 U.S.C. § 102 as being unpatentable over U.S. Patent No. 7,532,783 (Bai). Applicant respectfully requests reconsideration.

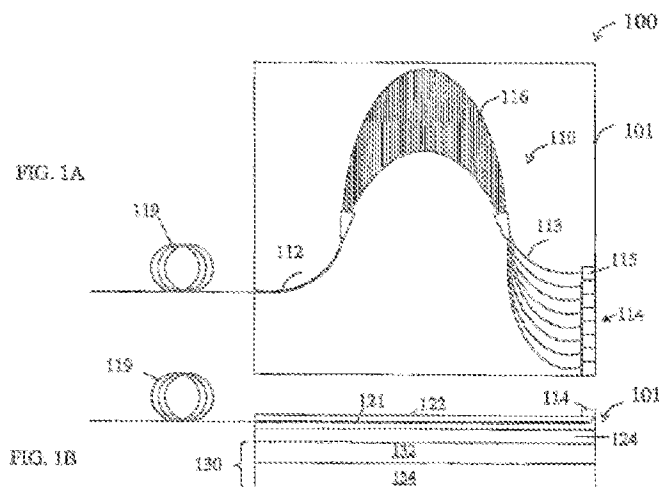
Without acceding as to the correctness of the rejection, Applicant herein amends claim 1 to recite an arrayed waveguide grating (AWG) chip including, *inter alia*, "a tapered region disposed at the second end of the AWG chip configured to receive light via the plurality of output waveguides and reflect the same towards an exposed output interface region of the AWG chip, wherein the exposed output interface region emits the received light from the AWG chip on the same side as the substrate without passing the received light through the substrate."

Bai discloses an AWG 110 that emits light from the side *opposite* the substrate 124 towards a photodetector 114 (see FIG. 1A and 1B of Bai reproduced below). Thus, Bai appears to disclose the opposite of Applicant's claimed invention. In contrast, claim 1 requires emitting light from the AWG chip "on the same side as the substrate."

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Applicant further submits that one of ordinary skill in the art would not be motivated to modify Bai to emit light on the same side as the substrate 124 as the result would prevent coupling with the photodetector 114. Applicant's claimed invention avoids this problem by including an *exposed* output interface region to allow light to emit from the AWG on the same side as the substrate. *See e.g., Applicant's Disclosure; FIG. 5A and accompanying description.*

For at least these reasons, Bai fails to anticipate independent claim 1 as Bai fails to disclose each and every element of claim 1. Claims 2-11 depend directly or indirectly from independent claim 1 and are allowable for at least the same reasons.

Accordingly, Applicant respectfully requests reconsideration and withdrawal of the rejections of claims 1-11 under 35 U.S.C. § 102.

Rejections Under 35 U.S.C. § 103

Claims 12-19 were rejected under 35 U.S.C. § 103 as being unpatentable over U.S. Patent No. 7,941,053 (Dallesasse) in view of Bai, or alternatively Dallesasse in view of U.S. Patent No. 7,058,263 (Welch). Applicant respectfully requests reconsideration.

Without any admission as to the merits of the rejection, independent claim 12 has been amended to recite, *inter alia*, "wherein the first end for coupling to the optical coupling

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receptacle includes an angled surface to reduce back reflections of an optical signal launched into the AWG chip.”

The Office Action correctly notes that Dallesasse fails to disclose an AWG as claimed. *See Office Action; page 6.* In effort to remedy this deficiency the Office Action cited to Bai, or alternatively, to Welch.

Bai discloses an AWG 110 that couples to a fiber 119 via an optical input port 112. As shown in FIG. 1A and 1B of Bai reproduced above, the output input port 112 includes a surface that appears to extend upright at 90 degrees, and thus, without being angled to reduce back reflections as recited in independent claim 12. Thus, the proposed combination of Dallesasse and Bai fails to render claim 12 obvious. Claims 13-19 depend directly or indirectly from independent claim 12 and are allowable for at least the same reasons.

Turning to Welch, Applicant is unable to identify any language in Welch disclosing an input port with an angled surface to reduce back reflections. Indeed, Welch discloses only using an anti-reflective (AR) coating on the input surface of chip 10 to “eliminate spurious reflections.” *See Welch; Col. 14; lines 38-42.* Thus, the proposed combination of Dallesasse and Welch fails to render claim 12 obvious. Claims 13-19 depend directly or indirectly from independent claim 12 and are allowable for at least the same reasons.

Accordingly, Applicant respectfully requests reconsideration and withdrawal of the rejection of claims 12-19 under 35 U.S.C. § 103.

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Having dealt with all the objections raised by the Examiner, it is respectfully submitted that the present application, as amended, is in condition for allowance. Thus, early allowance is earnestly solicited.

If the Examiner desires personal contact for further disposition of this case, the Examiner is invited to call the undersigned Attorney at 603.668.6560.

In the event there are any fees due, please charge them to our Deposit Account No. 50-1705 (Ref: PAT260-022US).

Respectfully submitted,

By: /Kenneth M. Thompson/

Date: January 29, 2018

Kenneth M. Thompson
Reg. No. 72,001

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)	Application Number		15137823
	Filing Date		2016-04-25
	First Named Inventor	HO	
	Art Unit	2636	
	Examiner Name	PHAN, Hanh	
	Attorney Docket Number	PAT260-018US	

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	1	20030174964	A1	2003-09-18	GAO ET AL	
	2	20040161186	A1	2004-08-19	CRAFTS ET AL	
	3	20160149662	A1	2016-05-26	SOLDANO ET AL	
	4	20160349451	A1	2016-12-01	SHEN ET AL	
	5	20170168252	A1	2017-06-15	PEZESHKI ET AL	

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**INFORMATION DISCLOSURE
STATEMENT BY APPLICANT**
(Not for submission under 37 CFR 1.99)

Application Number		15137823
Filing Date		2016-04-25
First Named Inventor	HO	
Art Unit	2636	
Examiner Name	PHAN, Hanh	
Attorney Docket Number	PAT260-018US	

Examiner Initial*	Cite No	Foreign Document Number ³	Country Code ² i	Kind Code ⁴	Publication Date	Name of Patentee or Applicant of cited Document	Pages, Columns, Lines where Relevant Passages or Relevant Figures Appear	T ⁵
	1							

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NON-PATENT LITERATURE DOCUMENTS

Examiner Initials*	Cite No	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc), date, pages(s), volume-issue number(s), publisher, city and/or country where published.	T ⁵
	1	US Office Action mailed August 29, 2017, received in US Application Serial No. 15/432,242, 15 pgs.	

If you wish to add additional non-patent literature document citation information please click the Add button

EXAMINER SIGNATURE

Examiner Signature		Date Considered	
--------------------	--	-----------------	--

*EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through a citation if not in conformance and not considered. Include copy of this form with next communication to applicant.

¹ See Kind Codes of USPTO Patent Documents at www.USPTO.GOV or MPEP 901.04. ² Enter office that issued the document, by the two-letter code (WIPO Standard ST.3). ³ For Japanese patent documents, the indication of the year of the reign of the Emperor must precede the serial number of the patent document. ⁴ Kind of document by the appropriate symbols as indicated on the document under WIPO Standard ST.16 if possible. ⁵ Applicant is to place a check mark here if English language translation is attached.

**INFORMATION DISCLOSURE
STATEMENT BY APPLICANT**
(Not for submission under 37 CFR 1.99)

Application Number	15137823
Filing Date	2016-04-25
First Named Inventor	HO
Art Unit	2636
Examiner Name	PHAN, Hanh
Attorney Docket Number	PAT260-018US

CERTIFICATION STATEMENT

Please see 37 CFR 1.97 and 1.98 to make the appropriate selection(s):

That each item of information contained in the information disclosure statement was first cited in any communication from a foreign patent office in a counterpart foreign application not more than three months prior to the filing of the information disclosure statement. See 37 CFR 1.97(e)(1).

OR

☐ That no item of information contained in the information disclosure statement was cited in a communication from a foreign patent office in a counterpart foreign application, and, to the knowledge of the person signing the certification after making reasonable inquiry, no item of information contained in the information disclosure statement was known to any individual designated in 37 CFR 1.56(c) more than three months prior to the filing of the information disclosure statement. See 37 CFR 1.97(e)(2).

See attached certification statement.

☒ The fee set forth in 37 CFR 1.17 (p) has been submitted herewith.

A certification statement is not submitted herewith.

SIGNATURE

A signature of the applicant or representative is required in accordance with CFR 1.33, 10.18. Please see CFR 1.4(d) for the form of the signature.

Signature	/Kenneth M. Thompson/	Date (YYYY-MM-DD)	2018-01-29
Name/Print	Kenneth M. Thompson	Registration Number	72001

This collection of information is required by 37 CFR 1.97 and 1.98. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 1 hour to complete, including gathering, preparing and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

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The Privacy Act of 1974 (P.L. 93-579) requires that you be given certain information in connection with your submission of the attached form related to a patent application or patent. Accordingly, pursuant to the requirements of the Act, please be advised that: (1) the general authority for the collection of this information is 35 U.S.C. 2(b)(2); (2) furnishing of the information solicited is voluntary; and (3) the principal purpose for which the information is used by the U.S. Patent and Trademark Office is to process and/or examine your submission related to a patent application or patent. If you do not furnish the requested information, the U.S. Patent and Trademark Office may not be able to process and/or examine your submission, which may result in termination of proceedings or abandonment of the application or expiration of the patent.

The information provided by you in this form will be subject to the following routine uses:

1. The information on this form will be treated confidentially to the extent allowed under the Freedom of Information Act (5 U.S.C. 552) and the Privacy Act (5 U.S.C. 552a). Records from this system of records may be disclosed to the Department of Justice to determine whether the Freedom of Information Act requires disclosure of these records.
2. A record from this system of records may be disclosed, as a routine use, in the course of presenting evidence to a court, magistrate, or administrative tribunal, including disclosures to opposing counsel in the course of settlement negotiations.
3. A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.
4. A record in this system of records may be disclosed, as a routine use, to a contractor of the Agency having need for the information in order to perform a contract. Recipients of information shall be required to comply with the requirements of the Privacy Act of 1974, as amended, pursuant to 5 U.S.C. 552a(m).
5. A record related to an International Application filed under the Patent Cooperation Treaty in this system of records may be disclosed, as a routine use, to the International Bureau of the World Intellectual Property Organization, pursuant to the Patent Cooperation Treaty.
6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).
7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (i.e., GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.
8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspections or an issued patent.
9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

Electronic Patent Application Fee Transmittal

Application Number:	15137823			
Filing Date:	25-Apr-2016			
Title of Invention:	TECHNIQUES FOR DIRECT OPTICAL COUPLING OF PHOTODETECTORS TO OPTICAL DEMULTIPLEXER OUTPUTS AND AN OPTICAL TRANSCEIVER USING THE SAME			
First Named Inventor/Applicant Name:	I-Lung HO			
Filer:	Kenneth M. Thompson/April Davis			
Attorney Docket Number:	PAT260-018US			
Filed as Large Entity				
Filing Fees for Utility under 35 USC 111(a)				
Description	Fee Code	Quantity	Amount	Sub-Total in USD(\$)
Basic Filing:				
Pages:				
Claims:				
Miscellaneous-Filing:				
Petition:				
Patent-Appeals-and-Interference:				
Post-Allowance-and-Post-Issuance:				
Extension-of-Time:				

Description	Fee Code	Quantity	Amount	Sub-Total in USD(\$)
Miscellaneous:				
Submission- Information Disclosure Stmt	1806	1	240	240
Total in USD (\$)				240

Electronic Acknowledgement Receipt

EFS ID:	31636619
Application Number:	15137823
International Application Number:	
Confirmation Number:	2275
Title of Invention:	TECHNIQUES FOR DIRECT OPTICAL COUPLING OF PHOTODETECTORS TO OPTICAL DEMULTIPLEXER OUTPUTS AND AN OPTICAL TRANSCEIVER USING THE SAME
First Named Inventor/Applicant Name:	I-Lung HO
Customer Number:	27543
Filer:	Kenneth M. Thompson/April Davis
Filer Authorized By:	Kenneth M. Thompson
Attorney Docket Number:	PAT260-018US
Receipt Date:	29-JAN-2018
Filing Date:	25-APR-2016
Time Stamp:	17:22:15
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	DA
Payment was successfully received in RAM	\$240
RAM confirmation Number	013018INTEFSW00005113501705
Deposit Account	501705
Authorized User	April Davis

The Director of the USPTO is hereby authorized to charge indicated fees and credit any overpayment as follows:

37 CFR 1.16 (National application filing, search, and examination fees)

37 CFR 1.17 (Patent application and reexamination processing fees)

37 CFR 1.19 (Document supply fees)					
37 CFR 1.20 (Post Issuance fees)					
37 CFR 1.21 (Miscellaneous fees and charges)					
File Listing:					
Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1		PAT260_018US_Amendment_asfiled_012918.pdf	123812	yes	10
			f19a2f2cb70260b1b44d4320be3e665e7bd6edb2		
	Multipart Description/PDF files in .zip description				
	Document Description		Start	End	
	Amendment/Req. Reconsideration-After Non-Final Reject		1	1	
	Claims		2	6	
	Applicant Arguments/Remarks Made in an Amendment		7	10	
Warnings:					
Information:					
2	Information Disclosure Statement (IDS) Form (SB08)	PAT260_018US_SUPP_IDS_012918.pdf	612437	no	4
			3d36d73ce70e95d9594451d18e7985fb20669e30		
Warnings:					
Information:					
3	Other Reference-Patent/App/Search documents	Office_Action_082917.pdf	583320	no	15
			c4c94c60c0cbcd6c3c71a645fed086e17865bd52		
Warnings:					
Information:					
4	Fee Worksheet (SB06)	fee-info.pdf	30897	no	2
			e8781fb6f669b13307055018bcb703edea1d0683		
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Total Files Size (in bytes):			1350466		

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If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371

If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office

If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

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PATENT APPLICATION FEE DETERMINATION RECORD Substitute for Form PTO-875	Application or Docket Number 15/137,823	Filing Date 04/25/2016	☐ To be Mailed
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ENTITY: ☒ LARGE ☐ SMALL ☐ MICRO**APPLICATION AS FILED – PART I**

(Column 1)

(Column 2)

FOR	NUMBER FILED	NUMBER EXTRA	RATE (\$)	FEE (\$)
☐ BASIC FEE (37 CFR 1.16(a), (b), or (c))	N/A	N/A	N/A	
☐ SEARCH FEE (37 CFR 1.16(k), (l), or (m))	N/A	N/A	N/A	
☐ EXAMINATION FEE (37 CFR 1.16(o), (p), or (q))	N/A	N/A	N/A	
TOTAL CLAIMS (37 CFR 1.16(i))	minus 20 =	*	X \$ =	
INDEPENDENT CLAIMS (37 CFR 1.16(h))	minus 3 =	*	X \$ =	
☐ APPLICATION SIZE FEE (37 CFR 1.16(s))	If the specification and drawings exceed 100 sheets of paper, the application size fee due is \$310 (\$155 for small entity) for each additional 50 sheets or fraction thereof. See 35 U.S.C. 41(a)(1)(G) and 37 CFR 1.16(s).			
☐ MULTIPLE DEPENDENT CLAIM PRESENT (37 CFR 1.16(j))				
* If the difference in column 1 is less than zero, enter "0" in column 2.			TOTAL	

APPLICATION AS AMENDED – PART II

(Column 1)

(Column 2)

(Column 3)

AMENDMENT	01/29/2018	CLAIMS REMAINING AFTER AMENDMENT	MINUS	HIGHEST NUMBER PREVIOUSLY PAID FOR	PRESENT EXTRA	RATE (\$)	ADDITIONAL FEE (\$)
	Total (37 CFR 1.16(i))	* 20	Minus	** 20	= 0	X \$100 =	0
	Independent (37 CFR 1.16(h))	* 3	Minus	***3	= 0	X \$460 =	0
	☐ Application Size Fee (37 CFR 1.16(s))						
	☐ FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))						
TOTAL ADD'L FEE						0	

(Column 1)

(Column 2)

(Column 3)

AMENDMENT	CLAIMS REMAINING AFTER AMENDMENT	MINUS	HIGHEST NUMBER PREVIOUSLY PAID FOR	PRESENT EXTRA	RATE (\$)	ADDITIONAL FEE (\$)
	Total (37 CFR 1.16(i))	*	Minus	**	=	X \$ =
	Independent (37 CFR 1.16(h))	*	Minus	***	=	X \$ =
	☐ Application Size Fee (37 CFR 1.16(s))					
	☐ FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))					
TOTAL ADD'L FEE						

* If the entry in column 1 is less than the entry in column 2, write "0" in column 3.

** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 20, enter "20".

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LIE
BRENDA MURPHY

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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
15/137,823	04/25/2016	I-Lung HO	PAT260-018US	2275
27543	7590	10/27/2017		
APPLIED OPTOELECTRONICS, INC. 13115 JESS PIRTLE BLVD. SUGAR LAND, TX 77478			EXAMINER PHAN, HANH	
			ART UNIT	PAPER NUMBER
			2636	
			NOTIFICATION DATE	DELIVERY MODE
			10/27/2017	ELECTRONIC

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The time period for reply, if any, is set in the attached communication.

Notice of the Office communication was sent electronically on above-indicated "Notification Date" to the following e-mail address(es):

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docketing@gtpp.com
kcarroll@gtpp.com

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Alexandria, Virginia 22313-1450

APPLICATION NO./ CONTROL NO.	FILING DATE	FIRST NAMED INVENTOR / PATENT IN REEXAMINATION	ATTORNEY DOCKET NO.
15/137,823	25 April, 2016	HO ET AL.	PAT260-018US

APPLIED OPTOELECTRONICS, INC. 13115 JESS PIRTLE BLVD. SUGAR LAND, TX 77478		EXAMINER	
		RICHARD ELLIS	
		ART UNIT	PAPER
		OPIM	20171024-150116

DATE MAILED:

Please find below and/or attached an Office communication concerning this application or proceeding.

Commissioner for Patents

The time period for reply set forth in the previous non-final action is being restarted to run from the mail date of the instant communication. Please refer to the non-final action for information on extensions of time if needed for the reply.

The time period is being restarted because the USPTO has identified that the zip code of the correspondence address of the instant application is in an area affected by a recent hurricane. In addition, the non-final action was outstanding on the applicable date and the statutory time period for reply has not yet expired.

If a reply to the non-final action has been filed, no reply to the instant communication is required.

For a copy of the relevant notice on the relief available due to the recent hurricane, see <https://www.uspto.gov/learning-and-resources/operational-status/customers-affected-hurricane-harvey>

Questions regarding this communication may be directed to DisasterRelief@uspto.gov



UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NUMBER	FILING OR 371(C) DATE	FIRST NAMED APPLICANT	ATTY. DOCKET NO./TITLE
15/137,823	04/25/2016	I-Lung HO	PAT260-018US

CONFIRMATION NO. 2275

PUBLICATION NOTICE



OC000000095036552

27543
APPLIED OPTOELECTRONICS, INC.
13115 JESS PIRTLE BLVD.
SUGAR LAND, TX 77478

Title: TECHNIQUES FOR DIRECT OPTICAL COUPLING OF PHOTODETECTORS TO OPTICAL DEMULTIPLEXER OUTPUTS AND AN OPTICAL TRANSCEIVER USING THE SAME

Publication No. US-2017-0307819-A1

Publication Date: 10/26/2017

NOTICE OF PUBLICATION OF APPLICATION

The above-identified application will be electronically published as a patent application publication pursuant to 37 CFR 1.211, et seq. The patent application publication number and publication date are set forth above.

The publication may be accessed through the USPTO's publically available Searchable Databases via the Internet at www.uspto.gov. The direct link to access the publication is currently <http://www.uspto.gov/patft/>.

The publication process established by the Office does not provide for mailing a copy of the publication to applicant. A copy of the publication may be obtained from the Office upon payment of the appropriate fee set forth in 37 CFR 1.19(a)(1). Orders for copies of patent application publications are handled by the USPTO's Public Records Division. The Public Records Division can be reached by telephone at (571) 272-3150 or (800) 972-6382, by facsimile at (571) 273-3250, by mail addressed to the United States Patent and Trademark Office, Public Records Division, Alexandria, VA 22313-1450 or via the Internet.

In addition, information on the status of the application, including the mailing date of Office actions and the dates of receipt of correspondence filed in the Office, may also be accessed via the Internet through the Patent Electronic Business Center at www.uspto.gov using the public side of the Patent Application Information and Retrieval (PAIR) system. The direct link to access this status information is currently <https://portal.uspto.gov/pair/PublicPair>. Prior to publication, such status information is confidential and may only be obtained by applicant using the private side of PAIR.

Further assistance in electronically accessing the publication, or about PAIR, is available by calling the Patent Electronic Business Center at 1-866-217-9197.

Office of Data Management, Application Assistance Unit (571) 272-4000, or (571) 272-4200, or 1-888-786-0101

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)	Application Number	15137823
	Filing Date	2016-04-25
	First Named Inventor	HO
	Art Unit	2636
	Examiner Name	PHAN, Hanh
	Attorney Docket Number	PAT260-018US

U.S.PATENTS						Remove
Examiner Initial*	Cite No	Patent Number	Kind Code ¹	Issue Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
	1	5617234		1997-04-01	KOGA ET AL	
	2	7376308	B2	2008-05-20	CHEBEN ET AL	
	3	8831433	B2	2014-09-09	HO ET AL	

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Examiner Initial*	Cite No	Foreign Document Number ³	Country Code ² i	Kind Code ⁴	Publication Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear	T ⁵
	1							

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)	Application Number		15137823
	Filing Date		2016-04-25
	First Named Inventor	HO	
	Art Unit	2636	
	Examiner Name	PHAN, Hanh	
	Attorney Docket Number	PAT260-018US	

If you wish to add additional Foreign Patent Document citation information please click the Add button

NON-PATENT LITERATURE DOCUMENTS

Examiner Initials*	Cite No	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc), date, pages(s), volume-issue number(s), publisher, city and/or country where published.	T ⁵
	1	PCT Search Report and Written Opinion mailed July 6, 2017, received in corresponding PCT Application No. PCT/US17/29350, 9 pgs.	

If you wish to add additional non-patent literature document citation information please click the Add button

EXAMINER SIGNATURE

Examiner Signature	Date Considered
--------------------	-----------------

*EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through a citation if not in conformance and not considered. Include copy of this form with next communication to applicant.

¹ See Kind Codes of USPTO Patent Documents at www.USPTO.GOV or MPEP 901.04. ² Enter office that issued the document, by the two-letter code (WIPO Standard ST.3). ³ For Japanese patent documents, the indication of the year of the reign of the Emperor must precede the serial number of the patent document. ⁴ Kind of document by the appropriate symbols as indicated on the document under WIPO Standard ST.16 if possible. ⁵ Applicant is to place a check mark here if English language translation is attached.

**INFORMATION DISCLOSURE
STATEMENT BY APPLICANT**
(Not for submission under 37 CFR 1.99)

Application Number	15137823
Filing Date	2016-04-25
First Named Inventor	HO
Art Unit	2636
Examiner Name	PHAN, Hanh
Attorney Docket Number	PAT260-018US

CERTIFICATION STATEMENT

Please see 37 CFR 1.97 and 1.98 to make the appropriate selection(s):

☒ That each item of information contained in the information disclosure statement was first cited in any communication from a foreign patent office in a counterpart foreign application not more than three months prior to the filing of the information disclosure statement. See 37 CFR 1.97(e)(1).

OR

☐ That no item of information contained in the information disclosure statement was cited in a communication from a foreign patent office in a counterpart foreign application, and, to the knowledge of the person signing the certification after making reasonable inquiry, no item of information contained in the information disclosure statement was known to any individual designated in 37 CFR 1.56(c) more than three months prior to the filing of the information disclosure statement. See 37 CFR 1.97(e)(2).

See attached certification statement.

The fee set forth in 37 CFR 1.17 (p) has been submitted herewith.

A certification statement is not submitted herewith.

SIGNATURE

A signature of the applicant or representative is required in accordance with CFR 1.33, 10.18. Please see CFR 1.4(d) for the form of the signature.

Signature	/Kevin J. Carroll/	Date (YYYY-MM-DD)	2017-10-06
Name/Print	Kevin J. Carroll	Registration Number	36384

This collection of information is required by 37 CFR 1.97 and 1.98. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 1 hour to complete, including gathering, preparing and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. **DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

Privacy Act Statement

The Privacy Act of 1974 (P.L. 93-579) requires that you be given certain information in connection with your submission of the attached form related to a patent application or patent. Accordingly, pursuant to the requirements of the Act, please be advised that: (1) the general authority for the collection of this information is 35 U.S.C. 2(b)(2); (2) furnishing of the information solicited is voluntary; and (3) the principal purpose for which the information is used by the U.S. Patent and Trademark Office is to process and/or examine your submission related to a patent application or patent. If you do not furnish the requested information, the U.S. Patent and Trademark Office may not be able to process and/or examine your submission, which may result in termination of proceedings or abandonment of the application or expiration of the patent.

The information provided by you in this form will be subject to the following routine uses:

1. The information on this form will be treated confidentially to the extent allowed under the Freedom of Information Act (5 U.S.C. 552) and the Privacy Act (5 U.S.C. 552a). Records from this system of records may be disclosed to the Department of Justice to determine whether the Freedom of Information Act requires disclosure of these records.
2. A record from this system of records may be disclosed, as a routine use, in the course of presenting evidence to a court, magistrate, or administrative tribunal, including disclosures to opposing counsel in the course of settlement negotiations.
3. A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.
4. A record in this system of records may be disclosed, as a routine use, to a contractor of the Agency having need for the information in order to perform a contract. Recipients of information shall be required to comply with the requirements of the Privacy Act of 1974, as amended, pursuant to 5 U.S.C. 552a(m).
5. A record related to an International Application filed under the Patent Cooperation Treaty in this system of records may be disclosed, as a routine use, to the International Bureau of the World Intellectual Property Organization, pursuant to the Patent Cooperation Treaty.
6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).
7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (i.e., GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.
8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspections or an issued patent.
9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

PATENT COOPERATION TREATY

From the INTERNATIONAL SEARCHING AUTHORITY

PCT

NOTIFICATION OF TRANSMITTAL OF
THE INTERNATIONAL SEARCH REPORT AND
THE WRITTEN OPINION OF THE INTERNATIONAL
SEARCHING AUTHORITY, OR THE DECLARATION

(PCT Rule 44.1)

To: KEVIN J. CARROLL
GROSSMAN TUCKER PERREAULT &
PFLEGER, PLLC
55 SOUTH COMMERCIAL STREET
MANCHESTER, NH 03101

RECEIVED

JUL 10 2017

Date of mailing
(day/month/year)

Applicant's or agent's file reference
PAT260018PCT

FOR FURTHER ACTION See paragraphs 1 and 4 below

International application No.
PCT/US2017/029350

GROSSMAN, TUCKER
PERREAULT & PFLEGER, PLLC

International filing date
(day/month/year) 25 April 2017

Applicant APPLIED OPTOELECTRONICS, INC.

1. ☒ The applicant is hereby notified that the international search report and the written opinion of the International Searching Authority have been established and are transmitted herewith.

Filing of amendments and statement under Article 19:

The applicant is entitled, if he so wishes, to amend the claims of the international application (see Rule 46):

When? The time limit for filing such amendments is normally two months from the date of transmittal of the international search report.

How? Directly to the International Bureau of WIPO preferably through ePCT or on paper to, 34 chemin des Colombettes 1211 Geneva 20, Switzerland, Facsimile No.: +41 22 338 82 70

For more detailed instructions, see *PCT Applicant's Guide*, International Phase, paragraphs 9.004 – 9.011.

2. ☐ The applicant is hereby notified that no international search report will be established and that the declaration under Article 17(2)(a) to that effect and the written opinion of the International Searching Authority are transmitted herewith.

3. ☐ With regard to any protest against payment of (an) additional fee(s) under Rule 40.2, the applicant is notified that:

- ☐ the protest together with the decision thereon has been transmitted to the International Bureau together with any request to forward the texts of both the protest and the decision thereon to the designated Offices.
- ☐ no decision has been made yet on the protest; the applicant will be notified as soon as a decision is made.

4. Reminders

The applicant may submit comments on an informal basis on the written opinion of the International Searching Authority to the International Bureau. These comments will be made available to the public after international publication. The International Bureau will send a copy of such comments to all designated Offices unless an international preliminary examination report has been or is to be established.

Shortly after the expiration of 18 months from the priority date, the international application will be published by the International Bureau. If the applicant wishes to avoid or postpone publication, a notice of withdrawal of the international application, or of the priority claim, must reach the International Bureau before the completion of the technical preparations for international publication (Rules 90bis.1 and 90bis.3).

Within 19 months from the priority date, but only in respect of some designated Offices, a demand for international preliminary examination must be filed if the applicant wishes to postpone the entry into the national phase until 30 months from the priority date (in some Offices even later); otherwise, the applicant must, within 20 months from the priority date, perform the prescribed acts for entry into the national phase before those designated Offices. In respect of other designated Offices, the time limit of 30 months (or later) will apply even if no demand is filed within 19 months. For details about the applicable time limits, Office by Office, see www.wipo.int/pct/en/texts/time_limits.html and the *PCT Applicant's Guide*, National Chapters.

Within 19 months from the priority date, the applicant may request that a supplementary international search be carried out by a different International Searching Authority that offers this service (Rule 45bis.1). The procedure for requesting supplementary international search is described in the *PCT Applicant's Guide*, International Phase, paragraphs 8.006-8.032.

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

Authorized officer
Blaine R. Copenheaver
PCT Helpdesk: 571-272-4300
Telephone No. PCT OSP: 571-272-7774

Form PCT/ISA/220 (July 2014)

PATENT COOPERATION TREATY

From the INTERNATIONAL SEARCHING AUTHORITY

PCT

NOTIFICATION OF TRANSMITTAL OF
THE INTERNATIONAL SEARCH REPORT AND
THE WRITTEN OPINION OF THE INTERNATIONAL
SEARCHING AUTHORITY, OR THE DECLARATION

(PCT Rule 44.1)

To: KEVIN J. CARROLL GROSSMAN TUCKER PERREAULT & PFLEGER, PLLC 55 SOUTH COMMERCIAL STREET MANCHESTER, NH 03101	06 JUL 2017
Applicant's or agent's file reference PAT260018PCT	FOR FURTHER ACTION See paragraphs 1 and 4 below
International application No. PCT/US2017/029350	International filing date (day/month/year) 25 April 2017
Applicant APPLIED OPTOELECTRONICS, INC.	

1. ☒ The applicant is hereby notified that the international search report and the written opinion of the International Searching Authority have been established and are transmitted herewith.

Filing of amendments and statement under Article 19:

The applicant is entitled, if he so wishes, to amend the claims of the international application (see Rule 46):

When? The time limit for filing such amendments is normally two months from the date of transmittal of the international search report.

How? Directly to the International Bureau of WIPO preferably through ePCT or on paper to, 34 chemin des Colombettes
1211 Geneva 20, Switzerland, Facsimile No.: +41 22 338 82 70

For more detailed instructions, see *PCT Applicant's Guide*, International Phase, paragraphs 9.004 – 9.011.

2. ☐ The applicant is hereby notified that no international search report will be established and that the declaration under Article 17(2)(a) to that effect and the written opinion of the International Searching Authority are transmitted herewith.

3. ☐ With regard to any protest against payment of (an) additional fee(s) under Rule 40.2, the applicant is notified that:

☐ the protest together with the decision thereon has been transmitted to the International Bureau together with any request to forward the texts of both the protest and the decision thereon to the designated Offices.

☐ no decision has been made yet on the protest; the applicant will be notified as soon as a decision is made.

4. Reminders

The applicant may submit comments on an informal basis on the written opinion of the International Searching Authority to the International Bureau. These comments will be made available to the public after international publication. The International Bureau will send a copy of such comments to all designated Offices unless an international preliminary examination report has been or is to be established.

Shortly after the expiration of 18 months from the priority date, the international application will be published by the International Bureau. If the applicant wishes to avoid or postpone publication, a notice of withdrawal of the international application, or of the priority claim, must reach the International Bureau before the completion of the technical preparations for international publication (Rules 90bis.1 and 90bis.3).

Within 19 months from the priority date, but only in respect of some designated Offices, a demand for international preliminary examination must be filed if the applicant wishes to postpone the entry into the national phase until 30 months from the priority date (in some Offices even later); otherwise, the applicant must, within 20 months from the priority date, perform the prescribed acts for entry into the national phase before those designated Offices. In respect of other designated Offices, the time limit of 30 months (or later) will apply even if no demand is filed within 19 months. For details about the applicable time limits, Office by Office, see www.wipo.int/pct/en/texts/time_limits.html and the *PCT Applicant's Guide*, National Chapters.

Within 19 months from the priority date, the applicant may request that a supplementary international search be carried out by a different International Searching Authority that offers this service (Rule 45bis.1). The procedure for requesting supplementary international search is described in the *PCT Applicant's Guide*, International Phase, paragraphs 8.006-8.032.

Name and mailing address of the ISA/US Mail Stop PCT, Attn: ISA/US Commissioner for Patents P.O. Box 1450, Alexandria, VA 22313-1450 Facsimile No. 571-273-8300	Authorized officer Blaine R. Copenheaver PCT Helpdesk: 571-272-4300 PCT OSP: 571-272-7774
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Form PCT/ISA/220 (July 2014)

PATENT COOPERATION TREATY

PCT

INTERNATIONAL SEARCH REPORT

(PCT Article 18 and Rules 43 and 44)

Applicant's or agent's file reference PAT260018PCT	FOR FURTHER ACTION see Form PCT/ISA/220 as well as, where applicable, item 5 below.	
International application No. PCT/US2017/029350	International filing date (<i>day/month/year</i>) 25 April 2017	(Earliest) Priority Date (<i>day/month/year</i>) 25 April 2016
Applicant APPLIED OPTOELECTRONICS, INC.		

This international search report has been prepared by this International Searching Authority and is transmitted to the applicant according to Article 18. A copy is being transmitted to the International Bureau.

This international search report consists of a total of 2 sheets.

☐ It is also accompanied by a copy of each prior art document cited in this report.

1. Basis of the report

a. With regard to the language, the international search was carried out 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)).

b. ☐ This international search report has been established taking into account the rectification of an obvious mistake authorized by or notified to this Authority under Rule 91 (Rule 43.6bis(a)).

c. ☐ With regard to any nucleotide and/or amino acid sequence disclosed in the international application, see Box No. I.

2. ☐ Certain claims were found unsearchable (see Box No. II).

3. ☐ Unity of invention is lacking (see Box No. III).

4. With regard to the title,

☒ the text is approved as submitted by the applicant.

☐ the text has been established by this Authority to read as follows:

5. With regard to the abstract,

☒ the text is approved as submitted by the applicant.

☐ the text has been established, according to Rule 38.2, by this Authority as it appears in Box No. IV. The applicant may, within one month from the date of mailing of this international search report, submit comments to this Authority.

6. With regard to the drawings,

a. the figure of the drawings to be published with the abstract is Figure No. 2

☒ as suggested by the applicant.

☐ as selected by this Authority, because the applicant failed to suggest a figure.

☐ as selected by this Authority, because this figure better characterizes the invention.

b. ☐ none of the figures is to be published with the abstract.

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2017/029350

A. CLASSIFICATION OF SUBJECT MATTER
IPC(8) - G02B 6/12; H04J 14/02 (2017.01)
CPC - G02B 6/12016; G02B 6/12009; G02B 6/4214 (2017.02)

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)

See Search History document

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
USPC - 385/14; 385/31; 398/79 (keyword delimited)Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
See Search History document

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 7,532,783 B2 (BAI) 12 May 2009 (12.05.2009) entire document	1-11, 20
---		12-19
Y		12-19
Y	US 8,831,433 B2 (HO et al) 09 September 2014 (09.09.2014) entire document	12-19
Y	US 7,376,308 B2 (CHEBEN et al) 20 May 2008 (20.05.2008) entire document	13
A	US 5,617,234 A (KOGA et al) 01 April 1997 (01.04.1997) entire document	1-20

☐ 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

15 June 2017

Date of mailing of the international search report

06 JUL 2017

Name and mailing address of the ISA/US

Mail Stop PCT, Attn: ISA/US, Commissioner for Patents
P.O. Box 1450, Alexandria, VA 22313-1450

Facsimile No. 571-273-8300

Authorized officer

Blaine R. Copenheaver

PCT Helpdesk: 571-272-4300
PCT OSP: 571-272-7774

PATENT COOPERATION TREATY

From the
INTERNATIONAL SEARCHING AUTHORITY

PCT

WRITTEN OPINION OF THE
INTERNATIONAL SEARCHING AUTHORITY

(PCT Rule 43bis.1)

To: KEVIN J. CARROLL
GROSSMAN TUCKER PERREAULT &
PFLEGER, PLLC
55 SOUTH COMMERCIAL STREET
MANCHESTER, NH 03101

Date of mailing
(day/month/year)

06 JUL 2017

Applicant's or agent's file reference
PAT260018PCT

FOR FURTHER ACTION

See paragraph 2 below

International application No.
PCT/US2017/029350

International filing date (day/month/year)
25 April 2017

Priority date (day/month/year)
25 April 2016

International Patent Classification (IPC) or both national classification and IPC
IPC(8) - G02B 6/12; H04J 14/02 (2017.01)
CPC - G02B 6/12016; G02B 6/12009; G02B 6/4214 (2017.02)

Applicant **APPLIED OPTOELECTRONICS, INC.**

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, VA 22313-1450
Facsimile No. 571-273-8300

Date of completion of this opinion

15 June 2017

Authorized officer

Blaine R. Copenheaver
PCT Helpdesk: 571-272-4300
PCT OSP: 571-272-7774

Form PCT/ISA/237 (cover sheet) (January 2015)

WRITTEN OPINION OF THE
INTERNATIONAL SEARCHING AUTHORITY

International application No.

PCT/US2017/029350

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 43bis.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 13ter.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 13ter.1(a)).
☐ on paper or in the form of an image file (Rule 13ter.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:

**WRITTEN OPINION OF THE
INTERNATIONAL SEARCHING AUTHORITY**

International application No.
PCT/US2017/029350

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	12-19	YES
	Claims	1-11, 20	NO
Inventive step (IS)	Claims	None	YES
	Claims	1-20	NO
Industrial applicability (IA)	Claims	1-20	YES
	Claims	None	NO

2. Citations and explanations:

Claims 1-11 and 20 lack novelty under PCT Article 33(2) as being anticipated by Bai.

Regarding Claim 1, Bai discloses an arrayed waveguide grating (AWG) chip (Hybrid receiver 100 also includes an optical demultiplexer in the silicon bench ... the optical demultiplexer includes an arrayed waveguide grating (AWG) 110 ... Col.5, Ln.37 - 55; Fig.1A) comprising: a first end for coupling to an optical coupling receptacle to receive an optical signal comprising a plurality of channel wavelengths (In an embodiment, the input port 112 is optically coupled to an optical fiber 119 for receiving a DWDM optical signal ... Col.5, Ln.56 - Col.6, Ln.6); a planar lightwave circuit (PLC) coupled to the first end configured to demultiplex each channel wavelength of the plurality of channel wavelengths (In a specific embodiment, the optical demultiplexer includes an arrayed waveguide grating (AWG) 110 made in a silica-on-silicon planar lightwave circuit (PLC) in the silicon bench. Col.5, Ln.37 - 55; Fig.1A); a plurality of output waveguides coupled to the PLC (... the AWG 110 includes ... multiple output ports 113 ... Col.5, Ln.56 - Col.6, Ln.6; Fig.1A), each of the output waveguides configured to receive light corresponding to an associated demultiplexed channel wavelength launched from the PLC (In a specific embodiment, each of the output ports outputs a demultiplexed optical signal. In some embodiments, each output port of the AWG has a center wavelength and pass band associated with light transmission. Col.5, Ln.56 - Col.6, Ln.6; Fig.1A) and provide the light along a first light path that extends towards a second end of the AWG chip (... at an end point of an output waveguide with a 45 degrees surface terminating the waveguide ... Col.7, Ln.48 -61; Fig.2B); and a tapered region disposed at the second end of the AWG chip configured to receive light via the plurality of output waveguides and reflect the same towards an output interface region of the AWG chip (For example, a gap is formed in the silica layer at an end point of an output waveguide with a 45 degrees surface terminating the waveguide to allow total internal reflection. Col.7, Ln.48 -61; Fig.2B).

Regarding Claim 2, Bai discloses the AWG chip of claim 1, wherein the output interface region is configured to pass the reflected light received via the plurality of output waveguides out of the AWG chip along a second light path that is substantially orthogonal to the first light path (In an embodiment, light coming out of each output waveguide is reflected to the surface of the PLC and collected by a corresponding photodetector, e.g., 214. Col.7, Ln.26 - 47; ... with a 45 degrees surface terminating the waveguide ... Col.7, Ln.48 -61; It is well known to all that such 45 degree structure will result in orthogonal reflected light path).

Regarding Claim 3, Bai discloses the AWG chip of claim 1, wherein the AWG chip defines a plurality of sidewalls extending longitudinally from the first end to the second end (the upper and lower side of waveguide 121 in Fig.1B), and wherein the tapered region of the second end defines an angled surface that extends from a first sidewall of the plurality of sidewalls to a second sidewall of the plurality of sidewalls (... at an end point of an output waveguide with a 45 degrees surface terminating the waveguide ... Col.7, Ln.48 -61; Fig.2B).

Regarding Claim 4, Bai discloses the AWG chip of claim 3, wherein the angled surface has an interior angle of about 41 to 45 degrees relative to the output interface region (... with a 45 degrees surface terminating the waveguide ... Col.7, Ln.48 -61; Fig.2B).

Regarding Claim 5, Bai discloses the AWG chip of claim 3, wherein each of the output waveguides comprise a core material, and wherein a cladding material is disposed on the core material (As shown, a waveguide includes doped silica region 121 enclosed in an undoped silica layer 122 on a silicon substrate 124. Col.6, Ln.7 - 24; Fig.1B), the core material defining at least a portion of the plurality of sidewalls of the AWG chip (waveguide 121 in Fig.1B).

Regarding Claim 6, Bai discloses the AWG chip of claim 5, wherein the core material of each of the plurality of output waveguides has a first index of refraction, and a medium external to and adjacent the tapered region has a second index of refraction, the first index of refraction being greater than the second index of refraction (In a specific embodiment, the doped silica region 121 has a higher index of refraction than the undoped silica region. Col.6, Ln.7 - 24).

Regarding Claim 7, Bai discloses the AWG chip of claim 5, wherein the core material of each of the plurality of output waveguides provide a portion of the angled surface (For example, a gap is formed in the silica layer at an end point of an output waveguide with a 45 degrees surface terminating the waveguide ... Col.7, Ln.48 -61; Fig.2B), and wherein the angled surface is configured to reflect incident light based on at least an interior angle of the angled surface (... with a 45 degrees surface terminating the waveguide to allow total internal reflection. Col.7, Ln.48 -61; Fig.2B).

Regarding Claim 8, Bai discloses the AWG chip of claim 5, wherein the core material comprises doped silica (SiO₂) having an index of refraction of about 1.45 to 1.50 (In a specific example, the doped silica region 121 has a index of refraction of about 1.47, ... Col.6, Ln.7 - 24).

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Supplemental Box

In case the space in any of the preceding boxes is not sufficient.

Continuation of:

Regarding Claim 9, Bai discloses the AWG chip of claim 6, wherein the external medium comprises a material having an index of refraction of about 1.0 (... in silica-air interface ... Col.7, Ln.48 -61; It is well known that the refractive index of air is about 1.0).

Regarding Claim 10, Bai discloses the AWG chip of claim 1, wherein the AWG chip is configured as a 1xN demultiplexer device whereby a single optical input signal is de-multiplexed into N different channel wavelengths (These waveguides have varying lengths for performing wavelength division multiplexing and demultiplexing functions. In a specific embodiment, each of the output ports outputs a demultiplexed optical signal. Col.5, Ln.56 - Col.6, Ln.6).

Regarding Claim 11, Bai discloses the AWG chip of claim 1, wherein the AWG chip is implemented in an AWG device package (Fig. 1A is a simplified top view diagram of a hybrid integrated DWDM receiver according to an embodiment of the present invention. Col.5, Ln.37 - 55; Fig.1A).

Regarding Claim 20, Bai discloses a method of forming an arrayed waveguide grating (AWG) (Fig. 4 is a simplified flowchart of a method for making an integrated DWDM receiver according to an embodiment of the invention. Col.8, Ln.24 - 30) comprising: depositing sequential layers of cladding and core material onto a substrate to form a planar lightwave circuit (PLC) (... forming a first un-doped silica sub-layer on the silicon layer; forming a doped silica sub-layer on the first un-doped silica sub-layer; Col.8, Ln.49 - 52); removing a portion of the substrate to expose an output interface region of the PLC (The recess includes a first surface that terminates a corresponding one of the output waveguides. Col.8, Ln.58 - Col.9, Ln.9); and removing a portion of the PLC to provide a tapered region proximal to the output interface region of the PLC (... is formed by first forming a recess region in the first region of the silica layer. Col.8, Ln.58 - Col.9, Ln.9).

Claims 12 and 14-19 lack an inventive step under PCT Article 33(3) as being obvious over Bai in view of Ho et al. (hereinafter Ho).

Regarding Claim 12, Bai discloses a multi-channel receiver optical sub-assembly (ROSA) including an AWG chip (Hybrid receiver 100 also includes an optical demultiplexer in the silicon bench ... the optical demultiplexer includes an arrayed waveguide grating (AWG) 110 ... Col.5, Ln.37 - 55; Fig.1A) comprising: a first end for coupling to an optical coupling receptacle to receive an optical signal comprising a plurality of channel wavelengths (In an embodiment, the input port 112 is optically coupled to an optical fiber 119 for receiving a DWDM optical signal ... Col.5, Ln.56 - Col.6, Ln.6); a planar lightwave circuit (PLC) coupled to the first end configured to demultiplex each channel wavelength of the plurality of channel wavelengths (In a specific embodiment, the optical demultiplexer includes an arrayed waveguide grating (AWG) 110 made in a silica-on-silicon planar lightwave circuit (PLC) in the silicon bench. Col.5, Ln.37 - 55; Fig.1A); a plurality of output waveguides coupled to the PLC (... the AWG 110 includes ... multiple output ports 113 ... Col.5, Ln.56 - Col.6, Ln.6; Fig.1A), each of the output waveguides configured to receive light corresponding to an associated demultiplexed channel wavelength launched from the PLC (In a specific embodiment, each of the output ports outputs a demultiplexed optical signal. In some embodiments, each output port of the AWG has a center wavelength and pass band associated with light transmission. Col.5, Ln.56 - Col.6, Ln.6; Fig.1A) and provide the light along a first light path that extends towards a second end of the AWG chip (... at an end point of an output waveguide with a 45 degrees surface terminating the waveguide... Col.7, Ln.48 -61; Fig.2B); and a tapered region disposed at the second end of the AWG chip configured to receive light via the plurality of output waveguides and reflect the same towards an output interface region of the AWG chip (For example, a gap is formed in the silica layer at an end point of an output waveguide with a 45 degrees surface terminating the waveguide to allow total internal reflection. Col.7, Ln.48 -61; Fig.2B); an array of detector devices disposed adjacent to the output interface region of the AWG chip (... and directed up toward a photodetector, which is mounted above the reflecting surface as described below. Col.8, Ln.58 - Col.9, Ln.9);

Bai fails to explicitly disclose a transceiver housing; a multi-channel receiver optical sub-assembly (ROSA) located in the transceiver housing and arrayed waveguide grating (AWG) chip, and a multi-channel transmitter optical assembly (TOSA) including at least one laser package located in the transceiver housing for transmitting optical signals at different channel wavelengths.

Ho teaches an optical transceiver module (The transceiver module 202 ... Col.5, Ln.32 - 48; Fig.2) comprising: a transceiver housing (... includes a transceiver housing 210 ... Col.5, Ln.32 - 48; Fig.2); a multi-channel receiver optical sub-assembly (ROSA) located in the transceiver housing and arrayed waveguide grating (AWG) chip (... a multi-channel ROSA 230, ... Col.5, Ln.32 - 48; Fig.2), ... and a multi-channel transmitter optical assembly (TOSA) (... containing the temperature controlled multi-channel TOSA 220, ... Col.5, Ln.32 - 48; Fig.2) including at least one laser package located in the transceiver housing (One embodiment of the multi-channel TOSA 120 includes an array of lasers 122, such as laser diodes, ... Col.4, Ln.18 - 30; Fig.1) for transmitting optical signals at different channel wavelengths (... the lasers 122 may be tunable lasers that generate the optical signals at the respective channel wavelengths. Col.4, Ln.31 - 49).

It would have been obvious to one of ordinary skill in the art at the time of the invention to modify Bai with the teaching of Ho for the purpose of forming demultiplexer including AWG (see Bai; Col.5, Ln.37 - 55).

Regarding Claim 14, modified Bai discloses the optical transceiver module of claim 12, wherein the output interface region of the AWG chip is separated from the array of detector devices (...a gap is formed in the silica layer at an end point of an output waveguide...Col.7, Ln.48 -61; Fig.2B).

Bai fails to explicitly disclose the output interface region of the AWG chip is separated from the array of detector devices by about 50 microns.

However, determining the optimal distance between components that provides the transmission of the highest quality optical signals across the transmitted wavelengths in such an optical system is a matter of routine experimentation for one of ordinary skill in the art. It would have been obvious to one of ordinary skill in the art at the time of the invention to modify Bai by providing the output of the AWG chip separated from the array of detector devices by about 50 microns for the purpose of optimizing the transmitted signal across the utilized wavelengths, since discovering the optimum value of a result effective variable requires only routine skill in the art.

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Supplemental Box

In case the space in any of the preceding boxes is not sufficient.

Continuation of:

Regarding Claim 15, modified Bai discloses the optical transceiver module of claim 12, wherein the AWG chip defines a plurality of sidewalls extending longitudinally from the first end to the second end, and wherein the tapered region of the second end defines an angled surface that extends from a first sidewall of the plurality of sidewalls to a second sidewall of the plurality of sidewalls (... at an end point of an output waveguide with a 45 degrees surface terminating the waveguide ... Col.7, Ln.48 -61; Fig.2B).

Regarding Claim 16, modified Bai discloses the optical transceiver module of claim 15, wherein the angled surface has an interior angle of about 41 to 45 degrees relative to the output interface region (... with a 45 degrees surface terminating the waveguide ... Col.7, Ln.48 -61; Fig2B).

Regarding Claim 17, modified Bai discloses the optical transceiver module of claim 15, wherein each of the output waveguides comprise a core material, and wherein a cladding material is disposed on the core material (As shown, a waveguide includes doped silica region 121 enclosed in an undoped silica layer 122 on a silicon substrate 124. Col.6, Ln.7 - 24; Fig.1B), the core material defining at least a portion of the plurality of sidewalls of the AWG chip (waveguide 121 in Fig.1B).

Regarding Claim 18, modified Bai discloses the optical transceiver module of claim 17, wherein the core material of each of the plurality of output waveguides provide a portion of the angled surface (For example, a gap is formed in the silica layer at an end point of an output waveguide with a 45 degrees surface terminating the waveguide ... Col.7, Ln.48 -61; Fig.2B), and wherein the angled surface is configured to reflect incident light based on at least an interior angle of the angled surface relative to the output interface of the AWG chip (... with a 45 degrees surface terminating the waveguide to allow total internal reflection. Col.7, Ln.48 -61; Fig.2B).

Regarding Claim 19, modified Bai discloses the optical transceiver of claim 12, and further discloses a hybrid receiver 100 includes an optical demultiplexer in the silicon bench (Hybrid receiver 100 also includes ... the optical demultiplexer includes an arrayed waveguide grating (AWG) 110 ... Col.5, Ln.37 - 55; Fig.1A).

Bai fails to explicitly disclose the transceiver is a Small Formfactor Pluggable (SFP) transceiver module and the ROSA is configured to receive at least four different channel wavelengths at transmission rates of at least about 25 Gbps per channel.

Ho teaches the transceiver is a Small Formfactor Pluggable (SFP) transceiver module (The transceiver module 202 ... may thus be designed to have a relatively small form factor with minimal space. Col.5, Ln.32 - 48. The dual fiber type direct link adapter 250 is also configured to receive pluggable optical connectors ... Col.5, Ln.49 - 61) and the ROSA is configured to receive at least four different channel wavelengths at transmission rates of at least about 25 Gbps per channel (Other data rates and modulation schemes may also be used. Col.5, Ln.1 - 13).

It would have been obvious to one of ordinary skill in the art at the time of the invention to modify Bai with the teaching of Ho for the purpose of forming demultiplexer including AWG (see Bai; Col.5, Ln.37 - 55).

Claim 13 lacks an inventive step under PCT Article 33(3) as being obvious over Bai in view of Ho et al. (hereinafter Ho) and Cheben et al. (hereinafter Cheben).

Regarding Claim 13, modified Bai discloses the optical transceiver module of claim 12, and further discloses an array of detector devices (... and directed up toward a photodetector, which is mounted above the reflecting surface as described below. Col.8, Ln.58 - Col.9, Ln.9).

Bai fails to explicitly disclose an air gap separates the output interface region of the AWG chip and the array of detector devices. Cheben teaches an air gap separates the output interface region of the AWG chip and the array of detector devices (The residual substrate 9 underneath the reflective element and the thinned aperture 8 are optional, the latter may be used to reduce distance between the reflection element and the second device that intercepts or emits the out-of-plane wave. Col.3, Ln.46 - 57; Fig.1a. The second device can be either an optical waveguide or an array of thereof, a photodetector or an array of thereof, ... Col.7, Ln.7 - 18). It would have been obvious to one of ordinary skill in the art at the time of the invention to modify Bai with the teaching of Cheben for the purpose of positioning photodetector to intercept reflected light from waveguide (see Cheben; Col.3, Ln.46 - 57).

Claims 1-20 meet the criteria set out in PCT Article 33(4), and thus have industrial applicability because the subject matter claimed can be made or used in industry.

Electronic Acknowledgement Receipt

EFS ID:	30588295
Application Number:	15137823
International Application Number:	
Confirmation Number:	2275
Title of Invention:	TECHNIQUES FOR DIRECT OPTICAL COUPLING OF PHOTODETECTORS TO OPTICAL DEMULTIPLEXER OUTPUTS AND AN OPTICAL TRANSCEIVER USING THE SAME
First Named Inventor/Applicant Name:	I-Lung HO
Customer Number:	27543
Filer:	Kevin J. Carroll/April Davis
Filer Authorized By:	Kevin J. Carroll
Attorney Docket Number:	PAT260-018US
Receipt Date:	06-OCT-2017
Filing Date:	25-APR-2016
Time Stamp:	14:19:26
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	no
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File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Information Disclosure Statement (IDS) Form (SB08)	PAT260_018US_IDS.pdf	612096	no	4
			e98f2383cee6b96b986b46bb5ac229e1011b2bc1		

Warnings:

Information:					
2	Other Reference-Patent/App/Search documents	PCT_SearchReport_WrittenOpinion.pdf	636607	no	9
			65bdfc49aa45d89e1984e0a52b3f18f009ef1b0c		
Warnings:					
Information:					
Total Files Size (in bytes):				1248703	
This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503. <u>New Applications Under 35 U.S.C. 111</u> If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application. <u>National Stage of an International Application under 35 U.S.C. 371</u> If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course. <u>New International Application Filed with the USPTO as a Receiving Office</u> If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.					



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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
15/137,823	04/25/2016	I-Lung HO	PAT260-018US	2275
27543	7590	08/21/2017	EXAMINER	
APPLIED OPTOELECTRONICS, INC.			PHAN, HANH	
13115 JESS PIRTLE BLVD.				
SUGAR LAND, TX 77478				
			ART UNIT	PAPER NUMBER
			2636	
			NOTIFICATION DATE	DELIVERY MODE
			08/21/2017	ELECTRONIC

Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

Notice of the Office communication was sent electronically on above-indicated "Notification Date" to the following e-mail address(es):

kinsella@ao-inc.com
docketing@gtpp.com
kcarroll@gtpp.com

Office Action Summary	Application No. 15/137,823	Applicant(s) HO ET AL.	
	Examiner HANH PHAN	Art Unit 2636	AIA (First Inventor to File) Status Yes

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTHS FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

- 1) ☒ Responsive to communication(s) filed on 04/25/2016.
☐ A declaration(s)/affidavit(s) under **37 CFR 1.130(b)** was/were filed on _____.
- 2a) ☐ This action is **FINAL**. 2b) ☒ This action is non-final.
- 3) ☐ An election was made by the applicant in response to a restriction requirement set forth during the interview on _____; the restriction requirement and election have been incorporated into this action.
- 4) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims*

- 5) ☒ Claim(s) 1-19 is/are pending in the application.
5a) Of the above claim(s) _____ is/are withdrawn from consideration.
- 6) ☐ Claim(s) _____ is/are allowed.
- 7) ☒ Claim(s) 1-19 is/are rejected.
- 8) ☐ Claim(s) _____ is/are objected to.
- 9) ☐ Claim(s) _____ are subject to restriction and/or election requirement.

* If any claims have been determined allowable, you may be eligible to benefit from the **Patent Prosecution Highway** program at a participating intellectual property office for the corresponding application. For more information, please see http://www.uspto.gov/patents/init_events/pph/index.jsp or send an inquiry to PPHfeedback@uspto.gov.

Application Papers

- 10) ☐ The specification is objected to by the Examiner.
- 11) ☒ The drawing(s) filed on 04/25/2016 is/are: a) ☒ accepted or b) ☐ objected to by the Examiner.
Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).
Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

Priority under 35 U.S.C. § 119

- 12) ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

Certified copies:

- a) ☐ All b) ☐ Some** c) ☐ None of the:
1. ☐ Certified copies of the priority documents have been received.
 2. ☐ Certified copies of the priority documents have been received in Application No. _____.
 3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

** See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

- | | |
|---|---|
| 1) ☒ Notice of References Cited (PTO-892) | 3) ☐ Interview Summary (PTO-413)
Paper No(s)/Mail Date. _____ |
| 2) ☐ Information Disclosure Statement(s) (PTO/SB/08a and/or PTO/SB/08b)
Paper No(s)/Mail Date _____ | 4) ☐ Other: _____ |

1. The present application, filed on or after March 16, 2013, is being examined under the first inventor to file provisions of the AIA.

DETAILED ACTION

Election/Restrictions

2. Applicant's election without traverse of Group I, Claims 1-19 in the reply filed on 08/07/2017 is acknowledged.

Claim Rejections - 35 USC § 102

3. The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

A person shall be entitled to a patent unless –

(a)(1) the claimed invention was patented, described in a printed publication, or in public use, on sale or otherwise available to the public before the effective filing date of the claimed invention.

4. Claims 1-11 are rejected under 35 U.S.C. 102(a)(1) as being anticipated by Bai (US Patent No. 7,532,783).

Regarding claim 1, referring to Figures 1A, 1B, 2A and 2B, Bai teaches an arrayed waveguide grating (AWG) chip (i.e., AWG chip 110, Figs. 1A, 1B, 2A and 2B) comprising:

a first end (i.e., input port 112, Figs. 1A, 1B, 2A and 2B) for coupling to an optical coupling receptacle to receive an optical signal comprising a plurality of channel wavelengths;

a planar lightwave circuit (PLC) (i.e., grating waveguides 116, Figs. 1A, 1B, 2A and 2B) coupled to the first end configured to demultiplex each channel wavelength of the plurality of channel wavelengths;

a plurality of output waveguides (i.e., output ports 113, Figs. 1A, 1B, 2A and 2B) coupled to the PLC, each of the output waveguides configured to receive light corresponding to an associated demultiplexed channel wavelength launched from the PLC and provide the light along a first light path that extends towards a second end of the AWG chip; and

a tapered region (i.e., mirror 225, and photodetector array chips 114, Figs. 1A, 1B, 2A and 2B) disposed at the second end of the AWG chip configured to receive light via the plurality of output waveguides and reflect the same towards an output interface region of the AWG chip (i.e., Figures 1A, 1B, 2A and 2B, col. 5, lines 17-67, col. 6, lines 1-67, col. 7, lines 1-61, and col. 10, lines 4-9).

Regarding claim 2, Bai further teaches wherein the output interface region (i.e., mirror 225, and photodetector array chips 114, Figs. 1A, 1B, 2A and 2B) is configured to pass the reflected light received via the plurality of output waveguides out of the AWG chip along a second light path that is substantially orthogonal to the first light path.

Regarding claim 3, Bai further teaches wherein the AWG chip (i.e., AWG chip 110, Figs. 1A, 1B, 2A and 2B) defines a plurality of sidewalls extending longitudinally from the first end to the second end, and wherein the tapered region of the second end defines an angled surface that extends from a first sidewall of the plurality of sidewalls to a second sidewall of the plurality of sidewalls.

Regarding claim 4, Bai further teaches wherein the angled surface (i.e., mirror 225, Fig. 2B) has an interior angle of about 41 to 45 degrees relative to the output interface region (i.e., Figs. 1A, 1B, 2A and 2B, col. 7, lines 25-61).

Regarding claim 5, Bai further teaches wherein each of the output waveguides (i.e., output port 113, Figs. 1A, 1B, 2A and 2B) comprise a core material, and wherein a cladding material is disposed on the core material, the core material defining at least a portion of the plurality of sidewalls of the AWG chip (i.e., Figures 1A, 1B, 2A and 2B, col. 5, lines 17-67, col. 6, lines 1-67, and col. 7, lines 1-61).

Regarding claim 6, Bai further teaches wherein the core material of each of the plurality of output waveguides (i.e., output ports 113, Figs. 1A, 1B, 2A and 2B) has a first index of refraction, and a medium external to and adjacent the tapered region has a second index of refraction, the first index of refraction being greater than the second index of refraction (i.e., Figures 1A, 1B, 2A and 2B, col. 5, lines 17-67, col. 6, lines 1-67, and col. 7, lines 1-61).

Regarding claim 7, Bai further teaches wherein the core material of each of the plurality of output waveguides provide a portion of the angled surface, and wherein the angled surface (i.e., mirror 225, Fig. 1B) is configured to reflect incident light based on at least an interior angle of the angled surface.

Regarding claim 8, Bai further teaches wherein the core material comprises doped silica (SiO_i) having an index of refraction of about 1.45 to 1.50 (i.e., Figures 1A, 1B, 2A and 2B, col. 5, lines 17-67, col. 6, lines 1-67, and col. 7, lines 1-61).

Regarding claim 9, Bai further teaches wherein the external medium comprises a material having an index of refraction of about 1.0 (i.e., Figures 1A, 1B, 2A and 2B, col. 5, lines 17-67, col. 6, lines 1-67, and col. 7, lines 1-61).

Regarding claim 10, Bai further wherein the AWG chip (i.e., AWG chip 110, Figs. 1A, 1B, 2A and 2B) is configured as a 1xN demultiplexer device whereby a single optical input signal is de-multiplexed into N different channel wavelengths.

Regarding claim 11, Bai further teaches wherein the AWG chip (i.e., AWG chip 110, Figs. 1A and 3A) is implemented in an AWG device package.

Claim Rejections - 35 USC § 103

5. The following is a quotation of 35 U.S.C. 103 which forms the basis for all obviousness rejections set forth in this Office action:

A patent for a claimed invention may not be obtained, notwithstanding that the claimed invention is not identically disclosed as set forth in section 102, if the differences between the claimed invention and the prior art are such that the claimed invention as a whole would have been obvious before the effective filing date of the claimed invention to a person having ordinary skill in the art to which the claimed invention pertains. Patentability shall not be negated by the manner in which the invention was made.

6. Claims 12-19 are rejected under 35 U.S.C. 103 as being unpatentable over Dallesasse (US Patent No. 7,941,053) in view of Bai (US Patent No. 7,532,783) **OR** Welch et al (US Patent No. 7,058,263).

Regarding claim 12, referring to Figures 1A, 1B, 2 and 3, Dallesasse teaches an optical transceiver module (i.e., optical transceiver module 100, Figs. 1A, 1B, 2 and 3) comprising:

a transceiver housing (i.e., transceiver housing 102, Fig. 2);

a multi-channel receiver optical sub-assembly (ROSA)(i.e., receiver subassembly 503, Fig. 3) located in the transceiver housing;

an array of detector devices (i.e., photodetectors 513, Fig. 3) disposed adjacent to the output of the optical demultiplexer (i.e., optical demultiplexer 512, Fig. 3); and

a multi-channel transmitter optical assembly (TOSA) (i.e., transmitter subassembly 502, Fig. 3) including at least one laser package located in the transceiver housing for transmitting optical signals at different channel wavelengths (i.e., Figures 1A, 1B, 2 and 3, col. 7, lines 6-67, col. 8, lines 1-67, col. 9, lines 1-67, and 10, lines 1-15).

Dallesasse differs from claim 12 in that he fails to specifically teach an arrayed waveguide grating (AWG) chip, the AWG chip comprising: a first end for coupling to an optical coupling receptacle to receive an optical signal comprising a plurality of channel wavelengths; a planar lightwave circuit (PLC) coupled to the first end configured to demultiplex each channel wavelength of the plurality of channel wavelengths; a plurality of output waveguides coupled to the PLC, each of the output waveguides configured to receive light corresponding to an associated demultiplexed channel wavelength launched from the PLC and provide the light along a first light path that extends towards a second end of the AWG chip; and a tapered region disposed at the second end of the AWG chip configured to receive light via the plurality of output waveguides and reflect the same towards an output interface region of the AWG chip; an array of detector devices disposed adjacent to the output interface region of the AWG chip. However, Bai in US Patent No. 7,532,783 teaches an arrayed waveguide grating (AWG) chip (i.e.,

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AWG chip 110, Figs. 1A, 1B, 2A and 2B) comprising: a first end (i.e., input port 112, Figs. 1A, 1B, 2A and 2B) for coupling to an optical coupling receptacle to receive an optical signal comprising a plurality of channel wavelengths; a planar lightwave circuit (PLC) (i.e., grating waveguides 116, Figs. 1A, 1B, 2A and 2B) coupled to the first end configured to demultiplex each channel wavelength of the plurality of channel wavelengths; a plurality of output waveguides (i.e., output ports 113, Figs. 1A, 1B, 2A and 2B) coupled to the PLC, each of the output waveguides configured to receive light corresponding to an associated demultiplexed channel wavelength launched from the PLC and provide the light along a first light path that extends towards a second end of the AWG chip; and a tapered region (i.e., mirror 225, and photodetector array chips 114, Figs. 1A, 1B, 2A and 2B) disposed at the second end of the AWG chip configured to receive light via the plurality of output waveguides and reflect the same towards an output interface region of the AWG chip (i.e., Figures 1A, 1B, 2A and 2B, col. 5, lines 17-67, col. 6, lines 1-67, col. 7, lines 1-61, and col. 10, lines 4-9). **OR**, Welch et al in US Patent No. 7,058,263 teaches an arrayed waveguide grating (AWG) chip (i.e., AWG chip 30, Figs. 28A, 28B, and 64) comprising: a first end for coupling to an optical coupling receptacle to receive an optical signal comprising a plurality of channel wavelengths; a planar lightwave circuit (PLC) coupled to the first end configured to demultiplex each channel wavelength of the plurality of channel wavelengths; a plurality of output waveguides coupled to the PLC, each of the output waveguides configured to receive light corresponding to an associated demultiplexed channel wavelength launched from the PLC and provide the light along a first light path that extends towards

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a second end of the AWG chip; and a tapered region disposed at the second end of the AWG chip configured to receive light via the plurality of output waveguides and reflect the same towards an output interface region of the AWG chip (i.e., Figures 28A, 28B, and 64, col. 31, lines 15-54). Based on this teaching, it would have been obvious to one having skill in the art at the time the invention was made to incorporate the arrayed waveguide grating (AWG) chip, the AWG chip comprising: a first end for coupling to an optical coupling receptacle to receive an optical signal comprising a plurality of channel wavelengths; a planar lightwave circuit (PLC) coupled to the first end configured to demultiplex each channel wavelength of the plurality of channel wavelengths; a plurality of output waveguides coupled to the PLC, each of the output waveguides configured to receive light corresponding to an associated demultiplexed channel wavelength launched from the PLC and provide the light along a first light path that extends towards a second end of the AWG chip; and a tapered region disposed at the second end of the AWG chip configured to receive light via the plurality of output waveguides and reflect the same towards an output interface region of the AWG chip; an array of detector devices disposed adjacent to the output interface region of the AWG chip as taught by Bai **OR** Welch et al in the system of Dallesasse. One of ordinary skill in the art would have been motivated to do this sine allowing improving the performance of the system.

Regarding claim 13, the combination of Dallesasse and Bai **OR** Welch et al teaches wherein an air gap separates the output interface region of the AWG chip and the array of detector devices (i.e., Fig. 2B of Bai, **OR** Figs. 28A and 28B of Welch et al).

Regarding claim 14, the combination of Dallesasse and Bai **OR** Welch et al teaches wherein the output interface region of the AWG chip is separated from the array of detector devices by about 50 microns (i.e., Fig. 2B of Bai, OR Figs. 28A and 28B of Welch et al).

Regarding claim 15, the combination of Dallesasse and Bai **OR** Welch et al teaches wherein the AWG chip defines a plurality of sidewalls extending longitudinally from the first end to the second end, and wherein the tapered region of the second end defines an angled surface that extends from a first sidewall of the plurality of sidewalls to a second sidewall of the plurality of sidewalls (i.e., Fig. 2B of Bai, OR Figs. 28A and 28B of Welch et al).

Regarding claim 16, the combination of Dallesasse and Bai **OR** Welch et al teaches wherein the angled surface has an interior angle of about 41 to 45 degrees relative to the output interface region (i.e., Fig. 2B of Bai, OR Figs. 28A and 28B of Welch et al).

Regarding claim 17, the combination of Dallesasse and Bai **OR** Welch et al teaches wherein each of the output waveguides comprise a core material, and wherein a cladding material is disposed on the core material, the core material defining at least a portion of the plurality of sidewalls of the AWG chip (i.e., Fig. 2B of Bai, OR Figs. 28A and 28B of Welch et al).

Regarding claim 18, the combination of Dallesasse and Bai **OR** Welch et al teaches wherein the core material of each of the plurality of output waveguides provide a portion of the angled surface, and wherein the angled surface is configured to reflect

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incident light based on at least an interior angle of the angled surface relative to the output interface of the AWG chip (i.e., Fig. 2B of Bai, OR Figs. 28A and 28B of Welch et al).

Regarding claim 19, the combination of Dallesasse and Bai **OR** Welch et al teaches wherein the transceiver is a Small Form-factor Pluggable (SFP) transceiver module and the ROSA is configured to receive at least four different channel wavelengths at transmission rates of at least about 25 Gbps per channel (i.e., Figs. 2 and 3 of Dallesasse).

Conclusion

7. The prior art made of record and not relied upon is considered pertinent to applicant's disclosure.

Nagarajan (Pub. No.: US 2015/0249501) discloses optical module.

8. Any inquiry concerning this communication or earlier communications from the examiner should be directed to Hanh Phan whose telephone number is (571)272-3035.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Kenneth Vanderpuye, can be reached on (571)272-3078. The fax phone number for the organization where this application or proceeding is assigned is (571)273-8300.

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Any inquiry of a general nature or relating to the status of this application or proceeding should be directed to the receptionist whose telephone number is (703)305-4700.

/HANH PHAN/

Primary Examiner, Art Unit 2636

Notice of References Cited	Application/Control No. 15/137,823		Applicant(s)/Patent Under Reexamination HO ET AL.	
	Examiner HANH PHAN		Art Unit 2636	Page 1 of 1

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*		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Name	CPC Classification	US Classification
*	A	US-7,532,783 B2	05-2009	Bai; Yu Sheng	G02B6/12019	385/14
*	B	US-7,058,263 B2	06-2006	Welch; David F.	B82Y20/00	385/24
*	C	US-7,941,053 B2	05-2011	Dallesasse; John	H04B10/40	398/135
*	D	US-2015/0249501 A1	09-2015	NAGARAJAN; Radhakrishnan L.	H04B10/40	398/79
	E	US-				
	F	US-				
	G	US-				
	H	US-				
	I	US-				
	J	US-				
	K	US-				
	L	US-				
	M	US-				

FOREIGN PATENT DOCUMENTS

*		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Country	Name	CPC Classification
	N					
	O					
	P					
	Q					
	R					
	S					
	T					

NON-PATENT DOCUMENTS

*		Include as applicable: Author, Title Date, Publisher, Edition or Volume, Pertinent Pages)
	U	
	V	
	W	
	X	

*A copy of this reference is not being furnished with this Office action. (See MPEP § 707.05(a).)
Dates in MM-YYYY format are publication dates. Classifications may be US or foreign.

EAST Search History

EAST Search History (Prior Art)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
L1	2	("2009/0154928").URPN.	USPAT	OR	ON	2017/08/15 22:52
L2	5	("2009/0022495").URPN.	USPAT	OR	ON	2017/08/15 22:55
L3	1	("2008/0089688").URPN.	USPAT	OR	ON	2017/08/15 23:00
L4	2	("8285144").URPN.	USPAT	OR	ON	2017/08/15 23:16
L5	20	("20020081062" "20020150329" "20030002102" "20040018019" "20050019031" "20050031259" "20050141077" "20050271093" "20060115270" "20070116468" "20070183778" "5295011" "5680490" "6023542" "6163393" "6545782" "6996302" "7035505" "7088885" "7869711").PN.	US-PGPUB; USPAT; USOCR	OR	ON	2017/08/15 23:16
L6	5	("6735364").URPN.	USPAT	OR	ON	2017/08/15 23:33
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L8	82	398/135-139.ccls. and AWG	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2017/08/15 23:52
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L12	0	("9287986").URPN.	USPAT	OR	ON	2017/08/16 00:20
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L16	0	("2012/0294623").URPN.	USPAT	OR	ON	2017/08/16 00:30
L17	26	("20020033984" "20030067652" "20040071473" "20040096225" "20050084269" "20050135816" "20070196111" "20080063396" "20080089693" "20080095541" "20100021166" "20130177309" "6532320" "6559996" "7123786" "7164692" "7215892" "7224907" "7580637" "7801445" "7860400" "8107820" "8107821" "8223768" "8340123" "8412051").PN.	US-PGPUB; USPAT; USOCR	OR	ON	2017/08/16 00:35
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L20	14	("7941053").URPN.	USPAT	OR	ON	2017/08/16 00:49
L21	14	("7941053").URPN.	USPAT	OR	ON	2017/08/16 00:57
L22	29	("20010004289" "20020063926" "20020089719" "20020126346" "20030020981" "20040068593" "20040078494" "20040156572" "20040175177" "20040225951" "20050019036" "20050047726" "20050084269" "20050105907" "20060189220" "20070047963" "20070050658" "20070154217" "20080089693" "4193664" "6449069" "6501781" "7106968" "7203426" "7286572" "7346082" "7373087" "7380993" "7577171").PN.	US-PGPUB; USPAT; USOCR	OR	ON	2017/08/16 00:57
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L34	23	H04B10/40.cpc. and TOSA and ROSA and photodetector and AWG	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO;	OR	ON	2017/08/16 02:11

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S4	5	"7532783"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2017/08/15 16:07
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S9	5	("2014/0029951").URPN.	USPAT	OR	ON	2017/08/15 16:53

S10	31	("20040123029" "20060200697" "20080104290" "20080183959" "20090141558" "20090297140" "20090300259" "20100005212" "20100162037" "20100199125" "20100274952" "20110072200" "20110125990" "20110170329" "20120151294" "20120243299" "20120257459" "20120297231" "20130060996" "20140029951" "20140169789" "5592612" "6128094" "6400621" "6542956" "6993701" "7656727" "7990746" "8325554" "8687451" "9071364").PN.	US-PGPUB; USPAT; USOCR	OR	ON	2017/08/15 18:15
S11	1	("2013/0016977").URPN.	USPAT	OR	ON	2017/08/15 18:36

8/ 16/ 2017 2:13:18 AM

<i>Index of Claims</i> 	Application/Control No. 15137823	Applicant(s)/Patent Under Reexamination HO ET AL.
	Examiner HANH PHAN	Art Unit 2636

✓	Rejected	-	Cancelled	N	Non-Elected	A	Appeal
=	Allowed	÷	Restricted	I	Interference	O	Objected

☐ Claims renumbered in the same order as presented by applicant ☐ CPA ☐ T.D. ☐ R.1.47										
CLAIM		DATE								
Final	Original	08/16/2017								
	1	✓								
	2	✓								
	3	✓								
	4	✓								
	5	✓								
	6	✓								
	7	✓								
	8	✓								
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	16	✓								
	17	✓								
	18	✓								
	19	✓								
	20	N								

Search Notes 	Application/Control No. 15137823	Applicant(s)/Patent Under Reexamination HO ET AL.
	Examiner HANH PHAN	Art Unit 2636

CPC- SEARCHED		
Symbol	Date	Examiner
H04J14/02, H04B10/40, H04J14/0282, H04j14/0221, H04j14/0202, H04B10/506, H04B10/503, H04B10/504, G02B6/4246, G02B6/4293	08/16/2017	HP

CPC COMBINATION SETS - SEARCHED		
Symbol	Date	Examiner

US CLASSIFICATION SEARCHED			
Class	Subclass	Date	Examiner
398	135, 136, 137, 138, 139, 79, 82, 158. 159, 85, 87, 84, 202, 208, 213, 214	08/16/2017	HP
385	24, 37, 14, 43	08/16/2017	HP

* See search history printout included with this form or the SEARCH NOTES box below to determine the scope of the search.

SEARCH NOTES		
Search Notes	Date	Examiner
EAST SEARCH SEE ATTACHED PRINTOUT IN THE FILE	08/16/2017	HP
IEEE SEARCH	08/16/2017	HP
JPO SEARCH	08/16/2017	HP
CPC SEARCH PERFORMED IN EAST	08/16/2017	HP

INTERFERENCE SEARCH			
US Class/ CPC Symbol	US Subclass / CPC Group	Date	Examiner

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BIB DATA SHEET

CONFIRMATION NO. 2275

SERIAL NUMBER 15/137,823	FILING or 371(c) DATE 04/25/2016 RULE	CLASS 398	GROUP ART UNIT 2636	ATTORNEY DOCKET NO. PAT260-018US		
APPLICANTS Applied Optoelectronics, Inc., Sugar Land, TX; INVENTORS I-Lung HO, Sugar Land, TX; Zhengyu MIAO, Sugar Land, TX; Qin LI, Houston, TX; ** CONTINUING DATA ***** ** FOREIGN APPLICATIONS ***** ** IF REQUIRED, FOREIGN FILING LICENSE GRANTED ** 05/09/2016						
Foreign Priority claimed ☐ Yes ☒ No 35 USC 119(a-d) conditions met ☐ Yes ☒ No Verified and Acknowledged <u>/HANH PHAN/</u> Examiner's Signature		☐ Met after Allowance Initials	STATE OR COUNTRY TX	SHEETS DRAWINGS 7	TOTAL CLAIMS 20	INDEPENDENT CLAIMS 3
ADDRESS APPLIED OPTOELECTRONICS, INC. 13115 JESS PIRTLE BLVD. SUGAR LAND, TX 77478 UNITED STATES						
TITLE TECHNIQUES FOR DIRECT OPTICAL COUPLING OF PHOTODETECTORS TO OPTICAL DEMULTIPLEXER OUTPUTS AND AN OPTICAL TRANSCEIVER USING THE SAME						
FILING FEE RECEIVED 1600	FEES: Authority has been given in Paper No. _____ to charge/credit DEPOSIT ACCOUNT No. _____ for following:		☐ All Fees ☐ 1.16 Fees (Filing) ☐ 1.17 Fees (Processing Ext. of time) ☐ 1.18 Fees (Issue) ☐ Other _____ ☐ Credit			

S/N: 15/137,823

PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

First Named Inventor: Ho, I-Lung

Examiner: PHAN, Hanh

Serial No.: 15/137,823

Group Art Unit: 2636 Conf. No.: 2275

Filed: April 25, 2016

Docket: PAT260-018US

Title: TECHNIQUES FOR DIRECT OPTICAL COUPLING OF
PHOTODETECTORS TO OPTICAL DEMULTIPLEXER OUTPUTS AND AN
OPTICAL TRANSCEIVER USING THE SAME

RESPONSE TO RESTRICTION/ELECTION REQUIREMENT

This is in response to the Official Action in this case mailed June 7, 2017. Applicant is filing this Amendment within the two-month shortened statutory period or before August 7, 2017. Hence, Applicant believes no extension of time fee is required. However, Applicant conditionally petitions for an extension of time to provide for the possibility that the need for such a petition has been inadvertently overlooked. As provided below, please charge Deposit Account No. 50-1705 for any required fee, or for any deficiency in the enclosed fee.

Electronic Acknowledgement Receipt

EFS ID:	30000571
Application Number:	15137823
International Application Number:	
Confirmation Number:	2275
Title of Invention:	TECHNIQUES FOR DIRECT OPTICAL COUPLING OF PHOTODETECTORS TO OPTICAL DEMULTIPLEXER OUTPUTS AND AN OPTICAL TRANSCEIVER USING THE SAME
First Named Inventor/Applicant Name:	I-Lung HO
Customer Number:	27543
Filer:	Kenneth M. Thompson
Filer Authorized By:	
Attorney Docket Number:	PAT260-018US
Receipt Date:	07-AUG-2017
Filing Date:	25-APR-2016
Time Stamp:	13:16:24
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	no
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File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1		Response_asfiled_080717.pdf	33238	yes	6
			b65e6de35bd983f60f893b410488c9d91380b450		

Multipart Description/PDF files in .zip description			
Document Description	Start	End	
Applicant Arguments/Remarks Made in an Amendment	6	6	
Claims	2	5	
Response to Election / Restriction Filed	1	1	
Warnings:			
Information:			
Total Files Size (in bytes):		33238	
This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503. <u>New Applications Under 35 U.S.C. 111</u> If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application. <u>National Stage of an International Application under 35 U.S.C. 371</u> If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course. <u>New International Application Filed with the USPTO as a Receiving Office</u> If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.			

REMARKS

In the Official Action of June 7, 2017, the Examiner required restriction to one of the following groups of claims:

- I. Claims 1-19, drawn to an arrayed waveguide grating (AWG) chip, classified in 385/79.
- II. Claim 20, drawn to a method of forming an arrayed waveguide grating (AWG), classified in 385/24.

Applicant elects, without traverse, to prosecute the claims of Group 1, i.e. claims 1-19. To expedite prosecution, claim 20 has been withdrawn. Applicant reserves the right to file claim 20 in a divisional application.

If the Examiner desires personal contact for further disposition of this case, the Examiner is invited to call the undersigned Attorney at 603.668.6560.

In the event there are any fee deficiencies or additional fees are payable, please charge them to our deposit account No. 50-2121.

Respectfully submitted,

Date: August 7, 2017

By: /Kenneth M. Thompson/
Kenneth M. Thompson
Reg. No. 72,001

Amendments to the Claims

This listing of claims will replace all prior versions and listings of claims in the subject application.

1. (Original) An arrayed waveguide grating (AWG) chip comprising:
 - a first end for coupling to an optical coupling receptacle to receive an optical signal comprising a plurality of channel wavelengths;
 - a planar lightwave circuit (PLC) coupled to the first end configured to demultiplex each channel wavelength of the plurality of channel wavelengths;
 - a plurality of output waveguides coupled to the PLC, each of the output waveguides configured to receive light corresponding to an associated demultiplexed channel wavelength launched from the PLC and provide the light along a first light path that extends towards a second end of the AWG chip; and
 - a tapered region disposed at the second end of the AWG chip configured to receive light via the plurality of output waveguides and reflect the same towards an output interface region of the AWG chip.
2. (Original) The AWG chip of claim 1, wherein the output interface region is configured to pass the reflected light received via the plurality of output waveguides out of the AWG chip along a second light path that is substantially orthogonal to the first light path.
3. (Original) The AWG chip of claim 1, wherein the AWG chip defines a plurality of sidewalls extending longitudinally from the first end to the second end, and wherein the tapered region of the second end defines an angled surface that extends from a first sidewall of the plurality of sidewalls to a second sidewall of the plurality of sidewalls.
4. (Original) The AWG chip of claim 3, wherein the angled surface has an interior angle of about 41 to 45 degrees relative to the output interface region.

5. (Original) The AWG chip of claim 3, wherein each of the output waveguides comprise a core material, and wherein a cladding material is disposed on the core material, the core material defining at least a portion of the plurality of sidewalls of the AWG chip.

6. (Original) The AWG chip of claim 5, wherein the core material of each of the plurality of output waveguides has a first index of refraction, and a medium external to and adjacent the tapered region has a second index of refraction, the first index of refraction being greater than the second index of refraction.

7. (Original) The AWG chip of claim 5, wherein the core material of each of the plurality of output waveguides provide a portion of the angled surface, and wherein the angled surface is configured to reflect incident light based on at least an interior angle of the angled surface.

8. (Original) The AWG chip of claim 5, wherein the core material comprises doped silica (SiO_2) having an index of refraction of about 1.45 to 1.50.

9. (Original) The AWG chip of claim 6, wherein the external medium comprises a material having an index of refraction of about 1.0.

10. (Original) The AWG chip of claim 1, wherein the AWG chip is configured as a 1xN demultiplexer device whereby a single optical input signal is de-multiplexed into N different channel wavelengths.

11. (Original) The AWG chip of claim 1, wherein the AWG chip is implemented in an AWG device package.

12. (Original) An optical transceiver module comprising:
a transceiver housing;

a multi-channel receiver optical sub-assembly (ROSA) located in the transceiver housing and including an arrayed waveguide grating (AWG) chip, the AWG chip comprising:

- a first end for coupling to an optical coupling receptacle to receive an optical signal comprising a plurality of channel wavelengths;
- a planar lightwave circuit (PLC) coupled to the first end configured to demultiplex each channel wavelength of the plurality of channel wavelengths;
- a plurality of output waveguides coupled to the PLC, each of the output waveguides configured to receive light corresponding to an associated demultiplexed channel wavelength launched from the PLC and provide the light along a first light path that extends towards a second end of the AWG chip; and
- a tapered region disposed at the second end of the AWG chip configured to receive light via the plurality of output waveguides and reflect the same towards an output interface region of the AWG chip;

an array of detector devices disposed adjacent to the output interface region of the AWG chip; and

a multi-channel transmitter optical assembly (TOSA) including at least one laser package located in the transceiver housing for transmitting optical signals at different channel wavelengths.

13. (Original) The optical transceiver module of claim 12, wherein an air gap separates the output interface region of the AWG chip and the array of detector devices.

14. (Original) The optical transceiver module of claim 12, wherein the output interface region of the AWG chip is separated from the array of detector devices by about 50 microns.

15. (Original) The optical transceiver module of claim 12, wherein the AWG chip defines a plurality of sidewalls extending longitudinally from the first end to the second end, and

wherein the tapered region of the second end defines an angled surface that extends from a first sidewall of the plurality of sidewalls to a second sidewall of the plurality of sidewalls.

16. (Original) The optical transceiver module of claim 15, wherein the angled surface has an interior angle of about 41 to 45 degrees relative to the output interface region.

17. (Original) The optical transceiver module of claim 15, wherein each of the output waveguides comprise a core material, and wherein a cladding material is disposed on the core material, the core material defining at least a portion of the plurality of sidewalls of the AWG chip.

18. (Original) The optical transceiver module of claim 17, wherein the core material of each of the plurality of output waveguides provide a portion of the angled surface, and wherein the angled surface is configured to reflect incident light based on at least an interior angle of the angled surface relative to the output interface of the AWG chip.

19. (Original) The optical transceiver of claim 12, wherein the transceiver is a Small Form-factor Pluggable (SFP) transceiver module and the ROSA is configured to receive at least four different channel wavelengths at transmission rates of at least about 25 Gbps per channel.

20. (Withdrawn) A method of forming an arrayed waveguide grating (AWG) comprising:

depositing sequential layers of cladding and core material onto a substrate to form a planar lightwave circuit (PLC);

removing a portion of the substrate to expose an output interface region of the PLC; and

removing a portion of the PLC to provide a tapered region proximal to the output interface region of the PLC.

Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number.

PATENT APPLICATION FEE DETERMINATION RECORD Substitute for Form PTO-875	Application or Docket Number 15/137,823	Filing Date 04/25/2016	☐ To be Mailed
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ENTITY: ☒ LARGE ☐ SMALL ☐ MICRO**APPLICATION AS FILED – PART I**

(Column 1)

(Column 2)

FOR	NUMBER FILED	NUMBER EXTRA	RATE (\$)	FEE (\$)
☐ BASIC FEE (37 CFR 1.16(a), (b), or (c))	N/A	N/A	N/A	
☐ SEARCH FEE (37 CFR 1.16(k), (i), or (m))	N/A	N/A	N/A	
☐ EXAMINATION FEE (37 CFR 1.16(o), (p), or (q))	N/A	N/A	N/A	
TOTAL CLAIMS (37 CFR 1.16(i))	minus 20 =	*	X \$ =	
INDEPENDENT CLAIMS (37 CFR 1.16(h))	minus 3 =	*	X \$ =	
☐ APPLICATION SIZE FEE (37 CFR 1.16(s))	If the specification and drawings exceed 100 sheets of paper, the application size fee due is \$310 (\$155 for small entity) for each additional 50 sheets or fraction thereof. See 35 U.S.C. 41(a)(1)(G) and 37 CFR 1.16(s).			
☐ MULTIPLE DEPENDENT CLAIM PRESENT (37 CFR 1.16(j))				
* If the difference in column 1 is less than zero, enter "0" in column 2.			TOTAL	

APPLICATION AS AMENDED – PART II

(Column 1)

(Column 2)

(Column 3)

AMENDMENT	08/07/2017	CLAIMS REMAINING AFTER AMENDMENT	MINUS	HIGHEST NUMBER PREVIOUSLY PAID FOR	PRESENT EXTRA	RATE (\$)	ADDITIONAL FEE (\$)
	Total (37 CFR 1.16(i))	* 20	Minus	** 20	= 0	X \$80 =	0
	Independent (37 CFR 1.16(h))	* 3	Minus	***3	= 0	X \$420 =	0
	☐ Application Size Fee (37 CFR 1.16(s))						
	☐ FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))						
TOTAL ADD'L FEE						0	

(Column 1)

(Column 2)

(Column 3)

AMENDMENT	CLAIMS REMAINING AFTER AMENDMENT	MINUS	HIGHEST NUMBER PREVIOUSLY PAID FOR	PRESENT EXTRA	RATE (\$)	ADDITIONAL FEE (\$)
	Total (37 CFR 1.16(i))	*	Minus	**	=	X \$ =
	Independent (37 CFR 1.16(h))	*	Minus	***	=	X \$ =
	☐ Application Size Fee (37 CFR 1.16(s))					
	☐ FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))					
TOTAL ADD'L FEE						

* If the entry in column 1 is less than the entry in column 2, write "0" in column 3.

** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 20, enter "20".

*** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 3, enter "3".

The "Highest Number Previously Paid For" (Total or Independent) is the highest number found in the appropriate box in column 1.

LIE
GYZELL P. JOHNSON SMITH

This collection of information is required by 37 CFR 1.16. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 12 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
15/137,823	04/25/2016	I-Lung HO	PAT260-018US	2275
27543	7590	06/07/2017	EXAMINER	
APPLIED OPTOELECTRONICS, INC.			PHAN, HANH	
13115 JESS PIRTLE BLVD.				
SUGAR LAND, TX 77478				
			ART UNIT	PAPER NUMBER
			2636	
			NOTIFICATION DATE	DELIVERY MODE
			06/07/2017	ELECTRONIC

Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

Notice of the Office communication was sent electronically on above-indicated "Notification Date" to the following e-mail address(es):

kinsella@ao-inc.com
docketing@gtpp.com
kcarroll@gtpp.com

Office Action Summary	Application No. 15/137,823	Applicant(s) HO ET AL.	
	Examiner HANH PHAN	Art Unit 2636	AIA (First Inventor to File) Status Yes

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 2 MONTHS FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

- 1) ☒ Responsive to communication(s) filed on 04/25/2016.
☐ A declaration(s)/affidavit(s) under **37 CFR 1.130(b)** was/were filed on _____.
- 2a) ☐ This action is **FINAL**. 2b) ☒ This action is non-final.
- 3) ☐ An election was made by the applicant in response to a restriction requirement set forth during the interview on _____; the restriction requirement and election have been incorporated into this action.
- 4) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims*

- 5) ☒ Claim(s) 1-20 is/are pending in the application.
5a) Of the above claim(s) _____ is/are withdrawn from consideration.
- 6) ☐ Claim(s) _____ is/are allowed.
- 7) ☐ Claim(s) _____ is/are rejected.
- 8) ☐ Claim(s) _____ is/are objected to.
- 9) ☒ Claim(s) 1-20 are subject to restriction and/or election requirement.

* If any claims have been determined allowable, you may be eligible to benefit from the **Patent Prosecution Highway** program at a participating intellectual property office for the corresponding application. For more information, please see http://www.uspto.gov/patents/init_events/pph/index.jsp or send an inquiry to PPHfeedback@uspto.gov.

Application Papers

- 10) ☐ The specification is objected to by the Examiner.
- 11) ☐ The drawing(s) filed on _____ is/are: a) ☐ accepted or b) ☐ objected to by the Examiner.
Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).
Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

Priority under 35 U.S.C. § 119

- 12) ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

Certified copies:

- a) ☐ All b) ☐ Some** c) ☐ None of the:
1. ☐ Certified copies of the priority documents have been received.
 2. ☐ Certified copies of the priority documents have been received in Application No. _____.
 3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

** See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

- | | |
|---|---|
| 1) ☐ Notice of References Cited (PTO-892) | 3) ☐ Interview Summary (PTO-413)
Paper No(s)/Mail Date. _____ |
| 2) ☐ Information Disclosure Statement(s) (PTO/SB/08a and/or PTO/SB/08b)
Paper No(s)/Mail Date _____ | 4) ☐ Other: _____ |

1. The present application, filed on or after March 16, 2013, is being examined under the first inventor to file provisions of the AIA.

DETAILED ACTION

Election/Restrictions

I. Claims 1-19, drawn to an arrayed waveguide grating (AWG) chip, classified in 398/79.

II. Claim 20, drawn to a method of forming an arrayed waveguide grating (AWG), classified in 385/24.

The inventions are distinct, each from the other because of the following reasons:

2. Inventions I and II are related as combination and subcombination. Inventions in this relationship are distinct if it can be shown that (1) the combination as claimed does not require the particulars of the subcombination as claimed for patentability, and (2) that the subcombination has utility by itself or in other combinations (MPEP § 806.05(c)). In the instant case, the combination as claimed does not require the particulars of the subcombination as claimed because Invention I discloses an arrayed waveguide grating (AWG) chip, Invention II discloses a method of forming an arrayed waveguide grating (AWG).

The examiner has required restriction between combination and subcombination inventions. Where applicant elects a subcombination, and claims thereto are subsequently found allowable, any claim(s) depending from or otherwise requiring all

the limitations of the allowable subcombination will be examined for patentability in accordance with 37 CFR 1.104. See MPEP § 821.04(a). Applicant is advised that if any claim presented in a continuation or divisional application is anticipated by, or includes all the limitations of, a claim that is allowable in the present application, such claim may be subject to provisional statutory and/or nonstatutory double patenting rejections over the claims of the instant application.

3. Applicant is advised that the reply to this requirement to be complete must include (i) an election of a invention to be examined even though the requirement may be traversed (37 CFR 1.143) and (ii) identification of the claims encompassing the elected invention.

The election of an invention may be made with or without traverse. To reserve a right to petition, the election must be made with traverse. If the reply does not distinctly and specifically point out supposed errors in the restriction requirement, the election shall be treated as an election without traverse. Traversal must be presented at the time of election in order to be considered timely. Failure to timely traverse the requirement will result in the loss of right to petition under 37 CFR 1.144. If claims are added after the election, applicant must indicate which of these claims are readable upon the elected invention.

Should applicant traverse on the ground that the inventions are not patentably distinct, applicant should submit evidence or identify such evidence now of record showing the inventions to be obvious variants or clearly admit on the record that this is

Art Unit: 2636

the case. In either instance, if the examiner finds one of the inventions unpatentable over the prior art, the evidence or admission may be used in a rejection under 35 U.S.C. 103 or pre-AIA 35 U.S.C. 103(a) of the other invention.

4. Any inquiry concerning this communication or earlier communications from the examiner should be directed to Hanh Phan whose telephone number is (571)272-3035.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Kenneth Vanderpuye, can be reached on (571)272-3078. The fax phone number for the organization where this application or proceeding is assigned is (571)273-8300.

Any inquiry of a general nature or relating to the status of this application or proceeding should be directed to the receptionist whose telephone number is (703)305-4700.

/HANH PHAN/

Primary Examiner, Art Unit 2636

<i>Index of Claims</i> 	Application/Control No. 15137823	Applicant(s)/Patent Under Reexamination HO ET AL.
	Examiner HANH PHAN	Art Unit 2636

✓	Rejected	-	Cancelled	N	Non-Elected	A	Appeal
=	Allowed	÷	Restricted	I	Interference	O	Objected

☐ Claims renumbered in the same order as presented by applicant ☐ CPA ☐ T.D. ☐ R.1.47										
CLAIM		DATE								
Final	Original	05/30/2017								
	1	÷								
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	19	÷								
	20	÷								

PATENT APPLICATION FEE DETERMINATION RECORD Substitute for Form PTO-875						Application or Docket Number 15/137,823				
APPLICATION AS FILED - PART I										
(Column 1)		(Column 2)		SMALL ENTITY		OR OTHER THAN SMALL ENTITY				
FOR	NUMBER FILED	NUMBER EXTRA	RATE(\$)	FEE(\$)		RATE(\$)	FEE(\$)			
BASIC FEE (37 CFR 1.16(a), (b), or (c))	N/A	N/A	N/A			N/A	280			
SEARCH FEE (37 CFR 1.16(k), (l), or (m))	N/A	N/A	N/A			N/A	600			
EXAMINATION FEE (37 CFR 1.16(o), (p), or (q))	N/A	N/A	N/A			N/A	720			
TOTAL CLAIMS (37 CFR 1.16(j))	20	minus 20 = *			OR	x 80 =	0.00			
INDEPENDENT CLAIMS (37 CFR 1.16(h))	3	minus 3 = *				x 420 =	0.00			
APPLICATION SIZE FEE (37 CFR 1.16(s)) If the specification and drawings exceed 100 sheets of paper, the application size fee due is \$310 (\$155 for small entity) for each additional 50 sheets or fraction thereof. See 35 U.S.C. 41(a)(1)(G) and 37 CFR 1.16(s).							0.00			
							0.00			
MULTIPLE DEPENDENT CLAIM PRESENT (37 CFR 1.16(j))							0.00			
			TOTAL			TOTAL	1600			
* If the difference in column 1 is less than zero, enter "0" in column 2.										
APPLICATION AS AMENDED - PART II										
(Column 1)		(Column 2)		(Column 3)		SMALL ENTITY		OR OTHER THAN SMALL ENTITY		
AMENDMENT A		CLAIMS REMAINING AFTER AMENDMENT		HIGHEST NUMBER PREVIOUSLY PAID FOR	PRESENT EXTRA	RATE(\$)	ADDITIONAL FEE(\$)		RATE(\$)	ADDITIONAL FEE(\$)
	Total (37 CFR 1.16(i))	*	Minus	**	=	x	=	OR	x	=
	Independent (37 CFR 1.16(h))	*	Minus	***	=	x	=	OR	x	=
	Application Size Fee (37 CFR 1.16(s))							OR		
	FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))							OR		
						TOTAL ADD'L FEE		OR	TOTAL ADD'L FEE	
AMENDMENT B		CLAIMS REMAINING AFTER AMENDMENT		HIGHEST NUMBER PREVIOUSLY PAID FOR	PRESENT EXTRA	RATE(\$)	ADDITIONAL FEE(\$)		RATE(\$)	ADDITIONAL FEE(\$)
	Total (37 CFR 1.16(i))	*	Minus	**	=	x	=	OR	x	=
	Independent (37 CFR 1.16(h))	*	Minus	***	=	x	=	OR	x	=
	Application Size Fee (37 CFR 1.16(s))							OR		
	FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))							OR		
						TOTAL ADD'L FEE		OR	TOTAL ADD'L FEE	
* If the entry in column 1 is less than the entry in column 2, write "0" in column 3. ** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 20, enter "20". *** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 3, enter "3". The "Highest Number Previously Paid For" (Total or Independent) is the highest found in the appropriate box in column 1.										



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APPLICATION NUMBER	FILING or 371(c) DATE	GRP ART UNIT	FIL FEE REC'D	ATTY. DOCKET NO	TOT CLAIMS	IND CLAIMS
15/137,823	04/25/2016	2883	1600	PAT260-018US	20	3

CONFIRMATION NO. 2275

FILING RECEIPT

27543
APPLIED OPTOELECTRONICS, INC.
13115 JESS PIRTLE BLVD.
SUGAR LAND, TX 77478



Date Mailed: 05/11/2016

Receipt is acknowledged of this non-provisional patent application. The application will be taken up for examination in due course. Applicant will be notified as to the results of the examination. Any correspondence concerning the application must include the following identification information: the U.S. APPLICATION NUMBER, FILING DATE, NAME OF APPLICANT, and TITLE OF INVENTION. Fees transmitted by check or draft are subject to collection. Please verify the accuracy of the data presented on this receipt. **If an error is noted on this Filing Receipt, please submit a written request for a Filing Receipt Correction. Please provide a copy of this Filing Receipt with the changes noted thereon. If you received a "Notice to File Missing Parts" for this application, please submit any corrections to this Filing Receipt with your reply to the Notice. When the USPTO processes the reply to the Notice, the USPTO will generate another Filing Receipt incorporating the requested corrections**

Inventor(s)

I-Lung HO, Sugar Land, TX;
Zhengyu MIAO, Sugar Land, TX;
Qin LI, Houston, TX;

Applicant(s)

Applied Optoelectronics, Inc., Sugar Land, TX;

Power of Attorney: The patent practitioners associated with Customer Number 27543

Domestic Applications for which benefit is claimed - None.

A proper domestic benefit claim must be provided in an Application Data Sheet in order to constitute a claim for domestic benefit. See 37 CFR 1.76 and 1.78.

Foreign Applications for which priority is claimed (You may be eligible to benefit from the **Patent Prosecution Highway** program at the USPTO. Please see <http://www.uspto.gov> for more information.) - None.

Foreign application information must be provided in an Application Data Sheet in order to constitute a claim to foreign priority. See 37 CFR 1.55 and 1.76.

Permission to Access Application via Priority Document Exchange: Yes

Permission to Access Search Results: Yes

Applicant may provide or rescind an authorization for access using Form PTO/SB/39 or Form PTO/SB/69 as appropriate.

If Required, Foreign Filing License Granted: 05/09/2016

The country code and number of your priority application, to be used for filing abroad under the Paris Convention, is **US 15/137,823**

Projected Publication Date: 10/26/2017

Non-Publication Request: No

Early Publication Request: No

Title

TECHNIQUES FOR DIRECT OPTICAL COUPLING OF PHOTODETECTORS TO OPTICAL
DEMULTIPLEXER OUTPUTS AND AN OPTICAL TRANSCEIVER USING THE SAME

Preliminary Class

385

Statement under 37 CFR 1.55 or 1.78 for AIA (First Inventor to File) Transition Applications: No

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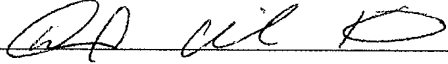
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TECHNIQUES FOR DIRECT OPTICAL COUPLING OF PHOTODETECTORS TO OPTICAL DEMULTIPLEXER OUTPUTS AND AN OPTICAL TRANSCEIVER USING THE SAME

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TECHNICAL FIELD

[0001] The present disclosure relates to optical transceiver modules, and more particularly, to direct optical coupling of photodetectors to optical demultiplexer outputs to reduce fiber use and insertion loss.

BACKGROUND INFORMATION

[0002] Optical transceivers are used to transmit and receive optical signals for various applications including, without limitation, internet data centers, cable TV broadband, and fiber to the home (FTTH) applications. Optical transceivers provide higher speeds and bandwidth over longer distances, for example, as compared to transmission over copper cables. The desire to provide higher speeds in smaller optical transceiver modules for a lower cost has presented challenges, for example, with respect to maintaining optical efficiency (power), thermal management, insertion loss, and manufacturing yield. Optical transceivers can include one or more transmitter optical subassemblies (TOSAs) and receiver optical subassemblies (ROSAs) for the purpose of transmitting and receiving optical signals. As channel density becomes an increasingly important aspect of optical transceivers, the ability scale-down while maintaining nominal transceiver performance raises numerous non-trivial challenges.

BRIEF DESCRIPTION OF THE DRAWINGS

[0003] These and other features and advantages will be better understood by reading the following detailed description, taken together with the drawings wherein:

[0004] FIG. 1 is a schematic diagram of an example arrayed waveguide grating (AWG) device.

[0005] FIG. 2 is a perspective view of the AWG device of FIG. 1 with an output coupled to a fiber array.

[0006] FIG. 3 schematically illustrates an embodiment of an optical transceiver module including a multi-channel transmitter optical sub-assembly (TOSA) and multi-channel receiver optical sub-assembly (ROSA).

[0007] FIG. 4 is a perspective view of an example small form-factor (SFF) pluggable transceiver with a multi-channel TOSA configuration and a multi-channel ROSA having a direct-coupling arrayed waveguide grating (AWG) device, in accordance with an embodiment of the present disclosure.

[0008] FIG. 5A shows a side plan view of the AWG device of FIG. 4, in accordance with an embodiment of the present disclosure.

[0009] FIG. 5B shows a cross-sectional view of the AWG device of FIG. 5A taken along the line A-A, in accordance with an embodiment of the present disclosure.

[0010] FIG. 6 shows an top plan view of the AWG device of FIG. 4, in accordance with an embodiment of the present disclosure.

[0011] FIG. 7 shows an enlarged detail view of the AWG device of FIG. 6 taken along the line B-B, in accordance with an embodiment of the present disclosure.

[0012] FIG. 8 shows an enlarged view of a direct coupling end of the AWG device of FIG. 4, in accordance with an embodiment of the present disclosure.

[0013] FIG. 9 shows a perspective view of the direct coupling end of the AWG device of FIG. 4, in accordance with an embodiment of the present disclosure.

[0014] These and other features of the present embodiments will be understood better by reading the following detailed description, taken together with the figures herein described. The accompanying drawings are not intended to be drawn to scale. In the drawings, each identical or nearly identical component that is illustrated in various figures is represented by a like numeral. For purposes of clarity, not every component may be labeled in every drawing.

DETAILED DESCRIPTION

[0015] As discussed above, optical transceivers can include receiver optical subassemblies (ROSAs) that are configured to receive multiple channel wavelengths via a common fiber and de-multiplex the same for detection, amplification and conversion purposes. Some approaches to ROSAs include the use of an arrayed waveguide grating (AWG), which operate based on some underlying principles of optics that recognize light waves of different wavelengths interfere linearly with each other. This fundamental principle manifests itself in WDM signaling, which allows a plurality of channel wavelengths to be carried by a single optical fiber with negligible crosstalk between channels. AWGs can both multiplex and de-multiplex a WDM signal.

[0016] A schematic of one example AWG device 100 configured to multiplex/de-multiplex WDM signals is shown in FIG. 1. The AWG device 100 may be a silica-based AWG device fabricated using planar lightwave circuit (PLC) techniques, which are similar to semiconductor processes used to produce ICs and can include depositing doped and un-doped layers of silica on a substrate, such as silicon. The AWG device 100 includes an input coupling region 102 to couple to the fiber 101, an AWG chip region 103 or circuit for de-multiplexing channel wavelengths, and an output coupling region 104 for coupling to a fiber array 106, with each fiber 106-1 to 106-4 being configured to receive different channel wavelengths. The AWG chip region 103 includes of an array of waveguides 107 (also called a phased array) and two couplers 109 and 111. An input waveguide, e.g., waveguide 105, carries an optical signal consisting of multiple wavelengths $\lambda_1 - \lambda_n$ into the first input coupler 109, which then distributes the light amongst an array of waveguides. The light subsequently propagates through the array of waveguides 107 to the second output coupler 111. The length of each of the waveguides 107 is chosen so that the optical path length difference between adjacent waveguides (dL) equals an integer multiple of the central wavelength λ_c of the demultiplexer. Linearly increasing length of the array waveguides 107 will cause interference and diffraction when light mixes in the output coupler 111. As a result, each wavelength is focused into only one of the N output waveguides 106-1 to 106-N, which may also be called output channels.

[0017] The particular configuration illustrated in FIG. 1 is a 1x4 PLC demultiplexer (or demux), but other channel configurations, e.g., 1x8, 1x16, 2x8, 2x16, etc., should be apparent in

light of this disclosure. PLC-type demuxes can provide relatively low insertion loss, low polarization dependent loss (PDL) and function within a range of operating temperatures. FIG. 2 shows one example packaging of the AWG device 100. As shown, the AWG device 100 includes the output coupling region 104 coupled to the fiber array 106, with the fiber array 106 being coupled to detector devices such as photodiodes (not shown).

[0018] In use, a multiplexed optical signal (e.g., a WDM) may be received via the input fiber 101 and split into separate channel wavelengths via, for example, waveguides 107 of the AWG circuit 103. The AWG device 100 may then launch the separated channel wavelengths into respective fibers 106-1 to 106-N of the fiber array 106. The AWG device 100 can introduce an insertion loss of about 3 to 7db based on, for example, the optical coupling between the optical fiber 101 and the input coupling region 102, and by virtue of the AWG circuit 103 itself. At an output end, additional loss can be introduced based on the optical coupling between the output coupling region 104 and the fiber array 106. While the fiber array 106 can include a 45 degree cut to reduce back-reflection and insertion loss, the overall insertion loss introduced can be about 0.5 to 1.0db, if not greater. Likewise, the optical coupling between the fiber array 106 and detector devices (not shown) can further introduce insertion loss of about 0.5 to 1.0db. Thus the overall insertion loss introduced by use of the fiber array 106 can total about 1.0 to 2.0db, which can significantly reduce sensitivity of the ROSA device and consequently reduce overall transceiver performance.

[0019] Thus, in accordance with an embodiment, a direct-coupling AWG device is disclosed that provides direct coupling between output channels of the AWG device and detector devices without the necessity of an intermediate fiber or other physical device. The direct-coupling AWG device may be used in combination with detectors and associated circuitry and can comprise a receiver optical subassembly (ROSA) for use in an optical transceiver device, or other optical device that seeks to de-multiplex optical WDM signals.

[0020] In more detail, the direct-coupling AWG device may be formed using, for example, PLC techniques or other suitable formation processes. In an embodiment, the AWG device is formed on a substrate such as a silicon wafer or any other suitable substrate, and may include depositing sequential layers of cladding and core material thereon. In an embodiment, the

cladding layer may comprise silicon (Si) and the core material may comprise silicon dioxide (SiO₂), also known as Silica. However, other cladding and core materials may be used and are also within the scope of this disclosure. The formed AWG device may then form essentially a monolithic structure and provide a PLC configured to de-multiplex a WDM signal into multiple different channel wavelengths for output to associated detectors. The formed AWG device can include a plurality of sidewalls that extend longitudinally from a first end to a second end, with the plurality of sidewalls being formed at least in part by the cladding material. The first end of the AWG device may be configured to optically couple with an input fiber, and a portion proximal to the second end of the AWG device may be configured to optically couple with a plurality of detector devices. Thus, and for the purpose of reference, the first end may be generally understood to be an input coupling end and the second end may be generally understood as providing an output coupling region.

[0021] The input coupling end of the AWG device may be coupled to, for example, an LC connector receptacle or other suitable connector receptacle. The connector receptacle may be coupled to the AWG device by, for example, an adhesive or other suitable approach. The input end may be configured with a surface that is angled at about 8 degrees for the purposes of reducing back reflection of an optical signal launched into the AWG device by an associated input fiber.

[0022] The output coupling region of the AWG device can include output waveguides or output channels comprising core materials that are configured to substantially confine light, e.g., at least 80 percent of incident light, along a first light path that extends longitudinally towards a substantially reflective surface. The substantially reflective surface may be provided by a portion of the output coupling end that includes a tapered region. As generally referred to herein, the term substantially reflective refers to a surface capable of reflecting at least 80 percent of incident light. The tapered region may be formed by cutting away and polishing a portion of the AWG chip such that an angled surface is formed, although other approaches to providing the tapered region will be apparent. The core material may have an index of refraction different from that of the medium adjacent to the AWG chip, such as air. Thus, and in accordance with Snell's law, light traveling via the longitudinal path provided by the output waveguides can

encounter the angled surface and substantially reflect along a second light path, with the second light path being generally orthogonal to the first light path. The particular amount of light reflected by the angled surface can be about 80% or more. Light along the second light path can encounter a sidewall of the AWG chip and be emitted therefrom towards detector devices. The surface of the sidewall region that emits the light away from the AWG device may be accurately described as an output interface or a direct coupling interface.

[0023] Detector devices such as a photodiode may be disposed in a manner that aligns light-sensitive regions of the same with the direct coupling interface of the AWG device. A detector device may be provided for each channel output such that each channel wavelength is received and detected by an associated detector. Each detector device may be configured to detect channel wavelengths and provide the same to associated circuitry for amplification and conversion to electrical signaling. The detector devices may be disposed a distance D from the direct coupling interface of the AWG device in order to reduce the potential of damage to the detector devices and/or the AWG device when, for example, shifting/moving the ROSA components during active alignment procedures. Active alignment procedures can be conducted during manufacturing by providing a test WDM signal into the AWG device and monitoring the optical power of the signals received by the detectors, moving components (e.g., the AWG device and/or the detectors) and retesting. Thus the potential for damage may be reduced by providing a small gap between the AWG device and detector devices. In some cases, a material such as a gel may be inserted between the AWG device and detector devices. The index of refraction for the material may be about 1.0 or other suitable index that allows light to pass into the detector devices. In other cases, the detector devices may be disposed directly on the surface of the AWG chip forming the direct coupling interface.

[0024] Thus, numerous advantages to the direct-coupling AWG device will be apparent in light of this disclosure. For example, the insertion losses associated with coupling a fiber array to an output end of the AWG device can be eliminated. Consequently, the insertion loss associated with coupling the fiber array to associated detectors devices may also be eliminated. Thus, overall insertion loss may be reduced by at least 1db to 2db. To this end, the overall performance of the ROSA improves as the sensitivity of the ROSA is increased by the same

amount, e.g., 1db to 2db. In addition, the overall length of the AWG device can be reduced as the direct coupling interface of the AWG allows detector devices to be positioned beside the AWG device versus a fiber array such as a pigtail that extends from an end of the AWG device. This reduction in length is particularly important when designing AWG devices for highly-constrained housings, e.g., small form-factor configurations.

[0025] As used herein, “channel wavelengths” refer to the wavelengths associated with optical channels and may include a specified wavelength band around a center wavelength. In one example, the channel wavelengths may be defined by an International Telecommunication (ITU) standard such as the ITU-T dense wavelength division multiplexing (DWDM) grid or course wavelength division multiplexing (CWDM).

[0026] The term “coupled” as used herein refers to any connection, coupling, link or the like and “optically coupled” refers to coupling such that light from one element is imparted to another element. Such “coupled” devices are not necessarily directly connected to one another and may be separated by intermediate components or devices that may manipulate or modify such signals. Likewise, the term “directly coupled” or “directly optically coupled” as used herein refers any optical connection that allows light to be imparted from one element to another without the use of an intermediate device such as a fiber.

Example Optical Transceiver System

[0027] Now turning to FIG. 3, there is an optical transceiver 300 consistent with embodiments of the present disclosure. In more detail, the optical transceiver 300 transmits and receives four (4) channels using four different channel wavelengths (λ_1 , λ_2 , λ_3 , λ_4) and may be capable of transmission rates of at least about 25 gigabits (Gbs) per channel or more. In one example, the channel wavelengths λ_1 , λ_2 , λ_3 , λ_4 may be 1270 nm, 1290 nm, 1310 nm, and 1330 nm, respectively. The optical transceiver 300 may also be capable of both short transmission distances of tens of meters, for example, to distances of 2 kilometers or more. The optical transceiver 300 may be used, for example, in internet data center applications or fiber to the home (FTTH) applications. In an embodiment, the optical transceiver 300 implements a Quad Small Form-Factor Plugging (QSFP) transceiver. For example, the optical transceiver 300 may

be implemented within a QSFP receiver that comports with the "SFF Committee Specification SFF-8665 for QSFP+ 28 Gb/s 4X Pluggable Transceiver Solution (QSFP28)" published on May 10, 2013. The aspects and embodiments disclosed herein may be used within other transceiver types and is not necessarily limited to QSFP or QSFP+ transceivers. The optical transceiver 300 may be configured for dense wavelength division multiplexing (DWDM) or coarse wavelength division multiplexing (CWDM), depending on a desired configuration. Although aspects and scenarios disclosed herein discuss a four (4) channel configuration, other channel configurations, e.g., 2, 4, 16, 32, and so on, are within the scope of this disclosure.

[0028] As shown, the optical transceiver 300 includes a housing 302 that includes a multi-channel TOSA arrangement 310 for transmitting optical signals on different channel wavelengths, and a multi-channel ROSA 312 for receiving optical signals on different channel wavelengths. A transmit connecting circuit 304 and a receive connecting circuit 308 provide electrical connections to the multi-channel TOSA 310 and the multi-channel ROSA 312, respectively, within the transceiver housing 302. The transmit connecting circuit 304 and the receive connecting circuit 308 may communicate with external systems via data bus 303. In some cases, data bus 303 is a 38-pin connector that comports with physical connector QSFP standards and data communication protocols.

[0029] In any event, the transmit connecting circuit 304 electrically couples to the electronic components in the multi-channel TOSA arrangement 310, e.g., laser assemblies, and the receive connecting circuit 308 electrically couples to the electronic components in the multi-channel ROSA 312, e.g., an array waveguide grating (AWG), detectors, amplification circuitry and so on. The transmit connecting circuit 304 and the receive connecting circuit 308 include at least conductive paths to provide electrical connections, and may also include additional circuitry. The multi-channel TOSA 310 transmits and multiplexes multiple different channel wavelengths, and is coupled to an optical interface port 314. The optical interface port 314 may include an LC connector port, although other connector types are also within the scope of this disclosure.

[0030] In cases where the optical interface port 314 comprises a duplex, or bi-directional, LC receptacle, the LC connector receptacle provides optical connections to the multi-channel TOSA 310, and provides optical connections to the multi-channel ROSA 312. The LC connector

receptacle may be configured to receive and be coupled to a mating LC connector 316 such that transmit optical fiber 322 of the external fibers 324 optically couples to the multi-channel TOSA 310 arrangement, and the receive optical fiber 317 of the external fibers 324 optically couples to the multi-channel ROSA 312.

[0031] The multi-channel TOSA arrangement 310 can include multiple laser packages 311-1 to 311-N (FIG. 4) and optics for producing associated channel wavelengths, and can couple the same into the transmit optical fiber 322. In particular, the lasers 311-1 to 311-N in the multi-channel TOSA arrangement 310 can convert electrical data signals (TX_D1 to TX_D4) received via the transmit connecting circuit 304 into modulated optical signals transmitted over transmit optical fiber 322. The lasers may include, for example, distributed feedback (DFB) lasers with diffraction gratings. In other cases, the lasers may comprise electro-absorption modulated laser (EML) laser diode packages. The multi-channel TOSA 310 may also include monitor photodiodes for monitoring the light emitted by the lasers. The multi-channel TOSA 310 may further include one or more temperature control devices, such as a resistive heater and/or a thermoelectric cooler (TEC), for controlling a temperature of the lasers, for example, to control or stabilize the laser wavelengths.

[0032] The multi-channel ROSA 312 can include demultiplexing optics such as an AWG device 402, as discussed further below, and a plurality of detectors such as photodiode packages configured to receive de-multiplexed channel wavelengths. The ROSA 312 can use the detectors and associated circuitry (e.g., a TIA) to detect, amplify and convert de-multiplexed channel wavelengths and can provide the same as electrical data signals, e.g., RX_D1 to RX_D4.

[0033] Referring to FIG. 4, an example small form-factor (SFF) pluggable optical transceiver 400 with a multi-channel TOSA arrangement and multi-channel ROSA is shown in greater detail. The embodiment shown in FIG. 4 is one example of the optical transceiver 300 of FIG. 3 implemented in a small-form factor. In some cases, the optical transceiver 400 may implement the QSFP+ specification, or other applicable pluggable small-form factor specification. To this end, and in an embodiment, the optical transceiver 400 may be compliant with the QSFP28 MSA standard, and may include physical dimensions that conform to the SFF-8661 specification. In other cases, the optical transceiver 400 may implement the C form-factor pluggable (CFP)

standard. In any such cases, the optical transceiver 400 may be configured to transmit and receive at a line rate of at least 100 Gb/s, respectively. This may be particularly advantageous when using the optical transceiver in, for example, a 100GBASE-LR4 application, per the IEEE 802.3ba standard. As shown, the optical transceiver 400 includes a transceiver housing 302, a multi-channel TOSA arrangement 310 including a plurality of laser assemblies to generate associated channel wavelengths and associated circuitry. The multi-channel TOSA arrangement 310 electrically couples to transmit flexible printed circuits (FPCs) 304 and couples to the optical interface port 314 at an end of the housing 302. The multi-channel ROSA arrangement 312 electrically couples to a receive FPC 308, and couples to the optical interface port 315 at an end of the housing 302. In an embodiment, the transceiver 400 can be configured to operate in a WDM passive optical network (PON), and to this end, the AWG 402 may be configured as a passive optical device. However, in some cases the AWG 402 can include active components and is not necessarily limited in this regard.

[0034] The multi-channel TOSA arrangement 310 can include a plurality of laser packages 311-1 to 311-N with each comprising, for example, an EML laser diode package. Each EML laser may include an integrated electro-absorption modulator (EAM) on a single chip, for example. Other laser types are also within the scope of this disclosure such as, for example, directly modulated laser (DML) diodes and TO can-type laser diodes. The particular laser type chosen may be based on a desired application. For instance, applications that require long-distance, e.g., about 10km or greater, may favor EML lasers. Conversely, applications requiring shorter distances may use DMLs. In any event, and in accordance with an embodiment, each laser diode device of the multi-channel TOSA arrangement can be configured to transmit at about 25Gb/s, or greater. Each laser package of the multi-channel TOSA arrangement 310 may provide a relatively narrow spectrum of channel wavelengths such as a single channel wavelength, or may be configured to provide a broad spectrum of channel wavelengths based on associated optics. In an embodiment, the lasers can provide center wavelengths 375 nm to 1650 nm, for example.

[0035] The multi-channel ROSA arrangement 312 can include a demux device, such as the direct-coupling arrayed waveguide grating (AWG) device 402. The direct-coupling AWG 402

may be configured to demultiplex a signal, e.g., a WDM signal, received via the optical interface port 315 into individual channel wavelengths. A fiber or other waveguide (not shown) can extend from the optical interface port 315 to an input of the AWG device 402. An output of the AWG 402 device can be coupled to, for example, an array of quad p-intrinsic-n (PIN) diodes and associated TIAs 403 for the purposes of detecting, amplifying and converting each of the channel wavelengths into an electrical signal. The AWG device 402 can be compatible with channel spacing configurations that comport with, for example, 25nm IEEE LX-4 grids, 20-nm ITU G.694.2 CWDM grids, and a range of ITU G.694.1 DWDM grids in the range of 400 Ghz to 800 Ghz (e.g., 2nm to 4nm). The AWG device 402 may be directly coupled to detector devices, e.g., the array of photodetectors 801 (FIG. 8), as discussed in greater detail below.

[0036] Referring to FIG. 5A, one example of the direct-coupling AWG device 402 is shown in further detail, in accordance with an embodiment of the present disclosure. As shown, the AWG device 402 includes an AWG chip 503 having a first end 505 coupled to an input coupling region 504 and having a second end 506, with the second end 506 being proximal to a direct coupling interface 517 or region. The input coupling region 504 can include an optical coupling port 507, with the optical coupling port 507 being configured to receive and optically couple to a fiber of the optical coupling receptacle 215. In general, AWG devices can support both multiplexing and de-multiplexing of optical signals, and thus, the first end 505 is not necessarily an “input” in all applications. However, for the purposes of the aspects and scenarios disclosed herein, the first end 505 is configured to receive an optical signal via fiber 508 and generally launch the same along a longitudinal path indicated by arrows appearing along fiber 508 to launch a WDM optical signal into the AWG chip 503. In some cases, the optical coupling port 507 is an LC receptacle. The input coupling region 504 may not necessarily contain a length of fiber and instead comprise, for instance, a cavity or other waveguide structure. Moreover, the length of fiber 508 depicted in FIG. 5A can be provided by an optical cable mated with optical coupling port 507 and is not necessarily a separate length of fiber.

[0037] The input coupling region 504 may be coupled to the AWG chip 503 using, for example, an adhesive, although other methods of fixation should be apparent in light of this disclosure. The input coupling region 504 can include an end with a mounting surface 510

having an angle 509, with angle 509 being about 8 degrees. The angle 509 can reduce back reflection when launching light into the AWG chip 503. To this end, the first end 505 of the AWG chip may also include a mounting surface with an angle of about 8 degrees, thus allowing for proper alignment between a core of the fiber 508 and an input of the AWG chip 503.

[0038] The AWG chip 503 can comprise, for example, a planar lightwave circuit (PLC) such as a silica-based planar lightwave PLC device. PLC devices can be fabricated using a wafer process similar to those used for integration of silicon microchips and ICs. Processes for AWG chips can include, for example, forming a circuit pattern using photolithography, etching and deposition and/or epitaxial growth on a substrate, e.g., a silicon or silicon-based substrate. The formed AWG chip 503 can include a cladding material of, for example, silica (SiO_2), and a core material of doped silica, or other suitable composition that can provide a contrasting index of refraction for light confinement purposes. The contours of the AWG chip 503 may be defined by the shaping/etching of the silica during formation processes, or by post-processes such as cutting and polishing. Thus the AWG chip 503 can comprise a plurality of sidewalls that are formed from a cladding material layer. However, the AWG chip 503 can include additional protective layers/coatings, such as a metal housing, and is not necessarily limited to the embodiment shown.

[0039] Turning to FIG. 5B, an enlarged cross-section taken along the line A-A of FIG. 5A shows additional aspects of the AWG chip 503 in greater detail. As shown, the AWG chip 503 can include a plurality of optical paths 511 or output waveguides formed via deposited/grown core layers, with the output waveguides 511 extending longitudinally along the AWG chip 503. The output waveguides 511 may be formed using, for example, sequentially deposited/grown layers of doped silica or suitable core material. The output waveguides 511 form at least a portion of the waveguide circuit of the AWG chip 503 and operate similar to that of conductive leads/traces on a printed circuit board. Each of the output waveguides 511 may have a width W_2 of about 6 microns and a height H_3 of about 3 microns, although other core configurations are also within the scope of this disclosure. Channel spacing, e.g., width W_3 , between each waveguide is discussed below with regard to FIG. 7.. Likewise, the cladding layer 513 can be formed from sequentially deposited/grown layers of silica or other suitable cladding material.

[0040] In an embodiment, the output waveguides 511 of the AWG chip 503 can enable confinement of light within the waveguides defined by the circuit patterned on the AWG chip 503. This functionality is based at least in part on the relative index of refraction between the compositions of the core versus the cladding. For example, a silica-based cladding material can include an index of refraction N_1 of about 1.45. In contrast, the output waveguides 511 can be formed from a core material having an index of refraction N_2 , with index of refraction N_2 being within about 0.7% of N_1 . The particular material composition of the core and cladding may be selected to reduce insertion loss with the fiber 508, which is also known as index-matching. In any event, aspects and embodiments disclosed herein are not necessarily limited to silicon or silicon-based compositions and are equally applicable to other materials used to form an AWG device.

[0041] Turning back to FIG. 5A, the AWG chip 503 can include an output interface 517 (also called a direct coupling interface), which is discussed in greater detail below. As shown, the second end 506 of the AWG chip 503 includes an angled surface 520 that extends from a first sidewall 519 to a second sidewall 523, with the angled surface 520 defining a tapered region of the AWG chip 503. The angled surface 520 can include an angle 514 relative to longitudinal axis 521, with angle 514 being selected to cause incident light to reflect downwardly at about a 90-degree angle towards the region indicated at 515, which is shown and discussed in further detail with reference to FIG. 8. Depending on the particular materials used to form the AWG chip 503, and more particularly, their respective index of refraction, the angle 514 can vary. Likewise, the angle 514 may vary within nominal manufacturing tolerances of, for instance, $\pm 2\%$. In an embodiment, the angle 514 is a range between about 40 degrees to 45 degrees. In some cases, the angled surface 520 is provided by cutting, buffing, etching, or otherwise removing a portion of the AWG chip 503. This removed region is generally indicated at 516 for purposes of illustration. The surface of the second end 506 may be polished to ensure surface-level defects caused by the removal process are removed or otherwise reduced such that a substantial portion, e.g., at least 80%, of light is reflected downwards towards the region indicated at 515. Formation of the AWG chip 503 can include removing a portion of the

substrate generally indicated at 515 to expose the output interface region 517. The exposed output interface region 517 may be polished to ensure a suitable optical coupling.

[0042] In an embodiment, the AWG device 402 can include an overall length L1 of about 13mm. The overall length L1 can be less than a similarly configured AWG chip that uses a fiber array coupling scheme, such as the one discussed above with regard to FIGs. 1 and 2. The AWG chip 503 can include a length L2 of about 10mm, and a height H2 of about 1.30mm including the substrate 502, and about 1mm without. To this end, the substrate can include a height H1 of about 0.3mm. The region generally indicated at 515, and more particularly the output interface region 517, can include a length L3 of about 0.60mm.

[0043] Turning to FIG. 6, a top plan view of the AWG 402 is shown, in accordance with an embodiment. As shown, the AWG 402 can include a width W of about 1.5mm. Other configurations are within the scope of this disclosure and the specific examples provided herein should not be construed as limiting. FIG. 7 shows a detail view of a portion of the AWG 402 taken along the line B-B, in accordance with an embodiment of the present disclosure. As shown, the output waveguides 511 include a channel spacing W3 of about 0.25mm, although other channel spacing arrangements will be apparent in light of this disclosure.

[0044] Turning to FIG. 8, an enlarged perspective view of the second end 506 of the AWG chip 503 is shown, in accordance with an embodiment of the present disclosure. The embodiment of FIG. 8 is illustrated in a highly simplified and exaggerated manner for the purposes of clarity and practicality. As shown, the output waveguides 511 can each provide a first light path generally indicated at 806, with the first light path 806 extending longitudinally towards the direct coupling end 506. A detector array 801 such as a photodiode (PD) array or bar can be positioned at a distance D1 from the direct coupling interface 517, with D1 being about 50 microns. As previously discussed, the second end 506 can include the surface 520 which has an angle 514 of about 40 degrees to 45 degrees relative to the light path 806, depending on the composition of the AWG chip. For example, the angle 514 may be about 41 degrees in instances where the output waveguides 511 and the cladding layer 513 are silicon-based or otherwise have an index of refraction of about 1.45 to 1.5. Each of the output waveguides 511 form at least a portion of the angled surface 520, and thus also include a tapered

region having the angle 514. Note that the tapered regions of the output waveguides 511 may be introduced when, for instance, a portion of the AWG chip 503 is cut or otherwise removed.

[0045] In any event, the angle 514 can provide an angle of incidence that can allow a substantial amount of light, e.g., at least 80 percent, to reflect towards the detectors 801. For example, as shown, light incident to the angled surface 520 or tapered region can reflect downwards along a second light path 530 and pass through the direct coupling interface 517, with the second light path 530 being generally orthogonal to the first light path 806. As previously discussed, the difference in the index of refraction between the cladding layer 513 (denoted as n_1) and the output waveguides 511 allow light signals to be substantially confined within the output waveguides 511. Furthermore, the external regions 809 adjacent to the AWG 402, and more particularly the angled surface 520, can include an index of refraction of n_3 , with the index of refraction N_3 being less than that of n_1 and n_2 . For example, the external regions 809 may comprise air which has an index of refraction of about 1.00. Thus the separated channel wavelengths that launch along associated ones of the output waveguides 511 along light path 806 can be reflected towards the detectors 804 as a result of the contrast between index of refraction n_2 and n_3 . The resulting angle of reflection may be calculated based on Snell's Law:

$$n_1 \sin \theta_1 = n_2 \sin \theta_2 \quad \text{Equation (1)}$$

Where n_1 is the refractive index of a first medium, n_2 is a refractive index of a second medium, $\sin \theta_1$ is the angle of incidence and $\sin \theta_2$ is the angle of reflection, thus:

$$\sin \theta_2 = \frac{n_1 \sin \theta_1}{n_2} \quad \text{Equation (2)}$$

[0046] In use, each of the output waveguides 511 can provide associated channel wavelengths along a first light path generally indicated at 806. The light along light path 806 may then encounter the angled surface 520 and reflect therefrom along the second light path 530, with the second light path 530 being generally orthogonal to the first light path 806. Then, light traveling along the second light path 530 can encounter the photo-sensitive regions of the detectors 804. FIG. 9 shows the orientation of the detectors 804 relative to each of the waveguides 511 in greater detail.

[0047] Turning to FIG. 9, and with additional reference to FIG. 8, another perspective view shows the second end 506 of the AWG chip 503 adjacent to the array of detectors 801, in

accordance with an embodiment of the present disclosure. The second end 506 is illustrated in a fully-transparent and simplified manner for practicality and clarity. As shown, each of the output waveguides 511 extends longitudinally to the second end 506 such that each of the output waveguides 511 provides a first respective light path, e.g., the first light path 806. As previously discussed with reference to FIG. 7, the output waveguides 511 can be spaced at a nominal distance W_3 , with the nominal distance W_3 being about 0.25mm or a different distance depending on a desired channel spacing configuration. As further shown, each of the detector devices 804 are aligned beneath the output interface region 517, and more particularly, beneath respective ones of the output waveguides 511. Thus the AWG 402 may be understood to directly couple to the detectors 804, without the necessity of an additional waveguide or fiber device there between. The detectors 804 may be electrically coupled to associated circuitry of the receive connecting circuit 108 such as a TIA via, for example, wire bonding 901 or other suitable electrical interconnection.

Further Example Embodiments

[0048] In one aspect an arrayed waveguide grating (AWG) chip is disclosed. The AWG chip comprising a first end for coupling to an optical coupling receptacle to receive an optical signal comprising a plurality of channel wavelengths, a planar lightwave circuit (PLC) coupled to the first end configured to de-multiplex each channel wavelength of the plurality of channel wavelengths, a plurality of output waveguides coupled to the PLC, each of the output waveguides configured to receive light corresponding to an associated de-multiplexed channel wavelength launched from the PLC and provide the light along a light path that extends towards a second end of the AWG chip, and a tapered region disposed at the second end of the AWG chip configured to receive light via the plurality of output waveguides and reflect the same towards an output interface region of the AWG chip.

[0049] In another aspect, an optical transceiver module is disclosed. The optical transceiver module comprising a transceiver housing, a multi-channel receiver optical sub-assembly (ROSA) located in the transceiver housing and including an arrayed waveguide grating (AWG) chip, the AWG chip comprising a first end for coupling to an optical coupling receptacle to receive an

optical signal comprising a plurality of channel wavelengths, a planar lightwave circuit (PLC) coupled to the first end configured to de-multiplex each channel wavelength of the plurality of channel wavelengths, a plurality of output waveguides coupled to the PLC, each of the output waveguides configured to receive light corresponding to an associated de-multiplexed channel wavelength launched from the PLC and provide the light along a light path that extends towards a second end of the AWG chip, and a tapered region disposed at the second end of the AWG chip configured to receive light via the plurality of output waveguides and reflect the same towards an output interface region of the AWG chip, an array of detector devices disposed adjacent to the output interface region of the AWG chip, and a multi-channel transmitter optical assembly (TOSA) including at least one laser package located in the transceiver housing for transmitting optical signals at different channel wavelengths.

[0050] In yet another aspect, a method of forming an arrayed waveguide grating (AWG) is disclosed. The method comprising depositing sequential layers of cladding and core material onto a substrate to form a planar lightwave circuit (PLC), removing a portion of the substrate to expose an output interface region of the PLC, and removing a portion of the PLC to provide a tapered region proximal to the output interface region of the PLC.

[0051] While the principles of the disclosure have been described herein, it is to be understood by those skilled in the art that this description is made only by way of example and not as a limitation as to the scope of the disclosure. Other embodiments are contemplated within the scope of the present disclosure in addition to the exemplary embodiments shown and described herein. Modifications and substitutions by one of ordinary skill in the art are considered to be within the scope of the present disclosure, which is not to be limited except by the following claims.

CLAIMS

What is claimed is:

1. An arrayed waveguide grating (AWG) chip comprising:
 - a first end for coupling to an optical coupling receptacle to receive an optical signal comprising a plurality of channel wavelengths;
 - a planar lightwave circuit (PLC) coupled to the first end configured to demultiplex each channel wavelength of the plurality of channel wavelengths;
 - a plurality of output waveguides coupled to the PLC, each of the output waveguides configured to receive light corresponding to an associated demultiplexed channel wavelength launched from the PLC and provide the light along a first light path that extends towards a second end of the AWG chip; and
 - a tapered region disposed at the second end of the AWG chip configured to receive light via the plurality of output waveguides and reflect the same towards an output interface region of the AWG chip.
2. The AWG chip of claim 1, wherein the output interface region is configured to pass the reflected light received via the plurality of output waveguides out of the AWG chip along a second light path that is substantially orthogonal to the first light path.
3. The AWG chip of claim 1, wherein the AWG chip defines a plurality of sidewalls extending longitudinally from the first end to the second end, and wherein the tapered region of the second end defines an angled surface that extends from a first sidewall of the plurality of sidewalls to a second sidewall of the plurality of sidewalls.
4. The AWG chip of claim 3, wherein the angled surface has an interior angle of about 41 to 45 degrees relative to the output interface region.

5. The AWG chip of claim 3, wherein each of the output waveguides comprise a core material, and wherein a cladding material is disposed on the core material, the core material defining at least a portion of the plurality of sidewalls of the AWG chip.

6. The AWG chip of claim 5, wherein the core material of each of the plurality of output waveguides has a first index of refraction, and a medium external to and adjacent the tapered region has a second index of refraction, the first index of refraction being greater than the second index of refraction.

7. The AWG chip of claim 5, wherein the core material of each of the plurality of output waveguides provide a portion of the angled surface, and wherein the angled surface is configured to reflect incident light based on at least an interior angle of the angled surface.

8. The AWG chip of claim 5, wherein the core material comprises doped silica (SiO_2) having an index of refraction of about 1.45 to 1.50.

9. The AWG chip of claim 6, wherein the external medium comprises a material having an index of refraction of about 1.0.

10. The AWG chip of claim 1, wherein the AWG chip is configured as a 1xN demultiplexer device whereby a single optical input signal is de-multiplexed into N different channel wavelengths.

11. The AWG chip of claim 1, wherein the AWG chip is implemented in an AWG device package.

12. An optical transceiver module comprising:
a transceiver housing;

a multi-channel receiver optical sub-assembly (ROSA) located in the transceiver housing and including an arrayed waveguide grating (AWG) chip, the AWG chip comprising:

- a first end for coupling to an optical coupling receptacle to receive an optical signal comprising a plurality of channel wavelengths;
- a planar lightwave circuit (PLC) coupled to the first end configured to demultiplex each channel wavelength of the plurality of channel wavelengths;
- a plurality of output waveguides coupled to the PLC, each of the output waveguides configured to receive light corresponding to an associated demultiplexed channel wavelength launched from the PLC and provide the light along a first light path that extends towards a second end of the AWG chip; and
- a tapered region disposed at the second end of the AWG chip configured to receive light via the plurality of output waveguides and reflect the same towards an output interface region of the AWG chip;

an array of detector devices disposed adjacent to the output interface region of the AWG chip; and

a multi-channel transmitter optical assembly (TOSA) including at least one laser package located in the transceiver housing for transmitting optical signals at different channel wavelengths.

13. The optical transceiver module of claim 12, wherein an air gap separates the output interface region of the AWG chip and the array of detector devices.

14. The optical transceiver module of claim 12, wherein the output interface region of the AWG chip is separated from the array of detector devices by about 50 microns.

15. The optical transceiver module of claim 12, wherein the AWG chip defines a plurality of sidewalls extending longitudinally from the first end to the second end, and wherein the tapered region of the second end defines an angled surface that extends from a first sidewall of the plurality of sidewalls to a second sidewall of the plurality of sidewalls.

16. The optical transceiver module of claim 15, wherein the angled surface has an interior angle of about 41 to 45 degrees relative to the output interface region.

17. The optical transceiver module of claim 15, wherein each of the output waveguides comprise a core material, and wherein a cladding material is disposed on the core material, the core material defining at least a portion of the plurality of sidewalls of the AWG chip.

18. The optical transceiver module of claim 17, wherein the core material of each of the plurality of output waveguides provide a portion of the angled surface, and wherein the angled surface is configured to reflect incident light based on at least an interior angle of the angled surface relative to the output interface of the AWG chip.

19. The optical transceiver of claim 12, wherein the transceiver is a Small Form-factor Pluggable (SFP) transceiver module and the ROSA is configured to receive at least four different channel wavelengths at transmission rates of at least about 25 Gbps per channel.

20. A method of forming an arrayed waveguide grating (AWG) comprising:
depositing sequential layers of cladding and core material onto a substrate to form a planar lightwave circuit (PLC);
removing a portion of the substrate to expose an output interface region of the PLC; and
removing a portion of the PLC to provide a tapered region proximal to the output interface region of the PLC.

TECHNIQUES FOR DIRECT OPTICAL COUPLING OF PHOTODETECTORS TO OPTICAL DEMULTIPLEXER OUTPUTS AND AN OPTICAL TRANSCEIVER USING THE SAME

ABSTRACT OF THE DISCLOSURE

An arrayed waveguide grating (AWG) device for use in an optical transceiver is disclosed, and can de-multiplex an optical signal into N number of channel wavelengths. The AWG device can include an AWG chip, with the AWG chip providing a planar lightwave (PLC) circuit configured to de-multiplex channel wavelengths and launch the same into output waveguides. A region of the AWG chip may be tapered such that light traveling via the output waveguides encounters an angled surface of the tapered region and reflects towards an output interface region of the AWG chip. Thus detector devices may optically couple to the output interface region of the AWG chip directly, and can avoid losses introduced by other approaches which couple an output of an AWG to detectors by way of a fiber array or other intermediate device.

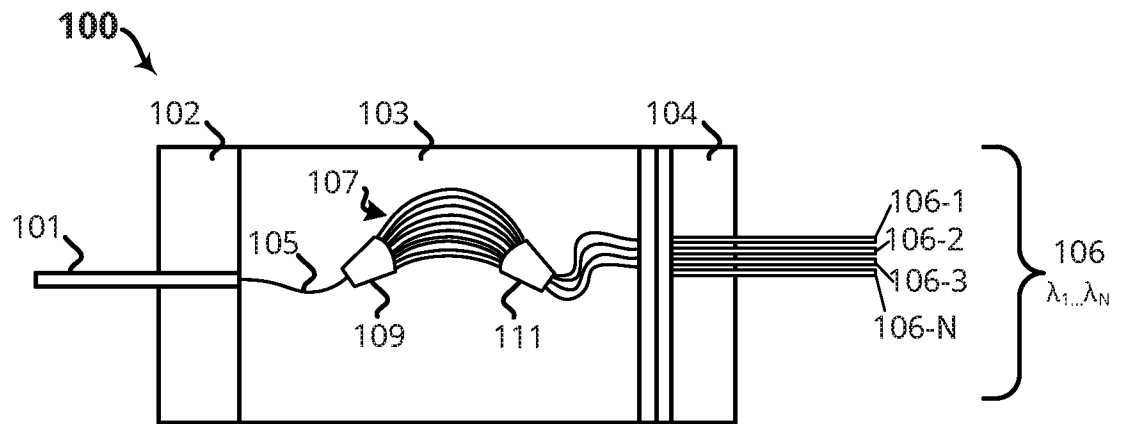


FIG. 1

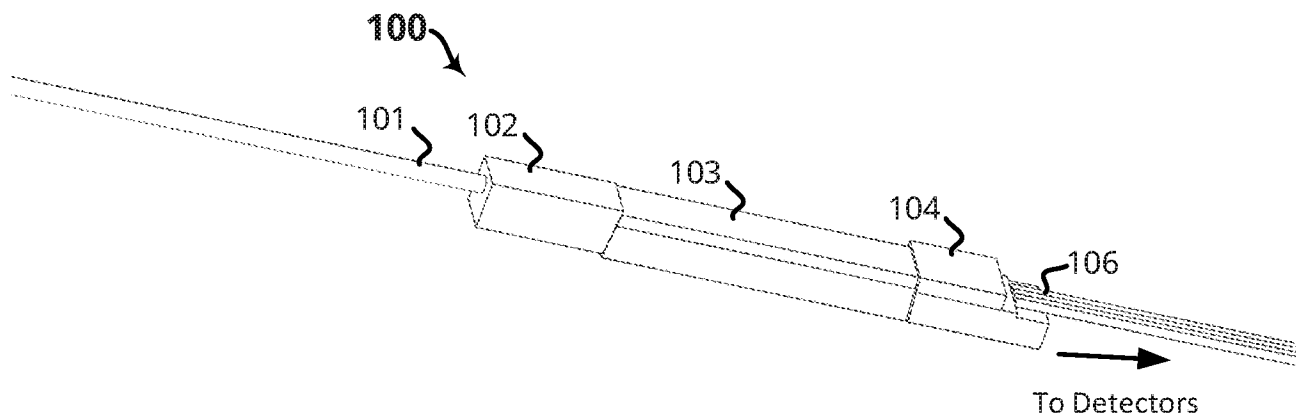


FIG. 2

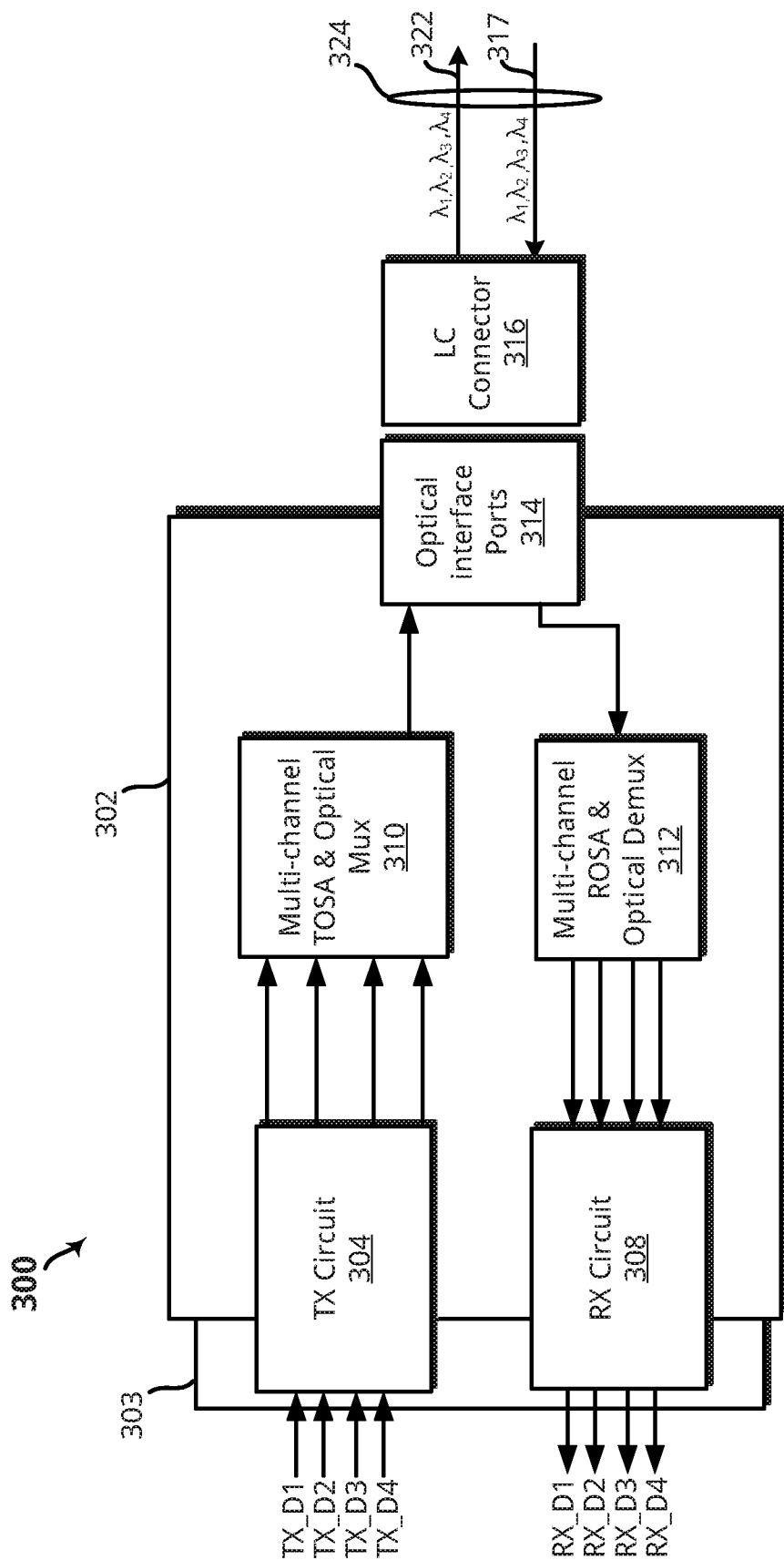
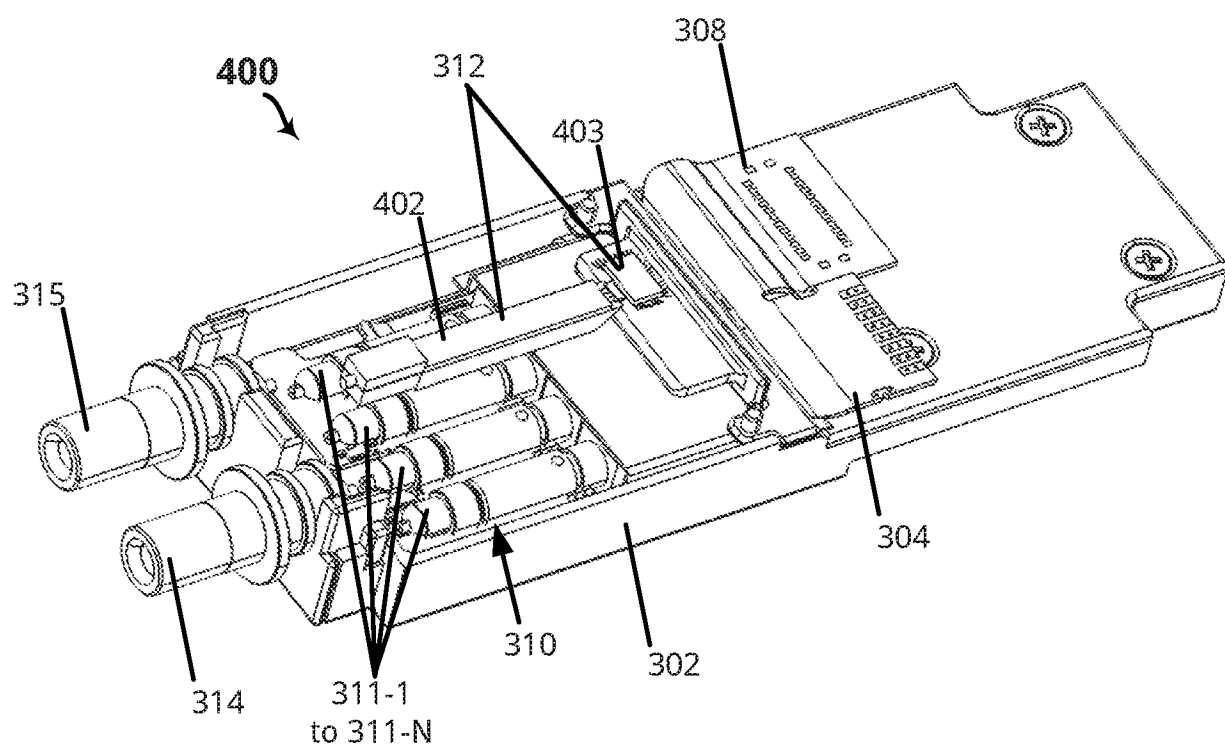


FIG. 3

**FIG. 4**

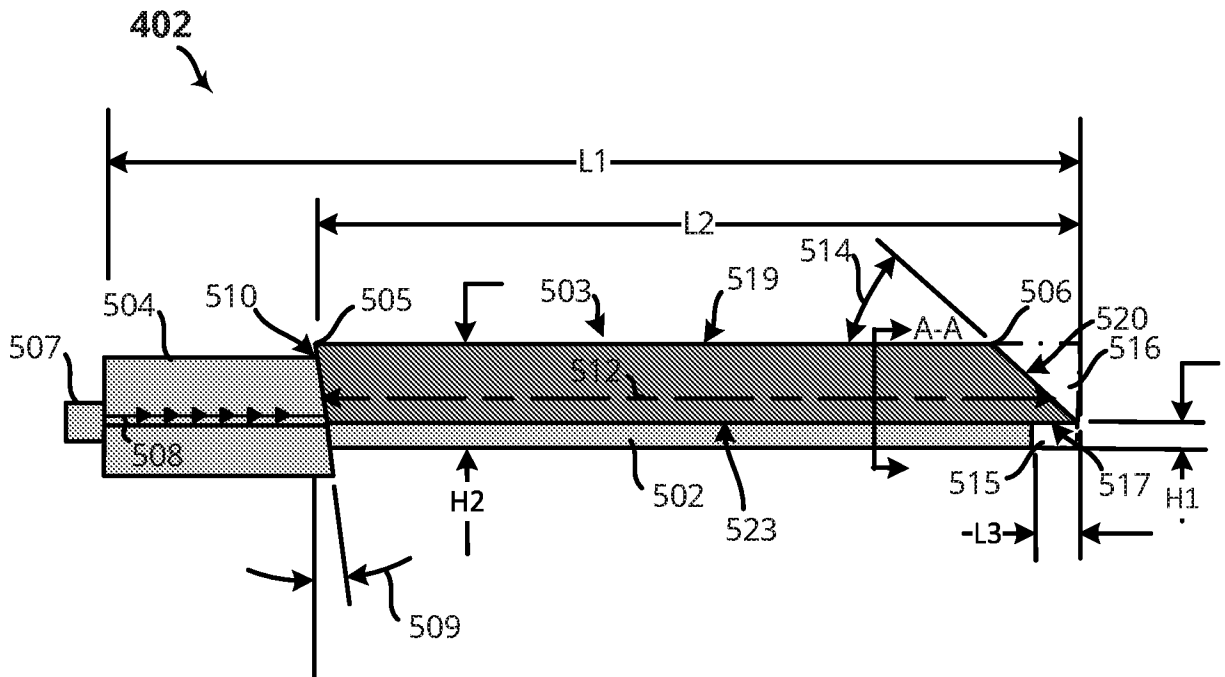


FIG. 5A

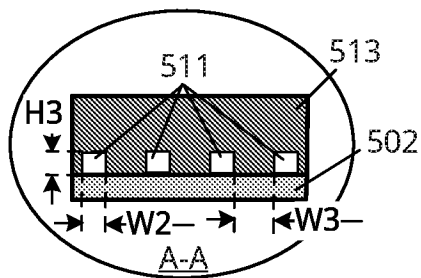


FIG. 5B

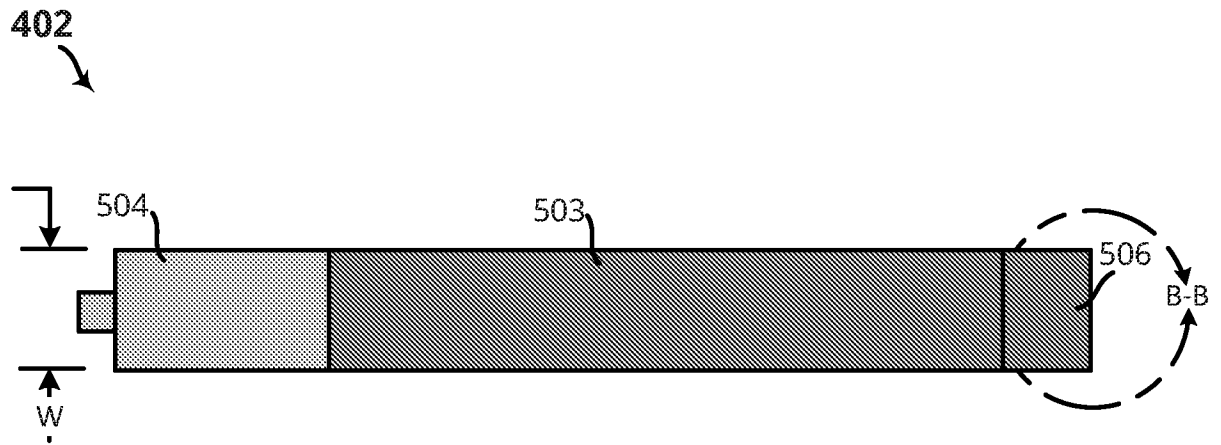


FIG. 6

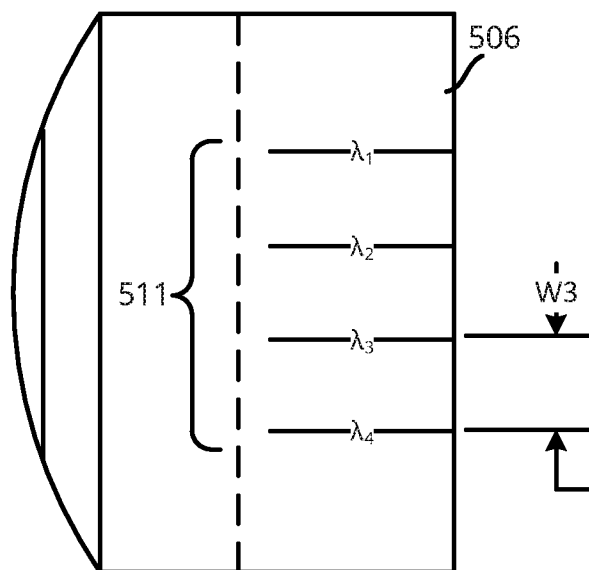
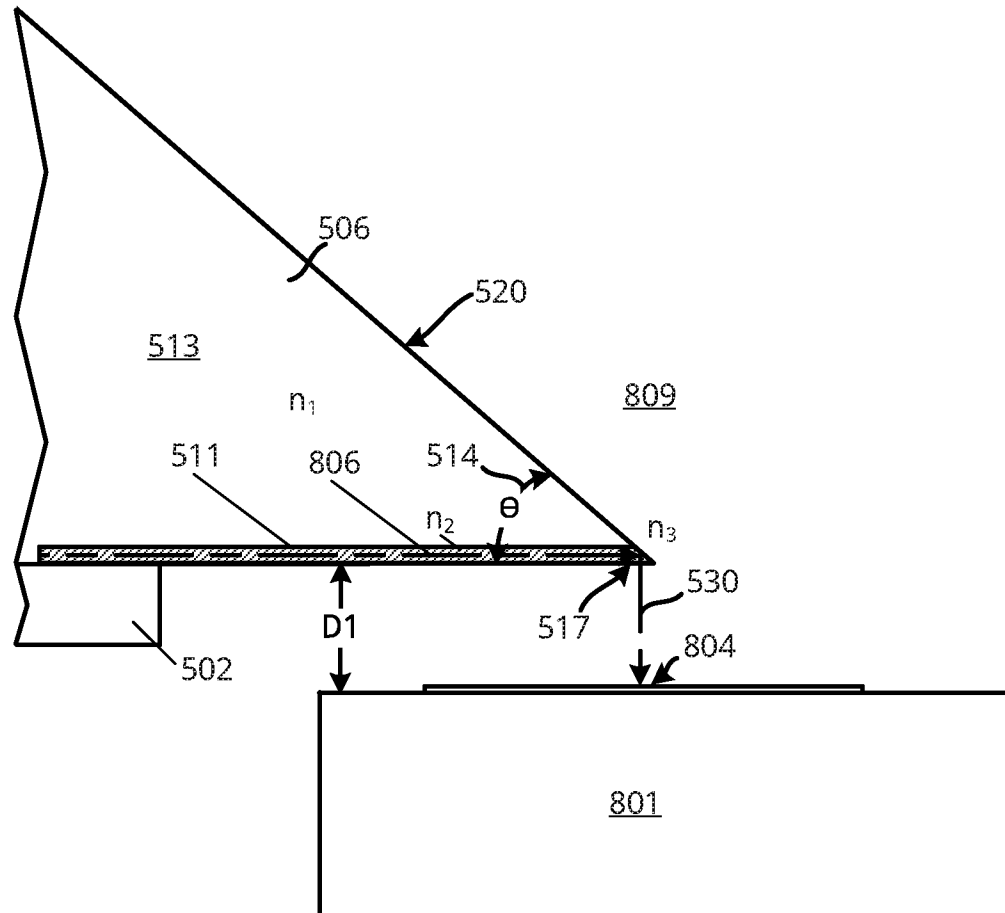


FIG. 7

**FIG. 8**

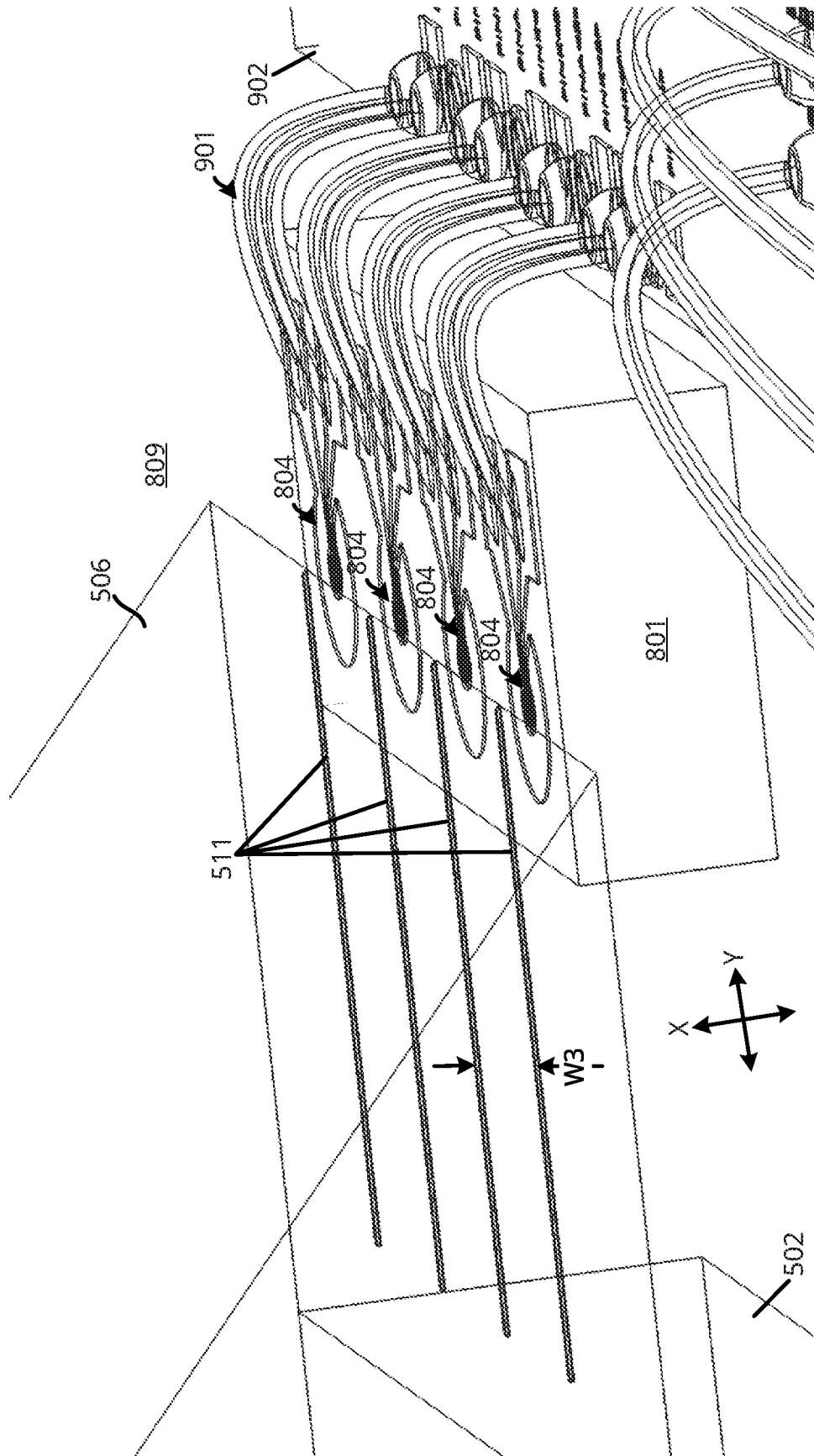


FIG. 9

Electronic Patent Application Fee Transmittal

Application Number:				
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Title of Invention:	TECHNIQUES FOR DIRECT OPTICAL COUPLING OF PHOTODETECTORS TO OPTICAL DEMULTIPLEXER OUTPUTS AND AN OPTICAL TRANSCEIVER USING THE SAME			
First Named Inventor/Applicant Name:	I-Lung HO			
Filer:	Kevin J. Carroll/April Davis			
Attorney Docket Number:	PAT260-018US			
Filed as Large Entity				
Filing Fees for Utility under 35 USC 111(a)				
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Basic Filing:				
Utility application filing	1011	1	280	280
Utility Search Fee	1111	1	600	600
Utility Examination Fee	1311	1	720	720
Pages:				
Claims:				
Miscellaneous-Filing:				
Petition:				
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Description	Fee Code	Quantity	Amount	Sub-Total in USD(\$)
Post-Allowance-and-Post-Issuance:				
Extension-of-Time:				
Miscellaneous:				
Total in USD (\$)				1600

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Title of Invention:	TECHNIQUES FOR DIRECT OPTICAL COUPLING OF PHOTODETECTORS TO OPTICAL DEMULTIPLEXER OUTPUTS AND AN OPTICAL TRANSCEIVER USING THE SAME
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Attorney Docket Number:	PAT260-018US
Receipt Date:	25-APR-2016
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1	Application Data Sheet	PAT260_018US_ADS.pdf	1823244	no	9
			3412b54622e98f64fc71c40cdf40b7ba30ed5594		
Warnings:					
Information:					
2	Oath or Declaration filed	PAT260_018US_Declaration_executed.pdf	137018	no	2
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			901025a5b736d47b5484029f2f40ce7f02c5b368		
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4		PAT260_018US_Application_as filed_042516.pdf	144824	yes	22
			014951ef42a79717dc2ab44eae4231adfd129cd		
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	Document Description		Start	End	
	Specification		1	17	
	Claims		18	21	
	Abstract		22	22	
Warnings:					
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5	Drawings-only black and white line drawings	PAT260_018US_Drawings_asfiled_042516.pdf	460839	no	7
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6	Fee Worksheet (SB06)	fee-info.pdf	35313	no	2
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Application Data Sheet 37 CFR 1.76		Attorney Docket Number	PAT260-018US
		Application Number	
Title of Invention	TECHNIQUES FOR DIRECT OPTICAL COUPLING OF PHOTODETECTORS TO OPTICAL DEMULTIPLEXER OUTPUTS AND AN OPTICAL TRANSCEIVER USING THE SAME		
The application data sheet is part of the provisional or nonprovisional application for which it is being submitted. The following form contains the bibliographic data arranged in a format specified by the United States Patent and Trademark Office as outlined in 37 CFR 1.76. This document may be completed electronically and submitted to the Office in electronic format using the Electronic Filing System (EFS) or the document may be printed and included in a paper filed application.			

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Application Data Sheet 37 CFR 1.76		Attorney Docket Number		PAT260-018US	
		Application Number			
Title of Invention	TECHNIQUES FOR DIRECT OPTICAL COUPLING OF PHOTODETECTORS TO OPTICAL DEMULTIPLEXER OUTPUTS AND AN OPTICAL TRANSCEIVER USING THE SAME				
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Customer Number	27543		
Email Address	kcarroll@gtp.com	Add Email	Remove Email

Application Information:

Title of the Invention	TECHNIQUES FOR DIRECT OPTICAL COUPLING OF PHOTODETECTORS TO OPTICAL DEMULTIPLEXER OUTPUTS AND AN OPTICAL TRANSCEIVER USING THE SAME		
Attorney Docket Number	PAT260-018US	Small Entity Status Claimed	☐
Application Type	Nonprovisional		
Subject Matter	Utility		
Total Number of Drawing Sheets (if any)	7	Suggested Figure for Publication (if any)	

Filing By Reference:

Only complete this section when filing an application by reference under 35 U.S.C. 111(c) and 37 CFR 1.57(a). Do not complete this section if application papers including a specification and any drawings are being filed. Any domestic benefit or foreign priority information must be provided in the appropriate section(s) below (i.e., "Domestic Benefit/National Stage Information" and "Foreign Priority Information").

For the purposes of a filing date under 37 CFR 1.53(b), the description and any drawings of the present application are replaced by this reference to the previously filed application, subject to conditions and requirements of 37 CFR 1.57(a).

Application number of the previously filed application	Filing date (YYYY-MM-DD)	Intellectual Property Authority or Country

Publication Information:

☐ Request Early Publication (Fee required at time of Request 37 CFR 1.219)
☐ Request Not to Publish. I hereby request that the attached application not be published under 35 U.S.C. 122(b) and certify that the invention disclosed in the attached application has not and will not be the subject of an application filed in another country, or under a multilateral international agreement, that requires publication at eighteen months after filing.

Application Data Sheet 37 CFR 1.76		Attorney Docket Number	PAT260-018US
		Application Number	
Title of Invention	TECHNIQUES FOR DIRECT OPTICAL COUPLING OF PHOTODETECTORS TO OPTICAL DEMULTIPLEXER OUTPUTS AND AN OPTICAL TRANSCEIVER USING THE SAME		

Representative Information:

Representative information should be provided for all practitioners having a power of attorney in the application. Providing this information in the Application Data Sheet does not constitute a power of attorney in the application (see 37 CFR 1.32). Either enter Customer Number or complete the Representative Name section below. If both sections are completed the customer Number will be used for the Representative Information during processing.

Please Select One:	☒ Customer Number	☐ US Patent Practitioner	☐ Limited Recognition (37 CFR 11.9)
Customer Number	27543		

Domestic Benefit/National Stage Information:

This section allows for the applicant to either claim benefit under 35 U.S.C. 119(e), 120, 121, 365(c), or 386(c) or indicate National Stage entry from a PCT application. Providing benefit claim information in the Application Data Sheet constitutes the specific reference required by 35 U.S.C. 119(e) or 120, and 37 CFR 1.78.

When referring to the current application, please leave the "Application Number" field blank.

Prior Application Status			Remove
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
Additional Domestic Benefit/National Stage Data may be generated within this form by selecting the Add button.			Add

Foreign Priority Information:

This section allows for the applicant to claim priority to a foreign application. Providing this information in the application data sheet constitutes the claim for priority as required by 35 U.S.C. 119(b) and 37 CFR 1.55. When priority is claimed to a foreign application that is eligible for retrieval under the priority document exchange program (PDX)ⁱ the information will be used by the Office to automatically attempt retrieval pursuant to 37 CFR 1.55(i)(1) and (2). Under the PDX program, applicant bears the ultimate responsibility for ensuring that a copy of the foreign application is received by the Office from the participating foreign intellectual property office, or a certified copy of the foreign priority application is filed, within the time period specified in 37 CFR 1.55(g)(1).

Application Number	Country ⁱ	Filing Date (YYYY-MM-DD)	Remove
			Access Code ⁱ (if applicable)
Additional Foreign Priority Data may be generated within this form by selecting the Add button.			Add

Application Data Sheet 37 CFR 1.76		Attorney Docket Number	PAT260-018US
		Application Number	
Title of Invention	TECHNIQUES FOR DIRECT OPTICAL COUPLING OF PHOTODETECTORS TO OPTICAL DEMULTIPLEXER OUTPUTS AND AN OPTICAL TRANSCEIVER USING THE SAME		

Statement under 37 CFR 1.55 or 1.78 for AIA (First Inventor to File) Transition Applications

This application (1) claims priority to or the benefit of an application filed before March 16, 2013 and (2) also contains, or contained at any time, a claim to a claimed invention that has an effective filing date on or after March 16, 2013. ☐ NOTE: By providing this statement under 37 CFR 1.55 or 1.78, this application, with a filing date on or after March 16, 2013, will be examined under the first inventor to file provisions of the AIA.	
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Application Data Sheet 37 CFR 1.76	Attorney Docket Number PAT260-018US	
	Application Number	
Title of Invention	TECHNIQUES FOR DIRECT OPTICAL COUPLING OF PHOTODETECTORS TO OPTICAL DEMULTIPLEXER OUTPUTS AND AN OPTICAL TRANSCEIVER USING THE SAME	

Authorization or Opt-Out of Authorization to Permit Access:

When this Application Data Sheet is properly signed and filed with the application, applicant has provided written authority to permit a participating foreign intellectual property (IP) office access to the instant application-as-filed (see paragraph A in subsection 1 below) and the European Patent Office (EPO) access to any search results from the instant application (see paragraph B in subsection 1 below).

Should applicant choose not to provide an authorization identified in subsection 1 below, applicant **must opt-out** of the authorization by checking the corresponding box A or B or both in subsection 2 below.

NOTE: This section of the Application Data Sheet is **ONLY** reviewed and processed with the **INITIAL** filing of an application. After the initial filing of an application, an Application Data Sheet cannot be used to provide or rescind authorization for access by a foreign IP office(s). Instead, Form PTO/SB/39 or PTO/SB/69 must be used as appropriate.

1. Authorization to Permit Access by a Foreign Intellectual Property Office(s)

A. Priority Document Exchange (PDX) - Unless box A in subsection 2 (opt-out of authorization) is checked, the undersigned hereby **grants the USPTO authority** to provide the European Patent Office (EPO), the Japan Patent Office (JPO), the Korean Intellectual Property Office (KIPO), the State Intellectual Property Office of the People's Republic of China (SIPO), the World Intellectual Property Organization (WIPO), and any other foreign intellectual property office participating with the USPTO in a bilateral or multilateral priority document exchange agreement in which a foreign application claiming priority to the instant patent application is filed, access to: (1) the instant patent application-as-filed and its related bibliographic data, (2) any foreign or domestic application to which priority or benefit is claimed by the instant application and its related bibliographic data, and (3) the date of filing of this Authorization. See 37 CFR 1.14(h)(1).

B. Search Results from U.S. Application to EPO - Unless box B in subsection 2 (opt-out of authorization) is checked, the undersigned hereby **grants the USPTO authority** to provide the EPO access to the bibliographic data and search results from the instant patent application when a European patent application claiming priority to the instant patent application is filed. See 37 CFR 1.14(h)(2).

The applicant is reminded that the EPO's Rule 141(1) EPC (European Patent Convention) requires applicants to submit a copy of search results from the instant application without delay in a European patent application that claims priority to the instant application.

2. Opt-Out of Authorizations to Permit Access by a Foreign Intellectual Property Office(s)

☐ A. Applicant **DOES NOT** authorize the USPTO to permit a participating foreign IP office access to the instant application-as-filed. If this box is checked, the USPTO will not be providing a participating foreign IP office with any documents and information identified in subsection 1A above.

☐ B. Applicant **DOES NOT** authorize the USPTO to transmit to the EPO any search results from the instant patent application. If this box is checked, the USPTO will not be providing the EPO with search results from the instant application.

NOTE: Once the application has published or is otherwise publicly available, the USPTO may provide access to the application in accordance with 37 CFR 1.14.

Application Data Sheet 37 CFR 1.76		Attorney Docket Number	PAT260-018US
		Application Number	
Title of Invention	TECHNIQUES FOR DIRECT OPTICAL COUPLING OF PHOTODETECTORS TO OPTICAL DEMULTIPLEXER OUTPUTS AND AN OPTICAL TRANSCEIVER USING THE SAME		

Applicant Information:

Providing assignment information in this section does not substitute for compliance with any requirement of part 3 of Title 37 of CFR to have an assignment recorded by the Office.

Applicant	1	Remove
If the applicant is the inventor (or the remaining joint inventor or inventors under 37 CFR 1.45), this section should not be completed. The information to be provided in this section is the name and address of the legal representative who is the applicant under 37 CFR 1.43; or the name and address of the assignee, person to whom the inventor is under an obligation to assign the invention, or person who otherwise shows sufficient proprietary interest in the matter who is the applicant under 37 CFR 1.46. If the applicant is an applicant under 37 CFR 1.46 (assignee, person to whom the inventor is obligated to assign, or person who otherwise shows sufficient proprietary interest) together with one or more joint inventors, then the joint inventor or inventors who are also the applicant should be identified in this section. Clear		
☒ Assignee	Legal Representative under 35 U.S.C. 117	Joint Inventor
Person to whom the inventor is obligated to assign.		Person who shows sufficient proprietary interest
If applicant is the legal representative, indicate the authority to file the patent application, the inventor is:		
Name of the Deceased or Legally Incapacitated Inventor:		
If the Applicant is an Organization check here. ☒		
Organization Name	Applied Optoelectronics, Inc.	
Mailing Address Information For Applicant:		
Address 1	13115 Jess Pirtle Blvd.	
Address 2		
City	Sugar Land	State/Province TX
Country	US	Postal Code 77478
Phone Number		Fax Number
Email Address		
Additional Applicant Data may be generated within this form by selecting the Add button. Add		

Assignee Information including Non-Applicant Assignee Information:

Providing assignment information in this section does not substitute for compliance with any requirement of part 3 of Title 37 of CFR to have an assignment recorded by the Office.

Application Data Sheet 37 CFR 1.76		Attorney Docket Number	PAT260-018US
		Application Number	
Title of Invention	TECHNIQUES FOR DIRECT OPTICAL COUPLING OF PHOTODETECTORS TO OPTICAL DEMULTIPLEXER OUTPUTS AND AN OPTICAL TRANSCEIVER USING THE SAME		

Assignee 1				
Complete this section if assignee information, including non-applicant assignee information, is desired to be included on the patent application publication. An assignee-applicant identified in the "Applicant Information" section will appear on the patent application publication as an applicant. For an assignee-applicant, complete this section only if identification as an assignee is also desired on the patent application publication.				
Remove				
If the Assignee or Non-Applicant Assignee is an Organization check here. ☐				
Prefix	Given Name	Middle Name	Family Name	Suffix
Mailing Address Information For Assignee including Non-Applicant Assignee:				
Address 1				
Address 2				
City		State/Province		
Country ⁱ		Postal Code		
Phone Number		Fax Number		
Email Address				
Additional Assignee or Non-Applicant Assignee Data may be generated within this form by selecting the Add button. Add				

Signature:

NOTE: This Application Data Sheet must be signed in accordance with 37 CFR 1.33(b). However, if this Application Data Sheet is submitted with the **INITIAL** filing of the application and either box A or B is not checked in subsection 2 of the "Authorization or Opt-Out of Authorization to Permit Access" section, then this form must also be signed in accordance with 37 CFR 1.14(c).

This Application Data Sheet **must** be signed by a patent practitioner if one or more of the applicants is a **juristic entity** (e.g., corporation or association). If the applicant is two or more joint inventors, this form must be signed by a patent practitioner, **all** joint inventors who are the applicant, or one or more joint inventor-applicants who have been given power of attorney (e.g., see USPTO Form PTO/AIA/81) on behalf of **all** joint inventor-applicants.

See 37 CFR 1.4(d) for the manner of making signatures and certifications.

Signature	/Kevin J. Carroll/		Date (YYYY-MM-DD)	2016-04-25
First Name	Kevin J.	Last Name	Carroll	Registration Number
				36384
Additional Signature may be generated within this form by selecting the Add button. Add				

Application Data Sheet 37 CFR 1.76		Attorney Docket Number	PAT260-018US
		Application Number	
Title of Invention	TECHNIQUES FOR DIRECT OPTICAL COUPLING OF PHOTODETECTORS TO OPTICAL DEMULTIPLEXER OUTPUTS AND AN OPTICAL TRANSCEIVER USING THE SAME		

This collection of information is required by 37 CFR 1.76. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 23 minutes to complete, including gathering, preparing, and submitting the completed application data sheet form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

Privacy Act Statement

The Privacy Act of 1974 (P.L. 93-579) requires that you be given certain information in connection with your submission of the attached form related to a patent application or patent. Accordingly, pursuant to the requirements of the Act, please be advised that: (1) the general authority for the collection of this information is 35 U.S.C. 2(b)(2); (2) furnishing of the information solicited is voluntary; and (3) the principal purpose for which the information is used by the U.S. Patent and Trademark Office is to process and/or examine your submission related to a patent application or patent. If you do not furnish the requested information, the U.S. Patent and Trademark Office may not be able to process and/or examine your submission, which may result in termination of proceedings or abandonment of the application or expiration of the patent.

The information provided by you in this form will be subject to the following routine uses:

- 1 The information on this form will be treated confidentially to the extent allowed under the Freedom of Information Act (5 U.S.C. 552) and the Privacy Act (5 U.S.C. 552a). Records from this system of records may be disclosed to the Department of Justice to determine whether the Freedom of Information Act requires disclosure of these records.
- 2 A record from this system of records may be disclosed, as a routine use, in the course of presenting evidence to a court, magistrate, or administrative tribunal, including disclosures to opposing counsel in the course of settlement negotiations.
- 3 A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.
- 4 A record in this system of records may be disclosed, as a routine use, to a contractor of the Agency having need for the information in order to perform a contract. Recipients of information shall be required to comply with the requirements of the Privacy Act of 1974, as amended, pursuant to 5 U.S.C. 552a(m).
- 5 A record related to an International Application filed under the Patent Cooperation Treaty in this system of records may be disclosed, as a routine use, to the International Bureau of the World Intellectual Property Organization, pursuant to the Patent Cooperation Treaty.
- 6 A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).
- 7 A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (i.e., GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.
- 8 A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspections or an issued patent.
- 9 A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

Declaration for United States Patent Application

TITLE OF APPLICATION: TECHNIQUES FOR DIRECT OPTICAL COUPLING OF PHOTODETECTORS TO OPTICAL DEMULTIPLEXER OUTPUTS AND AN OPTICAL TRANSCEIVER USING THE SAME

As a below named inventor, I hereby declare that:

This declaration is directed to:

☒ the attached application, or

☐ United States Application No. or PCT Application No. _____ filed on _____

The above-identified application was made or authorized to be made by me.

I believe that I am the original inventor or an original joint inventor of a claimed invention in the application.

I have reviewed and understand the contents of the application, including the claims, and I am aware of the duty to disclose to the Office all information known to the person to be material to patentability as defined in 37 C.F.R. § 1.56 (attached hereto).

I hereby acknowledge that any willful false statement made in this declaration is punishable under 18 U.S.C. 1001 by fine or imprisonment of not more than five (5) years, or both.

I-Lung HO Full name of sole or first inventor	
Sole or first inventor's signature	Date 4/22/16
Zhengyu MIAO Full name of additional inventor, if any	
Additional inventor's signature	Date 4/22/16
Qin LI Full name of additional inventor, if any	
Additional inventor's signature	Date 4/22/16

§ 1.56 Duty to disclose information material to patentability.

(a) A patent by its very nature is affected with a public interest. The public interest is best served, and the most effective patent examination occurs when, at the time an application is being examined, the Office is aware of and evaluates the teachings of all information material to patentability. Each individual associated with the filing and prosecution of a patent application has a duty of candor and good faith in dealing with the Office, which includes a duty to disclose to the Office all information known to that individual to be material to patentability as defined in this section. The duty to disclose information exists with respect to each pending claim until the claim is canceled or withdrawn from consideration, or the application becomes abandoned. Information material to the patentability of a claim that is canceled or withdrawn from consideration need not be submitted if the information is not material to the patentability of any claim remaining under consideration in the application. There is no duty to submit information which is not material to the patentability of any existing claim. The duty to disclose all information known to be material to patentability is deemed to be satisfied if all information known to be material to patentability of any claim issued in a patent was cited by the Office or submitted to the Office in the manner prescribed by §§ 1.97(b)-(d) and 1.98. However, no patent will be granted on an application in connection with which fraud on the Office was practiced or attempted or the duty of disclosure was violated through bad faith or intentional misconduct. The Office encourages applicants to carefully examine:

- (1) prior art cited in search reports of a foreign patent office in a counterpart application, and
- (2) the closest information over which individuals associated with the filing or prosecution of a patent application believe any pending claim patentably defines, to make sure that any material information contained therein is disclosed to the Office.

(b) Under this section, information is material to patentability when it is not cumulative to information already of record or being made of record in the application, and

- (1) It establishes, by itself or in combination with other information, a prima facie case of unpatentability of a claim; or
- (2) It refutes, or is inconsistent with, a position the applicant takes in:
 - (i) Opposing an argument of unpatentability relied on by the Office, or
 - (ii) Asserting an argument of patentability.

A prima facie case of unpatentability is established when the information compels a conclusion that a claim is unpatentable under the preponderance of evidence, burden-of-proof standard, giving each term in the claim its broadest reasonable construction consistent with the specification, and before any consideration is given to evidence which may be submitted in an attempt to establish a contrary conclusion of patentability.

(c) Individuals associated with the filing or prosecution of a patent application within the meaning of this section are:

- (1) Each inventor named in the application;
- (2) Each attorney or agent who prepares or prosecutes the application; and
- (3) Every other person who is substantively involved in the preparation or prosecution of the application and who is associated with the inventor, with the assignee or with anyone to whom there is an obligation to assign the application.

(d) Individuals other than the attorney, agent or inventor may comply with this section by disclosing information to the attorney, agent, or inventor.

SCORE Placeholder Sheet for IFW Content

Application Number: 15137823

Document Date: 04/25/2016

The presence of this form in the IFW record indicates that the following document type was received in electronic format on the date identified above. This content is stored in the SCORE database.

- Drawings – Other than Black and White Line Drawings

Since this was an electronic submission, there is no physical artifact folder, no artifact folder is recorded in PALM, and no paper documents or physical media exist. The TIFF images in the IFW record were created from the original documents that are stored in SCORE.

To access the documents in the SCORE database, refer to instructions below.

At the time of document entry (noted above):

- Examiners may access SCORE content via the eDAN interface.
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- External customers may access SCORE content via the Public and Private PAIR interfaces.