

UNITED STATES PATENT AND TRADEMARK OFFICE
CERTIFICATE OF CORRECTION

PATENT NO. : 10,446,700 B2
APPLICATION NO. : 15/797821
DATED : October 15, 2019
INVENTOR(S) : Shih-Yuan Wang, Shih-Ping Wang and M. Saif Islam

Page 1 of 2

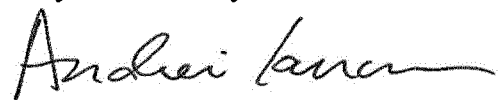
It is certified that error appears in the above-identified patent and that said Letters Patent is hereby corrected as shown below:

On the Title Page

Please add the following information after item (60) of the Related U.S. Application Data information on page 2:

-- Provisional application No. 62/290,391, filed on Feb. 2, 2016, Provisional application No. 62/304,907, filed on Mar. 7, 2016, Provisional application No. 62/334,934, filed on May 11, 2016, Provisional application No. 62/338,263, filed on May 18, 2016, Provisional application No. 62/346,850, filed on Jun. 7, 2016, Provisional application No. 62/359,349, filed on Jul. 7, 2016, Provisional application No. 62/366,188, filed on Jul. 25, 2016, Provisional application No. 62/368,109, filed on Jul. 28, 2016, Provisional application No. 62/374,828, filed on Aug. 13, 2016, Provisional application No. 62/376,869, filed on Aug. 18, 2016, Provisional application No. 62/380,364, filed on Aug. 27, 2016, Provisional application No. 62/383,391, filed on Sep. 3, 2016, Provisional application No. 62/383,479, filed on Sep. 4, 2016, Provisional application No. 62/394,222, filed on Sep. 14, 2016, Provisional application No. 62/398,607, filed on Sep. 23, 2016, Provisional application No. 62/401,126, filed on Sep. 28, 2016, Provisional application No. 62/406,999, filed on Oct. 12, 2016, Provisional application No. 62/414,671, filed on Oct. 29, 2016, Provisional application No. 62/465,734, filed on Mar. 1, 2017, Provisional application No. 62/474,179, filed on Mar. 21, 2017, Provisional application No. 62/484,474, filed on Apr. 12, 2017, Provisional application No. 62/487,606, filed on Apr. 20, 2017, Provisional application No. 62/488,998, filed on Apr. 24, 2017, Provisional application No. 62/500,581, filed on May 3, 2017, Provisional application No. 62/505,974, filed on May 14, 2017, Provisional application No. 62/509,093, filed on May 20, 2017, Provisional application No. 62/510,249, filed on May 23, 2017, Provisional application No. 62/514,889, filed on Jun. 4, 2017, Provisional application No. 62/521,504, filed on Jun. 18, 2017, Provisional application No. 62/522,169, filed on Jun. 20, 2017, Provisional application No. 62/527,962, filed on Jun. 30, 2017, Provisional application No. 62/530,281, filed on Jul. 9, 2017, Provisional application No. 62/533,078, filed on Jul. 16, 2017, Provisional application No. 62/533,603, filed on Jul. 17, 2017, Provisional application No. 62/535,801, filed on Jul. 21, 2017, Provisional application No. 62/540,524, filed on Aug. 2, 2017, Provisional application No. 62/542,243, filed on Aug. 7, 2017, Provisional application No. 62/547,728, filed on Aug. 18, 2017,

Signed and Sealed this
Twenty-fourth Day of November, 2020



Andrei Iancu
Director of the United States Patent and Trademark Office

Provisional application No. 62/553,844, filed on Sep. 2, 2017, Provisional application No. 62/556,426, filed on Sep. 10, 2017, Provisional application No. 62/561,869, filed on Sep. 22, 2017. --

In the Specification

At Column 2, Line 4, in the Reference To Related Applications section, please replace Aug. 27, 2016 with Jul. 28, 2016

Please insert the following at Column 2, after Line 4, in the Reference To Related Applications section:

-- U.S. Prov. Ser. No. 62/374,828 filed Aug. 13, 2016;
U.S. Prov. Ser. No. 62/376,869 filed Aug. 18, 2016;
U.S. Prov. Ser. No. 62/380,364 filed Aug. 27, 2016;
U.S. Prov. Ser. No. 62/383,479 filed Sep. 4, 2016; --



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
15/797,821	10/30/2017	Shih-Yuan WANG	309-0007US

CONFIRMATION NO. 1009

POA ACCEPTANCE LETTER



139982
Wissing Miller LLP
The Lofts at Manhattan West
434 West 33rd Street
12th Floor
New York, NY 10001

Date Mailed: 11/17/2020

NOTICE OF ACCEPTANCE OF POWER OF ATTORNEY

This is in response to the Power of Attorney filed 11/10/2020.

The Power of Attorney in this application is accepted. Correspondence in this application will be mailed to the above address as provided by 37 CFR 1.33.

Questions about the contents of this notice and the requirements it sets forth should be directed to the Office of Data Management, Application Assistance Unit, at (571) 272-4000 or (571) 272-4200 or 1-888-786-0101.

/zretta/



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
15/797,821	10/30/2017	Shih-Yuan WANG	5176/88184-CIP

23432
COOPER & DUNHAM LLP
845 Third Avenue, 6th Floor
NEW YORK, NY 10022

CONFIRMATION NO. 1009
POWER OF ATTORNEY NOTICE



OC000000121343669

Date Mailed: 11/17/2020

NOTICE REGARDING CHANGE OF POWER OF ATTORNEY

This is in response to the Power of Attorney filed 11/10/2020.

- The Power of Attorney to you in this application has been revoked by the assignee who has intervened as provided by 37 CFR 3.71. Future correspondence will be mailed to the new address of record(37 CFR 1.33).

Questions about the contents of this notice and the requirements it sets forth should be directed to the Office of Data Management, Application Assistance Unit, at (571) 272-4000 or (571) 272-4200 or 1-888-786-0101.

/zretta/

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.

STATEMENT UNDER 37 CFR 3.73(c)Applicant/Patent Owner: W&WSens Devices, Inc.Application No./Patent No.: 15/797,821Filed/Issue Date: October 30, 2017Titled: MICROSTRUCTURE ENHANCED ABSORPTION PHOTSENSITIVE DEVICESW&WSens Devices, Inc., a corporation

(Name of Assignee)

(Type of Assignee, e.g., corporation, partnership, university, government agency, etc.)

states that, for the patent application/patent identified above, it is (choose one of options 1, 2, 3 or 4 below):

1. ☒ The assignee of the entire right, title, and interest.
2. ☐ An assignee of less than the entire right, title, and interest (check applicable box):
- ☐ The extent (by percentage) of its ownership interest is _____%. Additional Statement(s) by the owners holding the balance of the interest must be submitted to account for 100% of the ownership interest.
- ☐ There are unspecified percentages of ownership. The other parties, including inventors, who together own the entire right, title and interest are:

Additional Statement(s) by the owner(s) holding the balance of the interest must be submitted to account for the entire right, title, and interest.

3. ☐ The assignee of an undivided interest in the entirety (a complete assignment from one of the joint inventors was made). The other parties, including inventors, who together own the entire right, title, and interest are:

Additional Statement(s) by the owner(s) holding the balance of the interest must be submitted to account for the entire right, title, and interest.

4. ☐ The recipient, via a court proceeding or the like (e.g., bankruptcy, probate), of an undivided interest in the entirety (a complete transfer of ownership interest was made). The certified document(s) showing the transfer is attached.

The interest identified in option 1, 2 or 3 above (not option 4) is evidenced by either (choose one of options A or B below):

- A. ☒ An assignment from the inventor(s) of the patent application/patent identified above. The assignment was recorded in the United States Patent and Trademark Office at Reel 044457, Frame 0751, or for which a copy thereof is attached.
- B. ☐ A chain of title from the inventor(s), of the patent application/patent identified above, to the current assignee as follows:

1. From: _____ To: _____
The document was recorded in the United States Patent and Trademark Office at
Reel _____, Frame _____, or for which a copy thereof is attached.
2. From: _____ To: _____
The document was recorded in the United States Patent and Trademark Office at
Reel _____, Frame _____, or for which a copy thereof is attached.

[Page 1 of 2]

This collection of information is required by 37 CFR 3.73(b). 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 1.11 and 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.**

If you need assistance in completing the form, call 1-800-PTO-9199 and select option 2.

STATEMENT UNDER 37 CFR 3.73(c)

3. From: _____ To: _____

The document was recorded in the United States Patent and Trademark Office at
 Reel _____, Frame _____, or for which a copy thereof is attached.

4. From: _____ To: _____

The document was recorded in the United States Patent and Trademark Office at
 Reel _____, Frame _____, or for which a copy thereof is attached.

5. From: _____ To: _____

The document was recorded in the United States Patent and Trademark Office at
 Reel _____, Frame _____, or for which a copy thereof is attached.

6. From: _____ To: _____

The document was recorded in the United States Patent and Trademark Office at
 Reel _____, Frame _____, or for which a copy thereof is attached.

☐ Additional documents in the chain of title are listed on a supplemental sheet(s).

☒ As required by 37 CFR 3.73(c)(1)(i), the documentary evidence of the chain of title from the original owner to the assignee was, or concurrently is being, submitted for recordation pursuant to 37 CFR 3.11.

[NOTE: A separate copy (i.e., a true copy of the original assignment document(s)) must be submitted to Assignment Division in accordance with 37 CFR Part 3, to record the assignment in the records of the USPTO. See MPEP 302.08]

The undersigned (whose title is supplied below) is authorized to act on behalf of the assignee.

/Gerard M. Wissing/

Signature

Gerard M. Wissing

Printed or Typed Name

November 10, 2020

Date

36309

Title or Registration 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.

TRANSMITTAL FOR POWER OF ATTORNEY TO ONE OR MORE REGISTERED PRACTITIONERS

NOTE: This form is to be submitted with the Power of Attorney by Applicant form (PTO/AIA/82B) to identify the application to which the Power of Attorney is directed, in accordance with 37 CFR 1.5, unless the application number and filing date are identified in the Power of Attorney by Applicant form. If neither form PTO/AIA/82A nor form PTO/AIA/82B identifies the application to which the Power of Attorney is directed, the Power of Attorney will not be recognized in the application.

Application Number	15/797,821
Filing Date	October 30, 2017
First Named Inventor	M. Saif Islam
Title	MICROSTRUCTURE ENHANCED ABSORPTION PHOTSENSITIVE DEVICES
Art Unit	2893
Examiner Name	Eduardo A. Rodela
Attorney Docket Number	309-0007US

SIGNATURE of Applicant or Patent Practitioner

Signature	/Gerard M. Wissing/	Date (Optional)	November 10, 2020
Name	Gerard M. Wissing	Registration Number	36309
Title (if Applicant is a juristic entity)			
Applicant Name (if Applicant is a juristic entity)			

NOTE: This form must be signed in accordance with 37 CFR 1.33. See 37 CFR 1.4(d) for signature requirements and certifications. If more than one applicant, use multiple forms.



*Total of 1 forms are submitted.

This collection of information is required by 37 CFR 1.131, 1.32, and 1.33. 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 1.11 and 1.14. This collection is estimated to take 3 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.**

If you need assistance in completing the form, call 1-800-PTO-9199 and select option 2.

POWER OF ATTORNEY BY APPLICANT

I hereby revoke all previous powers of attorney given in the application identified in either the attached transmittal letter or the boxes below.

Application Number

Filing Date

(Note: The boxes above may be left blank if information is provided on form PTO/AIA/82A.)

☒ I hereby appoint the Patent Practitioner(s) associated with the following Customer Number as my/our attorney(s) or agent(s), and to transact all business in the United States Patent and Trademark Office connected therewith for the application referenced in the attached transmittal letter (form PTO/AIA/82A) or identified above:

139982

OR

☐ I hereby appoint Practitioner(s) named in the attached list (form PTO/AIA/82C) as my/our attorney(s) or agent(s), and to transact all business in the United States Patent and Trademark Office connected therewith for the patent application referenced in the attached transmittal letter (form PTO/AIA/82A) or identified above. (Note: Complete form PTO/AIA/82C.)

Please recognize or change the correspondence address for the application identified in the attached transmittal letter or the boxes above to:

☒ The address associated with the above-mentioned Customer Number

OR

☐ The address associated with Customer Number:

OR

☐ Firm or Individual Name

Address

City

State

Zip

Country

Telephone

Email

I am the Applicant (if the Applicant is a juristic entity, list the Applicant name in the box):

W&WSens Devices, Inc.

- ☐ Inventor or Joint Inventor (title not required below)
- ☐ Legal Representative of a Deceased or Legally Incapacitated Inventor (title not required below)
- ☒ Assignee or Person to Whom the Inventor is Under an Obligation to Assign (provide signer's title if applicant is a juristic entity)
- ☐ Person Who Otherwise Shows Sufficient Proprietary Interest (e.g., a petition under 37 CFR 1.46(b)(2) was granted in the application or is concurrently being filed with this document) (provide signer's title if applicant is a juristic entity)

SIGNATURE of Applicant for Patent

The undersigned (whose title is supplied below) is authorized to act on behalf of the applicant (e.g., where the applicant is a juristic entity).

Signature

Date (Optional)

Name

Title

NOTE: Signature - This form must be signed by the applicant in accordance with 37 CFR 1.33. See 37 CFR 1.4 for signature requirements and certifications. If more than one applicant, use multiple forms.

☐ Total of forms are submitted.

This collection of information is required by 37 CFR 1.131, 1.32, and 1.33. 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 1.11 and 1.14. This collection is estimated to take 3 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.

If you need assistance in completing the form, call 1-800-PTO-9199 and select option 2.

Electronic Acknowledgement Receipt

EFS ID:	41089675
Application Number:	15797821
International Application Number:	
Confirmation Number:	1009
Title of Invention:	MICROSTRUCTURE ENHANCED ABSORPTION PHOTSENSITIVE DEVICES
First Named Inventor/Applicant Name:	Shih-Yuan WANG
Customer Number:	23432
Filer:	Gerard Michael Wissing/Mary Ellen Finnegan
Filer Authorized By:	Gerard Michael Wissing
Attorney Docket Number:	5176/88184-CIP
Receipt Date:	10-NOV-2020
Filing Date:	30-OCT-2017
Time Stamp:	19:45:32
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	no
------------------------	----

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Assignee showing of ownership per 37 CFR 3.73	309-0007US_StatementUnder37CFR373.pdf	121304 309c97975a3f7a604edde13a8cef3af76967540a	no	3

Warnings:

Information:					
2	Power of Attorney	309-0007US_POA.pdf	657068	no	2
			d64097b7cf4d1fdace17d29984694fd2158af83a		
Warnings:					
Information:					
Total Files Size (in bytes):				778372	
<p>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.</p> <p><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.</p> <p><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.</p> <p><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.</p>					



UNITED STATES PATENT AND TRADEMARK OFFICE

Commissioner for Patents
United States Patent and Trademark Office
P.O. Box 1450
Alexandria, VA 22313-1450
www.uspto.gov

COOPER & DUNHAM, LLP
30 Rockefeller Plaza
20th Floor
NEW YORK NY NEW YORK 10112

MAILED

FEB 05 2020

INTERNATIONAL PATENT LEGAL ADM.

In re Application of	:	
W&WSENS, DEVICES INC.	:	
Patent No.: 10,446,700	:	DECISION ON PETITION
Application No.: 15/797,821	:	UNDER 37 CFR 1.78(c)
Filing Date: October 30, 2017	:	
Attorney Docket No.: 5176/88184-CIP	:	

This is a decision on the renewed petition under 37 CFR 1.78(c), filed on January 13, 2020, to accept an unintentionally delayed claim under 35 U.S.C. 119(e) for the benefit of priority to one or more prior-filed provisional applications.

Under 37 CFR 1.78(c), a petition to accept an unintentionally delayed claim under 35 U.S.C. 119(e) for the benefit of a prior-filed application must be accompanied by:

- (i) the reference required by 35 U.S.C. 119(e) and 37 CFR 1.78(a)(3) to the prior-filed applications, unless previously submitted;
- (ii) the petition fee set forth in 37 CFR 1.17(m); and
- (iii) a statement that the entire delay between the date the claim was due under 37 CFR 1.78(a)(4) and the date the claim was filed was unintentional. The Director may require additional information where there is a question whether the delay was unintentional.

With regard to item (i), a proper reference to the prior-filed applications has been included in an application data sheet as required by 37 CFR 1.78(a)(3). Petitioner has also submitted a request for a Certificate of Correction.

With regard to item (ii), the petition fee set forth in 37 CFR 1.17(m) has been submitted.

With regard to item (iii), the statement of unintentional delay contained in the petition differs slightly from the language contained in 37 CFR 1.78(c)(3) and is hereby construed as a statement that the entire delay between the date the claim was due under 1.78(a)(4) and the date the claim was filed was unintentional. If this interpretation is incorrect, applicant is required to

immediately notify the Office. As construed, the provided statement of unintentional delay is acceptable.

For the reasons above, the petition under 37 CFR 1.78(c) is **GRANTED**.

Patentee is advised that the inclusion of a prior-filed application on any patent, published application, or certificate of correction should not be construed as meaning that the present application is necessarily entitled to the benefit of the prior-filed application. In order for an application to be entitled to the benefit of the prior-filed application, all other requirements under 35 U.S.C. 119(e) and 120 and 37 CFR 1.78 must be met.

This application is being forwarded to the Office of Data Management, Certificates of Correction Branch, for treatment of patentee's request for a certificate of correction.

/George Dombroske/
George Dombroske
PCT Legal Examiner
International Patent Legal Administration
571-272-3283

A petition pursuant to 37 C.F.R. 1.78 requires: (I) the reference required by 35 U.S.C. §119(e) and 37 CFR 1.78(a)(3) to the prior-filed applications; (II) the petition fee set forth in 37 CFR 1.17(m); and (III) a statement that the entire delay between the date the benefit claim was due under 37 CFR 1.78(a)(4) and the date the benefit claim was filed was unintentional.

Regarding requirement (I), as mentioned *supra*, the required references are being submitted via the request for Certificate of Correction under 37 C.F.R. § 1.323 filed concurrently herewith.

Regarding requirement (II), the December 6, 2019 Decision on Petition indicates that the petition fee set forth in 37 CFR 1.17(m) has been submitted.

Regarding requirement (III), the December 6, 2019 Decision on Petition indicates that requirement (III) was previously met. Nevertheless, applicant submits that the entire delay between the date the benefit claims were due and the filing of the present Petition was unintentional.

On behalf of Patentees, the undersigned respectfully requests that the Director issue a Certificate of Correction under § 1.323 reflecting the requested corrections.

No fee, other than the \$150.00 fee for providing a certificate of correction, is deemed necessary in connection with the filing of this response. However, if any additional fee is required, authorization is hereby given to charge the amount of any such fee to Deposit Account No. 03-3125.

Respectfully submitted,

/Ivan Kavrukov/
Ivan Kavrukov, Reg. No. 25,161
Attorney for Applicant
COOPER & DUNHAM LLP
30 Rockefeller Plaza, 20th Floor
New York, New York 10112
Tel.: (212) 278-0400

delay between the date the claim was due under 1.78(a)(4) and the date the claim was filed was unintentional. However, the December 6, 2019 Decision on Petition indicated that a request for certificate of correction is required because the application issued as a patent (on October 15, 2019), and indicated that the October 1, 2019 renewed petition pursuant to 37 CFR 1.78(c) was dismissed.

Patentees hereby request that the Director of the U.S. Patent and Trademark Office issue a Certificate of Correction under 37 C.F.R. § 1.323 in connection with the above-identified patent. 37 C.F.R. § 1.323 states that “[t]he Office may issue a certificate of correction under the conditions specified in 35 U.S.C. §255 at the request of the patentee or the patentee’s assignee, upon payment of the fee set forth in § 1.20(a).”

Patentees attach hereto as **Exhibit A**, Form PTO/SB/44 (PTO-1050) indicating corrections of errors in the above-identified patent, more specifically corrections to the Related U.S. Application Data in the above-identified patent. Such corrections were previously indicated in the corrected ADS filed with the above-mentioned October 1, 2019 petition, and such benefit claims are also present at Col. 1, line 63 – Col. 2, line 37 in the “Reference To Related Applications” section of the above-identified patent.

Page 1 of 2 of Certificate of Correction under 37 C.F.R. § 1.323 submitted herewith includes the following additions to section (60) of the benefit claims in the Related U.S. Application Data information on page 2 of the above-identified patent:

- Provisional application No. 62/290,391, filed on Feb. 2, 2016,
- Provisional application No. 62/304,907, filed on Mar. 7, 2016,
- Provisional application No. 62/334,934, filed on May 11, 2016,
- Provisional application No. 62/338,263, filed on May 18, 2016,
- Provisional application No. 62/346,850, filed on Jun. 7, 2016,

- Provisional application No. 62/359,349, filed on July. 7, 2016,
- Provisional application No. 62/366,188, filed on Jul. 25, 2016,
- Provisional application No. 62/368,109, filed on Jul. 28, 2016,
- Provisional application No. 62/374,828, filed on Aug. 13, 2016,
- Provisional application No. 62/376,869, filed on Aug. 18, 2016,
- Provisional application No. 62/380,364, filed on Aug. 27, 2016,
- Provisional application No. 62/383,391, filed on Sep. 3, 2016,
- Provisional application No. 62/383,479, filed on Sep. 4, 2016,
- Provisional application No. 62/394,222, filed on Sep. 14, 2016,
- Provisional application No. 62/398,607, filed on Sep. 23, 2016,
- Provisional application No. 62/401,126, filed on Sep. 28, 2016,
- Provisional application No. 62/406,999, filed on Oct. 12, 2016,
- Provisional application No. 62/414,671, filed on Oct. 29, 2016.

Page 2 of 2 of the Certificate of Correction under 37 C.F.R. § 1.323 submitted herewith includes the following additions to section (60) of the benefit claims in the Related U.S. Application Data information on page 2 of the above-identified patent:

- Provisional application No. 62/465,734, filed on Mar. 1, 2017,
- Provisional application No. 62/474,179, filed on Mar. 21, 2017,
- Provisional application No. 62/484,474, filed on Apr. 12, 2017,
- Provisional application No. 62/487,606, filed on Apr. 20, 2017,
- Provisional application No. 62/488,998, filed on Apr. 24, 2017,
- Provisional application No. 62/500,581, filed on May 3, 2017,
- Provisional application No. 62/505,974, filed on May 14, 2017,
- Provisional application No. 62/509,093, filed on May 20, 2017,
- Provisional application No. 62/510,249, filed on May 23, 2017,
- Provisional application No. 62/514,889, filed on Jun. 4, 2017,
- Provisional application No. 62/521,504, filed on Jun. 18, 2017,

- Provisional application No. 62/522,169, filed on Jun. 20, 2017,
- Provisional application No. 62/527,962, filed on Jun. 30, 2017,
- Provisional application No. 62/530,281, filed on Jul. 9, 2017,
- Provisional application No. 62/533,078, filed on Jul. 16, 2017,
- Provisional application No. 62/533,603, filed on Jul. 17, 2017,
- Provisional application No. 62/535,801, filed on Jul. 21, 2017,
- Provisional application No. 62/540,524, filed on Aug. 2, 2017,
- Provisional application No. 62/542,243, filed on Aug. 7, 2017,
- Provisional application No. 62/547,728, filed on Aug. 18, 2017,
- Provisional application No. 62/553,844, filed on Sep. 2, 2017,
- Provisional application No. 62/556,426, filed on Sep. 10, 2017,
- Provisional application No. 62/561,869, filed on Sep. 22, 2017.

In addition, page 2 of 2 of the Certificate of Correction includes the following changes at col. 2, after line 4, in the Reference To Related Applications section of the patent. It is respectfully submitted such information was correctly provided in the March 14, 2019 Amendment in connection with the above-identified patent, and was omitted or erroneously set forth via an Office mistake:

- At col. 2, line 4 of the patent, in the Reference To Related Applications section, corrects the filing date of U.S. Prov. Ser. No. 62/368,109 to Jul. 28, 2016;
- At col. 2, after line 4, in the Reference To Related Applications section of the patent, inserts the following:
 - U.S. Prov. Ser. No. 62/374,828 filed Aug. 13, 2016;
 - U.S. Prov. Ser. No. 62/376,869 filed Aug. 18, 2016;
 - U.S. Prov. Ser. No. 62/380,364 filed Aug. 27, 2016;
 - U.S. Prov. Ser. No. 62/383,479 filed Sep. 4, 2016;

The fee set forth in 37 C.F.R § 1.20(a) for providing a certificate of correction is \$150.00 and the undersigned hereby authorizes such fee to be charged to Deposit Account Number 03-3125.

Electronic Acknowledgement Receipt

EFS ID:	38276074
Application Number:	15797821
International Application Number:	
Confirmation Number:	1009
Title of Invention:	MICROSTRUCTURE ENHANCED ABSORPTION PHOTOSENSITIVE DEVICES
First Named Inventor/Applicant Name:	Shih-Yuan WANG
Customer Number:	23432
Filer:	Ivan Kavrukov/Thomas Trainor
Filer Authorized By:	Ivan Kavrukov
Attorney Docket Number:	5176/88184-CIP
Receipt Date:	13-JAN-2020
Filing Date:	30-OCT-2017
Time Stamp:	13:16:17
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	DA
Payment was successfully received in RAM	\$ 150
RAM confirmation Number	E20201CD16438901
Deposit Account	
Authorized User	

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

File Listing:					
Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1		88184-CIP-- Request_for_certificate_of_corr ection_and_Renewed_Petition. pdf	359843	yes	7
			5cda558c540b1d7d6fe04c17f01ad41c57756cb8		
	Multipart Description/PDF files in .zip description				
	Document Description		Start	End	
	Request for Certificate of Correction		6	7	
	Petition for review by the PCT legal office		5	5	
	Request for Certificate of Correction		2	4	
	Petition for review by the PCT legal office		1	1	
Warnings:					
Information:					
2	Fee Worksheet (SB06)	fee-info.pdf	30689	no	2
			3d48f8ff7070e0bfe9a4b564f484f506f8ca3c52		
Warnings:					
Information:					
Total Files Size (in bytes):			390532		

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

Patentees: W&WSens, Devices Inc.

Patent No: US 10,446,700

Inventors: Shih-Yuan WANG et al.

Application No.: 15/797,821

Art Unit: 2893

Filed: October 30, 2017

Examiner: Eduardo A. Rodela

For: MICROSTRUCTURE ENHANCED ABSORPTION PHOTOSENSITIVE DEVICES

Confirmation No.: 1009

This correspondence is being filed electronically with the U.S. Patent and Trademark Office via EFS-Web.

/Thomas Trainor/

January 13, 2020

Thomas Trainor

Date

30 Rockefeller Plaza, 20th Floor
New York, New York 10112
Tel.: (212) 278-0400

Mail Stop PCT
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Sir:

RENEWED PETITION FOR UNINTENTIONALLY DELAYED BENEFIT CLAIMS
PURSUANT TO 37 C.F.R. §1.78(c) AND
REQUEST FOR CERTIFICATE OF CORRECTION UNDER 37 C.F.R. § 1.323

On October 1, 2019, applicant submitted a renewed petition pursuant to 37 CFR 1.78(c) for acceptance of unintentionally delayed benefit claims under 35 U.S.C. §119(e) for the benefit of prior-filed provisional applications, and a corrected Application Data Sheet (ADS) to update benefit claims.

A December 6, 2019 Decision on Petition indicated that such October 1, 2019 renewed petition included a proper reference to the prior-filed applications in the ADS, as required by 37 CFR 1.78(a)(3), included the proper fee set forth in 37 CFR 1.17(m), and included an acceptable statement that the entire

Electronic Patent Application Fee Transmittal				
Application Number:		15797821		
Filing Date:		30-Oct-2017		
Title of Invention:		MICROSTRUCTURE ENHANCED ABSORPTION PHOTOSENSITIVE DEVICES		
First Named Inventor/Applicant Name:		Shih-Yuan WANG		
Filer:		Ivan Kavrukov/Thomas Trainor		
Attorney Docket Number:		5176/88184-CIP		
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:				
CERTIFICATE OF CORRECTION	1811	1	150	150

Description	Fee Code	Quantity	Amount	Sub-Total in USD(\$)
Extension-of-Time:				
Miscellaneous:				
Total in USD (\$)				150

**UNITED STATES PATENT AND TRADEMARK OFFICE
CERTIFICATE OF CORRECTION**

Page 1 of 2

PATENT NO. : 10,446,700

APPLICATION NO.: 15/797,821

ISSUE DATE : October 15, 2019

INVENTOR(S) : Shih-Yuan Wang; Shih-Ping Wang; M. Saif Islam

It is certified that an error appears or errors appear in the above-identified patent and that said Letters Patent is hereby corrected as shown below:

Please add the following information after section (60) of the Related U.S. Application Data information on page 2 of the patent :

-- Provisional application No. 62/290,391, filed on Feb. 2, 2016, Provisional application No. 62/304,907, filed on Mar. 7, 2016, Provisional application No. 62/334,934, filed on May 11, 2016, Provisional application No. 62/338,263, filed on May 18, 2016, Provisional application No. 62/346,850, filed on Jun. 7, 2016, Provisional application No. 62/359,349, filed on July. 7, 2016, Provisional application No. 62/366,188, filed on Jul. 25, 2016, Provisional application No. 62/368,109, filed on Jul. 28, 2016, Provisional application No. 62/374,828, filed on Aug. 13, 2016, Provisional application No. 62/376,869, filed on Aug. 18, 2016, Provisional application No. 62/380,364, filed on Aug. 27, 2016, Provisional application No. 62/383,391, filed on Sep. 3, 2016, Provisional application No. 62/383,479, filed on Sep. 4, 2016, Provisional application No. 62/394,222, filed on Sep. 14, 2016, Provisional application No. 62/398,607, filed on Sep. 23, 2016, Provisional application No. 62/401,126, filed on Sep. 28, 2016, Provisional application No. 62/406,999, filed on Oct. 12, 2016, Provisional application No. 62/414,671, filed on Oct. 29, 2016.--

MAILING ADDRESS OF SENDER (Please do not use Customer Number below):

COOPER & DUNHAM LLP
30 Rockefeller Plaza, 20th Floor
New York, NY 10112

This collection of information is required by 37 CFR 1.322, 1.323, and 1.324. 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 1.0 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: **Attention Certificate of Corrections Branch, Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

If you need assistance in completing the form, call 1-800-PTO-9199 and select option 2.

Exhibit A

**UNITED STATES PATENT AND TRADEMARK OFFICE
CERTIFICATE OF CORRECTION**

Page 2 of 2

PATENT NO. : 10,446,700

APPLICATION NO.: 15/797,821

ISSUE DATE : October 15, 2019

INVENTOR(S) : Shih-Yuan Wang; Shih-Ping Wang; M. Saif Islam

It is certified that an error appears or errors appear in the above-identified patent and that said Letters Patent is hereby corrected as shown below:

Please add the following information after section (60) of the Related U.S. Application Data information on page 2 of the patent :

-- Provisional application No. 62/465,734, filed on Mar. 1, 2017, Provisional application No. 62/474,179, filed on Mar. 21, 2017, Provisional application No. 62/484,474, filed on Apr. 12, 2017, Provisional application No. 62/487,606, filed on Apr. 20, 2017, Provisional application No. 62/488,998, filed on Apr. 24, 2017, Provisional application No. 62/500,581, filed on May 3, 2017, Provisional application No. 62/505,974, filed on May 14, 2017, Provisional application No. 62/509,093, filed on May 20, 2017, Provisional application No. 62/510,249, filed on May 23, 2017, Provisional application No. 62/514,889, filed on Jun. 4, 2017, Provisional application No. 62/521,504, filed on Jun. 18, 2017, Provisional application No. 62/522,169, filed on Jun. 20, 2017, Provisional application No. 62/527,962, filed on Jun. 30, 2017, Provisional application No. 62/530,281, filed on Jul. 9, 2017, Provisional application No. 62/533,078, filed on Jul. 16, 2017, Provisional application No. 62/533,603, filed on Jul. 17, 2017, Provisional application No. 62/535,801, filed on Jul. 21, 2017, Provisional application No. 62/540,524, filed on Aug. 2, 2017, Provisional application No. 62/542,243, filed on Aug. 7, 2017, Provisional application No. 62/547,728, filed on Aug. 18, 2017, Provisional application No. 62/553,844, filed on Sep. 2, 2017, Provisional application No. 62/556,426, filed on Sep. 10, 2017, Provisional application No. 62/561,869, filed on Sep. 22, 2017. --

At col. 2, line 4 of the patent, in the Reference To Related Applications section of the patent, please replace Aug. 27, 2016 with Jul. 28, 2016.

Please insert the following at col. 2, after line 4, in the Reference To Related Applications section of the patent:

-- U.S. Prov. Ser. No. 62/374,828 filed Aug. 13, 2016;
U.S. Prov. Ser. No. 62/376,869 filed Aug. 18, 2016;
U.S. Prov. Ser. No. 62/380,364 filed Aug. 27, 2016;
U.S. Prov. Ser. No. 62/383,479 filed Sep. 4, 2016; ---

MAILING ADDRESS OF SENDER (Please do not use Customer Number below):

COOPER & DUNHAM LLP
30 Rockefeller Plaza, 20th Floor
New York, NY 10112

This collection of information is required by 37 CFR 1.322, 1.323, and 1.324. 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 1.0 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: **Attention Certificate of Corrections Branch, Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

If you need assistance in completing the form, call 1-800-PTO-9199 and select option 2.



UNITED STATES PATENT AND TRADEMARK OFFICE

Commissioner for Patents
United States Patent and Trademark Office
P.O. Box 1450
Alexandria, VA 22313-1450
www.uspto.gov

MAILED

DEC 06 2019

INTERNATIONAL PATENT LEGAL ADM.

COOPER & DUNHAM, LLP
30 Rockefeller Plaza
20th Floor
NEW YORK NY NEW YORK 10112

In re Application of
W&WSENS, DEVICES INC.
Application No.: 15/797,821
Filing Date: October 30, 2017
Attorney Docket No.: 5176/88184-CIP

:
:
: DECISION ON PETITION
: UNDER 37 CFR 1.78(c)
:
:

This is a decision on the petition under 37 CFR 1.78(c), filed on October 1, 2019, to accept an unintentionally delayed claim under 35 U.S.C. 119(e) for the benefit of priority to one or more prior-filed provisional applications.

Under 37 CFR 1.78(c), a petition to accept an unintentionally delayed claim under 35 U.S.C. 119(e) for the benefit of a prior-filed application must be accompanied by:

- (i) the reference required by 35 U.S.C. 119(e) and 37 CFR 1.78(a)(3) to the prior-filed applications, unless previously submitted;
- (ii) the petition fee set forth in 37 CFR 1.17(m); and
- (iii) a statement that the entire delay between the date the claim was due under 37 CFR 1.78(a)(4) and the date the claim was filed was unintentional. The Director may require additional information where there is a question whether the delay was unintentional.

With regard to item (i), a proper reference to the prior-filed applications has been included in an application data sheet as required by 37 CFR 1.78(a)(3). However, since the instant application has matured into a patent, a request for a Certificate of Correction would be required in order for the requested relief to be granted.

With regard to item (ii), the petition fee set forth in 37 CFR 1.17(m) has been submitted.

With regard to item (iii), the statement of unintentional delay contained in the petition differs slightly from the language contained in 37 CFR 1.78(c)(3) and is hereby construed as a statement that the entire delay between the date the claim was due under 1.78(a)(4) and the date the claim was filed was unintentional. If this interpretation is incorrect, applicant is required to

immediately notify the Office. As construed, the provided statement of unintentional delay is acceptable.

For the reasons above, the petition under 37 CFR 1.78(c) is **DISMISSED** without prejudice.

Any further correspondence with respect to this matter may be filed electronically via EFS-Web selecting the document description "Petition for review and processing by the PCT Legal Office" or by mail addressed to Mail Stop PCT, Commissioner for Patents, International Patent Legal Administration, P.O. Box 1450, Alexandria, Virginia 22313-1450, with the contents of the letter marked to the attention of the International Patent Legal Administration.

/George Dombroske/
George Dombroske
PCT Legal Examiner
International Patent Legal Administration
571-272-3283

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant: W&WSens, Devices Inc.

Inventors: Shih-Yuan WANG et al.

Application No.: 15/797,821

Art Unit: 2893

Filed: October 30, 2017

Examiner: Eduardo A. Rodela

For: MICROSTRUCTURE ENHANCED ABSORPTION PHOTSENSITIVE DEVICES

Confirmation No.: 1009

Issue Fee Paid August 7, 2019

This correspondence is being filed electronically with the U.S. Patent and Trademark Office via EFS-Web.

/Thomas Trainor/

October 1, 2019

Thomas Trainor

Date

30 Rockefeller Plaza, 20th Floor
New York, New York 10112
Tel.: (212) 278-0400

Mail Stop PCT
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Sir:

**RENEWED PETITION FOR UNINTENTIONALLY DELAYED BENEFIT CLAIMS
PURSUANT TO 37 C.F.R. §1.78(c) AND
REQUEST FOR CORRECTED FILING RECEIPT**

On March 14, 2019, applicant submitted a petition pursuant to 37 CFR 1.78(c) for acceptance of unintentionally delayed benefit claims under 35 U.S.C. §119(e) for the benefit of prior-filed provisional applications, a corrected Application Data Sheet (ADS) to correct typographical errors in the Domestic Benefit/National Stage Information and to indicate that the present application claims benefit to twenty-three provisional applications [(i) through (xxiii) below] and that International Patent Appl. No. PCT/US16/67977 claims benefit to eighteen provisional applications [(a) through (r) below], and an Amendment to correct the Reference To Related Applications section to correct typographical errors in

said section and/or to otherwise improve a form thereof and to conform to the corrected ADS, and a request for corrected filing receipt reflecting such corrections.

There has not been an indication whether the aforementioned Amendment filed on March 14, 2019 would be entered. Applicant respectfully requests entry of such Amendment.

A Decision on Petition Under 37 CFR 1.78(c) and 1.78(e) dated September 20, 2019 from the USPTO indicated that the Petition filed March 14, 2019 was dismissed because the ADS filed March 14, 2019 allegedly purports to modify information which is not shown on the most recent filing of record at the time the ADS was filed. More specifically, the September 20, 2019 Decision on Petition stated that (A) no claim from 14/943,898 to "62/0181538," (B) no claim from 14/945,003 to 62/157,876, and (C) no claim from 15/309,922 to 14/945,003 appear to be present on the filing receipt mailed on 04 January 2018, and that therefore the purported changes to that (non-existent) information are improper. Further, the September 20, 2019 Decision on Petition indicated that the petition fee set forth in 37 CFR 1.17(m) has not been submitted.

Pursuant to 37 C.F.R. 1.78, this Renewed Petition is respectfully submitted along with a corrected ADS to update the claims to benefit which the September 20, 2019 Decision on Petition indicated are not proper. The corrected ADS submitted herewith shows changes relative to the most recent filing receipt mailed July 3, 2019 by the USPTO in connection with the present application.

Regarding (A), the corrected ADS submitted herewith includes markup (underline of information being inserted) indicating that Application No. 14/943,898 claims benefit to Provisional Application No. 62/081,538 filed 11/18/2014. Regarding (B), it is respectfully submitted that page 2 of the July 3, 2019 filing receipt indicates that Application No. 14/945,003 claim benefit of Provisional Application No. 62/157,876 filed 05/06/2015. Regarding (C), it is respectfully submitted

that page 2 of the July 3, 2019 filing receipt indicates that Application No. 15/309,922 is a CON of Application No. 14/945,003.

Such petition pursuant to 37 C.F.R. 1.78 requires: (I) the reference required by 35 U.S.C. §119(e) and 37 CFR 1.78(a)(3) to the prior-filed applications; (II) the petition fee set forth in 37 CFR 1.17(m); and (III) a statement that the entire delay between the date the benefit claim was due under 37 CFR 1.78(a)(4) and the date the benefit claim was filed was unintentional.

Regarding requirement (I), as mentioned *supra*, the required references are being submitted via the corrected ADS filed concurrently herewith.

Regarding requirement (II), the Patent Office is hereby authorized to charge the \$1,000.00 small entity fee under 37 C.F.R. 1.78, to Deposit Account No. 03-3125.

Regarding requirement (III), the September 20, 2019 Decision indicates that requirement (III) was previously met. Nevertheless, applicant submits that the entire delay between the date the benefit claims were due and the filing of the present Petition was unintentional.

The corrected ADS submitted concurrently herewith also makes the following changes:

- in the Domestic Benefit/National Stage Information section, indicates that Application No. 14/945,003 claims benefit of Provisional Application No. 62/209,311 filed 08/24/2015;
- in the Domestic Benefit/National Stage Information section, indicates that the present application claims benefit to the following twenty-three provisional applications (i) through (xxiii):
 - (i) U.S. Prov. Ser. No. 62/465,734 filed March 1, 2017;
 - (ii) U.S. Prov. Ser. No. 62/474,179 filed March 21, 2017;
 - (iii) U.S. Prov. Ser. No. 62/484,474 filed April 12, 2017;
 - (iv) U.S. Prov. Ser. No. 62/487,606 filed April 20, 2017;

- (v) U.S. Prov. Ser. No. 62/488,998 filed April 24, 2017;
- (vi) U.S. Prov. Ser. No. 62/500,581 filed May 3, 2017;
- (vii) U.S. Prov. Ser. No. 62/505,974 filed May 14, 2017;
- (viii) U.S. Prov. Ser. No. 62/509,093 filed May 20, 2017;
- (ix) U.S. Prov. Ser. No. 62/510,249 filed May 23, 2017;
- (x) U.S. Prov. Ser. No. 62/514,889 filed June 4, 2017;
- (xi) U.S. Prov. Ser. No. 62/521,504 filed June 18, 2017;
- (xii) U.S. Prov. Ser. No. 62/522,169 filed June 20, 2017;
- (xiii) U.S. Prov. Ser. No. 62/527,962 filed June 30, 2017;
- (xiv) U.S. Prov. Ser. No. 62/530,281 filed July 09, 2017;
- (xv) U.S. Prov. Ser. No. 62/533,078 filed July 16, 2017;
- (xvi) U.S. Prov. Ser. No. 62/533,603 filed July 17, 2017;
- (xvii) U.S. Prov. Ser. No. 62/535,801 filed July 21, 2017;
- (xviii) U.S. Prov. Ser. No. 62/540,524 filed August 2, 2017;
- (xix) U.S. Prov. Ser. No. 62/542,243 filed August 7, 2017;
- (x) U.S. Prov. Ser. No. 62/547,728 filed August 18, 2017;
- (xxi) U.S. Prov. Ser. No. 62/553,844 filed September 2, 2017;
- (xxii) U.S. Prov. Ser. No. 62/556,426 filed September 10, 2017; and
- (xxiii) U.S. Prov. Ser. No. 62/561,869 filed September 22, 2017.

- in the Domestic Benefit/National Stage Information section, indicates that International Patent Appl. No. PCT/US2016/067977 claims benefit to the following eighteen provisional applications (a) through (r):

- (a) U.S. Prov. Ser. No. 62/290,391 filed February 02, 2016;
- (b) U.S. Prov. Ser. No. 62/304,907 filed March 07, 2016;
- (c) U.S. Prov. Ser. No. 62/334,934 filed May 11, 2016;
- (d) U.S. Prov. Ser. No. 62/338,263 filed May 18, 2016;
- (e) U.S. Prov. Ser. No. 62/346,850 filed June 07, 2016;
- (f) U.S. Prov. Ser. No. 62/359,349 filed July 07, 2016;

- (g) U.S. Prov. Ser. No. 62/366,188 filed July 25, 2016;
- (h) U.S. Prov. Ser. No. 62/368,109 filed July 28, 2016;
- (i) U.S. Prov. Ser. No. 62/374,828 filed August 13, 2016;
- (j) U.S. Prov. Ser. No. 62/376,869 filed August 18, 2016;
- (k) U.S. Prov. Ser. No. 62/380,364 filed August 27, 2016;
- (l) U.S. Prov. Ser. No. 62/383,391 filed September 03, 2016;
- (m) U.S. Prov. Ser. No. 62/383,479 filed September 04, 2016;
- (n) U.S. Prov. Ser. No. 62/394,222 filed September 14, 2016;
- (o) U.S. Prov. Ser. No. 62/398,607 filed September 23, 2016;
- (p) U.S. Prov. Ser. No. 62/401,126 filed September 28, 2016;
- (q) U.S. Prov. Ser. No. 62/406,999 filed October 12, 2016; and
- (r) U.S. Prov. Ser. No. 62/414,671 filed October 29, 2016.

Request for Corrected Filing Receipt

Applicant hereby requests that the USPTO issue a corrected Filing Receipt reflecting the aforementioned corrections to the Domestic Priority Data.

If a telephone interview would be of assistance in advancing prosecution of the subject application, Applicant's undersigned attorney invites the Examiner to telephone him at the telephone number provided below.

The USPTO is hereby authorized to charge any additional fees that are required in connection with this Petition, to Deposit Account No. 03-3125.

Respectfully submitted,

/Ivan Kavrukov/
Ivan Kavrukov, Reg. No. 25,161
Attorney for Applicant
COOPER & DUNHAM LLP
30 Rockefeller Plaza, 20th Floor
New York, New York 10112
Tel.: (212) 278-0400

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

Application Data Sheet 37 CFR 1.76		Attorney Docket Number	5176/88184-CIP
		Application Number	15/797821
Title of Invention	MICROSTRUCTURE ENHANCED ABSORPTION PHOTOSENSITIVE DEVICES		
<p>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.</p> <p>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.</p>			

Secrecy Order 37 CFR 5.2:

☐ Portions or all of the application associated with this Application Data Sheet may fall under a Secrecy Order pursuant to 37 CFR 5.2 (Paper filers only. Applications that fall under Secrecy Order may not be filed electronically.)

Inventor Information:

Inventor 1 Remove				
Legal Name				
Prefix	Given Name	Middle Name	Family Name	Suffix
	Shih-Yuan		WANG	
Residence Information (Select One) ☒ US Residency ☐ Non US Residency ☐ Active US Military Service				
City	Palo Alto	State/Province	CA	Country of Residence US
Mailing Address of Inventor:				
Address 1		766 Encina Grande Dr.		
Address 2				
City	Palo Alto	State/Province		
Postal Code	94306	Country	US	
Inventor 2 Remove				
Legal Name				
Prefix	Given Name	Middle Name	Family Name	Suffix
	Shih-Ping		WANG	
Residence Information (Select One) ☒ US Residency ☐ Non US Residency ☐ Active US Military Service				
City	Los Altos	State/Province	CA	Country of Residence US
Mailing Address of Inventor:				
Address 1		38 3rd Street, Suite #307		
Address 2				
City	Los Altos	State/Province		
Postal Code	94022	Country	US	
Inventor 3 Remove				
Legal Name				
Prefix	Given Name	Middle Name	Family Name	Suffix
	M. Saif		ISLAM	
Residence Information (Select One) ☒ US Residency ☐ Non US Residency ☐ Active US Military Service				

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

Application Data Sheet 37 CFR 1.76		Attorney Docket Number	5176/88184-CIP		
		Application Number	15/797821		
Title of Invention	MICROSTRUCTURE ENHANCED ABSORPTION PHOTOSENSITIVE DEVICES				
City	Davis	State/Province	CA	Country of Residence	US
Mailing Address of Inventor:					
Address 1	3038 Mallorca Ln.				
Address 2					
City	Davis	State/Province	CA		
Postal Code	95618	Country	US		
All Inventors Must Be Listed - Additional Inventor Information blocks may be generated within this form by selecting the Add button. Add					

Correspondence Information:

Enter either Customer Number or complete the Correspondence Information section below. For further information see 37 CFR 1.33(a).			
☐ An Address is being provided for the correspondence Information of this application.			
Customer Number	23432		
Email Address	pdocketing@cooperdunham.com	Add Email	Remove Email

Application Information:

Title of the Invention	MICROSTRUCTURE ENHANCED ABSORPTION PHOTOSENSITIVE DEVICES		
Attorney Docket Number	5176/88184-CIP	Small Entity Status Claimed	☒
Application Type	Nonprovisional		
Subject Matter	Utility		
Total Number of Drawing Sheets (if any)	131	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.

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

Application Data Sheet 37 CFR 1.76		Attorney Docket Number	5176/88184-CIP
		Application Number	15/797821
Title of Invention	MICROSTRUCTURE ENHANCED ABSORPTION PHOTOSENSITIVE DEVICES		

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	23432		

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	Pending	Remove	
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
15797821	Continuation in part of	15309922	2016-11-09
Prior Application Status	Pending	Remove	
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
15309922	a 371 of international	PCT/US2015/061120	2015-11-17
Prior Application Status	Expired	Remove	
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
PCT/US2015/061120	Claims benefit of provisional	62081538	2014-11-18
Prior Application Status	Expired	Remove	
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
PCT/US2015/061120	Claims benefit of provisional	62090879	2014-12-11
Prior Application Status	Expired	Remove	
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
PCT/US2015/061120	Claims benefit of provisional	62100025	2015-01-05

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

Application Data Sheet 37 CFR 1.76		Attorney Docket Number	5176/88184-CIP
		Application Number	15/797821
Title of Invention	MICROSTRUCTURE ENHANCED ABSORPTION PHOTOSENSITIVE DEVICES		

Prior Application Status	Expired	Remove	
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
PCT/US2015/061120	Claims benefit of provisional	62111582	2015-02-03
Prior Application Status	Expired	Remove	
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
PCT/US2015/061120	Claims benefit of provisional	62139511	2015-03-27
Prior Application Status	Expired	Remove	
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
PCT/US2015/061120	Claims benefit of provisional	62153443	2015-04-27
Prior Application Status	Expired	Remove	
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
PCT/US2015/061120	Claims benefit of provisional	62154675	2015-04-29
Prior Application Status	Expired	Remove	
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
PCT/US2015/061120	Claims benefit of provisional	62157876	2015-05-06
Prior Application Status	Expired	Remove	
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
PCT/US2015/061120	Claims benefit of provisional	62171915	2015-06-05
Prior Application Status	Expired	Remove	
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
PCT/US2015/061120	Claims benefit of provisional	62174498	2015-06-11
Prior Application Status	Expired	Remove	
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
PCT/US2015/061120	Claims benefit of provisional	62175855	2015-06-15
Prior Application Status	Expired	Remove	
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
PCT/US2015/061120	Claims benefit of provisional	62182602	2015-06-21

Application Data Sheet 37 CFR 1.76		Attorney Docket Number		5176/88184-CIP	
		Application Number		15/797821	
Title of Invention		MICROSTRUCTURE ENHANCED ABSORPTION PHOTOSENSITIVE DEVICES			

Prior Application Status	Expired	Remove			
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)		
PCT/US2015/061120	Claims benefit of provisional	62188876	2015-07-06		
Prior Application Status	Expired	Remove			
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)		
PCT/US2015/061120	Claims benefit of provisional	62197120	2015-07-27		
Prior Application Status	Expired	Remove			
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)		
PCT/US2015/061120	Claims benefit of provisional	62199607	2015-07-31		
Prior Application Status	Expired	Remove			
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)		
PCT/US2015/061120	Claims benefit of provisional	62205717	2015-08-15		
Prior Application Status	Expired	Remove			
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)		
PCT/US2015/061120	Claims benefit of provisional	62209311	2015-08-24		
Prior Application Status	Expired	Remove			
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)		
PCT/US2015/061120	Claims benefit of provisional	62213556	2015-09-02		
Prior Application Status	Expired	Remove			
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)		
PCT/US2015/061120	Claims benefit of provisional	62232716	2015-09-25		
Prior Application Status	Patented	Remove			
Application Number	Continuity Type	Prior Application Number	Filing Date (YYYY-MM-DD)	Patent Number	Issue Date (YYYY-MM-DD)
15309922	Continuation of	14943898	2015-11-17	9530905	2016-12-27
Prior Application Status	Expired	Remove			
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)		
<u>14943898</u>	<u>Claims benefit of provisional</u>	<u>62081538</u>	<u>2014-11-18</u>		

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

Application Data Sheet 37 CFR 1.76		Attorney Docket Number	5176/88184-CIP
		Application Number	15/797821
Title of Invention	MICROSTRUCTURE ENHANCED ABSORPTION PHOTOSENSITIVE DEVICES		

Prior Application Status	Expired	Remove	
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
14943898	Claims benefit of provisional	62090879	2014-12-11
Prior Application Status	Expired	Remove	
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
14943898	Claims benefit of provisional	62100025	2015-01-05
Prior Application Status	Expired	Remove	
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
14943898	Claims benefit of provisional	62111582	2015-02-03
Prior Application Status	Expired	Remove	
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
14943898	Claims benefit of provisional	62139511	2015-03-27
Prior Application Status	Expired	Remove	
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
14943898	Claims benefit of provisional	62153443	2015-04-27
Prior Application Status	Expired	Remove	
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
14943898	Claims benefit of provisional	62154675	2015-04-29
Prior Application Status	Expired	Remove	
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
14943898	Claims benefit of provisional	62157876	2015-05-06
Prior Application Status	Expired	Remove	
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
14943898	Claims benefit of provisional	62171915	2015-06-05
Prior Application Status	Expired	Remove	
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
14943898	Claims benefit of provisional	62174498	2015-06-11

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

Application Data Sheet 37 CFR 1.76		Attorney Docket Number	5176/88184-CIP
		Application Number	15/797821
Title of Invention	MICROSTRUCTURE ENHANCED ABSORPTION PHOTOSENSITIVE DEVICES		

Prior Application Status	Expired	Remove	
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
14943898	Claims benefit of provisional	62175855	2015-06-15
Prior Application Status	Expired	Remove	
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
14943898	Claims benefit of provisional	62182602	2015-06-21
Prior Application Status	Expired	Remove	
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
14943898	Claims benefit of provisional	62188876	2015-07-06
Prior Application Status	Expired	Remove	
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
14943898	Claims benefit of provisional	62197120	2015-07-27
Prior Application Status	Expired	Remove	
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
14943898	Claims benefit of provisional	62199607	2015-07-31
Prior Application Status	Expired	Remove	
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
14943898	Claims benefit of provisional	62205717	2015-08-15
Prior Application Status	Expired	Remove	
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
14943898	Claims benefit of provisional	62209311	2015-08-24
Prior Application Status	Expired	Remove	
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
14943898	Claims benefit of provisional	62213556	2015-09-02
Prior Application Status	Expired	Remove	
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
14943898	Claims benefit of provisional	62232716	2015-09-25

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

Application Data Sheet 37 CFR 1.76		Attorney Docket Number	5176/88184-CIP
		Application Number	15/797821
Title of Invention	MICROSTRUCTURE ENHANCED ABSORPTION PHOTOSENSITIVE DEVICES		

Prior Application Status		Patented		Remove	
Application Number	Continuity Type	Prior Application Number	Filing Date (YYYY-MM-DD)	Patent Number	Issue Date (YYYY-MM-DD)
15309922	Continuation of	14945003	2015-11-18	9525084	2016-12-20
Prior Application Status		Expired		Remove	
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)		
14945003	Claims benefit of provisional	62081538	2014-11-18		
Prior Application Status		Expired		Remove	
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)		
14945003	Claims benefit of provisional	62090879	2014-12-11		
Prior Application Status		Expired		Remove	
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)		
14945003	Claims benefit of provisional	62100025	2015-01-05		
Prior Application Status		Expired		Remove	
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)		
14945003	Claims benefit of provisional	62111582	2015-02-03		
Prior Application Status		Expired		Remove	
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)		
14945003	Claims benefit of provisional	62139511	2015-03-27		
Prior Application Status		Expired		Remove	
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)		
14945003	Claims benefit of provisional	62153443	2015-04-27		
Prior Application Status		Expired		Remove	
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)		
14945003	Claims benefit of provisional	62157876	2015-05-06		
Prior Application Status		Expired		Remove	
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)		
14945003	Claims benefit of provisional	62154675	2015-04-29		

Application Data Sheet 37 CFR 1.76		Attorney Docket Number	5176/88184-CIP
		Application Number	15/797821
Title of Invention	MICROSTRUCTURE ENHANCED ABSORPTION PHOTOSENSITIVE DEVICES		

Prior Application Status	Expired	Remove	
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
14945003	Claims benefit of provisional	62157876	2015-05-06
Prior Application Status	Expired	Remove	
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
14945003	Claims benefit of provisional	62171915	2015-06-05
Prior Application Status	Expired	Remove	
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
14945003	Claims benefit of provisional	62174498	2015-06-11
Prior Application Status	Expired	Remove	
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
14945003	Claims benefit of provisional	62175855	2015-06-15
Prior Application Status	Expired	Remove	
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
14945003	Claims benefit of provisional	62182602	2015-06-21
Prior Application Status	Expired	Remove	
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
14945003	Claims benefit of provisional	62188876	2015-07-06
Prior Application Status	Expired	Remove	
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
14945003	Claims benefit of provisional	62197120	2015-07-27
Prior Application Status	Expired	Remove	
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
14945003	Claims benefit of provisional	62199607	2015-07-31
Prior Application Status	Expired	Remove	
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
14945003	Claims benefit of provisional	62205717	2015-08-15

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

Application Data Sheet 37 CFR 1.76		Attorney Docket Number	5176/88184-CIP
		Application Number	15/797821
Title of Invention	MICROSTRUCTURE ENHANCED ABSORPTION PHOTOSENSITIVE DEVICES		

Prior Application Status	<u>Expired</u>		Remove
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
<u>14945003</u>	<u>Claims benefit of provisional</u>	<u>62209311</u>	<u>2015-08-24</u>
Prior Application Status	Expired		Remove
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
14945003	Claims benefit of provisional	62213556	2015-09-02
Prior Application Status	Expired		Remove
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
14945003	Claims benefit of provisional	62232716	2015-09-25
Prior Application Status	Pending		Remove
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
15797821	Continuation in part of	PCT/US2016/067977	2016-12-21
Prior Application Status	Pending		Remove
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
PCT/US2016/067977	Claims benefit of provisional	62415339	2016-10-31
Prior Application Status	Pending		Remove
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
PCT/US2016/067977	Claims benefit of provisional	62270577	2015-12-21
Prior Application Status	Pending		Remove
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
15797821	Continuation in part of	14947718	2015-11-20
Prior Application Status	Expired		Remove
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
14947718	Continuation of	PCT/US2014/039208	2014-05-22
Prior Application Status	Expired		Remove
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
PCT/US2014/039208	Claims benefit of provisional	61826446	2013-05-22

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

Application Data Sheet 37 CFR 1.76		Attorney Docket Number	5176/88184-CIP
		Application Number	15/797821
Title of Invention	MICROSTRUCTURE ENHANCED ABSORPTION PHOTOSENSITIVE DEVICES		

Prior Application Status	Expired	Remove	
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
PCT/US2014/039208	Claims benefit of provisional	61834873	2013-06-13
Prior Application Status	Expired	Remove	
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
PCT/US2014/039208	Claims benefit of provisional	61843021	2013-07-04
Prior Application Status	Expired	Remove	
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
PCT/US2014/039208	Claims benefit of provisional	61905109	2013-11-15
Prior Application Status	<u>Expired</u>	Remove	
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
<u>PCT/US2016/067977</u>	<u>Claims benefit of provisional</u>	<u>62290391</u>	<u>2016-02-02</u>
Prior Application Status	<u>Expired</u>	Remove	
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
<u>PCT/US2016/067977</u>	<u>Claims benefit of provisional</u>	<u>62304907</u>	<u>2016-03-07</u>
Prior Application Status	<u>Expired</u>	Remove	
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
<u>PCT/US2016/067977</u>	<u>Claims benefit of provisional</u>	<u>62334934</u>	<u>2016-05-11</u>
Prior Application Status	<u>Expired</u>	Remove	
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
<u>PCT/US2016/067977</u>	<u>Claims benefit of provisional</u>	<u>62338263</u>	<u>2016-05-18</u>
Prior Application Status	<u>Expired</u>	Remove	
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
<u>PCT/US2016/067977</u>	<u>Claims benefit of provisional</u>	<u>62346850</u>	<u>2016-06-07</u>
Prior Application Status	<u>Expired</u>	Remove	
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
<u>PCT/US2016/067977</u>	<u>Claims benefit of provisional</u>	<u>62359349</u>	<u>2016-07-07</u>

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

Application Data Sheet 37 CFR 1.76		Attorney Docket Number	5176/88184-CIP
		Application Number	15/797821
Title of Invention	MICROSTRUCTURE ENHANCED ABSORPTION PHOTOSENSITIVE DEVICES		

Prior Application Status	<u>Expired</u>	Remove	
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
<u>PCT/US2016/067977</u>	<u>Claims benefit of provisional</u>	<u>62366188</u>	<u>2016-07-25</u>
Prior Application Status	<u>Expired</u>	Remove	
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
<u>PCT/US2016/067977</u>	<u>Claims benefit of provisional</u>	<u>62368109</u>	<u>2016-07-28</u>
Prior Application Status	<u>Expired</u>	Remove	
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
<u>PCT/US2016/067977</u>	<u>Claims benefit of provisional</u>	<u>62374828</u>	<u>2016-08-13</u>
Prior Application Status	<u>Expired</u>	Remove	
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
<u>PCT/US2016/067977</u>	<u>Claims benefit of provisional</u>	<u>62376869</u>	<u>2016-08-18</u>
Prior Application Status	<u>Expired</u>	Remove	
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
<u>PCT/US2016/067977</u>	<u>Claims benefit of provisional</u>	<u>62380364</u>	<u>2016-08-27</u>
Prior Application Status	<u>Expired</u>	Remove	
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
<u>PCT/US2016/067977</u>	<u>Claims benefit of provisional</u>	<u>62383391</u>	<u>2016-09-03</u>
Prior Application Status	<u>Expired</u>	Remove	
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
<u>PCT/US2016/067977</u>	<u>Claims benefit of provisional</u>	<u>62383479</u>	<u>2016-09-04</u>
Prior Application Status	<u>Expired</u>	Remove	
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
<u>PCT/US2016/067977</u>	<u>Claims benefit of provisional</u>	<u>62394222</u>	<u>2016-09-14</u>
Prior Application Status	<u>Expired</u>	Remove	
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
<u>PCT/US2016/067977</u>	<u>Claims benefit of provisional</u>	<u>62398607</u>	<u>2016-09-23</u>

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

Application Data Sheet 37 CFR 1.76		Attorney Docket Number	5176/88184-CIP
		Application Number	15/797821
Title of Invention	MICROSTRUCTURE ENHANCED ABSORPTION PHOTOSENSITIVE DEVICES		

Prior Application Status	<u>Expired</u>	Remove	
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
<u>PCT/US2016/067977</u>	<u>Claims benefit of provisional</u>	<u>62401126</u>	<u>2016-09-28</u>
Prior Application Status	<u>Expired</u>	Remove	
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
<u>PCT/US2016/067977</u>	<u>Claims benefit of provisional</u>	<u>62406999</u>	<u>2016-10-12</u>
Prior Application Status	<u>Expired</u>	Remove	
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
<u>PCT/US2016/067977</u>	<u>Claims benefit of provisional</u>	<u>62414671</u>	<u>2016-10-29</u>
Prior Application Status	<u>Pending</u>	Remove	
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
<u>15797821</u>	<u>Claims benefit of provisional</u>	<u>62465734</u>	<u>2017-03-01</u>
Prior Application Status	<u>Pending</u>	Remove	
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
<u>15797821</u>	<u>Claims benefit of provisional</u>	<u>62474179</u>	<u>2017-03-21</u>
Prior Application Status	<u>Pending</u>	Remove	
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
<u>15797821</u>	<u>Claims benefit of provisional</u>	<u>62484474</u>	<u>2017-04-12</u>
Prior Application Status	<u>Pending</u>	Remove	
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
<u>15797821</u>	<u>Claims benefit of provisional</u>	<u>62487606</u>	<u>2017-04-20</u>
Prior Application Status	<u>Pending</u>	Remove	
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
<u>15797821</u>	<u>Claims benefit of provisional</u>	<u>62488998</u>	<u>2017-04-24</u>
Prior Application Status	<u>Pending</u>	Remove	
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
<u>15797821</u>	<u>Claims benefit of provisional</u>	<u>62500581</u>	<u>2017-05-03</u>

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

Application Data Sheet 37 CFR 1.76		Attorney Docket Number	5176/88184-CIP
		Application Number	15/797821
Title of Invention	MICROSTRUCTURE ENHANCED ABSORPTION PHOTOSENSITIVE DEVICES		

Prior Application Status	<u>Pending</u>	Remove	
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
<u>15797821</u>	<u>Claims benefit of provisional</u>	<u>62505974</u>	<u>2017-05-14</u>
Prior Application Status	<u>Pending</u>	Remove	
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
<u>15797821</u>	<u>Claims benefit of provisional</u>	<u>62509093</u>	<u>2017-05-20</u>
Prior Application Status	<u>Pending</u>	Remove	
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
<u>15797821</u>	<u>Claims benefit of provisional</u>	<u>62510249</u>	<u>2017-05-23</u>
Prior Application Status	<u>Pending</u>	Remove	
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
<u>15797821</u>	<u>Claims benefit of provisional</u>	<u>62514889</u>	<u>2017-06-04</u>
Prior Application Status	<u>Pending</u>	Remove	
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
<u>15797821</u>	<u>Claims benefit of provisional</u>	<u>62521504</u>	<u>2017-06-18</u>
Prior Application Status	<u>Pending</u>	Remove	
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
<u>15797821</u>	<u>Claims benefit of provisional</u>	<u>62522169</u>	<u>2017-06-20</u>
Prior Application Status	<u>Pending</u>	Remove	
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
<u>15797821</u>	<u>Claims benefit of provisional</u>	<u>62527962</u>	<u>2017-06-30</u>
Prior Application Status	<u>Pending</u>	Remove	
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
<u>15797821</u>	<u>Claims benefit of provisional</u>	<u>62530281</u>	<u>2017-07-09</u>
Prior Application Status	<u>Pending</u>	Remove	
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
<u>15797821</u>	<u>Claims benefit of provisional</u>	<u>62533078</u>	<u>2017-07-16</u>

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

Application Data Sheet 37 CFR 1.76		Attorney Docket Number	5176/88184-CIP
		Application Number	15/797821
Title of Invention	MICROSTRUCTURE ENHANCED ABSORPTION PHOTOSENSITIVE DEVICES		

Prior Application Status	<u>Pending</u>	Remove	
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
<u>15797821</u>	<u>Claims benefit of provisional</u>	<u>62533603</u>	<u>2017-07-17</u>
Prior Application Status	<u>Pending</u>	Remove	
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
<u>15797821</u>	<u>Claims benefit of provisional</u>	<u>62535801</u>	<u>2017-07-21</u>
Prior Application Status	<u>Pending</u>	Remove	
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
<u>15797821</u>	<u>Claims benefit of provisional</u>	<u>62540524</u>	<u>2017-08-02</u>
Prior Application Status	<u>Pending</u>	Remove	
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
<u>15797821</u>	<u>Claims benefit of provisional</u>	<u>62542243</u>	<u>2017-08-07</u>
Prior Application Status	<u>Pending</u>	Remove	
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
<u>15797821</u>	<u>Claims benefit of provisional</u>	<u>62547728</u>	<u>2017-08-18</u>
Prior Application Status	<u>Pending</u>	Remove	
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
<u>15797821</u>	<u>Claims benefit of provisional</u>	<u>62553844</u>	<u>2017-09-02</u>
Prior Application Status	<u>Pending</u>	Remove	
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
<u>15797821</u>	<u>Claims benefit of provisional</u>	<u>62556426</u>	<u>2017-09-10</u>
Prior Application Status	<u>Pending</u>	Remove	
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
<u>15797821</u>	<u>Claims benefit of provisional</u>	<u>62561869</u>	<u>2017-09-22</u>
Additional Domestic Benefit/National Stage Data may be generated within this form by selecting the Add button.			

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

Application Data Sheet 37 CFR 1.76		Attorney Docket Number	5176/88184-CIP
		Application Number	15/797821
Title of Invention	MICROSTRUCTURE ENHANCED ABSORPTION PHOTOSENSITIVE DEVICES		

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)	Access Code ^j (if applicable)
			Remove

Additional Foreign Priority Data may be generated within this form by selecting the **Add** button.

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.

Application Data Sheet 37 CFR 1.76		Attorney Docket Number	5176/88184-CIP
		Application Number	15/797821
Title of Invention	MICROSTRUCTURE ENHANCED ABSORPTION PHOTOSENSITIVE DEVICES		

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.

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

Application Data Sheet 37 CFR 1.76		Attorney Docket Number	5176/88184-CIP
		Application Number	15/797821
Title of Invention	MICROSTRUCTURE ENHANCED ABSORPTION PHOTSENSITIVE DEVICES		

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

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 W&WSens, Devices Inc.

Mailing Address Information For Applicant:

Address 1		W&WSens, Devices Inc.	
Address 2		4546 El Camino Real, Suite 215	
City	Los Altos	State/Province	CA
Country	US	Postal Code	94022
Phone Number		Fax Number	
Email Address			

Additional Applicant Data may be generated within this form by selecting the Add button.

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.

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

Application Data Sheet 37 CFR 1.76		Attorney Docket Number	5176/88184-CIP
		Application Number	15/797821
Title of Invention	MICROSTRUCTURE ENHANCED ABSORPTION PHOTOSENSITIVE DEVICES		

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.

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		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.

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	/Ivan S. Kavrukov/		Date (YYYY-MM-DD)	2019-10-01
First Name	Ivan	Last Name	Kavrukov	Registration Number
				25,161
Additional Signature may be generated within this form by selecting the Add button.				

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

Application Data Sheet 37 CFR 1.76		Attorney Docket Number	5176/88184-CIP
		Application Number	15/797821
Title of Invention	MICROSTRUCTURE ENHANCED ABSORPTION PHOTSENSITIVE DEVICES		

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.**

Electronic Patent Application Fee Transmittal				
Application Number:		15797821		
Filing Date:		30-Oct-2017		
Title of Invention:		MICROSTRUCTURE ENHANCED ABSORPTION PHOTOSENSITIVE DEVICES		
First Named Inventor/Applicant Name:		Shih-Yuan WANG		
Filer:		Ivan Kavrukov/Thomas Trainor		
Attorney Docket Number:		5176/88184-CIP		
Filed as Small 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:				
PET. DELAY SUB OR RESTORE PRIORITY-CLAIM	2454	1	1000	1000
Patent-Appeals-and-Interference:				
Post-Allowance-and-Post-Issuance:				

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

Electronic Acknowledgement Receipt

EFS ID:	37335735
Application Number:	15797821
International Application Number:	
Confirmation Number:	1009
Title of Invention:	MICROSTRUCTURE ENHANCED ABSORPTION PHOTOSENSITIVE DEVICES
First Named Inventor/Applicant Name:	Shih-Yuan WANG
Customer Number:	23432
Filer:	Ivan Kavrukov/Thomas Trainor
Filer Authorized By:	Ivan Kavrukov
Attorney Docket Number:	5176/88184-CIP
Receipt Date:	01-OCT-2019
Filing Date:	30-OCT-2017
Time Stamp:	16:31:58
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	E201901G32148408
Deposit Account	
Authorized User	

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

File Listing:					
Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1		88184-CIP--Renewed_Petition.pdf	232943	yes	5
			dfcd7c4fbfcec96aa289843db936b42243fe6bd		
	Multipart Description/PDF files in .zip description				
	Document Description		Start	End	
	Petition for review by the PCT legal office		1	4	
	Request for Corrected Filing Receipt		5	5	
Warnings:					
Information:					
2	Application Data Sheet	88184-CIP--correctedADS_2019Oct1.pdf	2241153	no	20
			b8cce74b0388652eca34fb7733a2d25713c04d55		
Warnings:					
Information:					
This is not an USPTO supplied ADS fillable form					
3	Fee Worksheet (SB06)	fee-info.pdf	30609	no	2
			5e68d6acd61dc129a580d7bd9c3a930e794a126a		
Warnings:					
Information:					
Total Files Size (in bytes):			2504705		

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.



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.	ISSUE DATE	PATENT NO.	ATTORNEY DOCKET NO.	CONFIRMATION NO.
15/797,821	10/15/2019	10446700	5176/88184-CIP	1009

23432 7590 09/25/2019

COOPER & DUNHAM, LLP
30 Rockefeller Plaza
20th Floor
NEW YORK, NY 10112

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):

Shih-Yuan WANG, Palo Alto, CA;
W&WSens, Devices Inc., Los Altos, CA;
Shih-Ping WANG, Los Altos, CA;
M. Saif Islam, Davis, CA;

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.

IR103 (Rev. 10/09)



UNITED STATES PATENT AND TRADEMARK OFFICE

Commissioner for Patents
United States Patent and Trademark Office
P.O. Box 1450
Alexandria, VA 22313-1450
www.uspto.gov

COOPER & DUNHAM, LLP
30 Rockefeller Plaza
20th Floor
NEW YORK NY NEW YORK 10112

MAILED

SEP 20 2019

INTERNATIONAL PATENT LEGAL ADM.

In re Application of	:	
W&WSENS, DEVICES INC.	:	
Application No.: 15/797,821	:	DECISION ON PETITION
Filing Date: October 30, 2017	:	UNDER 37 CFR 1.78(c)
Attorney Docket No.: 5176/88184-CIP	:	AND 1.78(e)

This is a decision on the constructive petition under 37 CFR 1.78(c) and (e), filed March 14, 2019, to accept an unintentionally delayed claim under 35 U.S.C. 119(e) and 120 for the benefit of priority to one or more prior-filed provisional and nonprovisional/international applications.

Under 37 CFR 1.78(c) and (e), a petition to accept an unintentionally delayed claim under 35 U.S.C. 119(e) and 120 for the benefit of a prior-filed application must be accompanied by:

- (i) the reference required by 35 U.S.C. 119(e) and 120 and 37 CFR 1.78(a)(3) and 1.78(d)(2) to the prior-filed applications, unless previously submitted;
- (ii) the petition fee set forth in 37 CFR 1.17(m); and
- (iii) a statement that the entire delay between the date the claim was due under 37 CFR 1.78(a)(4) and (d)(3) and the date the claim was filed was unintentional. The Director may require additional information where there is a question whether the delay was unintentional.

With regard to item (i), the application data sheet does not properly identify the information being changed, with underlining for insertions, and strike-through or brackets for text removed, as required by 37 CFR 1.76(c)(2). The ADS purports to modify information which is not shown on the most recent filing of record at the time the ADS was filed. For instance, no claim from 14/943,898 to "62/0181538," no claim from 14/945,003 to 62/157,876, and no claim from 15/309,922 to 14/945,003 appear to be present on the filing receipt mailed on 04 January 2018. Therefore, the purported changes to that (non-existent) information are improper.

With regard to item (ii), the petition fee set forth in 37 CFR 1.17(m) has not been submitted.

With regard to item (iii), the statement of unintentional delay contained in the petition differs slightly from the language contained in 37 CFR 1.78(c)(3) and (e)(3) and is hereby construed as a statement that the entire delay between the date the claim was due under 1.78(a)(4) and (d)(3) and the date the claim was filed was unintentional. If this interpretation is incorrect, applicant is required to immediately notify the Office. As construed, the provided statement of unintentional delay is acceptable.

For the reasons above, the petition under 37 CFR 1.78(c) and (e) is **DISMISSED** without prejudice.

Any further correspondence with respect to this matter may be filed electronically via EFS-Web selecting the document description "Petition for review and processing by the PCT Legal Office" or by mail addressed to Mail Stop PCT, Commissioner for Patents, International Patent Legal Administration, P.O. Box 1450, Alexandria, Virginia 22313-1450, with the contents of the letter marked to the attention of the International Patent Legal Administration.

/George Dombroske/
George Dombroske
PCT Legal Examiner
International Patent Legal Administration
571-272-3283

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)	Application Number		15797821
	Filing Date		2017-10-30
	First Named Inventor	Shih-Yuan WANG	
	Art Unit	2893	
	Examiner Name	Eduardo A. Rodela	
	Attorney Docket Number	5176/88184-CIP	

	7	20160254407		2016-09-01	Wang et al.	
	8	20040222357		2004-11-11	King et al.	
	9	20020097962		2002-07-25	Yoshimura et al.	
Change(s) applied to document, /C.H.J./ 6/19/2019	10	20150340538		2015-11-26	Coriant Advanced Technology, LLC	Novack et al.

If you wish to add additional U.S. Published Application citation information please click the Add button.

FOREIGN PATENT DOCUMENTS

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	6-53424	JP		1994-02-25	International Business Machines Corporation		☐
	2	2003-142778	JP		2003-05-16	Samuelson et al.		☒
	3	2012-502466	JP		2012-01-26	Alcatel		☐

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
--------------------	---------	---	----------------

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)	Application Number		15797821
	Filing Date		2017-10-30
	First Named Inventor	Shih-Yuan WANG	
	Art Unit	2893	
	Examiner Name	Eduardo A. Rodela	
	Attorney Docket Number	5176/88184-CIP	

	9	7605406		2009-10-20	Iguchi	
Change(s) applied to document, /C.H.J/ 6/19/2019	10	9360554		2016-06-07	Retterath et al. Facet Technology Corp	
	11	8728847		2014-05-20	Maruyama et al.	

If you wish to add additional U.S. Patent citation information please click the Add button.

U.S.PATENT APPLICATION PUBLICATIONS

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	20030059820		2003-03-27	Vo-Dinh	
	2	20100059822		2010-03-11	Pinguet et al.	
	3	20080079022		2008-04-03	Yamamoto et al.	
	4	20070170536		2007-07-26	Hsu et al.	
	5	20060267054		2006-11-30	Martin et al.	
	6	20150054997		2015-02-26	Hyncek Aptina Imaging Corporation	

PART B - FEE(S) TRANSMITTAL

Complete and send this form, together with applicable fee(s), by mail or fax, or via EFS-Web.

By mail, send to: Mail Stop, ISSUE FEE
Commissioner for Patents
P.O. Box 1450
Alexandria, Virginia 22313-1450

By fax, send to: (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)

23432 7590 05/07/2019
COOPER & DUNHAM, LLP
30 Rockefeller Plaza
20th Floor
NEW YORK, NY 10112



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 transmitted to the USPTO via EFS-Web or by facsimile to (571) 273-2885, on the date below.

(Typed or printed name)
(Signature)
(Date)

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
15/797,821	10/30/2017	Shih-Yuan WANG	5176/88184-CIP	1009

TITLE OF INVENTION: MICROSTRUCTURE ENHANCED ABSORPTION PHOTSENSITIVE DEVICES

APPLN. TYPE	ENTITY STATUS	ISSUE FEE DUE	PUBLICATION FEE DUE	PREV. PAID ISSUE FEE	TOTAL FEE(S) DUE	DATE DUE
nonprovisional	SMALL	\$500	\$0.00	\$500.00	\$0	08/07/2019

EXAMINER	ART UNIT	CLASS-SUBCLASS
RODELA, EDUARDO A	2893	257-431000

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 03-09 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 COOPER & DUNHAM LLP

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 must have been previously recorded, or filed for recordation, as set forth in 37 CFR 3.11 and 37 CFR 3.81(a). Completion of this form is NOT a substitute for filing an assignment.

(A) NAME OF ASSIGNEE

W&Wsens Devices, Inc.

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

Los Altos, CA

Please check the appropriate assignee category or categories (will not be printed on the patent): ☐ Individual ☒ Corporation or other private group entity ☐ Government4a. Fees submitted: ☐ Issue Fee ☒ Publication Fee (if required) ☒ Advance Order - # of Copies (1)

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

☐ Electronic Payment via EFS-Web ☐ Enclosed check ☐ Non-electronic payment by credit card (Attach form PTO-2038)

☒ The Director is hereby authorized to charge the required fee(s), any deficiency, or credit any overpayment to Deposit Account No. 03-3125

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 /Ivan S. Kavrukov/

Date August 7, 2019

Typed or printed name Ivan S. Kavrukov

Registration No. 25,161

PART B - FEE(S) TRANSMITTAL

Complete and send this form, together with applicable fee(s), by mail or fax, or via EFS-Web.

By mail, send to: Mail Stop ISSUE FEE
Commissioner for Patents
P.O. Box 1450
Alexandria, Virginia 22313-1450

By fax, send to: (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)

23432 7590 05/07/2019
COOPER & DUNHAM, LLP
30 Rockefeller Plaza
20th Floor
NEW YORK, NY 10112

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 transmitted to the USPTO via EFS-Web or by facsimile to (571) 273-2885, on the date below.

(Typed or printed name)
(Signature)
(Date)

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
15/797,821	10/30/2017	Shih-Yuan WANG	5176/88184-CIP	1009

TITLE OF INVENTION: MICROSTRUCTURE ENHANCED ABSORPTION PHOTSENSITIVE DEVICES

APPLN. TYPE	ENTITY STATUS	ISSUE FEE DUE	PUBLICATION FEE DUE	PREV. PAID ISSUE FEE	TOTAL FEE(S) DUE	DATE DUE
nonprovisional	SMALL	\$500	\$0.00	\$500.00	\$0	08/07/2019

EXAMINER	ART UNIT	CLASS-SUBCLASS
RODELA, EDUARDO A	2893	257-431000

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 03-09 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. COOPER & DUNHAM LLP

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 must have been previously recorded, or filed for recordation, as set forth in 37 CFR 3.11 and 37 CFR 3.81(a). Completion of this form is NOT a substitute for filing an assignment.

(A) NAME OF ASSIGNEE

W&Wsens Devices, Inc.

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

Los Altos, CA

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

4a. Fees submitted: ☐ Issue Fee ☒ Publication Fee (if required) ☒ Advance Order - # of Copies (1)

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

☐ Electronic Payment via EFS-Web ☐ Enclosed check ☐ Non-electronic payment by credit card (Attach form PTO-2038)

☒ The Director is hereby authorized to charge the required fee(s), any deficiency, or credit any overpayment to Deposit Account No. 03-3125

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 /Ivan S. Kavrukov/

Date August 7, 2019

Typed or printed name Ivan S. Kavrukov

Registration No. 25,161

Electronic Acknowledgement Receipt

EFS ID:	36806329
Application Number:	15797821
International Application Number:	
Confirmation Number:	1009
Title of Invention:	MICROSTRUCTURE ENHANCED ABSORPTION PHOTSENSITIVE DEVICES
First Named Inventor/Applicant Name:	Shih-Yuan WANG
Customer Number:	23432
Filer:	Ivan Kavrukov/Thomas Trainor
Filer Authorized By:	Ivan Kavrukov
Attorney Docket Number:	5176/88184-CIP
Receipt Date:	07-AUG-2019
Filing Date:	30-OCT-2017
Time Stamp:	11:57:31
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	no
------------------------	----

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)	88184-CIP-- Issue_Fee_Transmittal.pdf	97623 4ea70e168208aef5f6ebc82e1e447de6f5f2e413	no	1

Warnings:

Information:	
Total Files Size (in bytes):	97623
<p>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.</p> <p><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.</p> <p><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.</p> <p><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.</p>	



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
15/797,821	10/30/2017	Shih-Yuan WANG	5176/88184-CIP

CONFIRMATION NO. 1009

POA ACCEPTANCE LETTER



0C000000110138918

23432
COOPER & DUNHAM, LLP
30 Rockefeller Plaza
20th Floor
NEW YORK, NY 10112

Date Mailed: 08/02/2019

NOTICE OF ACCEPTANCE OF POWER OF ATTORNEY

This is in response to the Power of Attorney filed 08/01/2019.

The Power of Attorney in this application is accepted. Correspondence in this application will be mailed to the above address as provided by 37 CFR 1.33.

Questions about the contents of this notice and the requirements it sets forth should be directed to the Office of Data Management, Application Assistance Unit, at (571) 272-4000 or (571) 272-4200 or 1-888-786-0101.

/nhorne/

TRANSMITTAL FOR POWER OF ATTORNEY TO ONE OR MORE REGISTERED PRACTITIONERS

NOTE: This form is to be submitted with the Power of Attorney by Applicant form (PTO/AIA/82B) to identify the application to which the Power of Attorney is directed, in accordance with 37 CFR 1.5, unless the application number and filing date are identified in the Power of Attorney by Applicant form. If neither form PTO/AIA/82A nor form PTO/AIA/82B identifies the application to which the Power of Attorney is directed, the Power of Attorney will not be recognized in the application.

Application Number	15/797,821
Filing Date	October 30, 2017
First Named Inventor	Shih-Yuan Wang
Title	MICROSTRUCTURE ENHANCED ABSORPTION PHOTSENSITIVE DEVICES
Art Unit	2893
Examiner Name	Eduardo A. Rodela
Attorney Docket Number	5176/88184-CIP

SIGNATURE of Applicant or Patent Practitioner

Signature	/Ivan S. Kavrukov/	Date (Optional)	
Name	Ivan S. Kavrukov	Registration Number	25,161
Title (if Applicant is a juristic entity)			
Applicant Name (if Applicant is a juristic entity)			
NOTE: This form must be signed in accordance with 37 CFR 1.33. See 37 CFR 1.4(d) for signature requirements and certifications. If more than one applicant, use multiple forms.			
☒ *Total of <u>1</u> forms are submitted.			

This collection of information is required by 37 CFR 1.131, 1.32, and 1.33. 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 1.11 and 1.14. This collection is estimated to take 3 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.**

If you need assistance in completing the form, call 1-800-PTO-9199 and select option 2.

POWER OF ATTORNEY BY APPLICANT

I hereby revoke all previous powers of attorney given in the application identified in either the attached transmittal letter or the boxes below.

Application Number	Filing Date

(Note: The boxes above may be left blank if information is provided on form PTO/AIA/82A.)

- ☒ I hereby appoint the Patent Practitioner(s) associated with the following Customer Number as my/our attorney(s) or agent(s), and to transact all business in the United States Patent and Trademark Office connected therewith for the application referenced in the attached transmittal letter (form PTO/AIA/82A) or identified above:
- OR
- ☐ I hereby appoint Practitioner(s) named in the attached list (form PTO/AIA/82C) as my/our attorney(s) or agent(s), and to transact all business in the United States Patent and Trademark Office connected therewith for the patent application referenced in the attached transmittal letter (form PTO/AIA/82A) or identified above. (Note: Complete form PTO/AIA/82C.)

Please recognize or change the correspondence address for the application identified in the attached transmittal letter or the boxes above to:

- ☒ The address associated with the above-mentioned Customer Number
- OR
- ☐ The address associated with Customer Number:
- OR

☐ Firm or Individual Name

Address

City

State

Zip

Country

Telephone

Email

I am the Applicant (if the Applicant is a juristic entity, list the Applicant name in the box):

W&Wsens Devices, Inc.

- ☐ Inventor or Joint Inventor (title not required below)
- ☐ Legal Representative of a Deceased or Legally Incapacitated Inventor (title not required below)
- ☒ Assignee or Person to Whom the Inventor is Under an Obligation to Assign (provide signer's title if applicant is a juristic entity)
- ☐ Person Who Otherwise Shows Sufficient Proprietary Interest (e.g., a petition under 37 CFR 1.46(b)(2) was granted in the application or is concurrently being filed with this document) (provide signer's title if applicant is a juristic entity)

SIGNATURE of Applicant for Patent

The undersigned (whose title is supplied below) is authorized to act on behalf of the applicant (e.g., where the applicant is a juristic entity).

Signature

Date (Optional)

Name

Shih-Ping Wang

Title

President and CEO

NOTE: Signature - This form must be signed by the applicant in accordance with 37 CFR 1.33. See 37 CFR 1.4 for signature requirements and certifications. If more than one applicant, use multiple forms.

☒ Total of 1 forms are submitted.

This collection of information is required by 37 CFR 1.131, 1.32, and 1.33. 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 1.11 and 1.14. This collection is estimated to take 3 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.

If you need assistance in completing the form, call 1-800-PTO-9199 and select option 2.

Electronic Acknowledgement Receipt

EFS ID:	36754914
Application Number:	15797821
International Application Number:	
Confirmation Number:	1009
Title of Invention:	MICROSTRUCTURE ENHANCED ABSORPTION PHOTSENSITIVE DEVICES
First Named Inventor/Applicant Name:	Shih-Yuan WANG
Customer Number:	23432
Filer:	Ivan Kavrukov/Thomas Trainor
Filer Authorized By:	Ivan Kavrukov
Attorney Docket Number:	5176/88184-CIP
Receipt Date:	01-AUG-2019
Filing Date:	30-OCT-2017
Time Stamp:	13:32:43
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	no
------------------------	----

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Power of Attorney	88184-CIP_POA.pdf	211408	no	2
			19e419063450a0551d7add13b64243853ef e4b7e		

Warnings:

Information:	
Total Files Size (in bytes):	211408
<p>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.</p> <p><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.</p> <p><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.</p> <p><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.</p>	



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	GRP ART UNIT	FIL FEE REC'D	ATTY. DOCKET NO	TOT CLAIMS	IND CLAIMS
15/797,821	10/30/2017	2893	5080	5176/88184-CIP	112	3

23432
COOPER & DUNHAM, LLP
30 Rockefeller Plaza
20th Floor
NEW YORK, NY 10112

CONFIRMATION NO. 1009
CORRECTED FILING RECEIPT



0000000109396420

Date Mailed: 07/03/2019

Receipt is acknowledged of this non-provisional utility 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 FIRST INVENTOR, 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 corrected Filing Receipt, including a properly marked-up ADS showing the changes with strike-through for deletions and underlining for additions. If you received a "Notice to File Missing Parts" or other Notice requiring a response for this application, please submit any request for correction 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 provided that the request is grantable.

Inventor(s)

Shih-Yuan WANG, Palo Alto, CA;
Shih-Ping WANG, Los Altos, CA;
M. Saif Islam, Davis, CA;

Applicant(s)

W&WSens, Devices Inc., Los Altos, CA;

Power of Attorney: None

Domestic Priority data as claimed by applicant

This application is a CIP of 15/309,922 11/09/2016 PAT 9818893
which is a 371 of PCT/US2015/061120 11/17/2015
which claims benefit of 62/081,538 11/18/2014
and claims benefit of 62/090,879 12/11/2014
and claims benefit of 62/100,025 01/05/2015
and claims benefit of 62/111,582 02/03/2015
and claims benefit of 62/139,511 03/27/2015
and claims benefit of 62/153,443 04/27/2015
and claims benefit of 62/154,675 04/29/2015
and claims benefit of 62/157,876 05/06/2015
and claims benefit of 62/171,915 06/05/2015
and claims benefit of 62/174,498 06/11/2015
and claims benefit of 62/175,855 06/15/2015
and claims benefit of 62/182,602 06/21/2015

page 1 of 5

and claims benefit of 62/188,876 07/06/2015
and claims benefit of 62/197,120 07/27/2015
and claims benefit of 62/199,607 07/31/2015
and claims benefit of 62/205,717 08/15/2015
and claims benefit of 62/209,311 08/24/2015
and claims benefit of 62/213,556 09/02/2015
and claims benefit of 62/232,716 09/25/2015
and said 15/309,922 11/09/2016
is a CON of 14/943,898 11/17/2015 PAT 9530905
which claims benefit of 62/090,879 12/11/2014
and claims benefit of 62/100,025 01/05/2015
and claims benefit of 62/111,582 02/03/2015
and claims benefit of 62/139,511 03/27/2015
and claims benefit of 62/153,443 04/27/2015
and claims benefit of 62/154,675 04/29/2015
and claims benefit of 62/157,876 05/06/2015
and claims benefit of 62/171,915 06/05/2015
and claims benefit of 62/174,498 06/11/2015
and claims benefit of 62/175,855 06/15/2015
and claims benefit of 62/182,602 06/21/2015
and claims benefit of 62/188,876 07/06/2015
and claims benefit of 62/197,120 07/27/2015
and claims benefit of 62/199,607 07/31/2015
and claims benefit of 62/205,717 08/15/2015
and claims benefit of 62/209,311 08/24/2015
and claims benefit of 62/213,556 09/02/2015
and claims benefit of 62/232,716 09/25/2015
and said 15/309,922 11/09/2016
is a CON of 14/945,003 11/18/2015 PAT 9525084
which claims benefit of 62/081,538 11/18/2014
and claims benefit of 62/090,879 12/11/2014
and claims benefit of 62/100,025 01/05/2015
and claims benefit of 62/111,582 02/03/2015
and claims benefit of 62/139,511 03/27/2015
and claims benefit of 62/153,443 04/27/2015
and claims benefit of 62/157,876 05/06/2015
and claims benefit of 62/154,675 04/29/2015
and claims benefit of 62/157,876 05/06/2015
and claims benefit of 62/171,915 06/05/2015
and claims benefit of 62/174,498 06/11/2015
and claims benefit of 62/175,855 06/15/2015
and claims benefit of 62/182,602 06/21/2015
and claims benefit of 62/188,876 07/06/2015
and claims benefit of 62/197,120 07/27/2015
and claims benefit of 62/199,607 07/31/2015
and claims benefit of 62/205,717 08/15/2015
and claims benefit of 62/213,556 09/02/2015
and claims benefit of 62/232,716 09/25/2015
This application 15/797,821
is a CIP of PCT/US2016/067977 12/21/2016
which claims benefit of 62/415,339 10/31/2016

page 2 of 5

and claims benefit of 62/270,577 12/21/2015
This application 15/797,821
is a CIP of 14/947,718 11/20/2015
which is a CON of PCT/US2014/039208 05/22/2014
which claims benefit of 61/826,446 05/22/2013
and claims benefit of 61/834,873 06/13/2013
and claims benefit of 61/843,021 07/04/2013
and claims benefit of 61/905,109 11/15/2013

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: 11/27/2017

The country code and number of your priority application, to be used for filing abroad under the Paris Convention, is **US 15/797,821**

Projected Publication Date: Not Applicable

Non-Publication Request: No

Early Publication Request: No

**** SMALL ENTITY ****

Title

MICROSTRUCTURE ENHANCED ABSORPTION PHOTSENSITIVE DEVICES

Preliminary Class

257

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

PROTECTING YOUR INVENTION OUTSIDE THE UNITED STATES

Since the rights granted by a U.S. patent extend only throughout the territory of the United States and have no effect in a foreign country, an inventor who wishes patent protection in another country must apply for a patent in a specific country or in regional patent offices. Applicants may wish to consider the filing of an international application under the Patent Cooperation Treaty (PCT). An international (PCT) application generally has the same effect as a regular national patent application in each PCT-member country. The PCT process **simplifies** the filing of patent applications on the same invention in member countries, but **does not result** in a grant of "an international patent" and does not eliminate the need of applicants to file additional documents and fees in countries where patent protection is desired.

Almost every country has its own patent law, and a person desiring a patent in a particular country must make an application for patent in that country in accordance with its particular laws. Since the laws of many countries differ

page 3 of 5

in various respects from the patent law of the United States, applicants are advised to seek guidance from specific foreign countries to ensure that patent rights are not lost prematurely.

Applicants also are advised that in the case of inventions made in the United States, the Director of the USPTO must issue a license before applicants can apply for a patent in a foreign country. The filing of a U.S. patent application serves as a request for a foreign filing license. The application's filing receipt contains further information and guidance as to the status of applicant's license for foreign filing.

Applicants may wish to consult the USPTO booklet, "General Information Concerning Patents" (specifically, the section entitled "Treaties and Foreign Patents") for more information on timeframes and deadlines for filing foreign patent applications. The guide is available either by contacting the USPTO Contact Center at 800-786-9199, or it can be viewed on the USPTO website at <http://www.uspto.gov/web/offices/pac/doc/general/index.html>.

For information on preventing theft of your intellectual property (patents, trademarks and copyrights), you may wish to consult the U.S. Government website, <http://www.stopfakes.gov>. Part of a Department of Commerce initiative, this website includes self-help "toolkits" giving innovators guidance on how to protect intellectual property in specific countries such as China, Korea and Mexico. For questions regarding patent enforcement issues, applicants may call the U.S. Government hotline at 1-866-999-HALT (1-866-999-4258).

LICENSE FOR FOREIGN FILING UNDER

Title 35, United States Code, Section 184

Title 37, Code of Federal Regulations, 5.11 & 5.15

GRANTED

The applicant has been granted a license under 35 U.S.C. 184, if the phrase "IF REQUIRED, FOREIGN FILING LICENSE GRANTED" followed by a date appears on this form. Such licenses are issued in all applications where the conditions for issuance of a license have been met, regardless of whether or not a license may be required as set forth in 37 CFR 5.15. The scope and limitations of this license are set forth in 37 CFR 5.15(a) unless an earlier license has been issued under 37 CFR 5.15(b). The license is subject to revocation upon written notification. The date indicated is the effective date of the license, unless an earlier license of similar scope has been granted under 37 CFR 5.13 or 5.14.

This license is to be retained by the licensee and may be used at any time on or after the effective date thereof unless it is revoked. This license is automatically transferred to any related applications(s) filed under 37 CFR 1.53(d). This license is not retroactive.

The grant of a license does not in any way lessen the responsibility of a licensee for the security of the subject matter as imposed by any Government contract or the provisions of existing laws relating to espionage and the national security or the export of technical data. Licensees should apprise themselves of current regulations especially with respect to certain countries, of other agencies, particularly the Office of Defense Trade Controls, Department of State (with respect to Arms, Munitions and Implements of War (22 CFR 121-128)); the Bureau of Industry and Security, Department of Commerce (15 CFR parts 730-774); the Office of Foreign Assets Control, Department of Treasury (31 CFR Parts 500+) and the Department of Energy.

NOT GRANTED

No license under 35 U.S.C. 184 has been granted at this time, if the phrase "IF REQUIRED, FOREIGN FILING LICENSE GRANTED" DOES NOT appear on this form. Applicant may still petition for a license under 37 CFR 5.12, if a license is desired before the expiration of 6 months from the filing date of the application. If 6 months has lapsed from the filing date of this application and the licensee has not received any indication of a secrecy order under 35 U.S.C. 181, the licensee may foreign file the application pursuant to 37 CFR 5.15(b).

SelectUSA

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 U.S. offers tremendous resources and advantages for those who invest and manufacture goods here. Through SelectUSA, our nation works to promote and facilitate business investment. SelectUSA provides information assistance to the international investor community; serves as an ombudsman for existing and potential investors; advocates on behalf of U.S. cities, states, and regions competing for global investment; and counsels U.S. economic development organizations on investment attraction best practices. To learn more about why the United States is the best country in the world to develop technology, manufacture products, deliver services, and grow your business, visit <http://www.SelectUSA.gov> or call +1-202-482-6800.

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant: W&WSens, Devices Inc.

Inventors: Shih-Yuan WANG et al.

Application No.: 15/797,821

Art Unit: 2893

Filed: October 30, 2017

Examiner: Eduardo A. Rodela

For: MICROSTRUCTURE ENHANCED ABSORPTION PHOTSENSITIVE DEVICES

Confirmation No.: 1009

This correspondence is being filed electronically with the U.S. Patent and Trademark Office via EFS-Web.

/Thomas Trainor/

July 2, 2019

Thomas Trainor

Date

30 Rockefeller Plaza, 20th Floor
New York, New York 10112
Tel.: (212) 278-0400

**RESPONSE TO JUNE 20, 2019 NOTICE TO FILE CORRECTED APPLICATION
PAPERS – NOTICE OF ALLOWANCE MAILED, AND
REQUEST FOR CORRECTED FILING RECEIPT**

This Response is being submitted in reply to a Notice To File Corrected Application Papers – Notice of Allowance Mailed, mailed June 20, 2019 in connection with the above-identified applications. A response to the Notice is due two (2) months from the mail date of the Notice (i.e. by August 20, 2019). Accordingly, this response is being timely filed.

The June 20, 2019 Notice (attached hereto as **Exhibit A**) states that the 37 CFR 1.78(a)(3) reference to prior U.S. provisional application number 62009311 is missing from the Application Data Sheet (ADS) filed March 14, 2019. The Notice indicates that a proper response would include any one of: (1) a corrected Application Data Sheet pursuant to 37 CFR 1.76(c) which provides benefit information that complies with 37 CFR 1.78(d)(2) or 37 CFR 1.78(a)(3); or (2) a petition under 37 CFR 1.78(e) or 37 CFR 1.78(c), including a corrected Application Data Sheet.

Applicant: W&WSens, Devices Inc.
Application No.: 15/797,821
Filed: October 30, 2017
Page 2

Dkt. 5176/88184-CIP

However, it is respectfully pointed out that, although the January 4, 2018 Filing Receipt (attached hereto as **Exhibit B**) mailed in connection with the present application correctly indicated that each of Application No. PCT/US2015/061120 and Application No. 14/943,898 claims the benefit of 62/209,311 filed 08/24/2015, such filing receipt erroneously indicated that Application No. 14/945,003 claims the benefit of 62/009,311 filed 06/08/2014. On the other hand, the March 14, 2019 corrected Application Data Sheet (attached hereto as **Exhibit C**) submitted in connection with the present application correctly indicated that Application No. 14/945,003 claims the benefit of 62/209,311 filed 08/24/2015. Applicant hereby requests the Patent Office to issue a corrected filing receipt correcting such error and reflecting the changes on such March 14, 2019 corrected Application Data Sheet, which was submitted along with a petition to add unintentionally delayed benefit claims.

No fees are deemed necessary in connection with the filing of this Response. Nevertheless, if any additional fee is required, authorization is hereby given to charge the amount of any such fee to Deposit Account No. 03-3125.

Respectfully submitted,

/Ivan Kavrukov/
Ivan Kavrukov, Reg. No. 25,161
Attorney for Applicant
COOPER & DUNHAM LLP
30 Rockefeller Plaza, 20th Floor
New York, New York 10112
Tel.: (212) 278-0400

EXHIBIT A

to

**RESPONSE TO JUNE 20, 2019 NOTICE TO FILE CORRECTED APPLICATION
PAPERS – NOTICE OF ALLOWANCE MAILED, AND
REQUEST FOR CORRECTED FILING RECEIPT**

Application No.: 15/797,821



UNITED STATES PATENT AND TRADEMARK OFFICE

Commissioner for Patents
United States Patent and Trademark Office
P.O. Box 1450
Alexandria, VA 22313-1450
www.uspto.gov

Application No. : 15797821
Applicant : Wang
Filing Date : 10/30/2017
Date Mailed : 06/20/2019

NOTICE TO FILE CORRECTED APPLICATION PAPERS

Notice of Allowance Mailed

This application has been accorded an Allowance Date and is being prepared for issuance. The application, however, is incomplete for the reasons below.

Applicant is given two (2) months from the mail date of this Notice within which to respond. This time period for reply is extendable under 37 CFR 1.136(a) for only TWO additional MONTHS.

The application is not in compliance with 37 CFR 1.78, as indicated in the attachment. The consequences of failure to respond within the above-identified time period are set forth in the attachment.

Even if the Office has recognized a benefit claim and has entered it into the Office's database and included it on applicant's filing receipt, the benefit claim is not a proper benefit claim unless the reference in compliance with 37 CFR 1.78 is included, depending upon the application's filing date and as indicated in the attachment, in an application data sheet or in the first sentence(s) of the specification and all other requirements are met.

See attachment.

*A copy of this notice **MUST** be returned with the reply. Please address response to
"Mail Stop Issue Fee, Commissioner for Patents,
P.O. Box 1450, Alexandria, VA 22313-1450".*

/Chris Harmon/
Publication Branch
Office of Data Management
(571) 272-4200

**APPLICATION FILED ON OR AFTER SEPTEMBER 16, 2012,
NOT IN COMPLIANCE WITH 37 CFR 1.78**

- ☐ The 37 CFR 1.78(d)(2) reference on the application data sheet does not indicate the relationship (continuation, division, continuation-in-part) to the prior U.S. nonprovisional application or international application designating the U.S. See document coded dated , listing application number(s) .
- ☐ The 37 CFR 1.78(d)(2) reference on the application data sheet does not indicate the relationship (continuation, division, continuation-in-part) to the prior international application designating the U.S. but instead indicates that an application is the national stage of the prior international application. However, the application was filed as a 35 U.S.C. 111 application and was not processed as a 35 U.S.C. 371 application, thus removing the validating link under 35 U.S.C. 119(a)-(d) to a prior foreign application or under 35 U.S.C. 119(e) to a prior U.S. provisional application. See document coded dated , listing application number(s) .
- ☐ The 37 CFR 1.78(d)(2) reference on the application data sheet does not provide the U.S. nonprovisional application number (series code and serial number) or, with respect to an international PCT application designating the U.S., it provides the international application number or international filing date but not both. See document coded dated , in which the following is missing: .
- ☐ The 37 CFR 1.78(d)(2) reference on the application data sheet shows an incorrect, incomplete, or illegible U.S. nonprovisional application number, international PCT application number, or international PCT filing date. See document coded dated , in which the following error was made: .
- ☐ The 37 CFR 1.78(d)(2) reference to the prior U.S. nonprovisional application or international application designating the U.S. is not present on an application data sheet, thus removing the validating link under 35 U.S.C. 119(a)-(d) to a prior foreign application or under 35 U.S.C. 119(e) to a prior U.S. provisional application. See document coded dated , in which the following is missing: .
- ☐ The 37 CFR 1.78(d)(2) reference to the prior U.S. nonprovisional application or international application designating the U.S. is not present on an application data sheet.
- ☐ The 37 CFR 1.78(a)(3) reference to the prior U.S. provisional application is not present on an application data sheet.
- ☒ The 37 CFR 1.78(a)(3) reference to the prior U.S. provisional application on an application data sheet does not provide the provisional application number (series code and serial number). See document coded ADS dated 03/14/2019, in which the following is missing: 62009311.
- ☐ The 37 CFR 1.78(a)(3) reference to the prior U.S. provisional application on an application data sheet shows an incorrect, incomplete, or illegible U.S. provisional application number. See document coded dated , in which the following error was made: .
- ☐ Other: .

HOW TO RESPOND

A proper response to this notice would include any one of: (1) a corrected Application Data Sheet (ADS) pursuant to 37 CFR 1.76(c) which provides benefit information that complies with 37 CFR 1.78(d)(2) or 37 CFR 1.78(a)(3) or (2) a petition filed pursuant to the provisions of 37 CFR 1.78(e) or 37 CFR 1.78(c) if the benefit information from the document identified above by code and date does not accurately reflect the benefits under 35 U.S.C. 119(e), 120, 121, 365(c) or 386(c) as claimed by applicant (a grantable petition would include a corrected ADS pursuant to 37 CFR 1.76(c)). In general, a petition would be required unless the proper benefit claim information was included on a properly signed ADS submitted with the application on filing, or a properly signed corrected ADS in compliance with 37 CFR 1.76(c) (e.g., with underlining to show insertions) that was filed within the time period in 37 CFR 1.78 for making the benefit claim(s), or the Office recognized the benefit claim(s) on the initial filing receipt. Such response may be filed after payment of the issue fee if limited to informalities noted herein. See Waiver of 37 CFR 1.312 for Document Required by Office of Patent Publication, 1280 Off. Gaz. Patent Office 918 (March 23, 2004).

WARNING: If Applicant fails to timely submit a proper response, the benefit information will be deleted and the patent will be printed without the benefit information present.

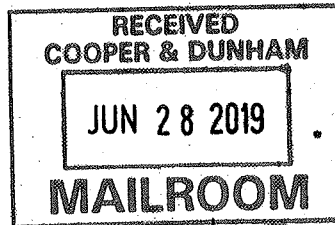


UNITED STATES PATENT AND TRADEMARK OFFICE

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.
15/797,821	10/30/2017	Shih-Yuan WANG	5176/88184-CIP	1009

23432 7590 06/20/2019
COOPER & DUNHAM, LLP
30 Rockefeller Plaza
20th Floor
NEW YORK, NY 10112



EXAMINER

RODELA, EDUARDO A

ART UNIT	PAPER NUMBER
----------	--------------

2893

MAIL DATE	DELIVERY MODE
-----------	---------------

06/20/2019

PAPER

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.

EXHIBIT B

to

**RESPONSE TO JUNE 20, 2019 NOTICE TO FILE CORRECTED APPLICATION
PAPERS – NOTICE OF ALLOWANCE MAILED, AND
REQUEST FOR CORRECTED FILING RECEIPT**

Application No.: 15/797,821



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	GRP ART UNIT	FIL FEE REC'D	ATTY. DOCKET NO	TOT CLAIMS	IND CLAIMS
15/797,821	10/30/2017		5080	5176/88184-CIP	112	3

23432
COOPER & DUNHAM, LLP
30 Rockefeller Plaza
20th Floor
NEW YORK, NY 10112

CONFIRMATION NO. 1009
UPDATED FILING RECEIPT



Date Mailed: 01/04/2018

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)

Shih-Yuan WANG, Palo Alto, CA;
Shih-Ping WANG, Los Altos, CA;
M. Saif Islam, Davis, CA;

Applicant(s)

W&WSens, Devices Inc., Los Altos, CA;

Power of Attorney: None

Domestic Priority data as claimed by applicant

This application is a CIP of 15/309,922 11/09/2016 PAT 9818893
which is a 371 of PCT/US2015/061120 11/17/2015
which claims benefit of 62/081,538 11/18/2014
and claims benefit of 62/090,879 12/11/2014
and claims benefit of 62/100,025 01/05/2015
and claims benefit of 62/111,582 02/03/2015
and claims benefit of 62/139,511 03/27/2015
and claims benefit of 62/153,443 04/27/2015
and claims benefit of 62/154,675 04/29/2015
and claims benefit of 62/157,876 05/06/2015
and claims benefit of 62/171,915 06/05/2015
and claims benefit of 62/174,498 06/11/2015
and claims benefit of 62/175,855 06/15/2015
and claims benefit of 62/182,602 06/21/2015
and claims benefit of 62/188,876 07/06/2015
and claims benefit of 62/197,120 07/27/2015
and claims benefit of 62/199,607 07/31/2015

page 1 of 5

and claims benefit of 62/205,717 08/15/2015
and claims benefit of 62/209,311 08/24/2015
and claims benefit of 62/213,556 09/02/2015
and claims benefit of 62/232,716 09/25/2015
and said 15/309,922 11/09/2016

is a CON of 14/943,898 11/17/2015 PAT 9530905

which claims benefit of 62/090,879 12/11/2014

and claims benefit of 62/100,025 01/05/2015

and claims benefit of 62/111,582 02/03/2015

and claims benefit of 62/139,511 03/27/2015

and claims benefit of 62/153,443 04/27/2015

and claims benefit of 62/154,675 04/29/2015

and claims benefit of 62/157,876 05/06/2015

and claims benefit of 62/171,915 06/05/2015

and claims benefit of 62/174,498 06/11/2015

and claims benefit of 62/175,855 06/15/2015

and claims benefit of 62/182,602 06/21/2015

and claims benefit of 62/188,876 07/06/2015

and claims benefit of 62/197,120 07/27/2015

and claims benefit of 62/199,607 07/31/2015

and claims benefit of 62/205,717 08/15/2015

and claims benefit of 62/209,311 08/24/2015

and claims benefit of 62/213,556 09/02/2015

and claims benefit of 62/232,716 09/25/2015

and said 15/309,922 11/09/2016

is a CON of 14/945,003 11/18/2015 PAT 9525084

which claims benefit of 62/081,538 11/18/2014

and claims benefit of 62/090,879 12/11/2014

and claims benefit of 62/100,025 01/05/2015

and claims benefit of 62/111,582 02/03/2015

and claims benefit of 62/139,511 03/27/2015

and claims benefit of 62/153,443 04/27/2015

and claims benefit of 62/157,876 05/06/2015

and claims benefit of 62/154,675 04/29/2015

and claims benefit of 62/157,876 05/06/2015

and claims benefit of 62/171,915 06/05/2015

and claims benefit of 62/174,498 06/11/2015

and claims benefit of 62/175,855 06/15/2015

and claims benefit of 62/182,602 06/21/2015

and claims benefit of 62/188,876 07/06/2015

and claims benefit of 62/197,120 07/27/2015

and claims benefit of 62/199,607 07/31/2015

and claims benefit of 62/205,717 08/15/2015

and claims benefit of 62/009,311 06/08/2014

and claims benefit of 62/213,556 09/02/2015

and claims benefit of 62/232,716 09/25/2015

This application 15/797,821

is a CIP of PCT/US2016/067977 12/21/2016

which claims benefit of 62/415,339 10/31/2016

and claims benefit of 62/270,577 12/21/2015

This application 15/797,821

is a CIP of 14/947,718 11/20/2015
which is a CON of PCT/US2014/039208 05/22/2014
which claims benefit of 61/826,446 05/22/2013
and claims benefit of 61/834,873 06/13/2013
and claims benefit of 61/843,021 07/04/2013
and claims benefit of 61/905,109 11/15/2013

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: 11/27/2017

The country code and number of your priority application, to be used for filing abroad under the Paris Convention, is **US 15/797,821**

Projected Publication Date: 04/12/2018

Non-Publication Request: No

Early Publication Request: No

**** SMALL ENTITY ****

Title

MICROSTRUCTURE ENHANCED ABSORPTION PHOTOSENSITIVE DEVICES

Preliminary Class

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

PROTECTING YOUR INVENTION OUTSIDE THE UNITED STATES

Since the rights granted by a U.S. patent extend only throughout the territory of the United States and have no effect in a foreign country, an inventor who wishes patent protection in another country must apply for a patent in a specific country or in regional patent offices. Applicants may wish to consider the filing of an international application under the Patent Cooperation Treaty (PCT). An international (PCT) application generally has the same effect as a regular national patent application in each PCT-member country. The PCT process **simplifies** the filing of patent applications on the same invention in member countries, but **does not result** in a grant of "an international patent" and does not eliminate the need of applicants to file additional documents and fees in countries where patent protection is desired.

Almost every country has its own patent law, and a person desiring a patent in a particular country must make an application for patent in that country in accordance with its particular laws. Since the laws of many countries differ in various respects from the patent law of the United States, applicants are advised to seek guidance from specific foreign countries to ensure that patent rights are not lost prematurely.

Applicants also are advised that in the case of inventions made in the United States, the Director of the USPTO must issue a license before applicants can apply for a patent in a foreign country. The filing of a U.S. patent application serves as a request for a foreign filing license. The application's filing receipt contains further information and guidance as to the status of applicant's license for foreign filing.

Applicants may wish to consult the USPTO booklet, "General Information Concerning Patents" (specifically, the section entitled "Treaties and Foreign Patents") for more information on timeframes and deadlines for filing foreign patent applications. The guide is available either by contacting the USPTO Contact Center at 800-786-9199, or it can be viewed on the USPTO website at <http://www.uspto.gov/web/offices/pac/doc/general/index.html>.

For information on preventing theft of your intellectual property (patents, trademarks and copyrights), you may wish to consult the U.S. Government website, <http://www.stopfakes.gov>. Part of a Department of Commerce initiative, this website includes self-help "toolkits" giving innovators guidance on how to protect intellectual property in specific countries such as China, Korea and Mexico. For questions regarding patent enforcement issues, applicants may call the U.S. Government hotline at 1-866-999-HALT (1-866-999-4258).

LICENSE FOR FOREIGN FILING UNDER

Title 35, United States Code, Section 184

Title 37, Code of Federal Regulations, 5.11 & 5.15

GRANTED

The applicant has been granted a license under 35 U.S.C. 184, if the phrase "IF REQUIRED, FOREIGN FILING LICENSE GRANTED" followed by a date appears on this form. Such licenses are issued in all applications where the conditions for issuance of a license have been met, regardless of whether or not a license may be required as set forth in 37 CFR 5.15. The scope and limitations of this license are set forth in 37 CFR 5.15(a) unless an earlier license has been issued under 37 CFR 5.15(b). The license is subject to revocation upon written notification. The date indicated is the effective date of the license, unless an earlier license of similar scope has been granted under 37 CFR 5.13 or 5.14.

This license is to be retained by the licensee and may be used at any time on or after the effective date thereof unless it is revoked. This license is automatically transferred to any related applications(s) filed under 37 CFR 1.53(d). This license is not retroactive.

The grant of a license does not in any way lessen the responsibility of a licensee for the security of the subject matter as imposed by any Government contract or the provisions of existing laws relating to espionage and the national security or the export of technical data. Licensees should apprise themselves of current regulations especially with respect to certain countries, of other agencies, particularly the Office of Defense Trade Controls, Department of State (with respect to Arms, Munitions and Implements of War (22 CFR 121-128)); the Bureau of Industry and Security, Department of Commerce (15 CFR parts 730-774); the Office of Foreign Assets Control, Department of Treasury (31 CFR Parts 500+) and the Department of Energy.

NOT GRANTED

No license under 35 U.S.C. 184 has been granted at this time, if the phrase "IF REQUIRED, FOREIGN FILING LICENSE GRANTED" DOES NOT appear on this form. Applicant may still petition for a license under 37 CFR 5.12, if a license is desired before the expiration of 6 months from the filing date of the application. If 6 months has lapsed

from the filing date of this application and the licensee has not received any indication of a secrecy order under 35 U.S.C. 181, the licensee may foreign file the application pursuant to 37 CFR 5.15(b).

SelectUSA

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 U.S. offers tremendous resources and advantages for those who invest and manufacture goods here. Through SelectUSA, our nation works to promote and facilitate business investment. SelectUSA provides information assistance to the international investor community; serves as an ombudsman for existing and potential investors; advocates on behalf of U.S. cities, states, and regions competing for global investment; and counsels U.S. economic development organizations on investment attraction best practices. To learn more about why the United States is the best country in the world to develop technology, manufacture products, deliver services, and grow your business, visit <http://www.SelectUSA.gov> or call +1-202-482-6800.

EXHIBIT C

to

**RESPONSE TO JUNE 20, 2019 NOTICE TO FILE CORRECTED APPLICATION
PAPERS – NOTICE OF ALLOWANCE MAILED, AND
REQUEST FOR CORRECTED FILING RECEIPT**

Application No.: 15/797,821

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

Application Data Sheet 37 CFR 1.76		Attorney Docket Number	5176/88184-CIP
		Application Number	15/797821
Title of Invention	MICROSTRUCTURE ENHANCED ABSORPTION PHOTSENSITIVE DEVICES		
<p>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.</p> <p>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.</p>			

Secrecy Order 37 CFR 5.2:

☐	Portions or all of the application associated with this Application Data Sheet may fall under a Secrecy Order pursuant to 37 CFR 5.2 (Paper filers only. Applications that fall under Secrecy Order may not be filed electronically.)
--------------------------	---

Inventor Information:

Inventor 1 Remove					
Legal Name					
Prefix	Given Name	Middle Name	Family Name	Suffix	
	Shih-Yuan		WANG		
Residence Information (Select One) ☒ US Residency ☐ Non US Residency ☐ Active US Military Service					
City	Palo Alto	State/Province	CA	Country of Residence	US
Mailing Address of Inventor:					
Address 1		766 Encina Grande Dr.			
Address 2					
City	Palo Alto	State/Province			
Postal Code	94306	Country	US		
Inventor 2 Remove					
Legal Name					
Prefix	Given Name	Middle Name	Family Name	Suffix	
	Shih-Ping		WANG		
Residence Information (Select One) ☒ US Residency ☐ Non US Residency ☐ Active US Military Service					
City	Los Altos	State/Province	CA	Country of Residence	US
Mailing Address of Inventor:					
Address 1		38 3rd Street, Suite #307			
Address 2					
City	Los Altos	State/Province			
Postal Code	94022	Country	US		
Inventor 3 Remove					
Legal Name					
Prefix	Given Name	Middle Name	Family Name	Suffix	
	M. Saif		ISLAM		
Residence Information (Select One) ☒ US Residency ☐ Non US Residency ☐ Active US Military Service					

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

Application Data Sheet 37 CFR 1.76		Attorney Docket Number	5176/88184-CIP		
		Application Number	15/797821		
Title of Invention	MICROSTRUCTURE ENHANCED ABSORPTION PHOTOSENSITIVE DEVICES				
City	Davis	State/Province	CA	Country of Residence	US
Mailing Address of Inventor:					
Address 1	3038 Mallorca Ln.				
Address 2					
City	Davis	State/Province	CA		
Postal Code	95618	Country	US		
All Inventors Must Be Listed - Additional Inventor Information blocks may be generated within this form by selecting the Add button.					

Correspondence Information:

Enter either Customer Number or complete the Correspondence Information section below. For further information see 37 CFR 1.33(a).	
☐ An Address is being provided for the correspondence Information of this application.	
Customer Number	23432
Email Address	pdocketing@cooperdunham.com Add Email Remove Email

Application Information:

Title of the Invention	MICROSTRUCTURE ENHANCED ABSORPTION PHOTOSENSITIVE DEVICES		
Attorney Docket Number	5176/88184-CIP	Small Entity Status Claimed	☒
Application Type	Nonprovisional		
Subject Matter	Utility		
Total Number of Drawing Sheets (if any)	131	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.

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

Application Data Sheet 37 CFR 1.76		Attorney Docket Number	5176/88184-CIP
		Application Number	15/797821
Title of Invention	MICROSTRUCTURE ENHANCED ABSORPTION PHOTOSENSITIVE DEVICES		

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	23432		

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	Pending	Remove	
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
15797821	Continuation in part of	15309922	2016-11-09
Prior Application Status	Pending	Remove	
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
15309922	a 371 of international	PCT/US2015/061120	2015-11-17
Prior Application Status	Expired	Remove	
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
PCT/US2015/061120	Claims benefit of provisional	62081538	2014-11-18
Prior Application Status	Expired	Remove	
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
PCT/US2015/061120	Claims benefit of provisional	62090879	2014-12-11
Prior Application Status	Expired	Remove	
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
PCT/US2015/061120	Claims benefit of provisional	62100025	2015-01-05

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

Application Data Sheet 37 CFR 1.76		Attorney Docket Number	5176/88184-CIP
		Application Number	15/797821
Title of Invention	MICROSTRUCTURE ENHANCED ABSORPTION PHOTOSENSITIVE DEVICES		

Prior Application Status	Expired	Remove	
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
PCT/US2015/061120	Claims benefit of provisional	62111582	2015-02-03
Prior Application Status	Expired	Remove	
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
PCT/US2015/061120	Claims benefit of provisional	62139511	2015-03-27
Prior Application Status	Expired	Remove	
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
PCT/US2015/061120	Claims benefit of provisional	62153443	2015-04-27
Prior Application Status	Expired	Remove	
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
PCT/US2015/061120	Claims benefit of provisional	62154675	2015-04-29
Prior Application Status	Expired	Remove	
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
PCT/US2015/061120	Claims benefit of provisional	62157876	2015-05-06
Prior Application Status	Expired	Remove	
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
PCT/US2015/061120	Claims benefit of provisional	62171915	2015-06-05
Prior Application Status	Expired	Remove	
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
PCT/US2015/061120	Claims benefit of provisional	62174498	2015-06-11
Prior Application Status	Expired	Remove	
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
PCT/US2015/061120	Claims benefit of provisional	62175855	2015-06-15
Prior Application Status	Expired	Remove	
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
PCT/US2015/061120	Claims benefit of provisional	62182602	2015-06-21

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

Application Data Sheet 37 CFR 1.76		Attorney Docket Number	5176/88184-CIP
		Application Number	15/797821
Title of Invention	MICROSTRUCTURE ENHANCED ABSORPTION PHOTOSENSITIVE DEVICES		

Prior Application Status	Expired	Remove			
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)		
PCT/US2015/061120	Claims benefit of provisional	62188876	2015-06-21 2015-07-06		
Prior Application Status	Expired	Remove			
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)		
PCT/US2015/061120	Claims benefit of provisional	62197120	2015-07-27		
Prior Application Status	Expired	Remove			
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)		
PCT/US2015/061120	Claims benefit of provisional	62199607	2015-07-31		
Prior Application Status	Expired	Remove			
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)		
PCT/US2015/061120	Claims benefit of provisional	62205717	2015-08-15		
Prior Application Status	Expired	Remove			
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)		
PCT/US2015/061120	Claims benefit of provisional	62209311	2015-08-24		
Prior Application Status	Expired	Remove			
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)		
PCT/US2015/061120	Claims benefit of provisional	62213556	2015-09-02		
Prior Application Status	Expired	Remove			
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)		
PCT/US2015/061120	Claims benefit of provisional	62232716	2015-09-25		
Prior Application Status	Patented	Remove			
Application Number	Continuity Type	Prior Application Number	Filing Date (YYYY-MM-DD)	Patent Number	Issue Date (YYYY-MM-DD)
15309922	Continuation of	14943898	2015-11-17	9530905	2016-12-27
Prior Application Status	Expired	Remove			
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)		
14943898	Claims benefit of provisional	620181538 62081538	2014-11-18		

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

Application Data Sheet 37 CFR 1.76		Attorney Docket Number	5176/88184-CIP
		Application Number	15/797821
Title of Invention	MICROSTRUCTURE ENHANCED ABSORPTION PHOTSENSITIVE DEVICES		

Prior Application Status	Expired	Remove	
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
14943898	Claims benefit of provisional	62090879	2014-12-11
Prior Application Status	Expired	Remove	
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
14943898	Claims benefit of provisional	62100025	2015-01-05
Prior Application Status	Expired	Remove	
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
14943898	Claims benefit of provisional	62111582	2015-02-03
Prior Application Status	Expired	Remove	
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
14943898	Claims benefit of provisional	62139511	2015-03-27
Prior Application Status	Expired	Remove	
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
14943898	Claims benefit of provisional	62153443	2015-04-27
Prior Application Status	Expired	Remove	
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
14943898	Claims benefit of provisional	62154675	2015-04-29
Prior Application Status	Expired	Remove	
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
14943898	Claims benefit of provisional	62157876	2015-05-06
Prior Application Status	Expired	Remove	
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
14943898	Claims benefit of provisional	62171915	2015-06-05
Prior Application Status	Expired	Remove	
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
14943898	Claims benefit of provisional	62174498	2015-06-11

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

Application Data Sheet 37 CFR 1.76		Attorney Docket Number	5176/88184-CIP
		Application Number	15/797821
Title of Invention	MICROSTRUCTURE ENHANCED ABSORPTION PHOTOSENSITIVE DEVICES		

Prior Application Status	Expired	Remove	
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
14943898	Claims benefit of provisional	62175855	2015-06-15
Prior Application Status	Expired	Remove	
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
14943898	Claims benefit of provisional	62182602	2015-06-21
Prior Application Status	Expired	Remove	
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
14943898	Claims benefit of provisional	62188876	2015-07-06
Prior Application Status	Expired	Remove	
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
14943898	Claims benefit of provisional	62197120	2015-07-27
Prior Application Status	Expired	Remove	
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
14943898	Claims benefit of provisional	62199607	2015-07-31
Prior Application Status	Expired	Remove	
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
14943898	Claims benefit of provisional	62205717	2015-08-15
Prior Application Status	Expired	Remove	
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
14943898	Claims benefit of provisional	62209311	2015-08-24
Prior Application Status	Expired	Remove	
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
14943898	Claims benefit of provisional	62213556	2015-09-02
Prior Application Status	Expired	Remove	
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
14943898	Claims benefit of provisional	62232716	2015-09-25

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

Application Data Sheet 37 CFR 1.76		Attorney Docket Number	5176/88184-CIP
		Application Number	15/797821
Title of Invention	MICROSTRUCTURE ENHANCED ABSORPTION PHOTOSENSITIVE DEVICES		

Prior Application Status	Patented	Remove	
Application Number	Continuity Type	Prior Application Number	Filing Date (YYYY-MM-DD)
15309922	Continuation of	14945003	2015-11-17 2015-11-18
Prior Application Status	Expired	Remove	
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
14945003	Claims benefit of provisional	62081538	2014-11-18
Prior Application Status	Expired	Remove	
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
14945003	Claims benefit of provisional	62090879	2014-12-11
Prior Application Status	Expired	Remove	
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
14945003	Claims benefit of provisional	62100025	2015-01-05
Prior Application Status	Expired	Remove	
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
14945003	Claims benefit of provisional	62111582	2015-02-03
Prior Application Status	Expired	Remove	
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
14945003	Claims benefit of provisional	62139511	2015-03-27
Prior Application Status	Expired	Remove	
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
14945003	Claims benefit of provisional	62153443	2015-04-27
Prior Application Status	Expired	Remove	
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
14945003	Claims benefit of provisional	62157876	2015-05-06
Prior Application Status	Expired	Remove	
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
14945003	Claims benefit of provisional	62154675	2015-04-29

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

Application Data Sheet 37 CFR 1.76		Attorney Docket Number	5176/88184-CIP
		Application Number	15/797821
Title of Invention	MICROSTRUCTURE ENHANCED ABSORPTION PHOTOSENSITIVE DEVICES		

Prior Application Status	Expired	Remove	
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
14945003	Claims benefit of provisional	62157876	2015-05-06
Prior Application Status	Expired	Remove	
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
14945003	Claims benefit of provisional	62171915	2015-06-05
Prior Application Status	Expired	Remove	
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
14945003	Claims benefit of provisional	62174498	2015-06-11
Prior Application Status	Expired	Remove	
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
14945003	Claims benefit of provisional	62175855	2015-06-15
Prior Application Status	Expired	Remove	
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
14945003	Claims benefit of provisional	62182602	2015-06-21
Prior Application Status	Expired	Remove	
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
14945003	Claims benefit of provisional	62188876	2015-07-06
Prior Application Status	Expired	Remove	
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
14945003	Claims benefit of provisional	62197120	2015-07-27
Prior Application Status	Expired	Remove	
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
14945003	Claims benefit of provisional	62199607	2015-07-31
Prior Application Status	Expired	Remove	
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
14945003	Claims benefit of provisional	62205717	2015-08-15

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

Application Data Sheet 37 CFR 1.76		Attorney Docket Number	5176/88184-CIP
		Application Number	15/797821
Title of Invention	MICROSTRUCTURE ENHANCED ABSORPTION PHOTOSENSITIVE DEVICES		

Prior Application Status	Expired	Remove	
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
14945003	Claims benefit of provisional	62209311	2015-08-24
Prior Application Status	Expired	Remove	
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
14945003	Claims benefit of provisional	62213556	2015-09-02
Prior Application Status	Expired	Remove	
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
14945003	Claims benefit of provisional	62232716	2015-09-25
Prior Application Status	Pending	Remove	
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
15797821	Continuation in part of	PCT/US2016/67977	2016-12-21
Prior Application Status	Pending	Remove	
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
PCT/US2016/67977	Claims benefit of provisional	62415339	2016-10-31
Prior Application Status	Pending Expired	Remove	
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
PCT/US2016/67977	Claims benefit of provisional	62270577	2016-12-21 2015-12-21
Prior Application Status	Pending	Remove	
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
15797821	Continuation in part of	14947718	2015-11-20
Prior Application Status	Expired	Remove	
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
14947718	Continuation of	PCT/US2014/039208	2014-05-22
Prior Application Status	Expired	Remove	
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
PCT/US2014/039208	Claims benefit of provisional	61826446	2013-05-05 2013-05-22

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

Application Data Sheet 37 CFR 1.76		Attorney Docket Number	5176/88184-CIP
		Application Number	15/797821
Title of Invention	MICROSTRUCTURE ENHANCED ABSORPTION PHOTSENSITIVE DEVICES		

Prior Application Status	Expired	Remove	
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
PCT/US2014/039208	Claims benefit of provisional	61834873	2013-06-13
Prior Application Status	Expired	Remove	
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
PCT/US2014/039208	Claims benefit of provisional	61843021	2013-07-04
Prior Application Status	Expired	Remove	
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
PCT/US2014/039208	Claims benefit of provisional	61905109	2013-11-15
Prior Application Status	<u>Expired</u>	Remove	
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
<u>PCT/US16/67977</u>	<u>Claims benefit of provisional</u>	<u>62290391</u>	<u>2016-02-02</u>
Prior Application Status	<u>Expired</u>	Remove	
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
<u>PCT/US16/67977</u>	<u>Claims benefit of provisional</u>	<u>62304907</u>	<u>2016-03-07</u>
Prior Application Status	<u>Expired</u>	Remove	
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
<u>PCT/US16/67977</u>	<u>Claims benefit of provisional</u>	<u>62334934</u>	<u>2016-05-11</u>
Prior Application Status	<u>Expired</u>	Remove	
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
<u>PCT/US16/67977</u>	<u>Claims benefit of provisional</u>	<u>62338263</u>	<u>2016-05-18</u>
Prior Application Status	<u>Expired</u>	Remove	
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
<u>PCT/US16/67977</u>	<u>Claims benefit of provisional</u>	<u>62346850</u>	<u>2016-06-07</u>
Prior Application Status	<u>Expired</u>	Remove	
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
<u>PCT/US16/67977</u>	<u>Claims benefit of provisional</u>	<u>62359349</u>	<u>2016-07-07</u>

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

Application Data Sheet 37 CFR 1.76		Attorney Docket Number	5176/88184-CIP
		Application Number	15/797821
Title of Invention	MICROSTRUCTURE ENHANCED ABSORPTION PHOTOSENSITIVE DEVICES		

Prior Application Status	<u>Expired</u>	Remove	
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
<u>PCT/US16/67977</u>	<u>Claims benefit of provisional</u>	<u>62366188</u>	<u>2016-07-25</u>
Prior Application Status	<u>Expired</u>	Remove	
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
<u>PCT/US16/67977</u>	<u>Claims benefit of provisional</u>	<u>62368109</u>	<u>2016-07-28</u>
Prior Application Status	<u>Expired</u>	Remove	
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
<u>PCT/US16/67977</u>	<u>Claims benefit of provisional</u>	<u>62374828</u>	<u>2016-08-13</u>
Prior Application Status	<u>Expired</u>	Remove	
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
<u>PCT/US16/67977</u>	<u>Claims benefit of provisional</u>	<u>62376869</u>	<u>2016-08-18</u>
Prior Application Status	<u>Expired</u>	Remove	
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
<u>PCT/US16/67977</u>	<u>Claims benefit of provisional</u>	<u>62380364</u>	<u>2016-08-27</u>
Prior Application Status	<u>Expired</u>	Remove	
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
<u>PCT/US16/67977</u>	<u>Claims benefit of provisional</u>	<u>62383391</u>	<u>2016-09-03</u>
Prior Application Status	<u>Expired</u>	Remove	
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
<u>PCT/US16/67977</u>	<u>Claims benefit of provisional</u>	<u>62383479</u>	<u>2016-09-04</u>
Prior Application Status	<u>Expired</u>	Remove	
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
<u>PCT/US16/67977</u>	<u>Claims benefit of provisional</u>	<u>62394222</u>	<u>2016-09-14</u>
Prior Application Status	<u>Expired</u>	Remove	
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
<u>PCT/US16/67977</u>	<u>Claims benefit of provisional</u>	<u>62398607</u>	<u>2016-09-23</u>

Application Data Sheet 37 CFR 1.76		Attorney Docket Number	5176/88184-CIP
		Application Number	15/797821
Title of Invention	MICROSTRUCTURE ENHANCED ABSORPTION PHOTOSENSITIVE DEVICES		

Prior Application Status	<u>Expired</u>	Remove	
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
<u>PCT/US16/67977</u>	<u>Claims benefit of provisional</u>	<u>62401126</u>	<u>2016-09-28</u>
Prior Application Status	<u>Expired</u>	Remove	
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
<u>PCT/US16/67977</u>	<u>Claims benefit of provisional</u>	<u>62406999</u>	<u>2016-10-12</u>
Prior Application Status	<u>Expired</u>	Remove	
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
<u>PCT/US16/67977</u>	<u>Claims benefit of provisional</u>	<u>62414671</u>	<u>2016-10-29</u>
Prior Application Status	<u>Pending</u>	Remove	
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
<u>15797821</u>	<u>Claims benefit of provisional</u>	<u>62465734</u>	<u>2017-03-01</u>
Prior Application Status	<u>Pending</u>	Remove	
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
<u>15797821</u>	<u>Claims benefit of provisional</u>	<u>62474179</u>	<u>2017-03-21</u>
Prior Application Status	<u>Pending</u>	Remove	
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
<u>15797821</u>	<u>Claims benefit of provisional</u>	<u>62484474</u>	<u>2017-04-12</u>
Prior Application Status	<u>Pending</u>	Remove	
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
<u>15797821</u>	<u>Claims benefit of provisional</u>	<u>62487606</u>	<u>2017-04-20</u>
Prior Application Status	<u>Pending</u>	Remove	
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
<u>15797821</u>	<u>Claims benefit of provisional</u>	<u>62488998</u>	<u>2017-04-24</u>
Prior Application Status	<u>Pending</u>	Remove	
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
<u>15797821</u>	<u>Claims benefit of provisional</u>	<u>62500581</u>	<u>2017-05-03</u>

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

Application Data Sheet 37 CFR 1.76		Attorney Docket Number	5176/88184-CIP
		Application Number	15/797821
Title of Invention	MICROSTRUCTURE ENHANCED ABSORPTION PHOTSENSITIVE DEVICES		

Prior Application Status	<u>Pending</u>	Remove	
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
<u>15797821</u>	<u>Claims benefit of provisional</u>	<u>62505974</u>	<u>2017-05-14</u>
Prior Application Status	<u>Pending</u>	Remove	
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
<u>15797821</u>	<u>Claims benefit of provisional</u>	<u>62509093</u>	<u>2017-05-20</u>
Prior Application Status	<u>Pending</u>	Remove	
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
<u>15797821</u>	<u>Claims benefit of provisional</u>	<u>62510249</u>	<u>2017-05-23</u>
Prior Application Status	<u>Pending</u>	Remove	
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
<u>15797821</u>	<u>Claims benefit of provisional</u>	<u>62514889</u>	<u>2017-06-04</u>
Prior Application Status	<u>Pending</u>	Remove	
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
<u>15797821</u>	<u>Claims benefit of provisional</u>	<u>62521504</u>	<u>2017-06-18</u>
Prior Application Status	<u>Pending</u>	Remove	
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
<u>15797821</u>	<u>Claims benefit of provisional</u>	<u>62522169</u>	<u>2017-06-20</u>
Prior Application Status	<u>Pending</u>	Remove	
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
<u>15797821</u>	<u>Claims benefit of provisional</u>	<u>62527962</u>	<u>2017-06-30</u>
Prior Application Status	<u>Pending</u>	Remove	
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
<u>15797821</u>	<u>Claims benefit of provisional</u>	<u>62530281</u>	<u>2017-07-09</u>
Prior Application Status	<u>Pending</u>	Remove	
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
<u>15797821</u>	<u>Claims benefit of provisional</u>	<u>62533078</u>	<u>2017-07-16</u>

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

Application Data Sheet 37 CFR 1.76		Attorney Docket Number	5176/88184-CIP
		Application Number	15/797821
Title of Invention	MICROSTRUCTURE ENHANCED ABSORPTION PHOTOSENSITIVE DEVICES		

Prior Application Status	<u>Pending</u>	Remove	
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
<u>15797821</u>	<u>Claims benefit of provisional</u>	<u>62533603</u>	<u>2017-07-17</u>
Prior Application Status	<u>Pending</u>	Remove	
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
<u>15797821</u>	<u>Claims benefit of provisional</u>	<u>62535801</u>	<u>2017-07-21</u>
Prior Application Status	<u>Pending</u>	Remove	
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
<u>15797821</u>	<u>Claims benefit of provisional</u>	<u>62540524</u>	<u>2017-08-02</u>
Prior Application Status	<u>Pending</u>	Remove	
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
<u>15797821</u>	<u>Claims benefit of provisional</u>	<u>62542243</u>	<u>2017-08-07</u>
Prior Application Status	<u>Pending</u>	Remove	
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
<u>15797821</u>	<u>Claims benefit of provisional</u>	<u>62547728</u>	<u>2017-08-18</u>
Prior Application Status	<u>Pending</u>	Remove	
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
<u>15797821</u>	<u>Claims benefit of provisional</u>	<u>62553844</u>	<u>2017-09-02</u>
Prior Application Status	<u>Pending</u>	Remove	
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
<u>15797821</u>	<u>Claims benefit of provisional</u>	<u>62556426</u>	<u>2017-09-10</u>
Prior Application Status	<u>Pending</u>	Remove	
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
<u>15797821</u>	<u>Claims benefit of provisional</u>	<u>62561869</u>	<u>2017-09-22</u>
Additional Domestic Benefit/National Stage Data may be generated within this form by selecting the Add button.			

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

Application Data Sheet 37 CFR 1.76		Attorney Docket Number	5176/88184-CIP
		Application Number	15/797821
Title of Invention	MICROSTRUCTURE ENHANCED ABSORPTION PHOTSENSITIVE DEVICES		

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)¹ 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)	Access Code ^j (if applicable)

Additional Foreign Priority Data may be generated within this form by selecting the **Add** button.

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

<p>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.</p> <p>☐ 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.</p>
--

Application Data Sheet 37 CFR 1.76		Attorney Docket Number	5176/88184-CIP
		Application Number	15/797821
Title of Invention	MICROSTRUCTURE ENHANCED ABSORPTION PHOTSENSITIVE DEVICES		

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.

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

Application Data Sheet 37 CFR 1.76		Attorney Docket Number	5176/88184-CIP
		Application Number	15/797821
Title of Invention	MICROSTRUCTURE ENHANCED ABSORPTION PHOTOSENSITIVE DEVICES		

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			
<p>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.</p>			
<input type="button" value="Clear"/>			
☒ Assignee		☐ Legal Representative under 35 U.S.C. 117	
☐ 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: <input type="text"/>			
If the Applicant is an Organization check here. ☒			
Organization Name	W&WSens, Devices Inc.		
Mailing Address Information For Applicant:			
Address 1	W&WSens, Devices Inc.		
Address 2	4546 El Camino Real, Suite 215		
City	Los Altos	State/Province	CA
Country	US	Postal Code	94022
Phone Number		Fax Number	
Email Address			
Additional Applicant Data may be generated within this form by selecting the Add button.			

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.

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

Application Data Sheet 37 CFR 1.76		Attorney Docket Number	5176/88184-CIP
		Application Number	15/797821
Title of Invention	MICROSTRUCTURE ENHANCED ABSORPTION PHOTOSENSITIVE DEVICES		

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.

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.

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	/Ivan S. Kavrukov/		Date (YYYY-MM-DD)	2019-03-14
First Name	Ivan	Last Name	Kavrukov	Registration Number
25,161				

Additional Signature may be generated within this form by selecting the Add button.

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

Application Data Sheet 37 CFR 1.76		Attorney Docket Number	5176/88184-CIP
		Application Number	15/797821
Title of Invention	MICROSTRUCTURE ENHANCED ABSORPTION PHOTOSENSITIVE DEVICES		

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.**

Electronic Acknowledgement Receipt

EFS ID:	36481484
Application Number:	15797821
International Application Number:	
Confirmation Number:	1009
Title of Invention:	MICROSTRUCTURE ENHANCED ABSORPTION PHOTSENSITIVE DEVICES
First Named Inventor/Applicant Name:	Shih-Yuan WANG
Customer Number:	23432
Filer:	Ivan Kavrukov/Thomas Trainor
Filer Authorized By:	Ivan Kavrukov
Attorney Docket Number:	5176/88184-CIP
Receipt Date:	02-JUL-2019
Filing Date:	30-OCT-2017
Time Stamp:	16:01:35
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	no
------------------------	----

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Amendment after Notice of Allowance (Rule 312)	88184-CIP-- ResponseTo2019June20Notice. pdf	2929811 d2e274f6e06dc5b98d5bd8501113ed1e8b58aa40	no	33

Warnings:

Information:	
Total Files Size (in bytes):	2929811
<p>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.</p> <p><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.</p> <p><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.</p> <p><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.</p>	



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.
15/797,821	10/30/2017	Shih-Yuan WANG	5176/88184-CIP	1009
23432 7590 06/20/2019 COOPER & DUNHAM, LLP 30 Rockefeller Plaza 20th Floor NEW YORK, NY 10112			EXAMINER RODELA, EDUARDO A	
			ART UNIT 2893	PAPER NUMBER
			MAIL DATE 06/20/2019	DELIVERY MODE PAPER

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.



UNITED STATES PATENT AND TRADEMARK OFFICE

Commissioner for Patents
United States Patent and Trademark Office
P.O. Box 1450
Alexandria, VA 22313-1450
www.uspto.gov

Application No. : 15797821
Applicant : Wang
Filing Date : 10/30/2017
Date Mailed : 06/20/2019

NOTICE TO FILE CORRECTED APPLICATION PAPERS

Notice of Allowance Mailed

This application has been accorded an Allowance Date and is being prepared for issuance. The application, however, is incomplete for the reasons below.

Applicant is given two (2) months from the mail date of this Notice within which to respond. This time period for reply is extendable under 37 CFR 1.136(a) for only TWO additional MONTHS.

The application is not in compliance with 37 CFR 1.78, as indicated in the attachment. The consequences of failure to respond within the above-identified time period are set forth in the attachment.

Even if the Office has recognized a benefit claim and has entered it into the Office's database and included it on applicant's filing receipt, the benefit claim is not a proper benefit claim unless the reference in compliance with 37 CFR 1.78 is included, depending upon the application's filing date and as indicated in the attachment, in an application data sheet or in the first sentence(s) of the specification and all other requirements are met.

See attachment.

*A copy of this notice **MUST** be returned with the reply. Please address response to
"Mail Stop Issue Fee, Commissioner for Patents,
P.O. Box 1450, Alexandria, VA 22313-1450".*

/Chris Harmon/
Publication Branch
Office of Data Management
(571) 272-4200

**APPLICATION FILED ON OR AFTER SEPTEMBER 16, 2012,
NOT IN COMPLIANCE WITH 37 CFR 1.78**

- ☐ The 37 CFR 1.78(d)(2) reference on the application data sheet does not indicate the relationship (continuation, division, continuation-in-part) to the prior U.S. nonprovisional application or international application designating the U.S. See document coded dated , listing application number(s) .
- ☐ The 37 CFR 1.78(d)(2) reference on the application data sheet does not indicate the relationship (continuation, division, continuation-in-part) to the prior international application designating the U.S. but instead indicates that an application is the national stage of the prior international application. However, the application was filed as a 35 U.S.C. 111 application and was not processed as a 35 U.S.C. 371 application, thus removing the validating link under 35 U.S.C. 119(a)-(d) to a prior foreign application or under 35 U.S.C. 119(e) to a prior U.S. provisional application. See document coded dated , listing application number(s) .
- ☐ The 37 CFR 1.78(d)(2) reference on the application data sheet does not provide the U.S. nonprovisional application number (series code and serial number) or, with respect to an international PCT application designating the U.S., it provides the international application number or international filing date but not both. See document coded dated , in which the following is missing: .
- ☐ The 37 CFR 1.78(d)(2) reference on the application data sheet shows an incorrect, incomplete, or illegible U.S. nonprovisional application number, international PCT application number, or international PCT filing date. See document coded dated , in which the following error was made: .
- ☐ The 37 CFR 1.78(d)(2) reference to the prior U.S. nonprovisional application or international application designating the U.S. is not present on an application data sheet, thus removing the validating link under 35 U.S.C. 119(a)-(d) to a prior foreign application or under 35 U.S.C. 119(e) to a prior U.S. provisional application. See document coded dated , in which the following is missing: .
- ☐ The 37 CFR 1.78(d)(2) reference to the prior U.S. nonprovisional application or international application designating the U.S. is not present on an application data sheet.
- ☐ The 37 CFR 1.78(a)(3) reference to the prior U.S. provisional application is not present on an application data sheet.
- ☒ The 37 CFR 1.78(a)(3) reference to the prior U.S. provisional application on an application data sheet does not provide the provisional application number (series code and serial number). See document coded ADS dated 03/14/2019, in which the following is missing: 62009311.
- ☐ The 37 CFR 1.78(a)(3) reference to the prior U.S. provisional application on an application data sheet shows an incorrect, incomplete, or illegible U.S. provisional application number. See document coded dated , in which the following error was made: .
- ☐ Other: .

HOW TO RESPOND

A proper response to this notice would include any one of: (1) a corrected Application Data Sheet (ADS) pursuant to 37 CFR 1.76(c) which provides benefit information that complies with 37 CFR 1.78(d)(2) or 37 CFR 1.78(a)(3) or (2) a petition filed pursuant to the provisions of 37 CFR 1.78(e) or 37 CFR 1.78(c) if the benefit information from the document identified above by code and date does not accurately reflect the benefits under 35 U.S.C. 119(e), 120, 121, 365(c) or 386(c) as claimed by applicant (a grantable petition would include a corrected ADS pursuant to 37 CFR 1.76(c)). In general, a petition would be required unless the proper benefit claim information was included on a properly signed ADS submitted with the application on filing, or a properly signed corrected ADS in compliance with 37 CFR 1.76(c) (e.g., with underlining to show insertions) that was filed within the time period in 37 CFR 1.78 for making the benefit claim(s), or the Office recognized the benefit claim(s) on the initial filing receipt. Such response may be filed after payment of the issue fee if limited to informalities noted herein. See Waiver of 37 CFR 1.312 for Document Required by Office of Patent Publication, 1280 Off. Gaz. Patent Office 918 (March 23, 2004).

WARNING: If Applicant fails to timely submit a proper response, the benefit information will be deleted and the patent will be printed without the benefit information present.



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
15/797,821	10/30/2017	Shih-Yuan WANG	5176/88184-CIP

CONFIRMATION NO. 1009

IMPROPER CFR REQUEST



23432
COOPER & DUNHAM, LLP
30 Rockefeller Plaza
20th Floor
NEW YORK, NY 10112

Date Mailed: 05/14/2019

RESPONSE TO REQUEST FOR CORRECTED FILING RECEIPT

Continuity, Priority Claims, Petitions, and Non-Publication Requests

In response to your request for a corrected Filing Receipt, the Office is unable to comply with your request because:

- The priority or continuity claim has not been entered because it was not filed during the required time period. Applicant may wish to consider filing a petition to accept an unintentionally delayed claim for priority. See 37 CFR 1.55 or 1.78.

Questions about the contents of this notice and the requirements it sets forth should be directed to the Office of Data Management, Application Assistance Unit, at (571) 272-4000 or (571) 272-4200 or 1-888-786-0101.

/sstephanos/

<i>Notice of References Cited</i>	Application/Control No. 15/797,821		Applicant(s)/Patent Under Reexamination WANG et al.	
	Examiner Eduardo A Rodela		Art Unit 2893	Page 1 of 1

U.S. PATENT DOCUMENTS						
*		Document Number Code-Number-Kind Code	Country	Date MM-YYYY	Name	CPC Classification
*	A	US-20100308428-A1		12-2010	Okamoto; Daisuke	H01L31/03529
	B					
	C					
	D					
	E					
	F					
	G					
	H					
	I					
	J					
	K					
	L					
	M					

FOREIGN PATENT DOCUMENTS						
*		Document Number Code-Number-Kind Code	Country	Date MM-YYYY	Country	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.



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

NOTICE OF ALLOWANCE AND FEE(S) DUE

23432 7590 05/07/2019
COOPER & DUNHAM, LLP
30 Rockefeller Plaza
20th Floor
NEW YORK, NY 10112

EXAMINER	
RODELA, EDUARDO A	
ART UNIT	PAPER NUMBER

2893

DATE MAILED: 05/07/2019

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
15/797,821	10/30/2017	Shih-Yuan WANG	5176/88184-CIP	1009

TITLE OF INVENTION: MICROSTRUCTURE ENHANCED ABSORPTION PHOTSENSITIVE DEVICES

APPLN. TYPE	ENTITY STATUS	ISSUE FEE DUE	PUBLICATION FEE DUE	PREV. PAID ISSUE FEE	TOTAL FEE(S) DUE	DATE DUE
nonprovisional	SMALL	\$500	\$0.00	\$500.00	\$0	08/07/2019

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), by mail or fax, or via EFS-Web.

By mail, send to: Mail Stop ISSUE FEE
Commissioner for Patents
P.O. Box 1450
Alexandria, Virginia 22313-1450

By fax, send to: (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)

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.

23432 7590 05/07/2019
COOPER & DUNHAM, LLP
30 Rockefeller Plaza
20th Floor
NEW YORK, NY 10112

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 transmitted to the USPTO via EFS-Web or by facsimile to (571) 273-2885, on the date below.

(Typed or printed name)
(Signature)
(Date)

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
15/797,821	10/30/2017	Shih-Yuan WANG	5176/88184-CIP	1009

TITLE OF INVENTION: MICROSTRUCTURE ENHANCED ABSORPTION PHOTSENSITIVE DEVICES

APPLN. TYPE	ENTITY STATUS	ISSUE FEE DUE	PUBLICATION FEE DUE	PREV. PAID ISSUE FEE	TOTAL FEE(S) DUE	DATE DUE
nonprovisional	SMALL	\$500	\$0.00	\$500.00	\$0	08/07/2019

EXAMINER	ART UNIT	CLASS-SUBCLASS
RODELA, EDUARDO A	2893	257-431000

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 03-09 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 _____
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 must have been previously recorded, or filed for recordation, as set forth in 37 CFR 3.11 and 37 CFR 3.81(a). 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. Fees submitted: ☐ Issue Fee ☐ Publication Fee (if required) ☐ Advance Order - # of Copies _____

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

- ☐ Electronic Payment via EFS-Web ☐ Enclosed check ☐ Non-electronic payment by credit card (Attach form PTO-2038)
- ☐ The Director is hereby authorized to charge the required fee(s), any deficiency, or credit any overpayment to Deposit Account No. _____

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 _____ 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.
15/797,821	10/30/2017	Shih-Yuan WANG	5176/88184-CIP	1009
23432 7590 05/07/2019 COOPER & DUNHAM, LLP 30 Rockefeller Plaza 20th Floor NEW YORK, NY 10112			EXAMINER RODELA, EDUARDO A	
			ART UNIT 2893	PAPER NUMBER

DATE MAILED: 05/07/2019

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 30 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. 15/797,821	Applicant(s) WANG et al.	
	Examiner Eduardo A Rodela	Art Unit 2893	AIA (FITF) 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 4/11/2019.
☐ 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 1-40. 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 areply 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. <u>4/11/2019</u> .	5. ☒ Examiner's Amendment/Comment 6. ☒ Examiner's Statement of Reasons for Allowance 7. ☐ Other _____.
--	---

/EDUARDO A RODELA/
Primary Examiner, Art Unit 2893

DETAILED ACTION

This correspondence is in response to the Telephone Interview conducted on April 11, 2019. Claims 1-40 are pending.

Notice of Pre-AIA or AIA Status

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

EXAMINER'S AMENDMENT

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:

In the claims:

Please amend **claim 1** as follows,

“A single-chip device comprising an integrated combination of a microstructure-enhanced photodetector (MSPD) configured for reverse-bias operation and an active electronic circuit, both formed on or in a single substrate and configured to receive an optical input that in

cross-section is substantially continuous, convert the optical input to an electrical output, and process the electrical output into a processed output, wherein:

the MSPD on or in said single substrate comprises an intermediate layer, a first layer at one side of the intermediate layer, and a second layer at an opposite side of the intermediate layer, wherein:

each of the layers comprises Silicon, Germanium, or an alloy thereof;

at least one of said layers, or an overlying covering layer that may be present, has holes intentionally formed therein, extending in directions transverse to the layers;

each of the first and second layers comprises a doped material;

the intermediate layer comprises a material that is less doped than at least one of the first and second layers or is undoped, wherein the degree of doping is the same or different for different positions in the intermediate layer;

an input portion configured to concurrently receive at a plurality of said holes said optical input that has said substantially continuous cross-section; and

an output portion configured to provide said electrical output from the MSPD;

the MSPD includes reverse-bias ~~contacts~~ electrodes coupled therewith to establish an electrical field therein when energized to thereby sweep in a selected direction electrical charges generated in the MSPD by said optical input;

said reverse-bias electrodes being free of a pattern of openings that matches said holes;

and

the active electronic circuit on or in said single substrate is configured to process the electrical output from the MSPD by applying thereto:

amplification to form said processed output from the single-chip device;

processing other than or in addition to amplification to form said processed output from the single-chip device; and

routing to one or more selected destinations; and

a communication channel on or in said single-chip device, configured to deliver the electrical output from the MSPD to the active electronic circuit”.

Please cancel claims 41-112. The claims are directed to an un-elected apparatus group embodiment without traverse, as detailed in the Applicant’s response dated April 25, 2018.

REASONS FOR ALLOWANCE

Claims 1-40 are allowed.

The following is an Examiner's statement of reasons for allowance: The microstructure enhanced photodetector device as recited in the claims of the instant invention fail to be taught by the prior art cited of interest.

Regarding claim 1, the prior art teaches a similar microstructure enhanced photodetector device, but fails to disclose the specific characteristic recited in the claims of the instant invention e.g. the single chip device with combination of photodetector as detailed in communication with active electronic unit which processes the information gathered by the photodetector, in conjunction with the details of the electrodes do not have the pattern of openings.

Fax / Telephone Information

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Eduardo A Rodela whose telephone number is (571)272-8797. The examiner can normally be reached on M-F, 8:30-5:00pm ET.

Examiner interviews are available via telephone, in-person, and video conferencing using a USPTO supplied web-based collaboration tool. To schedule an interview, applicant is encouraged to use the USPTO Automated Interview Request (AIR) at <http://www.uspto.gov/interviewpractice>.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Matthew Smith can be reached on (571) 272-1907. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300. Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see <http://pair-direct.uspto.gov>. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

/EDUARDO A RODELA/
Primary Examiner, Art Unit 2893

Summary of Record of Interview Requirements

Manual of Patent Examining Procedure (MPEP), Section 713.04, Substance of Interview Must be Made of Record

A complete written statement as to the substance of any face-to-face, video conference, or telephone interview with regard to an application must be made of record in the application whether or not an agreement with the examiner was reached at the interview.

Title 37 Code of Federal Regulations (CFR) 1.133 Interviews

Paragraph (b)

In every instance where reconsideration is requested in view of an interview with an examiner, a complete written statement of the reasons presented at the interview as warranting favorable action must be filed by the applicant. An interview does not remove the necessity for reply to Office action as specified in §§ 1.111, 1.135. (35 U.S.C. 132)

37 CFR §1.2 Business to be transacted in writing.

All business with the Patent or Trademark Office should be transacted in writing. The personal attendance of applicants or their attorneys or agents at the Patent and Trademark Office is unnecessary. The action of the Patent and Trademark Office will be based exclusively on the written record in the Office. No attention will be paid to any alleged oral promise, stipulation, or understanding in relation to which there is disagreement or doubt.

The action of the Patent and Trademark Office cannot be based exclusively on the written record in the Office if that record is itself incomplete through the failure to record the substance of interviews.

It is the responsibility of the applicant or the attorney or agent to make the substance of an interview of record in the application file, unless the examiner indicates he or she will do so. It is the examiners responsibility to see that such a record is made and to correct material inaccuracies which bear directly on the question of patentability.

Examiners must complete an Interview Summary Form for each interview held where a matter of substance has been discussed during the interview by checking the appropriate boxes and filling in the blanks. Discussions regarding only procedural matters, directed solely to restriction requirements for which interview recordation is otherwise provided for in Section 812.01 of the Manual of Patent Examining Procedure, or pointing out typographical errors or unreadable script in Office actions or the like, are excluded from the interview recordation procedures below. Where the substance of an interview is completely recorded in an Examiners Amendment, no separate Interview Summary Record is required.

The Interview Summary Form shall be given an appropriate Paper No., placed in the right hand portion of the file, and listed on the "Contents" section of the file wrapper. In a personal interview, a duplicate of the Form is given to the applicant (or attorney or agent) at the conclusion of the interview. In the case of a telephone or video-conference interview, the copy is mailed to the applicants correspondence address either with or prior to the next official communication. If additional correspondence from the examiner is not likely before an allowance or if other circumstances dictate, the Form should be mailed promptly after the interview rather than with the next official communication.

The Form provides for recordation of the following information:

- Application Number (Series Code and Serial Number)
- Name of applicant
- Name of examiner
- Date of interview
- Type of interview (telephonic, video-conference, or personal)
- Name of participant(s) (applicant, attorney or agent, examiner, other PTO personnel, etc.)
- An indication whether or not an exhibit was shown or a demonstration conducted
- An identification of the specific prior art discussed
- An indication whether an agreement was reached and if so, a description of the general nature of the agreement (may be by attachment of a copy of amendments or claims agreed as being allowable). Note: Agreement as to allowability is tentative and does not restrict further action by the examiner to the contrary.
- The signature of the examiner who conducted the interview (if Form is not an attachment to a signed Office action)

It is desirable that the examiner orally remind the applicant of his or her obligation to record the substance of the interview of each case. It should be noted, however, that the Interview Summary Form will not normally be considered a complete and proper recordation of the interview unless it includes, or is supplemented by the applicant or the examiner to include, all of the applicable items required below concerning the substance of the interview.

A complete and proper recordation of the substance of any interview should include at least the following applicable items:

- 1) A brief description of the nature of any exhibit shown or any demonstration conducted,
- 2) an identification of the claims discussed,
- 3) an identification of the specific prior art discussed,
- 4) an identification of the principal proposed amendments of a substantive nature discussed, unless these are already described on the Interview Summary Form completed by the Examiner,
- 5) a brief identification of the general thrust of the principal arguments presented to the examiner,
(The identification of arguments need not be lengthy or elaborate. A verbatim or highly detailed description of the arguments is not required. The identification of the arguments is sufficient if the general nature or thrust of the principal arguments made to the examiner can be understood in the context of the application file. Of course, the applicant may desire to emphasize and fully describe those arguments which he or she feels were or might be persuasive to the examiner.)
- 6) a general indication of any other pertinent matters discussed, and
- 7) if appropriate, the general results or outcome of the interview unless already described in the Interview Summary Form completed by the examiner.

Examiners are expected to carefully review the applicants record of the substance of an interview. If the record is not complete and accurate, the examiner will give the applicant an extendable one month time period to correct the record.

Examiner to Check for Accuracy

If the claims are allowable for other reasons of record, the examiner should send a letter setting forth the examiners version of the statement attributed to him or her. If the record is complete and accurate, the examiner should place the indication, Interview Record OK on the paper recording the substance of the interview along with the date and the examiners initials.

Issue Classification 	Application/Control No. 15/797,821	Applicant(s)/Patent Under Reexamination WANG et al.	
	Examiner Eduardo A Rodela	Art Unit 2893	

CPC						
Symbol					Type	Version
H01L	/	31	/	02327	F	2013-01-01
H01L	/	31	/	1808	I	2013-01-01
H01L	/	31	/	1804	I	2013-01-01
H01L	/	31	/	035281	I	2013-01-01
H01L	/	31	/	035218	I	2013-01-01
G02B	/	1	/	002	I	2013-01-01
H01L	/	31	/	107	I	2013-01-01
H01L	/	27	/	1446	I	2013-01-01
H01L	/	31	/	103	I	2013-01-01
H04B	/	10	/	6971	I	2013-01-01
H01L	/	27	/	14625	I	2013-01-01
H01L	/	27	/	1443	I	2013-01-01
H01L	/	31	/	02325	I	2013-01-01
H01L	/	31	/	028	I	2013-01-01
H01L	/	31	/	02	I	2013-01-01
H01L	/	31	/	0232	I	2013-01-01
H01L	/	31	/	0236	I	2013-01-01
H01L	/	31	/	02363	I	2013-01-01
H01L	/	31	/	09	I	2013-01-01
H04B	/	10	/	801	I	2013-01-01
H04B	/	10	/	25	I	2013-01-01
H04B	/	10	/	40	I	2013-01-01
H04B	/	10	/	691	I	2013-01-01
H01L	/	31	/	02016	I	2013-01-01
H01L	/	31	/	02002	I	2013-01-01
G02B	/	1	/	005	I	2013-01-01
Y02E	/	10	/	547	A	2013-01-01

NONE		Total Claims Allowed:	
(Assistant Examiner)	(Date)	40	
/EDUARDO A RODELA/ Primary Examiner, Art Unit 2893	12 April 2019	O.G. Print Claim(s)	O.G. Print Figure
(Primary Examiner)	(Date)	1	9B, 21

<i>Issue Classification</i> 	Application/Control No. 15/797,821	Applicant(s)/Patent Under Reexamination WANG et al.
	Examiner Eduardo A Rodela	Art Unit 2893

CPC Combination Sets				
Symbol	Type	Set	Ranking	Version

NONE (Assistant Examiner) (Date)		Total Claims Allowed: 40	
/EDUARDO A RODELA/ Primary Examiner, Art Unit 2893 (Primary Examiner) (Date)		12 April 2019 O.G. Print Claim(s) 1	O.G. Print Figure 9B, 21

Issue Classification 	Application/Control No. 15/797,821	Applicant(s)/Patent Under Reexamination WANG et al.	
	Examiner Eduardo A Rodela	Art Unit 2893	

INTERNATIONAL CLASSIFICATION			
CLAIMED			
H01L	/	31	/ 0232
NON-CLAIMED			
/		/	

US ORIGINAL CLASSIFICATION	
CLASS	SUBCLASS

CROSS REFERENCES(S)						
CLASS	SUBCLASS (ONE SUBCLASS PER BLOCK)					

NONE		Total Claims Allowed:	
(Assistant Examiner)	(Date)	40	
/EDUARDO A RODELA/ Primary Examiner, Art Unit 2893	12 April 2019	O.G. Print Claim(s)	O.G. Print Figure
(Primary Examiner)	(Date)	1	9B, 21

Issue Classification 	Application/Control No. 15/797,821	Applicant(s)/Patent Under Reexamination WANG et al.
	Examiner Eduardo A Rodela	Art Unit 2893

☐ Claims renumbered in the same order as presented by applicant ☐ CPA ☐ T.D. ☐ R.1.47															
CLAIMS															
Final	Original	Final	Original	Final	Original	Final	Original	Final	Original	Final	Original	Final	Original	Final	Original
1	1	10	10	19	19	28	28	37	37						
2	2	11	11	20	20	29	29	38	38						
3	3	12	12	21	21	30	30	39	39						
4	4	13	13	22	22	31	31	40	40						
5	5	14	14	23	23	32	32								
6	6	15	15	24	24	33	33								
7	7	16	16	25	25	34	34								
8	8	17	17	26	26	35	35								
9	9	18	18	27	27	36	36								

NONE (Assistant Examiner) (Date)		Total Claims Allowed: 40	
/EDUARDO A RODELA/ Primary Examiner, Art Unit 2893 (Primary Examiner) (Date)		O.G. Print Claim(s) 1	O.G. Print Figure 9B, 21

<i>Search Notes</i> 	Application/Control No. 15/797,821	Applicant(s)/Patent Under Reexamination WANG et al.
	Examiner Eduardo A Rodela	Art Unit 2893

CPC - Searched*		
Symbol	Date	Examiner
H01L31/02002,02016,0203,0232,0237,12	04/12/2019	EAR

CPC Combination Sets - Searched*		
Symbol	Date	Examiner

US Classification - Searched*			
Class	Subclass	Date	Examiner

* 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 history for complete details	04/12/2019	EAR
Inventor's name and assignee search	04/12/2019	EAR

Interference Search			
US Class/CPC Symbol	US Subclass/CPC Group	Date	Examiner
noted CPC search area	in conjunction with a text search	04/12/2019	EAR

	/EDUARDO A RODELA/ Primary Examiner, Art Unit 2893
--	---

EAST Search History

EAST Search History (Prior Art)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
L2	5615	(reverse adj bias\$2) with (photodiode or ((photo or light) near sensor))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2019/04/1 12:19
L3	47487	H01L31/00,02,0216,02161,02164,02165,0232,02327,0236,02363,02366,,035281,06,09,10,101,102,11.cpc.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2019/04/1 12:19
L4	419	(@pd<="20140901" or @ad<="20140901" or @riad<="20140901" or @ripd<="20140901") and L2 and L3	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2019/04/1 12:19
L5	122	(US-20160126381-\$ or US-20060082318-\$ or US-20110291103-\$ or US-20110165707-\$ or US-20120021525-\$ or US-20100288341-\$ or US-20060220000-\$ or US-20080179503-\$ or US-20080050081-\$ or US-20050053319-\$ or US-20060289960-\$ or US-20020175339-\$ or US-20140286367-\$ or US-20120153260-\$ or US-20110267612-\$ or US-20080095663-\$ or US-20090225804-\$ or US-20090203158-\$ or US-20080107388-\$ or US-20030218143-\$ or US-20030127608-\$ or US-20030123827-\$ or US-20090278125-\$ or US-20120044489-\$ or US-20090183774-\$ or US-20090141489-\$).did. or (US-20070014505-\$ or US-20020101895-\$ or US-20030016895-\$ or US-20130056623-\$ or US-20080303033-\$ or US-20120292676-\$ or US-20100221866-\$ or US-20100193768-\$ or US-20090267049-\$ or US-20080248608-\$ or US-20050184354-\$ or US-20100284432-\$ or US-20070013991-\$ or US-20180102442-\$ or US-20160307939-\$ or US-20150144797-\$ or US-20130089888-\$ or US-20100308428-\$ or US-20090230498-\$ or US-20090152664-\$ or US-20140341506-\$ or US-20050063634-\$ or US-20050117853-\$ or US-20040149998-\$ or US-20130084044-\$ or US-20130114629-\$ or US-20160011176-\$).did. or (US-20070277869-\$ or US-20130230272-\$ or US-20100148318-\$ or US-20100059789-\$ or US-20090321868-\$ or US-20080080854-\$).did. or (US-7239001-\$ or US-8319241-\$ or US-6687423-\$ or US-6295130-\$ or US-5329136-\$ or US-9419156-\$ or US-9312448-\$ or US-9099623-\$ or US-8796716-\$ or US-8785955-\$ or US-8754445-\$ or US-8604511-\$ or US-8160404-\$ or US-7683310-\$ or US-6879014-\$ or US-6316286-\$ or US-6043517-\$ or US-7973377-\$ or US-7579668-\$ or US-6858912-\$ or US-5942789-\$ or US-3914137-\$ or US-8372726-\$ or US-6359283-\$ or US-5451767-\$ or US-8436370-\$).did. or (US-7079307-\$ or US-9082922-\$ or US-4894526-\$ or US-4873555-\$ or US-7067853-\$ or US-5698858-\$ or US-6549684-\$ or US-4961198-\$ or US-4952791-\$ or US-4754132-\$ or US-6667528-\$ or US-8357960-\$ or US-7183127-\$ or US-7986022-\$ or US-7919347-\$ or US-6943409-\$ or US-8670637-\$ or US-8461541-\$ or US-7489014-\$ or US-7560784-\$ or US-6538299-\$ or US-6451702-\$ or US-6404031-\$ or US-5818066-\$ or US-4814847-\$ or US-6027956-\$ or US-5757057-\$).did. or (US-5625636-\$ or US-9214787-\$ or US-6711200-\$ or US-9042418-\$ or US-7915604-\$ or US-7994521-\$ or US-8462827-\$ or US-7251386-\$ or US-6392282-\$ or US-9525084-\$).did.	US-PGPUB; USPAT	OR	OFF	2019/04/1 12:20
L6	4	(wang near shih-yuan).in. and L5	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2019/04/1 12:20
L7	1	("W&WSens,") .as. and L5	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2019/04/1 12:20
L8	4	L6 or L7	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2019/04/1 12:20
L9	6	(7251386 20090230498 20160240718).pn.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2019/04/1 12:20
L10	3	"20100308428"	US-PGPUB;	OR	ON	2019/04/1

			USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB		12:20
--	--	--	---	--	-------

EAST Search History (Interference)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
L11	0	(H01L31/00,02,0216,02161,02164,02165,0232,02327,0236,02363,02366,,035281,06,09,10,101,102,11.cpc.) and ((single-chip near device)(integrated)(microstructure-enhanced near photodetector)(reverse-bias near operation)(active near electronic near circuit)(single near substrate)(convert)(optical near input)(electrical near output)(process)(processed near output)(intermediate near layer)(silicon or germnaium)(degree)(doping)(amplification)(openings)(holes)(pattern)(free)).clm.	US- PGPUB; USPAT	AND	OFF	2019/04/12 12:23

4/12/2019 12:23:55 PM
C:\Users\erodela\Documents\EASTold\EAST\Workspaces\15797821.wsp

<i>Search Notes</i> 	Application/Control No. 15/797,821	Applicant(s)/Patent Under Reexamination WANG et al.
	Examiner Eduardo A Rodela	Art Unit 2893

CPC - Searched*		
Symbol	Date	Examiner
H01L31/02002,02016,0203,0232,0237,12	03/25/2019	EAR

CPC Combination Sets - Searched*		
Symbol	Date	Examiner

US Classification - Searched*			
Class	Subclass	Date	Examiner

* 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 history for complete details	03/25/2019	EAR
Inventor's name and assignee search	03/25/2019	EAR

Interference Search			
US Class/CPC Symbol	US Subclass/CPC Group	Date	Examiner

	/EDUARDO A RODELA/ Primary Examiner, Art Unit 2893
--	---

<i>Notice of References Cited</i>	Application/Control No. 15/797,821		Applicant(s)/Patent Under Reexamination WANG et al.	
	Examiner Eduardo A Rodela		Art Unit 2893	Page 1 of 1

U.S. PATENT DOCUMENTS

*		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Name	CPC Classification	US Classification
*	A	US-20160240718-A1	08-2016	GIZIEWICZ; Wojciech	H01L31/02327	1/1
	B					
	C					
	D					
	E					
	F					
	G					
	H					
	I					
	J					
	K					
	L					
	M					

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.

U.S. Patent and Trademark Office
PTO-892 (Rev. 01-2001)

Notice of References Cited

Part of Paper No. 20190325

EAST Search History

EAST Search History (Prior Art)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
L1	5586	(reverse adj bias\$2) with (photodiode or ((photo or light) near sensor))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2019/03/2 10:44
L2	47272	H01L31/00,02,0216,02161,02164,02165,0232,02327,0236,02363,02366,,035281,06,09,10,101,102,11.cpc.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2019/03/2 10:44
L3	417	((@pd<="20140901" or @ad<="20140901" or @rld<="20140901" or @rldp<="20140901") and I1 and I2	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2019/03/2 10:44
L4	122	(US-20160126381-\$ or US-20060082318-\$ or US-20110291103-\$ or US-20110165707-\$ or US-20120021525-\$ or US-20100288341-\$ or US-20060220000-\$ or US-20080179503-\$ or US-20080050081-\$ or US-20050053319-\$ or US-20060289960-\$ or US-20020175339-\$ or US-20140286367-\$ or US-20120153260-\$ or US-20110267612-\$ or US-20080095663-\$ or US-20090225804-\$ or US-20090203158-\$ or US-20080107388-\$ or US-20030218143-\$ or US-20030127608-\$ or US-20030123827-\$ or US-20090278125-\$ or US-20120044489-\$ or US-20090183774-\$ or US-20090141489-\$).did. or (US-20070014505-\$ or US-20020101895-\$ or US-20030016895-\$ or US-20130056623-\$ or US-20080303033-\$ or US-20120292676-\$ or US-20100221866-\$ or US-20100193768-\$ or US-20090267049-\$ or US-20080248608-\$ or US-20050184354-\$ or US-20100284432-\$ or US-20070013991-\$ or US-20180102442-\$ or US-20160307939-\$ or US-20150144797-\$ or US-20130089888-\$ or US-20100308428-\$ or US-20090230498-\$ or US-20090152664-\$ or US-20140341506-\$ or US-20050063634-\$ or US-20050117853-\$ or US-20040149998-\$ or US-20130084044-\$ or US-20130114629-\$ or US-20160011176-\$).did. or (US-20070277869-\$ or US-20130230272-\$ or US-20100148318-\$ or US-20100059789-\$ or US-20090321868-\$ or US-20080080854-\$).did. or (US-7239001-\$ or US-8319241-\$ or US-6687423-\$ or US-6295130-\$ or US-5329136-\$ or US-9419156-\$ or US-9312448-\$ or US-9099623-\$ or US-8796716-\$ or US-8785955-\$ or US-8754445-\$ or US-8604511-\$ or US-8160404-\$ or US-7683310-\$ or US-6879014-\$ or US-6316286-\$ or US-6043517-\$ or US-7973377-\$ or US-7579668-\$ or US-6858912-\$ or US-5942789-\$ or US-3914137-\$ or US-8372726-\$ or US-6359283-\$ or US-5451767-\$ or US-8436370-\$).did. or (US-7079307-\$ or US-9082922-\$ or US-4894526-\$ or US-4873555-\$ or US-7067853-\$ or US-5698858-\$ or US-6549684-\$ or US-4961198-\$ or US-4952791-\$ or US-4754132-\$ or US-6667528-\$ or US-8357960-\$ or US-7183127-\$ or US-7986022-\$ or US-7919347-\$ or US-6943409-\$ or US-8670637-\$ or US-8461541-\$ or US-7489014-\$ or US-7560784-\$ or US-6538299-\$ or US-6451702-\$ or US-6404031-\$ or US-5818066-\$ or US-4814847-\$ or US-6027956-\$ or US-5757057-\$).did. or (US-5625636-\$ or US-9214787-\$ or US-6711200-\$ or US-9042418-\$ or US-7915604-\$ or US-7994521-\$ or US-8462827-\$ or US-7251386-\$ or US-6392282-\$ or US-9525084-\$).did.	US-PGPUB; USPAT	OR	OFF	2019/03/2 12:58
L5	4	(wang near shih-yuan).in. and L4	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2019/03/2 12:58
L6	1	("W&WSens,") .as. and L4	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2019/03/2 12:58
L7	4	L5 or L6	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2019/03/2 12:58

EAST Search History (Interference)

< This search history is empty >

3/ 25/ 2019 12:59:12 PM
C:\Users\erodela\Documents\EASTold\EAST\Workspaces\15797821.wsp

Doc code: IDS

PTO/SB/08a (02-18)

Doc description: Information Disclosure Statement (IDS) Filed

Approved for use through 11/30/2020. OMB 0651-0031

U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE

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

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)	Application Number	15797821
	Filing Date	2017-10-30
	First Named Inventor	Shih-Yuan WANG
	Art Unit	2893
	Examiner Name	Eduardo A. Rodela
	Attorney Docket Number	5176/88184-CIP

U.S. PATENTS

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	6724798		2004-04-20	Liu et al.	
	2	5244749		1993-09-14	Bean et al.	
	3	6,845,034		2005-01-18	Bhattacharyya	
	4	9818893		2017-11-14	Wang et al.	
	5	9496435		2016-11-15	Wang et al.	
	6	9525084		2016-12-20	Wang et al.	
	7	9530905		2016-12-27	Wang et al.	
	8	5525828		1996-06-11	Bassous et al.	

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)	Application Number	15797821
	Filing Date	2017-10-30
	First Named Inventor	Shih-Yuan WANG
	Art Unit	2893
	Examiner Name	Eduardo A. Rodela
	Attorney Docket Number	5176/88184-CIP

	9	7605406		2009-10-20	Iguchi	
	10	9360554		2016-06-07	Facet Technology Corp	
	11	8728847		2014-05-20	Maruyama et al.	

If you wish to add additional U.S. Patent citation information please click the Add button.

U.S.PATENT APPLICATION PUBLICATIONS

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	20030059820		2003-03-27	Vo-Dinh	
	2	20100059822		2010-03-11	Pinguet et al.	
	3	20080079022		2008-04-03	Yamamoto et al.	
	4	20070170536		2007-07-26	Hsu et al.	
	5	20060267054		2006-11-30	Martin et al.	
	6	20150054997		2015-02-26	Aptina Imaging Corporation	

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)	Application Number		15797821
	Filing Date		2017-10-30
	First Named Inventor	Shih-Yuan WANG	
	Art Unit	2893	
	Examiner Name	Eduardo A. Rodela	
	Attorney Docket Number	5176/88184-CIP	

7	20160254407		2016-09-01	Wang et al.	
8	20040222357		2004-11-11	King et al.	
9	20020097962		2002-07-25	Yoshimura et al.	
10	20150340538		2015-11-26	Coriant Advanced Technology, LLC	

If you wish to add additional U.S. Published Application citation information please click the Add button.

FOREIGN PATENT DOCUMENTS

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	6-53424	JP		1994-02-25	International Business Machines Corporation		☐
	2	2003-142778	JP		2003-05-16	Samuelson et al.		☒
	3	2012-502466	JP		2012-01-26	Alcatel		☐

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
--------------------	---------	---	----------------

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

Application Number	15797821
Filing Date	2017-10-30
First Named Inventor	Shih-Yuan WANG
Art Unit	2893
Examiner Name	Eduardo A. Rodela
Attorney Docket Number	5176/88184-CIP

1	July 16, 2018 European Search Report issued by the European Patent Office in connection with European Patent Application No. 15861593.0	☐
2	ACKERT et al., "10 Gbps silicon waveguide-integrated infrared avalanche photodiode." Optics Express, 12 August 2013, pp. 19530-19537	☐
3	January 8, 2019 official action issued by the Japanese Patent Office in connection with Japanese Patent Application No. 2016-515097	☐
4	January 15, 2019 International Search Report of the International Searching Authority in connection with PCT/US2018/057963	☐
5	February 12, 2019 International Search Report of the International Searching Authority in connection with PCT/US2018/043289	☐
6	Houng et al., "Characterization of the Nanoporous Template Using Anodic Alumina Method", Journal of Nanomaterials, Vol. 2014, Article ID 130716, pp. 1-7.	☐

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

EXAMINER SIGNATURE

Examiner Signature	/EDUARDO A. RODELA/	Date Considered	03/25/2019
--------------------	---------------------	-----------------	------------

*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.



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.
15/797,821	10/30/2017	Shih-Yuan WANG	5176/88184-CIP	1009
23432	7590	03/26/2019		
COOPER & DUNHAM, LLP			EXAMINER	
30 Rockefeller Plaza			RODELA, EDUARDO A	
20th Floor				
NEW YORK, NY 10112			ART UNIT	PAPER NUMBER
			2893	
			MAIL DATE	DELIVERY MODE
			03/26/2019	PAPER

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.

U.S. Patent and Trademark Office

PTOL-326 (Rev. 11-13)

Office Action Summary

Part of Paper No./Mail Date 20190325

DETAILED ACTION

This office action is in response to the Request for Continued Examination received March 14, 2019. Claims 1-40 are pending.

Notice of Pre-AIA or AIA Status

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

Election/Restrictions

Claims 41-112 are withdrawn from further consideration pursuant to 37 CFR 1.142(b) as being drawn to a nonelected Group II and Species claims, there being no allowable generic or linking claim. Election was made **without** traverse in the reply filed on April 25, 2018

Claim Rejections - 35 USC § 103

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.

Claims 1-3, 9-12, 22, 24, 26, 28, 29, 32-36 and 39 are rejected under 35 U.S.C. 103 as being unpatentable over Dickinson et al. (US 7,251,386) in view of Kim et al. (US

2010/0288341) in view of Okamoto et al. (US 2010/0308428) in view of Iwai et al. (US 2009/0230498) in view of Giziewicz (US 2016/0240718).

Regarding claim 1, Dickinson teaches in Figures 1 and 7, a single-chip device (200, “integrated photonic-electronic ... DRAM chip”, column 11, last paragraph) comprising an integrated combination of a photodetector (203) and an active electronic circuit (various other devices included on 200), both formed on or in a single substrate (chip 200) and configured to receive an optical input (fibers 206-209 allow for light signal I/O) that in cross-section is substantially continuous (holes in photodetector to be addressed in the teaching of Iwai immediately below), convert the optical input to an electrical output (columns 11 and 12 describe the conversion of the optical signals to electrical signals), and process the electrical output into a processed output (transmitter portion of 203/204, which outputs data from DRAM Cores 201/202), wherein:

the active electronic circuit on or in said single substrate is configured to process the electrical output from the photodetector by applying thereto (input through receiver cell with detector array, which converts the optical signals from the fiber at the detector array, then an electrical signal is sent to the CMOS Logic Module where processing takes place, column 5, lines 29-55):

processing other than or in addition to amplification to form said processed output from the single-chip device (column 5, lines 29-55, amplification discussed below by teaching of Iwai); and

routing to one or more selected destinations; and (either of the DRAM Cores and output)

a communication channel on or in said single-chip device, configured to deliver the electrical output from the MSPD to the active electronic circuit (circuit paths in both Figs. 1 and 7, from Detector Array to CMOS Logic Module and output).

Dickinson does not teach:

- the photodetector is a microstructure-enhanced photodetector (MSPD).

the photodetector on or in said single substrate comprises an intermediate layer, a first layer at one side of the intermediate layer, and a second layer at an opposite side of the intermediate layer, wherein:

each of the layers comprises Silicon, Germanium, or an alloy thereof;

at least one of said layers, or an overlying covering layer that may be present (it is noted that the claim language regarding the overlying layer is not a positive recitation, nor does the claim language require the presence, but merely states the overlying layer as an optional component), has holes intentionally formed therein, extending in directions transverse to the layers; each of the first and second layers comprises a doped material;

the intermediate layer comprises a material that is less doped than at least one of the first and second layers or is undoped, wherein the degree of doping is the same or different for different positions in the intermediate layer;

an input portion configured to concurrently receive at a plurality of said holes said optical input that has said substantially continuous cross-section; and

an output portion configured to provide said electrical output from the MSPD.

Kim teaches in Figures 5A-B and 12:

- the photodetector is a microstructure-enhanced photodetector (MSPD) (detector shown is enhanced by holes 51 formed in the material layers),

the photodetector (device including mesa 550, n-type layer 510, ¶ 0042, intrinsic layer 59, ¶ 0042, and p-type layer 520, ¶ 0042) on or in said single substrate (this feature as taught by Dickinson above) comprises an intermediate layer (59), a first layer (520) at one side of the intermediate layer (beneath 59), and a second layer at an opposite side of the intermediate layer (510 over 59), wherein:

at least one of said layers, or an overlying covering layer that may be present, has holes intentionally formed therein (51), extending in directions transverse to the layers (vertically); each of the first and second layers comprises a doped material (510 and 520 doped oppositely paragraph 0042);

the intermediate layer comprises a material that is less doped than at least one of the first and second layers or is undoped (59 is undoped, ¶ 0042), wherein the degree of doping is the same or different for different positions in the intermediate layer (as the intermediate layer is shown to be undoped, the positions all have no doping);

an input portion configured to concurrently receive at a plurality of said holes said optical input that has said substantially continuous cross-section (top of mesa with holes in it, 1201 connecting 1203); and

an output portion configured to provide said electrical output from the MSPD (electrical output from the device, paragraph 0037, 0038, 1204 to 1202).

Therefore it would have been obvious to one of ordinary skill in the art at the time the invention was made (for Pre-AIA) or before the effective filing date of the claimed invention (for the AIA FITF practice) to have used:

- the photodetector is a microstructure-enhanced photodetector (MSPD).

the photodetector on or in said single substrate comprises an intermediate layer, a first layer at one side of the intermediate layer, and a second layer at an opposite side of the intermediate layer, wherein:

each of the layers comprises Silicon, Germanium, or an alloy thereof;

at least one of said layers, or an overlying covering layer that may be present, has holes intentionally formed therein, extending in directions transverse to the layers; each of the first and second layers comprises a doped material;

the intermediate layer comprises a material that is less doped than at least one of the first and second layers or is undoped, wherein the degree of doping is the same or different for different positions in the intermediate layer;

an input portion configured to concurrently receive at a plurality of said holes said optical input that has said substantially continuous cross-section; and

an output portion configured to provide said electrical output from the MSPD,

in the invention of Dickinson as taught by Kim, for the purpose of providing a light signal detector which can be used to convert light signals into electrical signals.

Kim does not teach:

- each of the layers comprises Silicon, Germanium, or an alloy thereof.

Okamoto et al. (US 2010/0308428) teaches in Figure 2, wherein:

- each of the layers comprises Silicon, Germanium, or an alloy thereof (paragraph 0063 describes layers 3-6 as being Si, Ge or SiGe).

Therefore it would have been obvious to one of ordinary skill in the art at the time the invention was made (for Pre-AIA) or before the effective filing date of the claimed invention (for the AIA FITF practice) to have used:

- each of the layers comprises Silicon, Germanium, or an alloy thereof,

in the invention of Dickinson as taught by Okamoto, for the purpose of utilizing industry standard materials which are less costly and function as semiconductors to allow for the detection of incoming light signals.

Dickinson does not specify:

- amplification to form said processed output from the single-chip device.

Iwai teaches the optical device is subjected to amplification and processing performed by electronic circuits, as discussed in paragraph 0010.

Therefore it would have been obvious to one of ordinary skill in the art at the time the invention was made (for Pre-AIA) or before the effective filing date of the claimed invention (for the AIA FITF practice) to have used:

- amplification to form said processed output from the single-chip device,

in the invention of Dickinson as taught by Iwai, for at least the purpose of allowing for the increase in sensitivity of the optical detectors.

Dickinson does not disclose,

the microstructure enhanced photodetector (MSPD) is configured for reverse bias operation, and

the MSPD includes reverse-bias contacts coupled therewith to establish an electrical field therein when energized to thereby sweep in a selected direction electrical charges generated in the MSPD by said optical input.

Giziewicz discusses in paragraph 0025, “photodiodes are generally used in reverse bias”, therefore if the device of Giziewicz is used in reverse bias, then the electrode passing the reverse bias signal will be reverse bias electrodes and will sweep charges through the device acting as a photodiode sensitive to incoming light.

Therefore it would have been obvious to one of ordinary skill in the art at the time the invention was made (for Pre-AIA) or before the effective filing date of the claimed invention (for the AIA FITF practice) to have used:

the microstructure enhanced photodetector (MSPD) is configured for reverse bias operation, and

the MSPD includes reverse-bias contacts coupled therewith to establish an electrical field therein when energized to thereby sweep in a selected direction electrical charges generated in the MSPD by said optical input,

in the invention of Dickinson as taught by Giziewicz, for the purpose of providing the necessary signals to operate the light sensing diode.

Regarding claim 2, Dickinson et al. teach the single-chip device of claim 1, in which said active electronic circuit is at least partly extends beyond said substrate (fiber portions extend past the perimeter of 200).

Regarding claim 3, Dickinson et al. teach the single-chip device of claim 1, in which said active electronic circuit is at least partly inside said substrate (components of the circuit are all within the confines of the perimeter of 200, with the exception of the fibers).

Regarding claim 9, Dickinson et al. teach the single-chip device of claim 1, in which said holes are present in said intermediate layer (all of 510, 59, 520 have holes 51 formed in them).

Regarding claim 10, Dickinson et al. teach the single-chip device of claim 1, in which said holes are present in said intermediate layer as well as in at least one of the first and second layers (all of 510, 59, 520 have holes 51 formed in them).

Regarding claim 11, Dickinson et al. teach the single-chip device of claim 1, in which said holes are present in each of the first, second, and intermediate layer (all of 510, 59, 520 have holes 51 formed in them).

Regarding claim 12, Dickinson et al. teach the single-chip device of claim 1, in which each of said first and second layers and said intermediate layer has a thickness and at least some of said holes extend through the entire thickness of said intermediate layer and of one of said first layer and second layer and through at least a part of the thickness of the other one of said first and second layers (all of 510, 59, 520 have holes 51 formed in them).

Regarding claim 22, Dickinson et al. teach the single-chip device of claim 1, in which said optical input enters the MSPD through one or both of said first and second layers, and each of the first and second layers through which the optical input enters is no more than 500 nanometers thick (Kim teaches this in paragraph 0043, wherein the device region is 426 or 325 nanometers).

Regarding claim 24, Dickinson et al. teach the single-chip device of claim 1, and Okamoto teaches in paragraph 0062, in which said MSPD further comprises ohmic contacts configured for reverse-biasing the MSPD. Regarding the limitation of “configured for reverse-biasing the MSPD”, it is noted that, it has been held that a recitation with respect to the manner in which a claimed apparatus is intended to be employed does not differentiate the claimed apparatus from a prior art apparatus satisfying the claimed structural limitations. *Ex Parte*

Masham, 2 USPQ F.2d 1647 (1987). Therefore since the device of Kim is structurally the same as the claimed structure, then it would be able to be used in the same fashion.

Regarding claim 26, Dickinson et al. teach the single-chip device of claim 1, further comprising a light guide to said MSPD for directing said optical input thereto, and electrical contacts from the active electronic circuit configured to carry said processed output out of the single-chip device (light guides are fibers 206-209, and electrical signals further carried out by schematically represented electrodes in Fig. 1 of lines leaving the “Detector Array 9”).

Regarding claim 28, Dickinson teaches the single-chip device of claim 1, further comprising one or more additional MSPD (microstructured cavity taught by Kim, two detectors shown in Fig. 7 of Dickinson as the optical busses which contain arrays of detectors) on or in the same substrate (on 200), and respective different optical bandpass filters coupled with at least two of the MSPDs on or in said single substrate (discussion which addresses the “demultiplexer” which splits and routes various wavelengths in multiple routing paths is carried out by selectively allowing certain wavelengths to traverse certain pathways, e.g. bandpass), whereby at least two of said MSPDs are configured to respond to different wavelength ranges that are within said optical input (204/203 respond to various wavelengths incoming from 206-209 fibers, at least columns 5 and 6 discuss this topic).

Regarding claim 29, Dickinson et al. teach the single-chip device of claim 1, further comprising one or more additional MSPDs (microstructured cavity taught by Kim, two detectors shown in Fig. 7 of Dickinson as the optical busses which contain arrays of detectors) on or in

said single substrate (200), one or more additional active electronic circuits (cross bar and DRAM CORES and discussed processor circuitries) on or in the said single substrate (on 200), and one or more additional communication channels configured to supply electrical outputs from the MSPDs to the one or more of the active electronic circuits (shown as arrows in Fig. 7 and as schematic wirings in Fig. 1).

Regarding claim 30, Dickinson et al. teach the single-chip device of claim 1, further comprising one or more additional active electronic circuits that are formed on or in the said single substrate (further circuitries present in addition to the optical devices on 200).

Regarding claim 32, Dickinson et al. teach the single-chip device of claim 1, further comprising one or more additional active electronic circuits (at least as shown in) that are formed on or in the said single substrate and comprise one or more of CMOS, BiCMOS, and bipolar active devices (discussed in at least, lines 1-27, col. 8).

Regarding claim 33, Dickinson et al. teach the single-chip device of claim 1, further comprising one or more additional MSPDs in an array on or in said single substrate (this limitation is addressed several times in the claims above) and one or more additional active electronic circuits also on or in said single substrate (this limitation is addressed several times in the claims above), said MSPDs and active electronic circuits being configured into an optical communication structure (optical communication structure as shown in Figs. 1 and 7, where light is input via the fibers and processed by the circuitries on 200) or a light distance and ranging (LIDAR) structure (previous option addressed).

Regarding claim 34, Dickinson et al. teach the single-chip device of claim 1, further comprising a laser emitter formed on or in said single substrate (in I/O section 203/204, lasers are present to output optical communication signals, see col. 8, lines 40-65).

Regarding claim 35, Dickinson et al. teach the single-chip device of claim 1, further including a layer of selected material that is over a side of one of the first and second layers facing away from the intermediate layer and is configured to reduce sheet resistance (Okomoto teaches in Fig. 1 and ¶ 0062, the desire for ohmic contacts, which inherently reduce sheet resistance by lowering resistance at the interface of the electrodes and the semiconductor material).

Regarding claim 36, Dickinson teaches the single-chip device of claim 1, further including a layer of selected material that is over a side of one of the first and second layers facing away from the intermediate layer and is configured to reflect light that has passed through the intermediate layer back toward the intermediate layer (shows an optical device with a DBR filter (32) on the back side of the active regions and over the substrate).

Regarding claim 39, Dickinson teaches the single-chip device of claim 1, and Okamoto teaches in Fig. 9 further including one or more distributed Bragg reflectors formed at one of said first and second layers, at a surface thereof away from the intermediate layer (shows an optical device with a DBR filter (32) on the back side of the active regions and over the substrate).

Claim 5 is rejected under 35 U.S.C. 103 as being unpatentable over Dickinson et al. (US 7,251,386) in view of Kim et al. (US 2010/0288341) in view of Okamoto et al. (US 2010/0308428) in view of Iwai et al. (US 2009/0230498) in view of Giziewicz (US 2016/0240718) in view of Kim et al. (US 9,045,418).

Regarding claim 5, Dickinson teaches the single-chip device of claim 1, however Dickinson does not specify:

- in which said MSPD comprises a III-V materials family photodiode.

Kim teaches in Figure 1 wherein the P-I-N region (145, 140, 135) are formed of III-V (see Figure 1).

Therefore it would have been obvious to one of ordinary skill in the art at the time the invention was made (for Pre-AIA) or before the effective filing date of the claimed invention (for the AIA FITF practice) to have used:

- in which said MSPD comprises a III-V materials family photodiode,

in the invention of Dickinson et al. as taught by Kim, for the purpose of using a material which performs well under high power and high frequency electronics because of it's high electron mobility.

Claim 6 is rejected under 35 U.S.C. 103 as being unpatentable over Dickinson et al. (US 7,251,386) in view of Kim et al. (US 2010/0288341) in view of Okamoto et al. (US 2010/0308428) in view of Iwai et al. (US 2009/0230498) in view of Giziewicz (US 2016/0240718) in view of Kim et al. (US 2012/0153260).

Regarding claim 6, Dickinson teaches the single-chip device of claim 1, however Dickinson does not teach:

- further including an air-filled volume between the substrate and the MSPD.

Kim teaches in Figure 20H:

- further including an air-filled volume between the substrate and the MSPD ("Air gap").

Therefore it would have been obvious to one of ordinary skill in the art at the time the invention was made (for Pre-AIA) or before the effective filing date of the claimed invention (for the AIA FITF practice) to have used:

in the invention of Dickinson et al. as taught by Kim, for the purpose of refocusing light back to the active region.

Claim 7 is rejected under 35 U.S.C. 103 as being unpatentable over Dickinson et al. (US 7,251,386) in view of Kim et al. (US 2010/0288341) in view of Okamoto et al. (US 2010/0308428) in view of Iwai et al. (US 2009/0230498) in view of Giziewicz (US 2016/0240718) in view of Wanger et al. (US 6,879,014).

Regarding claim 7, Dickinson teaches the single-chip device of claim 1, however Dickinson et al. do not teach:

- further including a layer of a dielectric material that covers the holes and is in the propagation path of said optical input.

Wagner teaches in Figure 9 wherein an optical device is ultimately covered in an insulating / passivating layer (801).

Therefore it would have been obvious to one of ordinary skill in the art at the time the invention was made (for Pre-AIA) or before the effective filing date of the claimed invention (for the AIA FITF practice) to have used:

- further including a layer of a dielectric material that covers the holes and is in the propagation path of said optical input,

in the invention of Dickinson as taught by Wagner, for the purpose of passivating the surface to protect the active device from external damage or environmental degradation.

Claim 8 is rejected under 35 U.S.C. 103 as being unpatentable over Dickinson et al. (US 7,251,386) in view of Kim et al. (US 2010/0288341) in view of Okamoto et al. (US 2010/0308428) in view of Iwai et al. (US 2009/0230498) in view of Giziewicz (US 2016/0240718) in view of Tabatabaie (US 4,814,847).

Regarding claim 8, Dickinson teaches the single-chip device of claim 1, however Dickinson does not teach:

- further including an avalanche region at one side of the MSPD, forming therewith an avalanche microstructured photodiode (MSAPD).

Tabatabaie teaches on column 2, lines 18-45 teach an APD as a light sensitive device.

Therefore it would have been obvious to one of ordinary skill in the art at the time the invention was made (for Pre-AIA) or before the effective filing date of the claimed invention (for the AIA FITF practice) to have used:

- further including an avalanche region at one side of the MSPD, forming therewith an avalanche microstructured photodiode (MSAPD),

in the invention of Dickinson et al. as taught by Tabatabaie, for the purpose of using a diode which is a very sensitive to light and thus allows for a highly sensitive device which can detect minute amounts of light.

Claim 13 is rejected under 35 U.S.C. 103 as being unpatentable over Dickinson et al. (US 7,251,386) in view of Kim et al. (US 2010/0288341) in view of Okamoto et al. (US 2010/0308428) in view of Iwai et al. (US 2009/0230498) in view of Giziewicz (US 2016/0240718) in view of Wang et al. (US 2010/0148318)

Regarding claim 13, Dickinson teaches the single-chip device of claim 1, however Dickinson et al. do not teach:

- in which at least some of said holes are shaped as inverted pyramids.

Wang teaches in Fig. 6D and 7 holes that are inverted pyramid shaped.

Therefore it would have been obvious to one of ordinary skill in the art at the time the invention was made (for Pre-AIA) or before the effective filing date of the claimed invention (for the AIA FITF practice) to have used:

- in which at least some of said holes are shaped as inverted pyramids,

in the invention of Dickinson et al. as taught by Wang, for the purpose of utilizing a shape which could improve device sensitivity by altering the shape to have more surface area presented to the normal and incoming optical signal.

Claims 14-17 are rejected under 35 U.S.C. 103 as being unpatentable over Dickinson et al. (US 7,251,386) in view of Kim et al. (US 2010/0288341) in view of Okamoto et al. (US 2010/0308428) in view of Iwai et al. (US 2009/0230498) in view of Giziewicz (US 2016/0240718) in view of Na et al. (US 8,319,241).

Regarding claim 14, Dickinson teaches the single-chip device of claim 1, however Dickinson et al. do not teach:

- in which at least some of said holes have triangular sections in planes transverse to said layers.

Na teaches in Figures 2 and 6 wherein the undoped layer 160 and one of the doped layers 170 have holes in them, as can be seen clearly Fig. 2 and cross sectionally in Fig. 6.

Therefore it would have been obvious to one of ordinary skill in the art at the time the invention was made (for Pre-AIA) or before the effective filing date of the claimed invention (for the AIA FITF practice) to have used:

- in which at least some of said holes have triangular sections in planes transverse to said layers,

in the invention of Dickinson et al. as taught by Na, for the purpose of increasing surface area for improving sensitivity in the device of Dickinson et al.

Regarding claim 15, Dickinson teaches the single-chip device of claim 1, however Dickinson et al. do not teach:

- in which at least some of said holes have triangular sections in planes transverse to said layers, with vertices within the intermediate layer.

Na teaches in Figures 2 and 6 wherein the undoped layer 160 and one of the doped layers 170 have holes in them, as can be seen clearly Fig. 2 and cross sectionally in Fig. 6.

Therefore it would have been obvious to one of ordinary skill in the art at the time the invention was made (for Pre-AIA) or before the effective filing date of the claimed invention (for the AIA FITF practice) to have used:

- in which at least some of said holes have triangular sections in planes transverse to said layers, with vertices within the intermediate layer,

in the invention of Dickinson et al. as taught by Na, for the purpose of increasing surface area for improving sensitivity in the device of Dickinson et al.

Regarding claim 16, Dickinson teaches the single-chip device of claim 1, however Dickinson et al. do not teach:

- in which at least some of said holes have sidewalls that slope in planes transverse to said layers.

Na teaches in Figures 2 and 6 wherein the undoped layer 160 and one of the doped layers 170 have holes in them, as can be seen clearly Fig. 2 and cross sectionally in Fig. 6.

Therefore it would have been obvious to one of ordinary skill in the art at the time the invention was made (for Pre-AIA) or before the effective filing date of the claimed invention (for the AIA FITF practice) to have used:

- in which at least some of said holes have sidewalls that slope in planes transverse to said layers,

in the invention of Dickinson et al. as taught by Na, for the purpose of increasing surface area for improving sensitivity in the device of Dickinson et al.

Regarding claim 17, Dickinson teaches the single-chip device of claim 1, however Dickinson et al. do not teach:

- in which at least some of said holes have sidewalls with plural different slopes along the inside walls of the holes.

Na teaches in Figures 2 and 6 wherein the undoped layer 160 and one of the doped layers 170 have holes in them, as can be seen clearly Fig. 2 and cross sectionally in Fig. 6.

Therefore it would have been obvious to one of ordinary skill in the art at the time the invention was made (for Pre-AIA) or before the effective filing date of the claimed invention (for the AIA FITF practice) to have used:

- in which at least some of said holes have sidewalls with plural different slopes along the inside walls of the holes,

in the invention of Dickinson et al. as taught by Na, for the purpose of increasing surface area for improving sensitivity in the device of Dickinson et al.

Claims 20 and 21 are rejected under 35 U.S.C. 103 as being unpatentable over Dickinson et al. (US 7,251,386) in view of Kim et al. (US 2010/0288341) in view of Okamoto et al. (US 2010/0308428) in view of Iwai et al. (US 2009/0230498) in view of Giziewicz (US 2016/0240718) in view of Sasahata et al. (US 2009/0225804).

Regarding claim 20, Dickinson teaches the single-chip device of claim 1, however they do not teach:

- in which the holes are at least partly filled with a dielectric material.

Sasahata teaches in Figure 1, where an optical device with holes are filled dielectric material, see paragraph 0050.

Therefore it would have been obvious to one of ordinary skill in the art at the time the invention was made (for Pre-AIA) or before the effective filing date of the claimed invention (for the AIA FITF practice) to have used:

- in which the holes are at least partly filled with a dielectric material,

in the invention of Dickinson et al. as taught by Sasahata, for the purpose of passivating the surfaces to prevent mechanical damage or environmental corrosion.

Regarding claim 21, Dickinson teaches the single-chip device of claim 1, however they do not teach:

- in which the holes are entirely filled with a dielectric material.

Sasahata teaches in Figure 1, where an optical device with holes are filled dielectric material, see paragraph 0050.

Therefore it would have been obvious to one of ordinary skill in the art at the time the invention was made (for Pre-AIA) or before the effective filing date of the claimed invention (for the AIA FITF practice) to have used:

- in which the holes are entirely filled with a dielectric material,

in the invention of Dickinson et al. as taught by Sasahata, for the purpose of passivating the surfaces to prevent mechanical damage or environmental corrosion.

Claim 23 is rejected under 35 U.S.C. 103 as being unpatentable over Dickinson et al. (US 7,251,386) in view of Kim et al. (US 2010/0288341) in view of Okamoto et al. (US 2010/0308428) in view of Iwai et al. (US 2009/0230498) in view of Giziewicz (US 2016/0240718) in view of Shan et al. (US 2007/0277869).

Regarding claim 23, Dickinson teaches the single-chip device of claim 1, however they do not teach:

- in which at least one of the first layer, the second layer, and the intermediate layer comprises a material represented by $\text{Ge}_x\text{Si}_{1-x}$, where x is greater than zero.

Shan teaches in paragraph 0093 discusses SiGe in this manner for use as a light sensitive pn junction device.

Therefore it would have been obvious to one of ordinary skill in the art at the time the invention was made (for Pre-AIA) or before the effective filing date of the claimed invention (for the AIA FITF practice) to have used:

- in which at least one of the first layer, the second layer, and the intermediate layer comprises a material represented by $\text{Ge}_x\text{Si}_{1-x}$, where x is greater than zero,

in the invention of Dickinson as taught by Shan, for the purpose of using a material with high electron mobility which can aid in improving the sensitivity of the device.

Claim 27 is rejected under 35 U.S.C. 103 as being unpatentable over Dickinson et al. (US 7,251,386) in view of Kim et al. (US 2010/0288341) in view of Okamoto et al. (US 2010/0308428) in view of Iwai et al. (US 2009/0230498) in view of Giziewicz (US 2016/0240718) in view of Ertel et al. (US 2013/0084044).

Regarding claim 27, Dickinson teaches the single-chip device of claim 1, however Dickinson does not teach:

- further comprising a light guide to said MSPD configured to bend the optical input from an initial propagation direction to a propagation direction transverse to said layers, and electrical contacts from the active electronic circuit configured to carry said processed output out of the single-chip (output electrodes contained within 115).

Ertel teaches in Fig. 1A:

- further comprising a light guide to said MSPD configured to bend the optical input from an initial propagation direction to a propagation direction transverse to said layers (§ 0042), and electrical contacts from the active electronic circuit configured to carry said processed output out of the single-chip (I/O electrodes contained within 115).

Therefore it would have been obvious to one of ordinary skill in the art at the time the invention was made (for Pre-AIA) or before the effective filing date of the claimed invention (for the AIA FITF practice) to have used:

- further comprising a light guide to said MSPD configured to bend the optical input from an initial propagation direction to a propagation direction transverse to said layers, and electrical contacts from the active electronic circuit configured to carry said processed output out of the single-chip,

in the invention of Dickinson et al. as taught by Benjamin, for the purpose of allowing for electrical and optical means of input and output of information with a flexible light coupling mechanism.

Claim 31 is rejected under 35 U.S.C. 103 as being unpatentable over Dickinson et al. (US 7,251,386) in view of Kim et al. (US 2010/0288341) in view of Okamoto et al. (US 2010/0308428) in view of Iwai et al. (US 2009/0230498) in view of Giziewicz (US 2016/0240718) in view of Raj et al. (US 2013/0230272).

Regarding claim 31, Dickinson teaches the single-chip device of claim 1, however they do not teach:

- further comprising one or more additional active electronic circuits that are formed on or in the said single substrate and comprise one or more transimpedance amplifiers (TIAs) and one or more application specific integrated circuits (ASICs).

Raj teaches the use of ASICS (§ 0054) and TIAs (§ 0039) in optical electrical communication (§ 0028) arrangements.

Therefore it would have been obvious to one of ordinary skill in the art at the time the invention was made (for Pre-AIA) or before the effective filing date of the claimed invention (for the AIA FITF practice) to have used:

- further comprising one or more additional active electronic circuits that are formed on or in the said single substrate and comprise one or more transimpedance amplifiers (TIAs) and one or more application specific integrated circuits (ASICs),

in the invention of Dickinson as taught by Raj, for the purpose of utilizing components which aid in the transfer of information switching between the optical signal domain and the electrical signal domain in a high frequency setting.

Claims 37 and 38 are rejected under 35 U.S.C. 103 as being unpatentable over Dickinson et al. (US 7,251,386) in view of Kim et al. (US 2010/0288341) in view of Okamoto et al. (US

2010/0308428) in view of Iwai et al. (US 2009/0230498) in view of Giziewicz (US 2016/0240718) in view of Choi et al. (US 2010/0059789).

Regarding claims 37 and 38, Dickinson teaches the single-chip device of claim 1, however they do not teach:

- further including a deliberately textured surface at a side of one of said first and second layers facing away from the intermediate layer,

- (and for claim 38) further including a layer of micro-nano structures formed at of one of said first and second facing, at a surface thereof facing away from the intermediate layer.

Choi teaches in many of the Figures including Fig. 9 which has one of the semiconductor layers (300) having a textured surface (220) that is formed away from the active region / intermediate layer (400), and further it is noted that the devices are on a nano scale and any features present will be of the nano size, Kim teaches this in paragraph 0043, wherein the device region is 426 or 325 nanometers, therefore a feature smaller than the device layer itself will be smaller than the noted dimensions of Kim).

Therefore it would have been obvious to one of ordinary skill in the art at the time the invention was made (for Pre-AIA) or before the effective filing date of the claimed invention (for the AIA FITF practice) to have used:

- further including a deliberately textured surface at a side of one of said first and second layers facing away from the intermediate layer,

(and for claim 38) further including a layer of micro-nano structures formed at of one of said first and second facing, at a surface thereof facing away from the intermediate layer,

in the invention of Dickinson et al. as taught by Choi, for the purpose of increasing light conversion efficiency.

Claim 40 is rejected under 35 U.S.C. 103 as being unpatentable over Dickinson et al. (US 7,251,386) in view of Kim et al. (US 2010/0288341) in view of Okamoto et al. (US 2010/0308428) in view of Iwai et al. (US 2009/0230498) in view of Giziewicz (US 2016/0240718) in view of Sahura et al. (US 6,392,282).

Regarding claim 40, Dickinson teaches the single-chip device of claim 1, however they do not teach:

- further including an isolation trench between the MSPD and the active electronic circuit.

Sahura teaches in Fig. 3A wherein the locos shallow trenches are formed between avalanche photodiode and the circuit active region.

Therefore it would have been obvious to one of ordinary skill in the art at the time the invention was made (for Pre-AIA) or before the effective filing date of the claimed invention (for the AIA FITF practice) to have used:

- further including an isolation trench between the MSPD and the active electronic circuit,

in the invention of Dickinson et al. as taught by Sahura, for the purpose of preventing crosstalk between device intended to function separately.

Claim 42 is rejected under 35 U.S.C. 103 as being unpatentable over Dickinson et al. (US 7,251,386) in view of Kim et al. (US 2010/0288341) in view of Okamoto et al. (US 2010/0308428) in view of Iwai et al. (US 2009/0230498) in view of Giziewicz (US 2016/0240718) in view of Tian et al. (US 2008/0080854).

Regarding claim 42, Dickinson et al. teaches the single-chip device of claim 1, however they do not teach:

- wherein the optical input and the electrical output are each modulated at a frequency of at least 30 Gigabits per second.

Tian teaches a device with optical signal frequency operating speeds as claimed in paragraph 0022.

Therefore it would have been obvious to one of ordinary skill in the art at the time the invention was made (for Pre-AIA) or before the effective filing date of the claimed invention (for the AIA FITF practice) to have used:

- wherein the optical input and the electrical output are each modulated at a frequency of at least 30 Gigabits per second,

in the invention of Dickinson as taught by Tian, for the purpose of improving data transfer rates in the device.

Claim 43 is rejected under 35 U.S.C. 103 as being unpatentable over Dickinson et al. (US 7,251,386) in view of Kim et al. (US 2010/0288341) in view of Okamoto et al. (US 2010/0308428) in view of Iwai et al. (US 2009/0230498) in view of Giziewicz (US 2016/0240718) in view of Nakaji et al. (US 2009/0321868).

Regarding claim 43, Dickinson et al. teaches the single-chip device of claim 1, however they do not teach:

- wherein the quantum efficiency of the MSPD that is at least 1.5 times greater than that of an otherwise same photodetector that does not include said holes.

Nikaji teaches in Fig. 5 and 6, a pin photodiode device with optical efficiencies reaching as high 80 plus percent. Further the holes added by Kim would only improve the efficiency above the 80 percent shown by Nikaji.

Therefore it would have been obvious to one of ordinary skill in the art at the time the invention was made (for Pre-AIA) or before the effective filing date of the claimed invention (for the AIA FITF practice) to have used:

- wherein the quantum efficiency of the MSPD that is at least 1.5 times greater than that of an otherwise same photodetector that does not include said holes,

in the invention of Dickinson et al. as taught by Nikaji, for the purpose of improving the sensitivity of the detector.

Claim 44 is rejected under 35 U.S.C. 103 as being unpatentable over Dickinson et al. (US 7,251,386) in view of Kim et al. (US 2010/0288341) in view of Okamoto et al. (US 2010/0308428) in view of Iwai et al. (US 2009/0230498) in view of Giziewicz (US 2016/0240718) in view of Firth et al. (US 2013/0114629).

Regarding claim 44, Dickinson et al. teaches the single-chip device of claim 1, however they do not teach:

- further including a hermetic seal integral with the device.

Firth teaches in paragraph 0057 where it is discussed that the optical and electrical package is hermetically sealed.

Therefore it would have been obvious to one of ordinary skill in the art at the time the invention was made (for Pre-AIA) or before the effective filing date of the claimed invention (for the AIA FITF practice) to have used:

- further including a hermetic seal integral with the device,

in the invention of Dickinson et al. as taught by Firth, for the purpose of preventing mechanical damage or environmental corrosion.

Allowable Subject Matter

Claim 4 is objected to as being dependent upon a rejected base claim, but would be allowable if rewritten in independent form including all of the limitations of the base claim and any intervening claims. While the prior art teaches using overlying layers over the device layers, the prior art does not teach the overlying layer has holes that match with the holes of the device, and therefore does not teach, “in which said overlying layer is present as a superstrate at one side of said first, intermediate, and second layers, and contains said holes”.

Claim 18 is objected to as being dependent upon a rejected base claim, but would be allowable if rewritten in independent form including all of the limitations of the base claim and any intervening claims. The prior art does not teach, “in which at least some of said holes differ from each other in at least one of (i) distance by which the holes extend in said directions, (ii) shape of the holes, and (iii) spacing of the holes from each other”.

Claim 19 is objected to as being dependent upon a rejected base claim, but would be allowable if rewritten in independent form including all of the limitations of the base claim and any intervening claims. The prior art does not teach, “in which the holes are in the intermediate layer and wherein one of said first and second layers conformally covers inside walls of the holes as well as spaces between the holes”.

Claim 25 is objected to as being dependent upon a rejected base claim, but would be allowable if rewritten in independent form including all of the limitations of the base claim and any intervening claims. The prior art does not teach, “in which the MSPD further includes ohmic contacts to said first and second layers, at least one of said ohmic contact being through a via in said substrate”.

Fax / Telephone Information

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Eduardo A. Rodela whose telephone number is (571)272-8797. The examiner can normally be reached on M-F, 9 AM - 5:30 PM.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Tom Thomas can be reached on (571)272-1664. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see <http://pair-direct.uspto.gov>. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

/EDUARDO A RODELA/
Primary Examiner, Art Unit 2893

Doc Code: PET.AUTO Document Description: Petition automatically granted by EFS-Web		PTO/SB/140 U.S. Patent and Trademark Office Department of Commerce
Electronic Petition Request	PETITION TO WITHDRAW AN APPLICATION FROM ISSUE AFTER PAYMENT OF THE ISSUE FEE UNDER 37 CFR 1.313(c)	
Application Number	15797821	
Filing Date	30-Oct-2017	
First Named Inventor	Shih-Yuan WANG	
Art Unit	2893	
Examiner Name	EDUARDO RODELA	
Attorney Docket Number	5176/88184-CIP	
Title	MICROSTRUCTURE ENHANCED ABSORPTION PHOTSENSITIVE DEVICES	
<p>An application may be withdrawn from issue for further action upon petition by the applicant. To request that the Office withdraw an application from issue, applicant must file a petition under this section including the fee set forth in § 1.17(h) and a showing of good and sufficient reasons why withdrawal of the application from issue is necessary.</p> <p>APPLICANT HEREBY PETITIONS TO WITHDRAW THIS APPLICATION FROM ISSUE UNDER 37 CFR 1.313(c).</p> <p>A grantable petition requires the following items:</p> <p>(1) Petition fee; and</p> <p>(2) One of the following reasons:</p> <p>(a) Unpatentability of one or more claims, which must be accompanied by an unequivocal statement that one or more claims are unpatentable, an amendment to such claim or claims, and an explanation as to how the amendment causes such claim or claims to be patentable;</p> <p>(b) Consideration of a request for continued examination in compliance with § 1.114 (for a utility or plant application only); or</p> <p>(c) Express abandonment of the application. Such express abandonment may be in favor of a continuing application, but not a CPA under 37 CFR 1.53(d).</p>		
Petition Fee		
<div style="border: 1px solid black; padding: 5px;"> ☒ Small Entity </div>		
<div style="border: 1px solid black; padding: 5px;"> ☐ Micro Entity </div>		
<div style="border: 1px solid black; padding: 5px;"> ☐ Regular Undiscounted </div>		
Reason for withdrawal from issue		

☐ One or more claims are unpatentable ☒ Consideration of a request for continued examination (RCE) (List of Required Documents and Fees) ☐ Applicant hereby expressly abandons the instant application (any attorney/agent signing for this reason must have power of attorney pursuant to 37 CFR 1.32(b)).	
RCE request, submission, and fee. <div style="margin-left: 20px;"> ☐ I certify, in accordance with 37 CFR 1.4(d)(4) that : The RCE request ,submission, and fee have already been filed in the above-identified application on Are attached. ☒ </div>	
THIS PORTION MUST BE COMPLETED BY THE SIGNATORY OR SIGNATORIES I certify, in accordance with 37 CFR 1.4(d)(4) that I am: <div style="margin-left: 20px;"> ☐ An attorney or agent registered to practice before the Patent and Trademark Office who has been given power of attorney in this application. ☒ An attorney or agent registered to practice before the Patent and Trademark Office, acting in a representative capacity. ☐ A sole inventor ☐ A joint inventor; I certify that I am authorized to sign this submission on behalf of all of the inventors as evidenced by the power of attorney in the application ☐ A joint inventor; all of whom are signing this e-petition </div>	
Signature	/Ivan S. Kavrukov/
Name	Ivan S. Kavrukov
Registration Number	25161

Electronic Patent Application Fee Transmittal				
Application Number:		15797821		
Filing Date:		30-Oct-2017		
Title of Invention:		MICROSTRUCTURE ENHANCED ABSORPTION PHOTOSENSITIVE DEVICES		
First Named Inventor/Applicant Name:		Shih-Yuan WANG		
Filer:		Ivan Kavrukov/Thomas Trainor		
Attorney Docket Number:		5176/88184-CIP		
Filed as Small Entity				
Filing Fees for Utility under 35 USC 111(a)				
Description	Fee Code	Quantity	Amount	Sub-Total in USD(\$)
Basic Filing:				
PETITION FEE-37CFR 1.17(H) (GROUP II)	2464	1	70	70
RCE- 1ST REQUEST	2801	1	650	650
Pages:				
Claims:				
Miscellaneous-Filing:				
Petition:				
Patent-Appeals-and-Interference:				

Description	Fee Code	Quantity	Amount	Sub-Total in USD(\$)
Post-Allowance-and-Post-Issuance:				
Extension-of-Time:				
Miscellaneous:				
Total in USD (\$)				720

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

Application Data Sheet 37 CFR 1.76		Attorney Docket Number	5176/88184-CIP
		Application Number	15/797821
Title of Invention	MICROSTRUCTURE ENHANCED ABSORPTION PHOTSENSITIVE DEVICES		
<p>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.</p> <p>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.</p>			

Secrecy Order 37 CFR 5.2:

☐	Portions or all of the application associated with this Application Data Sheet may fall under a Secrecy Order pursuant to 37 CFR 5.2 (Paper filers only. Applications that fall under Secrecy Order may not be filed electronically.)
--------------------------	---

Inventor Information:

Inventor 1 Remove					
Legal Name					
Prefix	Given Name	Middle Name	Family Name	Suffix	
	Shih-Yuan		WANG		
Residence Information (Select One) ☒ US Residency ☐ Non US Residency ☐ Active US Military Service					
City	Palo Alto	State/Province	CA	Country of Residence	US
Mailing Address of Inventor:					
Address 1		766 Encina Grande Dr.			
Address 2					
City	Palo Alto	State/Province			
Postal Code	94306	Country	US		
Inventor 2 Remove					
Legal Name					
Prefix	Given Name	Middle Name	Family Name	Suffix	
	Shih-Ping		WANG		
Residence Information (Select One) ☒ US Residency ☐ Non US Residency ☐ Active US Military Service					
City	Los Altos	State/Province	CA	Country of Residence	US
Mailing Address of Inventor:					
Address 1		38 3rd Street, Suite #307			
Address 2					
City	Los Altos	State/Province			
Postal Code	94022	Country	US		
Inventor 3 Remove					
Legal Name					
Prefix	Given Name	Middle Name	Family Name	Suffix	
	M. Saif		ISLAM		
Residence Information (Select One) ☒ US Residency ☐ Non US Residency ☐ Active US Military Service					

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

Application Data Sheet 37 CFR 1.76		Attorney Docket Number	5176/88184-CIP		
		Application Number	15/797821		
Title of Invention	MICROSTRUCTURE ENHANCED ABSORPTION PHOTOSENSITIVE DEVICES				
City	Davis	State/Province	CA	Country of Residence	US
Mailing Address of Inventor:					
Address 1	3038 Mallorca Ln.				
Address 2					
City	Davis	State/Province	CA		
Postal Code	95618	Country	US		
All Inventors Must Be Listed - Additional Inventor Information blocks may be generated within this form by selecting the Add button.					

Correspondence Information:

Enter either Customer Number or complete the Correspondence Information section below. For further information see 37 CFR 1.33(a).	
☐ An Address is being provided for the correspondence Information of this application.	
Customer Number	23432
Email Address	pdocketing@cooperdunham.com Add Email Remove Email

Application Information:

Title of the Invention	MICROSTRUCTURE ENHANCED ABSORPTION PHOTOSENSITIVE DEVICES		
Attorney Docket Number	5176/88184-CIP	Small Entity Status Claimed	☒
Application Type	Nonprovisional		
Subject Matter	Utility		
Total Number of Drawing Sheets (if any)	131	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	5176/88184-CIP
		Application Number	15/797821
Title of Invention	MICROSTRUCTURE ENHANCED ABSORPTION PHOTOSENSITIVE DEVICES		

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	23432		

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	Pending	Remove	
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
15797821	Continuation in part of	15309922	2016-11-09
Prior Application Status	Pending	Remove	
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
15309922	a 371 of international	PCT/US2015/061120	2015-11-17
Prior Application Status	Expired	Remove	
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
PCT/US2015/061120	Claims benefit of provisional	62081538	2014-11-18
Prior Application Status	Expired	Remove	
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
PCT/US2015/061120	Claims benefit of provisional	62090879	2014-12-11
Prior Application Status	Expired	Remove	
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
PCT/US2015/061120	Claims benefit of provisional	62100025	2015-01-05

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

Application Data Sheet 37 CFR 1.76		Attorney Docket Number	5176/88184-CIP
		Application Number	15/797821
Title of Invention	MICROSTRUCTURE ENHANCED ABSORPTION PHOTSENSITIVE DEVICES		

Prior Application Status	Expired	Remove	
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
PCT/US2015/061120	Claims benefit of provisional	62111582	2015-02-03
Prior Application Status	Expired	Remove	
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
PCT/US2015/061120	Claims benefit of provisional	62139511	2015-03-27
Prior Application Status	Expired	Remove	
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
PCT/US2015/061120	Claims benefit of provisional	62153443	2015-04-27
Prior Application Status	Expired	Remove	
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
PCT/US2015/061120	Claims benefit of provisional	62154675	2015-04-29
Prior Application Status	Expired	Remove	
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
PCT/US2015/061120	Claims benefit of provisional	62157876	2015-05-06
Prior Application Status	Expired	Remove	
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
PCT/US2015/061120	Claims benefit of provisional	62171915	2015-06-05
Prior Application Status	Expired	Remove	
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
PCT/US2015/061120	Claims benefit of provisional	62174498	2015-06-11
Prior Application Status	Expired	Remove	
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
PCT/US2015/061120	Claims benefit of provisional	62175855	2015-06-15
Prior Application Status	Expired	Remove	
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
PCT/US2015/061120	Claims benefit of provisional	62182602	2015-06-21

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

Application Data Sheet 37 CFR 1.76		Attorney Docket Number	5176/88184-CIP
		Application Number	15/797821
Title of Invention	MICROSTRUCTURE ENHANCED ABSORPTION PHOTOSENSITIVE DEVICES		

Prior Application Status	Expired	Remove			
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)		
PCT/US2015/061120	Claims benefit of provisional	62188876	2015-06-21 2015-07-06		
Prior Application Status	Expired	Remove			
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)		
PCT/US2015/061120	Claims benefit of provisional	62197120	2015-07-27		
Prior Application Status	Expired	Remove			
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)		
PCT/US2015/061120	Claims benefit of provisional	62199607	2015-07-31		
Prior Application Status	Expired	Remove			
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)		
PCT/US2015/061120	Claims benefit of provisional	62205717	2015-08-15		
Prior Application Status	Expired	Remove			
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)		
PCT/US2015/061120	Claims benefit of provisional	62209311	2015-08-24		
Prior Application Status	Expired	Remove			
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)		
PCT/US2015/061120	Claims benefit of provisional	62213556	2015-09-02		
Prior Application Status	Expired	Remove			
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)		
PCT/US2015/061120	Claims benefit of provisional	62232716	2015-09-25		
Prior Application Status	Patented	Remove			
Application Number	Continuity Type	Prior Application Number	Filing Date (YYYY-MM-DD)	Patent Number	Issue Date (YYYY-MM-DD)
15309922	Continuation of	14943898	2015-11-17	9530905	2016-12-27
Prior Application Status	Expired	Remove			
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)		
14943898	Claims benefit of provisional	620181538 62081538	2014-11-18		

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

Application Data Sheet 37 CFR 1.76		Attorney Docket Number	5176/88184-CIP
		Application Number	15/797821
Title of Invention	MICROSTRUCTURE ENHANCED ABSORPTION PHOTOSENSITIVE DEVICES		

Prior Application Status	Expired	Remove	
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
14943898	Claims benefit of provisional	62090879	2014-12-11
Prior Application Status	Expired	Remove	
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
14943898	Claims benefit of provisional	62100025	2015-01-05
Prior Application Status	Expired	Remove	
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
14943898	Claims benefit of provisional	62111582	2015-02-03
Prior Application Status	Expired	Remove	
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
14943898	Claims benefit of provisional	62139511	2015-03-27
Prior Application Status	Expired	Remove	
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
14943898	Claims benefit of provisional	62153443	2015-04-27
Prior Application Status	Expired	Remove	
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
14943898	Claims benefit of provisional	62154675	2015-04-29
Prior Application Status	Expired	Remove	
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
14943898	Claims benefit of provisional	62157876	2015-05-06
Prior Application Status	Expired	Remove	
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
14943898	Claims benefit of provisional	62171915	2015-06-05
Prior Application Status	Expired	Remove	
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
14943898	Claims benefit of provisional	62174498	2015-06-11

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

Application Data Sheet 37 CFR 1.76		Attorney Docket Number	5176/88184-CIP
		Application Number	15/797821
Title of Invention	MICROSTRUCTURE ENHANCED ABSORPTION PHOTOSENSITIVE DEVICES		

Prior Application Status	Expired	Remove	
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
14943898	Claims benefit of provisional	62175855	2015-06-15
Prior Application Status	Expired	Remove	
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
14943898	Claims benefit of provisional	62182602	2015-06-21
Prior Application Status	Expired	Remove	
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
14943898	Claims benefit of provisional	62188876	2015-07-06
Prior Application Status	Expired	Remove	
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
14943898	Claims benefit of provisional	62197120	2015-07-27
Prior Application Status	Expired	Remove	
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
14943898	Claims benefit of provisional	62199607	2015-07-31
Prior Application Status	Expired	Remove	
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
14943898	Claims benefit of provisional	62205717	2015-08-15
Prior Application Status	Expired	Remove	
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
14943898	Claims benefit of provisional	62209311	2015-08-24
Prior Application Status	Expired	Remove	
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
14943898	Claims benefit of provisional	62213556	2015-09-02
Prior Application Status	Expired	Remove	
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
14943898	Claims benefit of provisional	62232716	2015-09-25

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

Application Data Sheet 37 CFR 1.76		Attorney Docket Number	5176/88184-CIP
		Application Number	15/797821
Title of Invention	MICROSTRUCTURE ENHANCED ABSORPTION PHOTOSENSITIVE DEVICES		

Prior Application Status	Patented	Remove	
Application Number	Continuity Type	Prior Application Number	Filing Date (YYYY-MM-DD)
15309922	Continuation of	14945003	2015-11-17 2015-11-18
Prior Application Status	Expired	Remove	
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
14945003	Claims benefit of provisional	62081538	2014-11-18
Prior Application Status	Expired	Remove	
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
14945003	Claims benefit of provisional	62090879	2014-12-11
Prior Application Status	Expired	Remove	
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
14945003	Claims benefit of provisional	62100025	2015-01-05
Prior Application Status	Expired	Remove	
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
14945003	Claims benefit of provisional	62111582	2015-02-03
Prior Application Status	Expired	Remove	
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
14945003	Claims benefit of provisional	62139511	2015-03-27
Prior Application Status	Expired	Remove	
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
14945003	Claims benefit of provisional	62153443	2015-04-27
Prior Application Status	Expired	Remove	
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
14945003	Claims benefit of provisional	62157876	2015-05-06
Prior Application Status	Expired	Remove	
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
14945003	Claims benefit of provisional	62154675	2015-04-29

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

Application Data Sheet 37 CFR 1.76		Attorney Docket Number	5176/88184-CIP
		Application Number	15/797821
Title of Invention	MICROSTRUCTURE ENHANCED ABSORPTION PHOTOSENSITIVE DEVICES		

Prior Application Status	Expired	Remove	
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
14945003	Claims benefit of provisional	62157876	2015-05-06
Prior Application Status	Expired	Remove	
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
14945003	Claims benefit of provisional	62171915	2015-06-05
Prior Application Status	Expired	Remove	
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
14945003	Claims benefit of provisional	62174498	2015-06-11
Prior Application Status	Expired	Remove	
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
14945003	Claims benefit of provisional	62175855	2015-06-15
Prior Application Status	Expired	Remove	
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
14945003	Claims benefit of provisional	62182602	2015-06-21
Prior Application Status	Expired	Remove	
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
14945003	Claims benefit of provisional	62188876	2015-07-06
Prior Application Status	Expired	Remove	
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
14945003	Claims benefit of provisional	62197120	2015-07-27
Prior Application Status	Expired	Remove	
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
14945003	Claims benefit of provisional	62199607	2015-07-31
Prior Application Status	Expired	Remove	
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
14945003	Claims benefit of provisional	62205717	2015-08-15

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

Application Data Sheet 37 CFR 1.76		Attorney Docket Number	5176/88184-CIP
		Application Number	15/797821
Title of Invention	MICROSTRUCTURE ENHANCED ABSORPTION PHOTOSENSITIVE DEVICES		

Prior Application Status	Expired	Remove	
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
14945003	Claims benefit of provisional	62209311	2015-08-24
Prior Application Status	Expired	Remove	
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
14945003	Claims benefit of provisional	62213556	2015-09-02
Prior Application Status	Expired	Remove	
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
14945003	Claims benefit of provisional	62232716	2015-09-25
Prior Application Status	Pending	Remove	
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
15797821	Continuation in part of	PCT/US2016/67977	2016-12-21
Prior Application Status	Pending	Remove	
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
PCT/US2016/67977	Claims benefit of provisional	62415339	2016-10-31
Prior Application Status	Pending Expired	Remove	
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
PCT/US2016/67977	Claims benefit of provisional	62270577	2016-12-21 2015-12-21
Prior Application Status	Pending	Remove	
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
15797821	Continuation in part of	14947718	2015-11-20
Prior Application Status	Expired	Remove	
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
14947718	Continuation of	PCT/US2014/039208	2014-05-22
Prior Application Status	Expired	Remove	
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
PCT/US2014/039208	Claims benefit of provisional	61826446	2013-05-05 2013-05-22

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

Application Data Sheet 37 CFR 1.76		Attorney Docket Number	5176/88184-CIP
		Application Number	15/797821
Title of Invention	MICROSTRUCTURE ENHANCED ABSORPTION PHOTSENSITIVE DEVICES		

Prior Application Status	Expired	Remove	
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
PCT/US2014/039208	Claims benefit of provisional	61834873	2013-06-13
Prior Application Status	Expired	Remove	
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
PCT/US2014/039208	Claims benefit of provisional	61843021	2013-07-04
Prior Application Status	Expired	Remove	
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
PCT/US2014/039208	Claims benefit of provisional	61905109	2013-11-15
Prior Application Status	<u>Expired</u>	Remove	
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
<u>PCT/US16/67977</u>	<u>Claims benefit of provisional</u>	<u>62290391</u>	<u>2016-02-02</u>
Prior Application Status	<u>Expired</u>	Remove	
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
<u>PCT/US16/67977</u>	<u>Claims benefit of provisional</u>	<u>62304907</u>	<u>2016-03-07</u>
Prior Application Status	<u>Expired</u>	Remove	
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
<u>PCT/US16/67977</u>	<u>Claims benefit of provisional</u>	<u>62334934</u>	<u>2016-05-11</u>
Prior Application Status	<u>Expired</u>	Remove	
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
<u>PCT/US16/67977</u>	<u>Claims benefit of provisional</u>	<u>62338263</u>	<u>2016-05-18</u>
Prior Application Status	<u>Expired</u>	Remove	
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
<u>PCT/US16/67977</u>	<u>Claims benefit of provisional</u>	<u>62346850</u>	<u>2016-06-07</u>
Prior Application Status	<u>Expired</u>	Remove	
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
<u>PCT/US16/67977</u>	<u>Claims benefit of provisional</u>	<u>62359349</u>	<u>2016-07-07</u>

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

Application Data Sheet 37 CFR 1.76		Attorney Docket Number	5176/88184-CIP
		Application Number	15/797821
Title of Invention	MICROSTRUCTURE ENHANCED ABSORPTION PHOTOSENSITIVE DEVICES		

Prior Application Status	<u>Expired</u>	Remove	
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
<u>PCT/US16/67977</u>	<u>Claims benefit of provisional</u>	<u>62366188</u>	<u>2016-07-25</u>
Prior Application Status	<u>Expired</u>	Remove	
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
<u>PCT/US16/67977</u>	<u>Claims benefit of provisional</u>	<u>62368109</u>	<u>2016-07-28</u>
Prior Application Status	<u>Expired</u>	Remove	
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
<u>PCT/US16/67977</u>	<u>Claims benefit of provisional</u>	<u>62374828</u>	<u>2016-08-13</u>
Prior Application Status	<u>Expired</u>	Remove	
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
<u>PCT/US16/67977</u>	<u>Claims benefit of provisional</u>	<u>62376869</u>	<u>2016-08-18</u>
Prior Application Status	<u>Expired</u>	Remove	
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
<u>PCT/US16/67977</u>	<u>Claims benefit of provisional</u>	<u>62380364</u>	<u>2016-08-27</u>
Prior Application Status	<u>Expired</u>	Remove	
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
<u>PCT/US16/67977</u>	<u>Claims benefit of provisional</u>	<u>62383391</u>	<u>2016-09-03</u>
Prior Application Status	<u>Expired</u>	Remove	
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
<u>PCT/US16/67977</u>	<u>Claims benefit of provisional</u>	<u>62383479</u>	<u>2016-09-04</u>
Prior Application Status	<u>Expired</u>	Remove	
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
<u>PCT/US16/67977</u>	<u>Claims benefit of provisional</u>	<u>62394222</u>	<u>2016-09-14</u>
Prior Application Status	<u>Expired</u>	Remove	
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
<u>PCT/US16/67977</u>	<u>Claims benefit of provisional</u>	<u>62398607</u>	<u>2016-09-23</u>

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

Application Data Sheet 37 CFR 1.76		Attorney Docket Number	5176/88184-CIP
		Application Number	15/797821
Title of Invention	MICROSTRUCTURE ENHANCED ABSORPTION PHOTSENSITIVE DEVICES		

Prior Application Status	<u>Expired</u>	Remove	
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
<u>PCT/US16/67977</u>	<u>Claims benefit of provisional</u>	<u>62401126</u>	<u>2016-09-28</u>
Prior Application Status	<u>Expired</u>	Remove	
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
<u>PCT/US16/67977</u>	<u>Claims benefit of provisional</u>	<u>62406999</u>	<u>2016-10-12</u>
Prior Application Status	<u>Expired</u>	Remove	
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
<u>PCT/US16/67977</u>	<u>Claims benefit of provisional</u>	<u>62414671</u>	<u>2016-10-29</u>
Prior Application Status	<u>Pending</u>	Remove	
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
<u>15797821</u>	<u>Claims benefit of provisional</u>	<u>62465734</u>	<u>2017-03-01</u>
Prior Application Status	<u>Pending</u>	Remove	
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
<u>15797821</u>	<u>Claims benefit of provisional</u>	<u>62474179</u>	<u>2017-03-21</u>
Prior Application Status	<u>Pending</u>	Remove	
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
<u>15797821</u>	<u>Claims benefit of provisional</u>	<u>62484474</u>	<u>2017-04-12</u>
Prior Application Status	<u>Pending</u>	Remove	
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
<u>15797821</u>	<u>Claims benefit of provisional</u>	<u>62487606</u>	<u>2017-04-20</u>
Prior Application Status	<u>Pending</u>	Remove	
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
<u>15797821</u>	<u>Claims benefit of provisional</u>	<u>62488998</u>	<u>2017-04-24</u>
Prior Application Status	<u>Pending</u>	Remove	
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
<u>15797821</u>	<u>Claims benefit of provisional</u>	<u>62500581</u>	<u>2017-05-03</u>

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

Application Data Sheet 37 CFR 1.76		Attorney Docket Number	5176/88184-CIP
		Application Number	15/797821
Title of Invention	MICROSTRUCTURE ENHANCED ABSORPTION PHOTSENSITIVE DEVICES		

Prior Application Status	<u>Pending</u>	Remove	
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
<u>15797821</u>	<u>Claims benefit of provisional</u>	<u>62505974</u>	<u>2017-05-14</u>
Prior Application Status	<u>Pending</u>	Remove	
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
<u>15797821</u>	<u>Claims benefit of provisional</u>	<u>62509093</u>	<u>2017-05-20</u>
Prior Application Status	<u>Pending</u>	Remove	
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
<u>15797821</u>	<u>Claims benefit of provisional</u>	<u>62510249</u>	<u>2017-05-23</u>
Prior Application Status	<u>Pending</u>	Remove	
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
<u>15797821</u>	<u>Claims benefit of provisional</u>	<u>62514889</u>	<u>2017-06-04</u>
Prior Application Status	<u>Pending</u>	Remove	
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
<u>15797821</u>	<u>Claims benefit of provisional</u>	<u>62521504</u>	<u>2017-06-18</u>
Prior Application Status	<u>Pending</u>	Remove	
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
<u>15797821</u>	<u>Claims benefit of provisional</u>	<u>62522169</u>	<u>2017-06-20</u>
Prior Application Status	<u>Pending</u>	Remove	
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
<u>15797821</u>	<u>Claims benefit of provisional</u>	<u>62527962</u>	<u>2017-06-30</u>
Prior Application Status	<u>Pending</u>	Remove	
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
<u>15797821</u>	<u>Claims benefit of provisional</u>	<u>62530281</u>	<u>2017-07-09</u>
Prior Application Status	<u>Pending</u>	Remove	
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
<u>15797821</u>	<u>Claims benefit of provisional</u>	<u>62533078</u>	<u>2017-07-16</u>

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

Application Data Sheet 37 CFR 1.76		Attorney Docket Number	5176/88184-CIP
		Application Number	15/797821
Title of Invention	MICROSTRUCTURE ENHANCED ABSORPTION PHOTOSENSITIVE DEVICES		

Prior Application Status	<u>Pending</u>	Remove	
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
<u>15797821</u>	<u>Claims benefit of provisional</u>	<u>62533603</u>	<u>2017-07-17</u>
Prior Application Status	<u>Pending</u>	Remove	
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
<u>15797821</u>	<u>Claims benefit of provisional</u>	<u>62535801</u>	<u>2017-07-21</u>
Prior Application Status	<u>Pending</u>	Remove	
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
<u>15797821</u>	<u>Claims benefit of provisional</u>	<u>62540524</u>	<u>2017-08-02</u>
Prior Application Status	<u>Pending</u>	Remove	
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
<u>15797821</u>	<u>Claims benefit of provisional</u>	<u>62542243</u>	<u>2017-08-07</u>
Prior Application Status	<u>Pending</u>	Remove	
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
<u>15797821</u>	<u>Claims benefit of provisional</u>	<u>62547728</u>	<u>2017-08-18</u>
Prior Application Status	<u>Pending</u>	Remove	
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
<u>15797821</u>	<u>Claims benefit of provisional</u>	<u>62553844</u>	<u>2017-09-02</u>
Prior Application Status	<u>Pending</u>	Remove	
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
<u>15797821</u>	<u>Claims benefit of provisional</u>	<u>62556426</u>	<u>2017-09-10</u>
Prior Application Status	<u>Pending</u>	Remove	
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
<u>15797821</u>	<u>Claims benefit of provisional</u>	<u>62561869</u>	<u>2017-09-22</u>
Additional Domestic Benefit/National Stage Data may be generated within this form by selecting the Add button.			

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

Application Data Sheet 37 CFR 1.76		Attorney Docket Number	5176/88184-CIP
		Application Number	15/797821
Title of Invention	MICROSTRUCTURE ENHANCED ABSORPTION PHOTOSENSITIVE DEVICES		

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)¹ 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)	Access Code ^j (if applicable)

Additional Foreign Priority Data may be generated within this form by selecting the **Add** button.

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

<p>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.</p> <p>☐ 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.</p>
--

Application Data Sheet 37 CFR 1.76		Attorney Docket Number	5176/88184-CIP
		Application Number	15/797821
Title of Invention	MICROSTRUCTURE ENHANCED ABSORPTION PHOTSENSITIVE DEVICES		

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.

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

Application Data Sheet 37 CFR 1.76		Attorney Docket Number	5176/88184-CIP
		Application Number	15/797821
Title of Invention	MICROSTRUCTURE ENHANCED ABSORPTION PHOTOSENSITIVE DEVICES		

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			
<p>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.</p>			
<input type="button" value="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: <input type="text"/>			
If the Applicant is an Organization check here. ☒			
Organization Name	W&WSens, Devices Inc.		
Mailing Address Information For Applicant:			
Address 1	W&WSens, Devices Inc.		
Address 2	4546 El Camino Real, Suite 215		
City	Los Altos	State/Province	CA
Country	US	Postal Code	94022
Phone Number		Fax Number	
Email Address			
Additional Applicant Data may be generated within this form by selecting the Add button.			

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.

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

Application Data Sheet 37 CFR 1.76		Attorney Docket Number	5176/88184-CIP
		Application Number	15/797821
Title of Invention	MICROSTRUCTURE ENHANCED ABSORPTION PHOTSENSITIVE DEVICES		

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.

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.

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	/Ivan S. Kavrukov/		Date (YYYY-MM-DD)	2019-03-14
First Name	Ivan	Last Name	Kavrukov	Registration Number
25,161				

Additional Signature may be generated within this form by selecting the Add button.

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

Application Data Sheet 37 CFR 1.76		Attorney Docket Number	5176/88184-CIP
		Application Number	15/797821
Title of Invention	MICROSTRUCTURE ENHANCED ABSORPTION PHOTOSENSITIVE DEVICES		

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.**

PATENT COOPERATION TREATY

PCT

INTERNATIONAL SEARCH REPORT

(PCT Article 18 and Rules 43 and 44)

Applicant's or agent's file reference 88184-CIP-PCT	FOR FURTHER ACTION see Form PCT/ISA/220 as well as, where applicable, item 5 below.	
International application No. PCT/US18/57963	International filing date (day/month/year) 29 October 2018 (29.10.2018)	(Earliest) Priority Date (day/month/year) 30 October 2017 (30.10.2017)
Applicant W&Wsens Devices 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 9 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. 4

☐ 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.

Form PCT/ISA/210 (first sheet) (January 2015)

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US18/57963

A. CLASSIFICATION OF SUBJECT MATTER IPC - G02B 1/00; H01L 31/00, 31/02, 31/0248, 31/0352 (2018.01) CPC - G02B 1/002, 1/005, 6/42; H01L 31/00, 31/0236, 27/144 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 See Search History document 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 2017/0194522 A1 (WANG, S et al.) 6 July 2017; figures 42, 44 & 52, paragraphs [0037], [0041], [0094], [0150], [0163], [0171]-[0172], [0217], [0200], [0222]-[0223], [0225], [0231], [0237], [0246], [0262], [0288], [0316]-[0317], [0331], [0341], claims 81-82, 86 & 91	1-18
A	US 9,360,554 B2 (FACET TECHNOLOGY CORP) 7 June 2016; abstract, column 9, lines 1-25, claim 1	1-18
A	US 8,728,847 B2 (MARUYAMA, Y et al.) 20 May 2014 ; abstrct, column 7, lines 30-55, claim 1	1-18
☐ 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 09 December 2018 (09.12.2018)		Date of mailing of the international search report 15 JAN 2019
Name and mailing address of the ISA/ Mail Stop PCT, Attn: ISA/US, Commissioner for Patents P.O. Box 1450, Alexandria, Virginia 22313-1450 Facsimile No. 571-273-8300		Authorized officer Shane Thomas PCT Helpdesk: 571-272-4300 PCT OSP: 571-272-7774

Form PCT/ISA/210 (second sheet) (January 2015)

Electronic Acknowledgement Receipt

EFS ID:	35424122
Application Number:	15797821
International Application Number:	
Confirmation Number:	1009
Title of Invention:	MICROSTRUCTURE ENHANCED ABSORPTION PHOTOSENSITIVE DEVICES
First Named Inventor/Applicant Name:	Shih-Yuan WANG
Customer Number:	23432
Filer:	Ivan Kavrukov/Thomas Trainor
Filer Authorized By:	Ivan Kavrukov
Attorney Docket Number:	5176/88184-CIP
Receipt Date:	14-MAR-2019
Filing Date:	30-OCT-2017
Time Stamp:	14:55:24
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	DA
Payment was successfully received in RAM	\$ 720
RAM confirmation Number	031519INTEFSW00001293033125
Deposit Account	
Authorized User	

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

File Listing:					
Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Petition automatically granted by EFS	petition-request.pdf	31579	no	2
			ea331bc35e67e184ebe54a952373f633f30b9ef3		
Warnings:					
Information:					
2	Request for Continued Examination (RCE)	88184-CIP--RCE.pdf	1350078	no	3
			8111b632cb3047ad8f8f33e06b1892bec79ad724		
Warnings:					
Information:					
3		88184-CIP--IDS.pdf	253955	yes	6
			e8bb898501fe7e262953ed6f80773b961e76ed0a		
	Multipart Description/PDF files in .zip description				
	Document Description		Start	End	
	Transmittal Letter		1	2	
	Information Disclosure Statement (IDS) Form (SB08)		3	6	
Warnings:					
Information:					
4	Other Reference-Patent/App/Search documents	2018July16_EuropeanSearchReport_158615930.pdf	208894	no	5
			b839c81d37d5b68a7677d1b204694f7e51508d92		
Warnings:					
Information:					
5	Other Reference-Patent/App/Search documents	2019Jan8_officialAction_JP2016-515097.pdf	1274464	no	17
			94f566e294360c9ded4b9fe19c590c7fe064485e		
Warnings:					
Information:					

6	Non Patent Literature	PCTUS2018043289_2019Feb12_ISR.pdf	112340	no	2
			6605a21221d02de3394e5423f434376e9296c95d		
Warnings:					
Information:					
7	Non Patent Literature	PCTUS2018057963_2019Jan15_ISR.pdf	106604	no	2
			d9f047b7de4371927224eb1e4d42c7e843bdac245		
Warnings:					
Information:					
8	Foreign Reference	JP2003142778A.pdf	668621	no	21
			3c867f0f4d18fc68d4d7cd9a377c3ccf3986aac14		
Warnings:					
Information:					
9	Foreign Reference	JP2012502466A.pdf	978881	no	23
			c1fce1319fa1747db3c7d69c8d991536cd1f89c6		
Warnings:					
Information:					
10	Foreign Reference	JP6-53424.pdf	467038	no	8
			bb42d02e45da0f7cfd114f3bd98fbbd7e45a160f		
Warnings:					
Information:					
11	Non Patent Literature	Ackert_10Gbpsiliconwaveguide-integratedinfraredavalanchephotodiode.pdf	582404	no	8
			ad0e0b31d6b40bf28b1bc20f59088420c8394a4c		
Warnings:					
Information:					
12	Non Patent Literature	Houng_CharacterizationoftheNonporousTemplateUsingAnodicAluminaMethod.pdf	1226459	no	8
			faf229abfec2d0c141eab81c225429945ef419b6		
Warnings:					
Information:					

13	Amendment Submitted/Entered with Filing of CPA/RCE	88184-CIP--Petition.pdf	413468	no	9
			8681745a08680ce44105c80662eea08f892f41c2		
Warnings:					
Information:					
14	Amendment Submitted/Entered with Filing of CPA/RCE	88184-CIP_correctedADS.pdf	2379317	no	20
			0bd02fd19bac7ede84a657703d53fa289b8e1f0e		
Warnings:					
Information:					
15	Fee Worksheet (SB06)	fee-info.pdf	32352	no	2
			7daae4184632099205fef6af14113995ae578eb2		
Warnings:					
Information:					
Total Files Size (in bytes):			10086454		
<p>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.</p> <p><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.</p> <p><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.</p> <p><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.</p>					



UNITED STATES PATENT AND TRADEMARK OFFICE

Commissioner for Patents
United States Patent and Trademark Office
P.O. Box 1450
Alexandria, VA 22313-1450
www.uspto.gov

Decision Date : March 14, 2019

In re Application of :

Shih-Yuan WANG

DECISION ON PETITION

UNDER CFR 1.313(c)(2)

Application No : 15797821

Filed : 30-Oct-2017

Attorney Docket No : 5176/88184-CIP

This is an electronic decision on the petition under 37 CFR 1.313(c)(2), filed March 14, 2019 , to withdraw the above-identified application from issue after payment of the issue fee.

The petition is **GRANTED**.

The above-identified application is withdrawn from issue for consideration of a submission under 37 CFR 1.114 (request for continued examination). See 37 CFR 1.313(c)(2).

Petitioner is advised that the issue fee paid in this application cannot be refunded. If, however, this application is again allowed, petitioner may request that it be applied towards the issue fee required by the new Notice of Allowance.

Telephone inquiries concerning this decision should be directed to the Patent Electronic Business Center (EBC) at 866-217-9197.

This application file is being referred to Technology Center AU 2893 for processing of the request for continuing examination under 37 CFR 1.114 .

Office of Petitions

(19) 日本国特許庁 (J P)

(12) 公開特許公報 (A)

(11) 特許出願公開番号

特開2003-142778

(P2003-142778A)

(43) 公開日 平成15年5月16日 (2003.5.16)

(51) Int.Cl.⁷

識別記号

F I

データベース* (参考)

H 0 1 S 5/20

H 0 1 S 5/20

5 F 0 7 3

5/026

6 5 0

5/026

6 5 0

審査請求 未請求 請求項の数14 O L 外国語出願 (全 21 頁)

(21) 出願番号 特願2002-257353(P2002-257353)

(22) 出願日 平成14年9月3日 (2002.9.3)

(31) 優先権主張番号 0 1 1 1 6 3 8

(32) 優先日 平成13年9月5日 (2001.9.5)

(33) 優先権主張国 フランス (F R)

(71) 出願人 391030332

アルカテル

フランス国、75008 パリ、リュ・ラ・ボ

エティ 54

(72) 発明者 レオン・ゴールドスタン

フランス国、92370・シヤビル、アレ・ド

ユ・コロンビエ、1

(72) 発明者 クリストフ・ウジエ

フランス国、92160・アントニー、アブニ

ユ・ドウ・ラ・プロビダンス・28

(74) 代理人 100062007

弁理士 川口 義雄 (外4名)

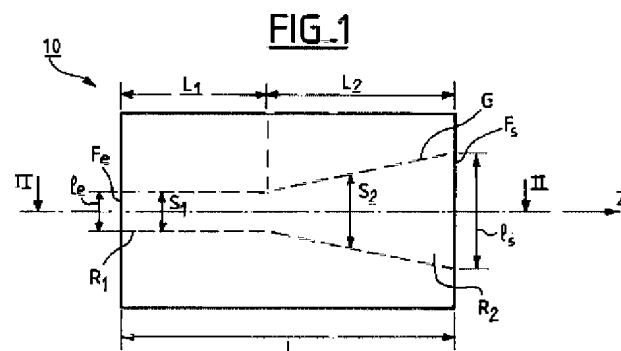
最終頁に続く

(54) 【発明の名称】 半導体光部品およびその製造方法

(57) 【要約】

【課題】 ドーピングがp型ドーピングであるようにアクセプタドーパントを含む半導体材料閉込め層を備える半導体光部品を提供すること。

【解決手段】 閉込め層は、別の半導体層の上に堆積され、この別の半導体層に平行な面を画定する。さらに、閉込め層のp型ドーピング濃度は、この面内の一方向でゼロと著しく異なる少なくとも1つの勾配を有する。この部品を製造する方法もまた開示される。



【特許請求の範囲】

【請求項1】 ドーピングがp型ドーピングであるようにアクセプタドーパントを含む半導体材料の閉込め層を備える半導体光部品であって、前記閉込め層が、別の半導体層の上に堆積され、前記別の半導体層に平行な面を画定し、前記閉込め層のp型ドーピング濃度が、前記面内の一方においてゼロと著しく異なる少なくとも1つの勾配を有する半導体光部品。

【請求項2】 前記一方が、光伝搬軸である請求項1に記載の半導体光部品。

【請求項3】 前記勾配の符号が、負である請求項2に記載の半導体光部品。

【請求項4】 前記半導体材料が、前記一方の全体にわたってアクセプタ濃度よりも低い濃度のドナーをさらに含む請求項3に記載の半導体光部品。

【請求項5】 前記アクセプタが、亜鉛、マグネシウム、およびカドミウムから選ばれる請求項4に記載の半導体光部品。

【請求項6】 前記ドナーが、珪素および硫黄から選ばれる請求項4に記載の半導体光部品。

【請求項7】 前記半導体材料が、InPおよびGaAsに基づいた合金のような、元素の周期律表のIIIおよび/またはVの列の材料に基づいた合金から選ばれる請求項1に記載の半導体光部品。

【請求項8】 入射面と出射面の間の光伝搬軸に沿って配置されたテーパ付光導波路を含むテーパ付導波路半導体光増幅器の形態であり、このテーパ付導波路が、一定断面領域と呼ばれる、前記光の単一モード伝搬のための一定表面積を有する断面領域を含み、前記一定断面領域が、増加断面領域と呼ばれる、前記半導体光増幅器の光パワー密度を減少させるための増加する表面積を有する断面領域に通じており、前記閉込め層が、前記光導波路の一部であり、前記勾配が負で、前記増加断面領域内の前記伝搬軸に沿って位置している請求項1に記載の半導体光部品。

【請求項9】 前記勾配が、前記増加断面領域の全体にわたって位置している請求項8に記載の半導体光部品。

【請求項10】 前記p型ドーピング濃度が、前記出射面で最小である請求項8に記載の半導体光部品。

【請求項11】 前記最小濃度が、 10^{17} cm^{-3} から 10^{18} cm^{-3} であり、好ましくは実質的に $3 \times 10^{17} \text{ cm}^{-3}$ である請求項10に記載の半導体光部品。

【請求項12】 請求項1から7のいずれかに記載の半導体光部品を製造する方法であって、別の半導体層にシリカ型誘電体材料のマスキング層を堆積することによるマスキングステップと、前記別の層を露出させる開口を生成するように前記マスキング層を部分的に除去するステップと、前記閉込め層が前記開口に選択的に堆積される、前記閉

込め層を堆積するステップとを含む方法。

【請求項13】 前記閉込め層を堆積する前記ステップの後で、前記マスキング層を全体的に抑制するステップをさらに含む請求項12に記載の部品製造方法。

【請求項14】 前記マスキング層の全体的な抑制の後で前記閉込め層を部分的に抑制するステップをさらに含む請求項13に記載の部品製造方法。

【発明の詳細な説明】

【0001】

【発明の属する技術分野】本発明は半導体光部品に関し、より詳細には、p型ドーパ半導体材料の閉込め層を備える半導体光部品に関し、さらにこの種の部品を製造する方法に関する。

【0002】

【従来の技術】本出願は、2001年9月5日に提出されたフランス特許出願第0111638号に基づいており、このフランス特許出願の開示を、全体として参照して組み込み、また、このフランス特許出願の優先権を主張する。

【0003】半導体光増幅器のような半導体光部品は、光ファイバーを用いて波長分割多重(WDM)光信号を増幅するために、特にそのような信号のラマン増幅を行うために、定格数ワットの従来技術の励起源で使用されることが多い。この種の増幅器の動作は、電流が供給されると、一般には0.8 μm から 1.6 μm の波長の入射光波が伝搬するときに、その入射光波を増幅する能動層を使用することに基づいている。

【0004】半導体光部品は、能動層の上部に配置された、部品中を伝搬する光波の誘導に寄与する閉込め層を有する。閉込め層は、正孔として知られている正の自由電荷を生成する電子アクセプタを含む半導体材料の層である。正孔は電気導通のより大きな部分を担う。ドーピングはp型ドーピングと呼ばれ、このp型ドーピングによって、とりわけ、半導体の固有抵抗よりも低い電気抵抗の半導体閉込め層が生じる。また、p型ドーピングにより、特に部品の過熱が回避され、能動層中への電流の十分な注入が確実化される。しかし、この種のドーピングによって、例えば光吸収による損失が光部品中に生じる。これは、正孔が能動層で放出されたフォトンを吸収することができ、部品から使用可能な光パワーを制限するからである。

【0005】閉込め層は、能動層に平行な平面を画定する。当今の部品では、この平面内でp型ドーパントの濃度は一様である。濃度の値を固定するために、最小限の抵抗と同時に最小限の全体損失が得られるように、妥協が達成される。

【0006】光吸収の確率は、光パワー、すなわちフォトン数とともに増加する。したがって、或る特定の濃度のp型ドーパントに関して、生じる損失は光部品の一部の領域でより大きくなる。同様に、閉込め層の固有抵

抗は、局部的に変化することがあり、例えば閉込め層の厚さまたは幅が変わると変化する。

【0007】

【発明が解決しようとする課題】したがって、本発明の目的は、半導体光部品の性能を向上させるように各領域で最適化された光電気特性を有するp型ドーピング半導体の閉込め層を備える半導体光部品を提供することである。

【0008】

【課題を解決するための手段】このために、本発明は、ドーピングがp型ドーピングであるようにアクセプタドープメントを含む半導体材料の閉込め層を備える半導体光部品を提案する。この半導体光部品では、閉込め層は、別の半導体層の上に堆積され、この別の半導体層に平行な面を画定する。また、この閉込め層のp型ドーピング濃度は、この平面内の一方向でゼロと著しく異なる少なくとも1つの勾配を有する。

【0009】上記の勾配は、本発明に従って、半導体光部品で必要な局所的な電気光学特性に応じて決定される。

【0010】上記の方向は、有利には、光伝搬軸とすることができ、光パワーはその軸に沿って変化する。

【0011】本発明によれば、勾配の符号は負とすることができ、この場合、最小光損失を必要とする領域において有利である。

【0012】本発明の一実施形態では、さらに半導体材料はドナーを含み、このドナーの濃度は、上記の方向の全体にわたってアクセプタの濃度よりも低く、その結果、ドーピングは依然としてp型のままである。

【0013】この構成で、p型ドーピング濃度は、アクセプタ濃度とドナー濃度の差に対応する。したがって、ドーピングの勾配は、ドナー濃度の勾配から得ることができる。

【0014】アクセプタは、好ましくは、亜鉛、マグネシウムおよびカドミウムから選ばれ、また、ドナーは、好ましくは、珪素および硫黄から選ばれる。

【0015】本発明によれば、半導体材料は、InPおよびGaAsに基づいた合金のように、元素周期律表のIII列および／またはV列の材料に基づいた合金から選ぶことができる。

【0016】本発明の好ましい一実施形態では、本部品は、入射面と出射面の間に配置された光伝搬軸に沿って長さLのテーパ付光導波路を含むテーパ付導波路半導体光増幅器であり、このテーパ付導波路は、一定断面領域と呼ばれる、光の単一モード伝搬のための一定表面積を有する断面領域を含み、この一定断面領域は、増加断面領域と呼ばれる、半導体光増幅器の光パワー密度を減少させるための増加する表面積を有する断面領域に通じている。また、閉込め層は、光導波路の一部であり、さらに、勾配は、負で、伝搬軸に沿った増加断面領域内にある。

【0017】増加断面領域の表面積は、一定断面領域の表面積よりも大きいので、増加断面領域の抵抗は一定断面領域の抵抗よりも小さい。さらに、光パワーが入射面から出射面に向けて増加するので、光損失は増加断面領域で大きくなり易い。したがって、この領域でp型ドーピング濃度を減少させるのが有利である。

【0018】この増加断面領域でp型ドーピング濃度を減少させる実施形態の一構成では、本発明による部品の性能を最適化するように、増加断面領域の全体にわたって勾配がある。

【0019】本発明による部品から利用できる光パワーを増加させるために、有利には、p型ドーピング濃度は出射面で最小とすることができる。

【0020】さらに、このp型ドーピング濃度を出射面で最小にする実施形態では、最小濃度が、 10^{17} cm^{-3} から 10^{18} cm^{-3} であり、好ましくは実質的に $3 \times 10^{17} \text{ cm}^{-3}$ に等しい。

【0021】また、本発明は、本発明による半導体光部品を製造する方法を提案し、この方法は次のステップを含む。すなわち、別の半導体層にシリカ型誘電体材料のマスキング層を堆積することによるマスキングステップと、この別の層を露出させる開口を生成するようにマスキング層を部分的に除去するステップと、閉込め層が開口に選択的に堆積される、閉込め層を堆積するステップとを含む。

【0022】本発明による閉込め層は、選択領域成長(SAG)法を使用して、開口に選択的に堆積される。この選択領域成長(SAG)法は、A. M. Jones et al. による文献「Growth, Characterization, and Modeling of Ternary InGaAs-GaAs Quantum Wells by Selective Area Metalorganic Chemical Vapor Deposition」, Journal of Electronic Materials, Vol. 24, No. 11, 1995, pages 1631~1636に記載されている。SAG法は、GaAsまたはInP型の材料がシリカ酸化物のマスク上には堆積されないで、半導体基板に向かって拡散するというに基づいている。

【0023】本発明による方法は、閉込め層を堆積するステップの後で、マスキング層を全体的に抑制するステップをさらに含むことができる。

【0024】本発明による部品を製造する方法は、全体的抑制ステップの後に閉込め層を部分的に抑制するステップを含むことができる。

【0025】本発明の特徴および目的は、以下の詳細な説明から明らかになるであろう。この詳細な説明は、添付の図面に関連して行われるが、これらの図面は、例証であって限定しない例として与えられる。

【0026】

【発明の実施の形態】以下の説明全体を通して、「層」の用語は、単一の層または同じ機能を実現する多数の層を示すことができる。

【0027】図1は、本発明によるテーパ付導波路半導体光増幅器10の概略平面図であり、この光増幅器10は、例えば、ラマン増幅を使用する光ファイバーまたはエルビウムがドープされたファイバー増幅器(EDFA)を用いてWDM信号を増幅するための励起源で利用される。

【0028】テーパ付導波路半導体光増幅器10は、光伝搬軸Zに沿って、ほぼ2mmの長さLのテーパ付光導波路G(破線の外形で示す)を含む。光導波路Gは、約2μmの幅Leの入射面Feと約6μmの幅Lsの出射面Fsの間に配置されている。導波路Gは、光の単一モード伝搬を行うための一定表面積の断面S₁を有する長さL₁の領域R₁を含み、この領域は一定断面領域とも呼ばれる。

【0029】半導体光増幅器10の光パワー密度を減少させるための、数百ミクロンの長さL₂で、かつ増加する表面積の断面S₂を有する領域R₂に、領域R₁は通じている。この領域R₂は、増加断面領域とも呼ばれる。

【0030】テーパ付光導波路Gは、本発明の心臓部の領域である。

【0031】したがって、図2は、導波路Gの面に垂直な面における、図1のテーパ付導波路半導体光増幅器のテーパ付光導波路の概略断面図を示す。

【0032】テーパ付光導波路Gは、GaAs支持体1を含み、この上に、金属有機気相エピタキシ(MOVPE)プロセスによって、

- ・電子ドナーをドープされたn型のInPまたはGaAsに基づいた半導体合金の下部の閉込め層2と、
- ・次の層の成長を促進するための半導体バッファ層3と、
- ・光を増幅するように意図され、場合によっては量子井戸を内蔵するInPまたはGaAsに基づいた半導体合金の能動層4と、
- ・約0.1μmの厚さを有し、保護層と呼ばれる、別の半導体層5と、
- ・その厚さが長さ方向で約0.5μmから約1μmに変化する、InPまたはGaAsに基づいた半導体合金の本発明によるn型ドープ閉込め層6と、
- ・高濃度p型にドープされ、かつ電子電流の注入を修正するのに寄与する、コンタクト層と呼ばれる半導体層7と、
- ・金属メタライゼーション層8とが堆積される。

【0033】閉込め層6は、亜鉛の電子アクセプターA、および、より低濃度の珪素の電子ドナーDを含む。p型ドーピング濃度n_pは、アクセプターAの濃度とド

ナーDの濃度の差に対応する。

【0034】図3は、伝搬軸Zに沿ったテーパ付光導波路Gの長さLの関数として、閉込め層6のp型ドーピング濃度のプロファイルn_pを表す曲線11を示す。

【0035】濃度n_pは、領域R₁では実質的に一定であり、したがって長さL₁の全体にわたって一定である。この濃度n_pは、一般に、約7×10¹⁷cm⁻³である。濃度n_pは、領域R₂では実質的に直線的に減少し、したがって、光伝搬軸Zに沿って一定の負の勾配を有する。p型ドーピング濃度の最小値は、Z=Lの出射面Fs(図1参照)で得られ、実質的に約3×10¹⁷cm⁻³に等しい。

【0036】図4から図8は、図1のテーパ付導波路半導体光増幅器を製造する方法のステップを示す。

【0037】図4は、GaAs支持体1の同じ面に一連の連続するMOVPE堆積、すなわち、

- ・下の閉込め層2の堆積、
- ・バッファ層3の堆積、
- ・能動層4の堆積、および
- ・保護層5の堆積、の後で得られるテーパ付導波路半導体光増幅器10の長さ方向の断面を示す。

【0038】次に、プロセスは、プラズマ増速化学気相成長(PECVD)プロセスによって、保護層5の上にシリカ型の誘電体材料のマスキング層12を堆積するマスキングステップを含む。

【0039】図5は、保護層5の上に開口Oを生成するようにマスキング層12を部分的に除去するステップの後で得られた半導体光増幅器10の平面図である。

【0040】開口Oは、一定表面積の断面SO₁を有する第1の領域Z_{o1}を含む。一定表面積の幅l_{o1}は、約10μmである。また、開口Oは、増加する表面積の断面SO₂を有する領域Z_{o2}を含む。開口Oの縁部Bでの増加する表面積の幅l_{o2}は、約20μmから50μmである。開口Oの長さLOは、光導波路Gの長さLよりも実質的に長い。

【0041】半導体光増幅器が完成したときの閉込め層6を含む領域に対応する領域R_Gを、開口O内に破線の外形で示す。

【0042】図6は、閉込め層6をMOVPE堆積するステップの後で得られる半導体光増幅器10の平面図である。

【0043】閉込め層6は、SAG法により開口O全体に選択的に堆積する。InPまたはGaAsはシリカに付着しないので、開口Oに向かって横に拡散する。領域Z_{o1}は、領域Z_{o2}よりも狭いので、拡散は領域Z_{o1}でより大きくなり、結果として、領域Z_{o1}での平均成長速度V₁は、平均成長速度V₂のほぼ2倍になる。

【0044】例えば、半導体光増幅器が、約600℃であり、InとPまたはGaとAsを含むある特定の流束

に関する場合、 V_1 は $2\mu\text{m}/\text{h}$ 、 V_2 は $1\mu\text{m}/\text{h}$ に等しい。約30分の堆積時間の間に、領域 Z_{O1} および Z_{O2} での層6の平均厚さは、 Z_{O1} では約 $1\mu\text{m}$ 、 Z_{O2} では約 $0.5\mu\text{m}$ となる。

【0045】さらに、p型ドーピングをつくるために、亜鉛のようなアクセプタを含む流れ、例えばジエチル亜鉛の流れ、および珪素のようなドナーDを含む流れ、例えばシランの流れ、をInPまたはGaAsの流れに加える。

【0046】亜鉛濃度は、成長速度と実質的に無関係であり、したがって領域 Z_{O1} および Z_{O2} で実質的に同じである。他方で、珪素濃度は、成長速度 V_1 、 V_2 に逆比例し、したがって、領域 Z_{O2} でより大きくなり、縁部Bで最大である。

【0047】p型ドーピング濃度 n_p は、軸Zに沿った領域 Z_{O1} 内で実質的に一定で、約 $7 \times 10^{17} \text{cm}^{-3}$ である。濃度 n_p は、軸Zに沿った領域 Z_{O2} 内で一定の負の勾配を有する。縁部Bでの濃度 n_p は、実質的に約 $3 \times 10^{17} \text{cm}^{-3}$ である。

【0048】図7は、閉込め層6を堆積するステップの後のマスキング層12を全体的に抑制するステップの後で得られた半導体光増幅器10の平面図である。

【0049】図8は、光導波路G内の閉込め層6を制限するために領域 R_G の外側の閉込め層6を部分的に抑制するステップの後で得られた半導体光増幅器10の側面図である。

【0050】一連の従来の堆積、マスキングおよびエッチングのステップが上のステップに続き、半導体光増幅器10が得られる。

【0051】本発明は、一定断面の光導波路を含む半導体光部品および全ての種類の半導体光増幅器、すなわち埋め込みリッジ型半導体光増幅器、利得導波半導体光増幅器、および屈折率導波半導体光増幅器、に等しく適用することができる。

【0052】本発明は、マッハツェンダ干渉計構造の部品のような必要電流密度が一樣でない光部品でも使用することができる。このように、分布電極に基づいた解決策の代わりに、本発明を使うことができる。

【0053】さらに、開口Oの形状は、本発明に従って必要な勾配に応じて選ぶことができる。勾配は、選ばれた方向で一定であることもあり変化することもある。

【0054】本発明による半導体光部品の光導波路の断面は、長方形または台形とすることができる。

【図面の簡単な説明】

【図1】本発明によるテーパ付導波路半導体光増幅器の概略平面図である。

【図2】図1のテーパ付導波路半導体光増幅器の光導波路の、導波路Gの面に垂直な面内における概略の断面図である。

【図3】図2の光導波路の閉込め層のp型ドーピング濃度プロファイルを、光伝搬軸Zに沿った光導波路の長さの関数として示す図である。

【図4】図1のテーパ付導波路半導体光増幅器を製造するための、本発明による製造方法のステップを示す図である。

【図5】図1のテーパ付導波路半導体光増幅器を製造するための、本発明による製造方法のステップを示す図である。

【図6】図1のテーパ付導波路半導体光増幅器を製造するための、本発明による製造方法のステップを示す図である。

【図7】図1のテーパ付導波路半導体光増幅器を製造するための、本発明による製造方法のステップを示す図である。

【図8】図1のテーパ付導波路半導体光増幅器を製造するための、本発明による製造方法のステップを示す図である。

【符号の説明】

Fe 入射面

Fs 出射面

G テーパ付光導波路

S_1 、 SO_1 一定表面積の断面

S_2 、 SO_2 増加する表面積の断面

R_1 、 Z_{O1} 一定表面積の断面を有する領域（一定断面領域）

R_2 、 Z_{O2} 増加する表面積の断面を有する領域（増加断面領域）

Z 光伝搬軸

A アクセプタ濃度

D ドナー濃度

n_p p型ドーピング濃度

R_G 閉込め層を含む領域

O 開口

1 GaAs支持体

2 下部の閉込め層

3 半導体バッファ層

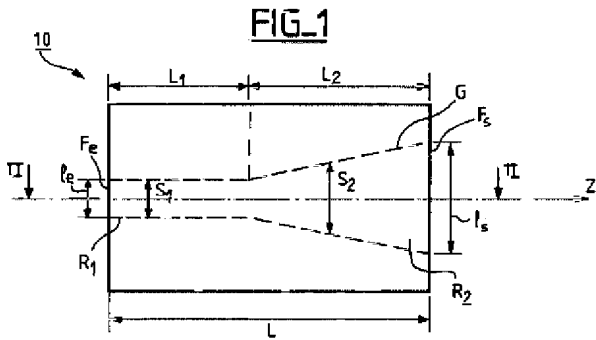
4 InPまたはGaAsに基づいた半導体合金の能動層

6 閉込め層

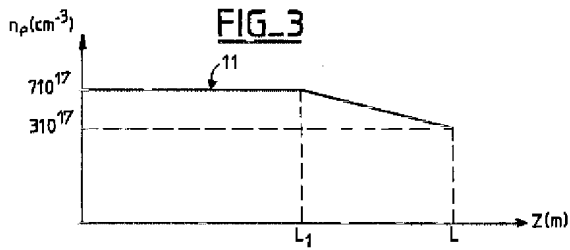
10 テーパ付導波路半導体光増幅器

12 シリカ型誘電体材料のマスキング層

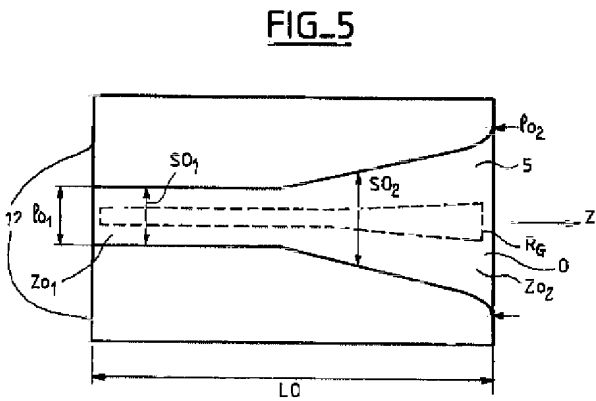
【図1】



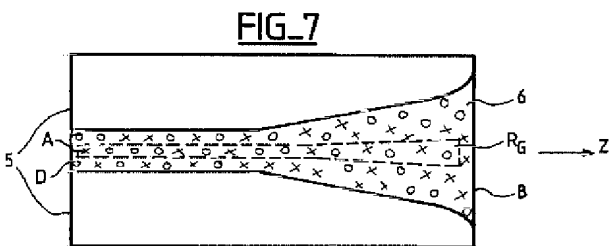
【図3】



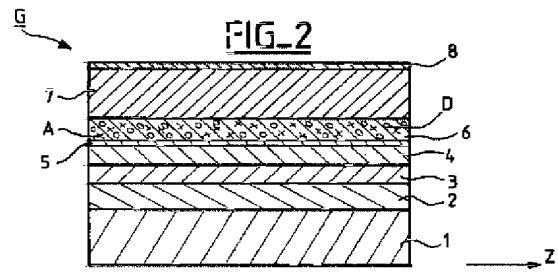
【図5】



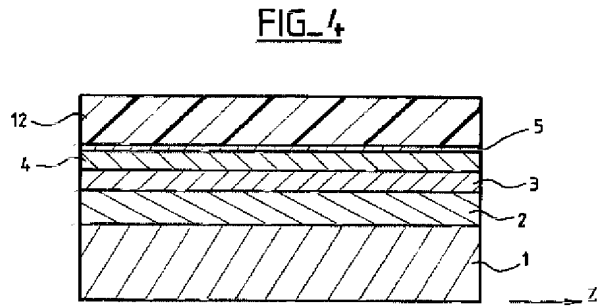
【図7】



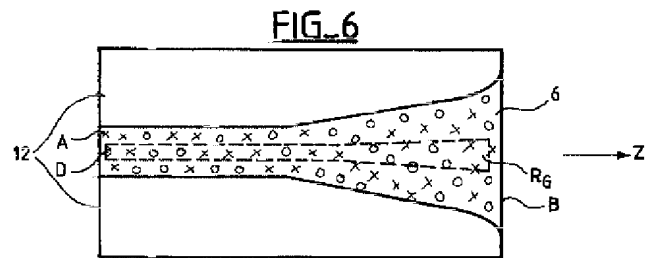
【図2】



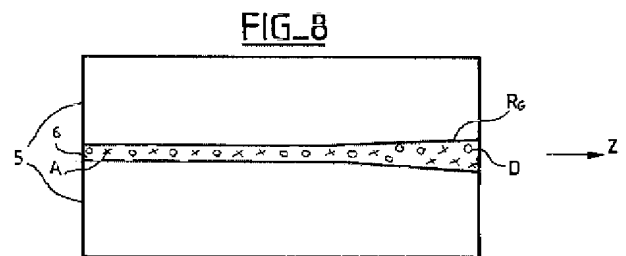
【図4】



【図6】



【図8】



フロントページの続き

(72)発明者 ドウニ・ルクレール
フランス国、91430・イニー、アレ・ジャ
ック・カルティエ・23

(72)発明者 ジャン・ドウコベール
フランス国、91620・ノゼ、リュ・デ・フ
レール・リュミエール・51
Fターム(参考) 5F073 AA03 AA89 CB19 DA35

【外国語明細書】

1. Title of Invention**A SEMICONDUCTOR OPTICAL COMPONENT AND A METHOD OF FABRICATING****II****2. Claims**

1. A semiconductor optical component including a semiconductor material confinement layer containing acceptor dopants such that the doping is p-type doping, in which component said confinement layer is deposited on another semiconductor layer and defines a plane parallel to said other semiconductor layer and the p-type doping concentration of said confinement layer has at least one gradient significantly different from zero in one direction in said plane.
2. The semiconductor optical component claimed in claim 1 wherein said one direction is the light propagation axis.
3. The semiconductor optical component claimed in claim 2 wherein the sign of said gradient is negative.
4. The semiconductor optical component claimed in claim 3 wherein said semiconductor material further contains donors at a concentration lower than the acceptor concentration over the whole of said one direction.
5. The semiconductor optical component claimed in claim 4 wherein said acceptors are chosen from zinc, magnesium and cadmium.
6. The semiconductor optical component claimed in claim 4 wherein said donors are chosen from silicon and sulfur.
7. The semiconductor optical component claimed in claim 1 wherein said semiconductor material is chosen from alloys based on materials from column(s) III and/or V of the periodic table of the elements, such as alloys based on InP and GaAs.
8. The semiconductor optical component claimed in claim 1 in the form of a tapered guide semiconductor optical amplifier including a tapered optical guide disposed along the light propagation axis between an entry face and an exit face, which tapered guide includes a cross section region having a constant surface area, referred to as the constant section region, for monomode propagation of said light, said constant section region leads to a cross section region having an increasing surface area, referred to as the increasing section region, for reducing the optical power density of said semiconductor optical amplifier, said confinement layer is part of said optical guide, and said gradient is negative and situated along said propagation axis inside said increasing section region.

9. The semiconductor optical component claimed in claim 8 wherein said gradient is situated over the whole of said increasing section region.
10. The semiconductor optical component claimed in claim 8 wherein said p-type doping concentration is at a minimum at said exit face.
11. The semiconductor optical component claimed in claim 10 wherein said minimum concentration is from 10^{17} cm^{-3} to 10^{19} cm^{-3} and preferably substantially equal to $3 \times 10^{17} \text{ cm}^{-3}$.
12. A method of fabricating a semiconductor optical component as claimed in any of claims 1 to 7, including the following steps:
 - a masking step by depositing a silica type dielectric material masking layer onto another semiconductor layer,
 - a step of partial elimination of said masking layer to create an opening exposing said other layer, and
 - a step of depositing said confinement layer, in which said confinement layer is deposited selectively in said opening.
13. The component fabrication method claimed in claim 12 further including a step of total suppression of said masking layer after said step of depositing said confinement layer.
14. The component fabrication method claimed in claim 13 further including a step of partial suppression of said confinement layer after said step of total suppression of said masking layer.

3. Detailed Description of Invention

CROSS-REFERENCE TO RELATED APPLICATIONS

This application is based on French Patent Application No. 01 11 638 filed September 5, 2001, the disclosure of which is hereby incorporated by reference thereto in its entirety, and the priority of which is hereby claimed under 35 U.S.C. §119.

BACKGROUND OF THE INVENTION

Field of the invention

The present invention relates to semiconductor optical components, and more particularly to a semiconductor optical component comprising a p-type doped semiconductor material confinement layer, and to a method of fabricating this type of component.

Description of the prior art

A semiconductor optical component, such as a semiconductor optical amplifier, is often used in prior art pumping sources rated at a few watts for amplifying wavelength division multiplex (WDM) optical signals by means of an optical fiber, in particular for Raman amplification of such signals. The operation of this kind of amplifier is based on the use of an active layer which, once supplied with current, amplifies an injected optical wave, generally at a wavelength from 0.8 μm to 1.6 μm , as it propagates.

A semiconductor optical component has a confinement layer disposed on top of the active layer and contributing to guiding the wave propagating in the component. The confinement layer is a layer of a semiconductor material containing electron acceptors creating positive free carriers known as holes. The holes then account for the greater part of the electrical conduction: the doping is referred to as p-type doping, which among other things yields a semiconductor confinement layer of lower electrical resistance than the intrinsic resistance of the semiconductor, which in particular avoids overheating of the component and ensures good injection of current into the active layer. However, this kind of doping introduces losses in the optical component, for example through photoabsorption. This is because the holes are able to absorb photons emitted by the active layer, thus limiting the optical power available from the component.

The confinement layer defines a plane parallel to the active layer. In modern components, the concentration of p-type dopants is uniform in this plane. To fix the

value of the concentration, a compromise is therefore arrived at to obtain the lowest possible resistance and at the same time the lowest possible overall losses.

The probability of photoabsorption increases with the optical power, i.e. with the number of photons. Accordingly, for a given concentration of p-type dopants, the losses generated are greater in some regions of the optical component. Similarly, the intrinsic resistance of the confinement layer can vary locally, for example if the thickness or the width of the layer varies.

An object of the present invention is therefore to provide a semiconductor optical component comprising a p-type doped semiconductor confinement layer having opto-electrical properties that are optimized in each region in order to improve the performance of the component.

SUMMARY OF THE INVENTION

To this end, the present invention proposes a semiconductor optical component including a semiconductor material confinement layer containing acceptor dopants such that the doping is p-type doping, in which component the confinement layer is deposited on another semiconductor layer and defines a plane parallel to the other semiconductor layer and the p-type doping concentration of the confinement layer has at least one gradient significantly different from zero in one direction in the plane.

The gradient(s) are determined as a function of the local electro-optical properties required in the semiconductor optical component according to the invention.

The direction can advantageously be the light propagation axis, the optical power varying along that axis.

According to the invention, the sign of the gradient can be negative, which is advantageous in a region necessitating minimum optical losses.

In one embodiment of the invention, the semiconductor material further contains donors whose concentration is lower than the concentration of the acceptors over the whole of the direction so that the doping remains of the p-type.

In this configuration, the p-type doping concentration corresponds to the difference between the acceptor concentration and the donor concentration. The doping gradient can thus be obtained from a donor concentration gradient.

The acceptors are preferably chosen from zinc, magnesium and cadmium and the donors are preferably chosen from silicon and sulfur.

According to the invention, the semiconductor material can be chosen from

alloys based on materials from column(s) III and/or V of the periodic table of the elements, such as alloys based on InP and GaAs.

In one preferred embodiment of the invention, the component is a tapered guide semiconductor optical amplifier including a tapered optical guide having a length L along the light propagation axis disposed between an entry face and an exit face, the tapered guide including a cross section region having a constant surface area, referred to as the constant section region, for monomode propagation of light, the constant section region leading to a cross section region having an increasing surface area, referred to as the increasing section region, in order to reduce the optical power density of the semiconductor optical amplifier. Also, the confinement layer is part of the optical guide and the gradient is negative and is in the increasing section region along the propagation axis.

The surface area of the increasing section region is greater than that of the constant section region so that the resistance in the increasing section region is less than that in the constant section region. Moreover, as the optical power increases from the entry face to the exit face, the optical losses are liable to be greater in the increasing section region. It is therefore advantageous to reduce the p-type doping concentration in that region.

In one configuration of this latter embodiment, the gradient is situated over the whole of the increasing section region to optimize the performance of the component according to the invention.

To increase the optical power available from the component according to the invention, the p-type doping concentration can advantageously be at a minimum at the exit face.

Furthermore, in this latter embodiment, the minimum concentration is from 10^{17} cm^{-3} to 10^{18} cm^{-3} and is preferably substantially equal to $3 \times 10^{17} \text{ cm}^{-3}$.

The invention also proposes a method of fabricating a semiconductor optical component according to the invention, the method including the following steps:

- a masking step by depositing a silica type dielectric material masking layer onto another semiconductor layer,
- a step of partial elimination of the masking layer to create an opening exposing the other layer, and
- a step of depositing the confinement layer, in which the confinement layer is deposited selectively in the opening.

The confinement layer in accordance with the invention is selectively

deposited over the opening using the selective area growth (SAG) technique described in the paper by A.M. Jones et al. "Growth, Characterization, and Modeling of Ternary InGaAs-GaAs Quantum Wells by Selective Area Metalorganic Chemical Vapor Deposition", Journal of Electronic Materials, Vol. 24, N° 11, 1995, pages 1631-1636. The SAG technique is based on the fact that GaAs or InP type materials are not deposited on a silica oxide mask and therefore diffuse toward the semiconductor substrate.

The method according to the invention can further include a step of totally suppressing the masking layer after the step of depositing the confinement layer.

The method of fabricating a component in accordance with the invention can include a step of partly suppressing the confinement layer after the total suppression step.

The features and objects of the present invention will emerge from the following detailed description, which is given with reference to the accompanying drawings, which are provided by way of illustrative and non-limiting example.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

Throughout the following description, the term "layer" can designate a single layer or a stack of layers fulfilling the same function.

Figure 1 is a diagrammatic plan view of a tapered guide semiconductor optical amplifier 10 according to the invention which is used, for example, in a pumping source for amplifying WDM signals by means of an optical fiber using Raman amplification or an erbium-doped fiber amplifier (EDFA).

The tapered guide semiconductor optical amplifier 10 includes a tapered

optical guide G (shown in dashed outline) of length L equal to approximately 2 mm along the light propagation axis Z. The optical guide G is disposed between an entry face Fe of width La equal to approximately 2 μm and an exit face Fs of width Ls equal to approximately 6 μm . The guide G includes a region R₁ of length L₂ having a cross section S₁ of constant surface area, also referred to as the constant section region, for monomode propagation of light.

The region R₁ leads to a region R₂ of length L₂ equal to a few hundred microns and having a cross section S₂ of increasing surface area, also referred to as the increasing section region, for reducing the optical power density of the semiconductor optical amplifier 10.

The tapered optical guide G is the region at the heart of the invention.

Accordingly, figure 2 is a diagrammatic sectional view of the tapered optical guide of the tapered guide semiconductor optical amplifier from figure 1 in a plane perpendicular to the faces of the guide G.

The tapered optical guide G includes a GaAs support 1 on which are deposited, by the metal organic vapor phase epitaxy (MOVPE) process:

- a lower confinement layer 2 of a semiconductor alloy based on InP or GaAs doped with electron donors, and thus of the n-type,
- a semiconductor buffer layer 3, for encouraging the growth of subsequent layers,
- an active layer 4 of a semiconductor alloy based on InP or GaAs intended to amplify light, and possibly incorporating quantum wells,
- another semiconductor layer 5, referred to as a protection layer, having a thickness of the order of 0.1 μm ,
- an n-type doped confinement layer 6 according to the invention of a semiconductor alloy based on InP or GaAs, whose thickness varies longitudinally from approximately 0.5 μm to approximately 1 μm ,
- a semiconductor layer 7, referred to as the contact layer, which is strongly p-type doped and contributes to correct injection of an electric current, and
- a metal metalization layer 8.

The confinement layer 6 contains zinc electron acceptors A and a lower concentration of silicon electron donors D. The p-type doping concentration n_p corresponds to the difference between the concentration of acceptors A and the concentration of donors D.

Figure 3 shows a curve 11 representing the p-type doping concentration

profile n_p of the confinement layer 6 as a function of the length L of the tapered optical guide G along the propagation axis Z .

The concentration n_p is substantially constant in the region R_1 and therefore over the whole of the length L_1 . It is typically equal to approximately $7 \times 10^{17} \text{ cm}^{-3}$. The concentration n_p decreases substantially linearly in the region R_2 and therefore has a constant negative gradient along the light propagation axis Z . The minimum value of the p-type doping concentration is found at the exit face F_s (see figure 1) at $Z = L$ and is substantially equal to 3×10^{17} .

Figures 4 to 8 show the steps of a method of fabricating the tapered guide semiconductor optical amplifier from figure 1.

Figure 4 shows a longitudinal section of the tapered guide semiconductor optical amplifier 10 obtained after a series of successive MOVPE depositions on the same face of a GaAs support 1:

- deposition of the lower confinement layer 2,
- deposition of the buffer layer 3,
- deposition of the active layer 4, and
- deposition of the protection layer 5.

The process then includes a masking step of depositing a masking layer 12 of a silica type dielectric material onto the protection layer 5 by the plasma enhanced chemical vapor deposition (PECVD) process.

Figure 5 is a plan view of the semiconductor optical amplifier 10 obtained after a step of partial elimination of the masking layer 12 to create an opening O above the protection layer 5.

The opening O includes a first area Zo_1 having a cross section SO_1 of constant surface area. The width lo_1 of the constant surface area is of the order of $10 \mu\text{m}$. The opening O also includes an area Zo_2 having a cross section SO_2 of increasing surface area. The width lo_2 of the increasing surface area at the edge B of the opening O is of the order of $20 \mu\text{m}$ to $50 \mu\text{m}$. The length LO of the opening O is substantially greater than the length L of the optical guide G .

A region R_G which corresponds to the region containing the confinement layer 6 when the semiconductor optical amplifier is finished is shown in dashed outline in the opening O .

Figure 6 is a plan view of the semiconductor optical amplifier 10 obtained after a step of MOVPE deposition of the confinement layer 6.

The confinement layer 6 is deposited selectively over the opening O by the

SAG technique. The InP or GaAs does not adhere to the silica, and therefore diffuses laterally toward the opening O. The area Zo_1 being narrower than the area Zo_2 , the diffusion is greater in the area Zo_1 with the result that the average growth speed v_1 in the area Zo_1 can be approximately twice the average growth speed v_2 .

For example, v_1 and v_2 are respectively equal to 2 $\mu\text{m/h}$ and 1 $\mu\text{m/h}$ when the semiconductor optical amplifier is at a temperature of the order of 600°C and for a given flux containing In and P or Ga and As. For a deposition time of the order of 30 minutes, the average thickness of the layer 6 in the areas Zo_1 and Zo_2 is respectively equal to approximately 1 μm and approximately 0.5 μm .

Furthermore, to produce the p-type doping, a flow comprising acceptors such as zinc, such as a flow of diethyl zinc, and a flow comprising donors D such as silicon, such as a flow of silane, are added to the flow of InP or of GaAs.

The zinc concentration is virtually independent of the growth speed, and is therefore also virtually identical in the areas Zo_1 and Zo_2 . On the other hand, the silicon concentration is inversely proportional to the growth speed v_1 , v_2 , and is therefore greater in the area Zo_2 and at a maximum at the edge B.

The p-type doping concentration n_p is therefore substantially constant in the region Zo_1 along the axis Z and is equal to approximately $1 \times 10^{17} \text{ cm}^{-3}$. The concentration n_p has a constant negative gradient in the region Zo_2 along the axis Z. The concentration n_p at the edge B is substantially of the order of $3 \times 10^{17} \text{ cm}^{-3}$.

Figure 7 is a plan view of the semiconductor optical amplifier 10 obtained after a step of total suppression of the masking layer 12 following the step of depositing the confinement layer 6.

Figure 8 is an elevation view of the semiconductor optical amplifier 10 obtained after a step of partial suppression of the confinement layer 6 outside the region R_G in order to limit the confinement layer 6 in the optical guide C.

The above steps are followed by a series of conventional deposition, masking and etching steps to obtain the semiconductor optical amplifier 10.

The invention can equally be applied to a semiconductor optical component including an optical guide of constant cross section and to all categories of semiconductor optical amplifiers: buried ridge semiconductor optical amplifiers, gain-guided semiconductor optical amplifiers, and index-guided semiconductor optical amplifiers.

The invention can also be employed in optical components for which the required current density is non-uniform, such as some Mach Zehnder interferometer

structure components. In this way, the invention can be substituted for a solution based on a distributed electrode.

Furthermore, the shape of the opening O is chosen as a function of the gradients required in accordance with the invention. The gradient(s) can be constant or vary in the chosen direction.

The cross section(s) of an optical guide of a semiconductor optical component according to the invention can be rectangular or trapezoidal.

4. Brief Description of Drawings

Figure 1 is a diagrammatic plan view of a tapered guide semiconductor optical amplifier according to the invention.

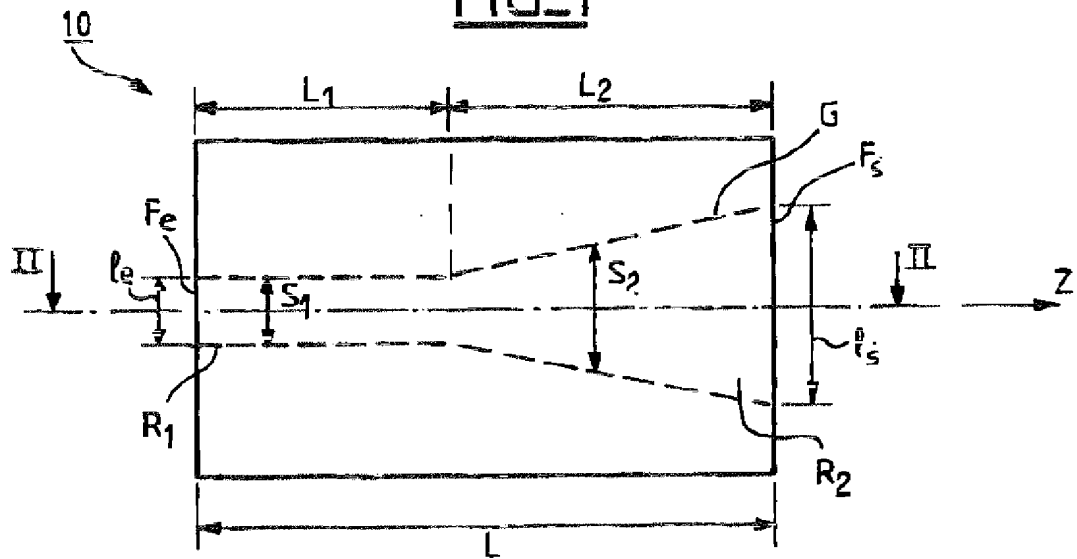
Figure 2 is a diagrammatic sectional view of the optical guide of the tapered guide semiconductor optical amplifier from figure 1 in a plane perpendicular to the faces of the guide G.

Figure 3 shows the p-type doping concentration profile of a confinement layer of the optical guide from figure 2 as a function of the length of the optical guide along the light propagation axis Z.

Figures 4 to 8 represent steps of a fabrication method in accordance with the invention for fabricating the tapered guide semiconductor optical amplifier from figure 1.

Fig. 1

FIG. 1



G **Fig. 2**

FIG. 2

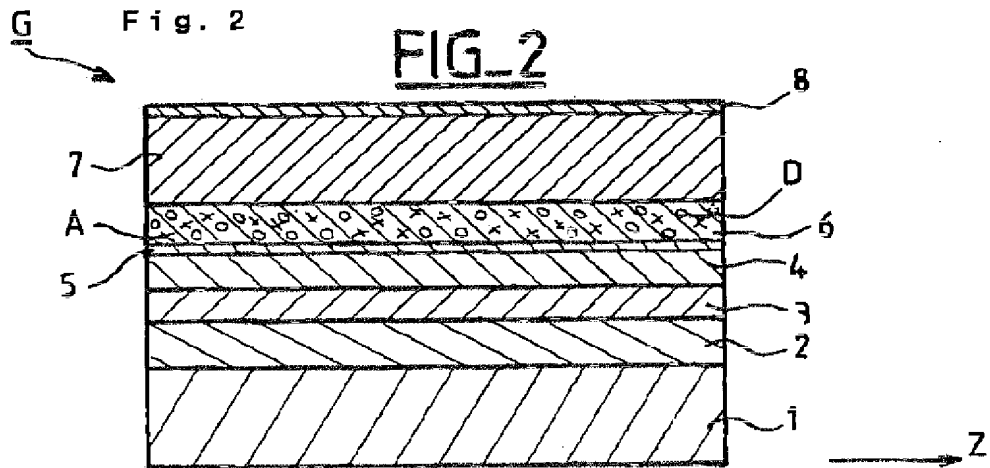


Fig. 3

FIG. 3

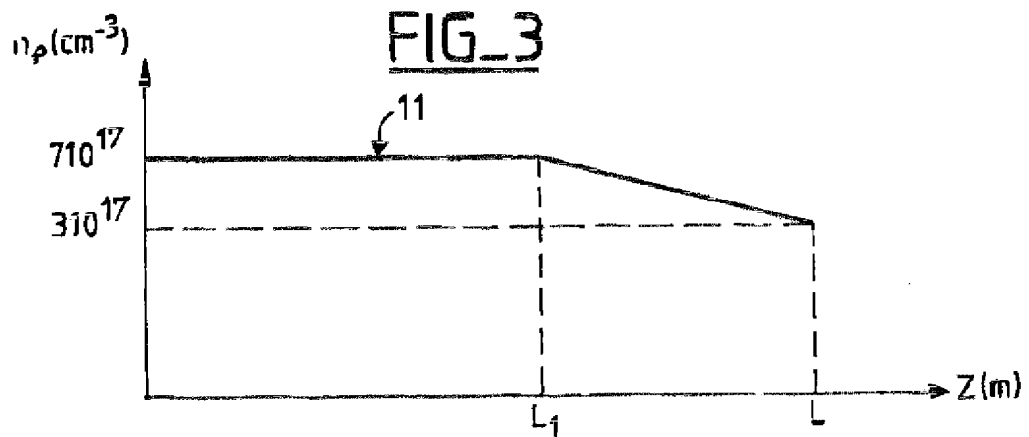


Fig. 4

FIG_4

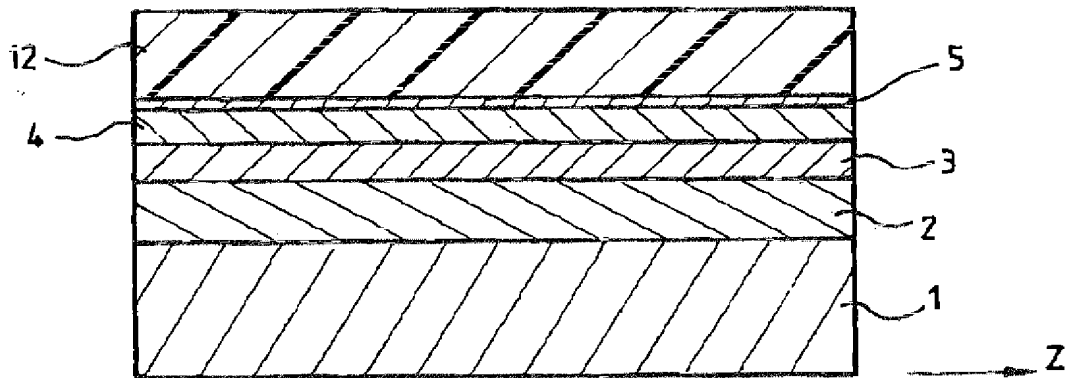


Fig. 5

FIG_5

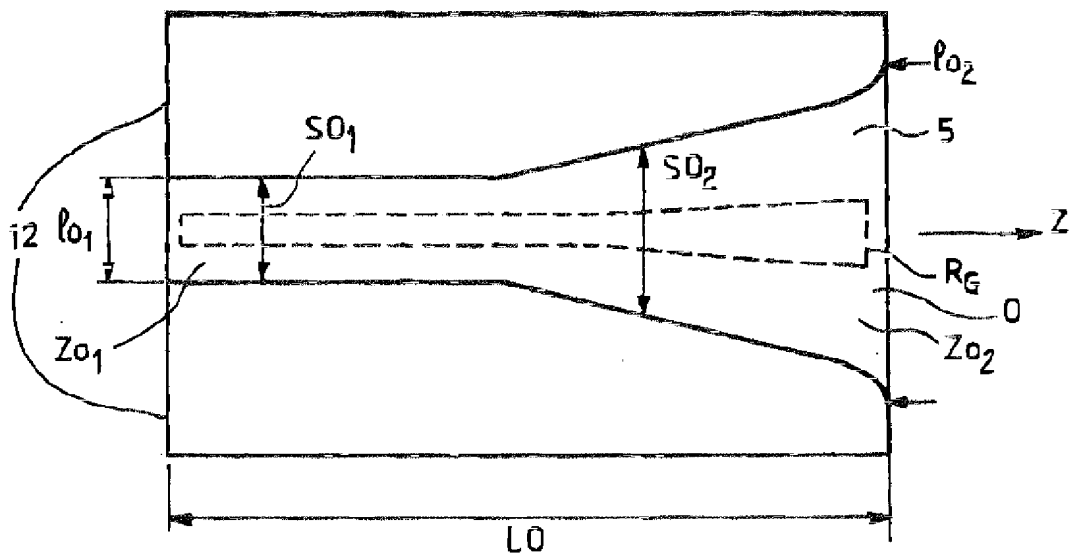


Fig. 6

FIG_6

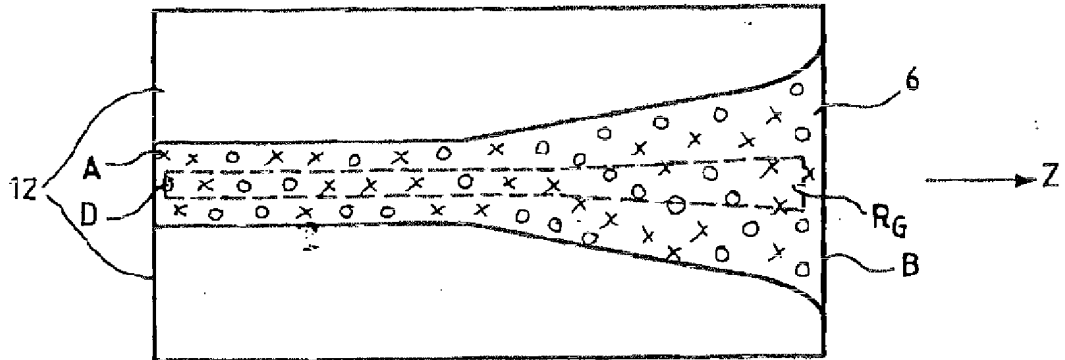


Fig. 7

FIG_7

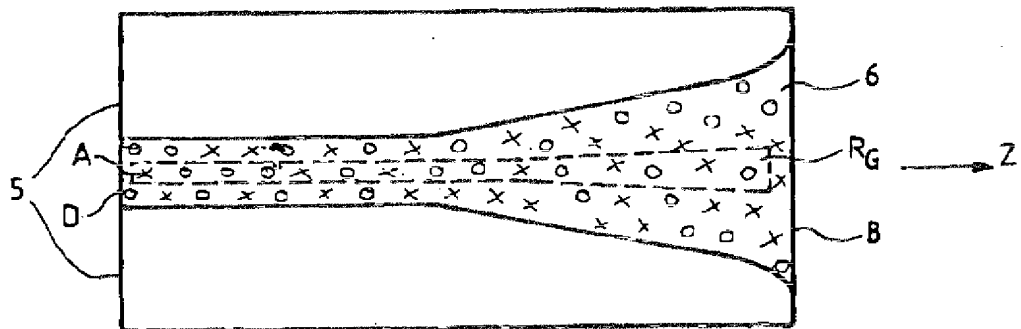
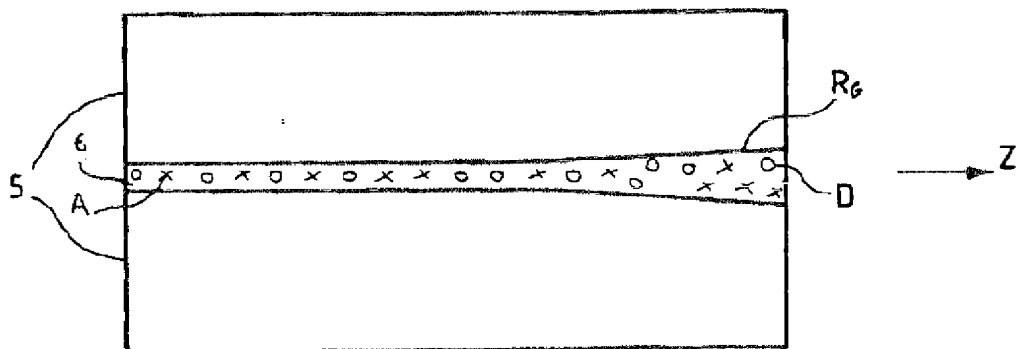


Fig. 8

FIG_8



1. Abstract

A semiconductor optical component is disclosed which includes a semiconductor material confinement layer containing acceptor dopants such that the doping is p-type doping. The confinement layer is deposited on another semiconductor layer and defines a plane parallel to the other semiconductor layer. Furthermore, the p-type doping concentration of the confinement layer has at least one gradient significantly different from zero in one direction in the plane. A method of fabricating the component is also disclosed.

2. Representative Drawing

Fig. 1



Espacenet

Bibliographic data: JP2012502466 (A) — 2012-01-26

NANOSTRUCTURED PHOTODIODE

Inventor(s):

Applicant(s):

Classification: - international: H01L31/10; H01L31/107
- cooperative: H01L31/03529; H01L31/105; H01L31/1075;
Y02E10/50

Application number: JP20110526011 20090904 Global Dossier

Priority number(s): SE20080001906 20080904 ; SE20090000498 20090415 ;
WO2009SE50997 20090904

Also published as: CN102144298 (A); CN102144298 (B); EP2321856 (A1);
KR20110073493 (A); US2011180894 (A1); more

Abstract not available for JP2012502466 (A)

Abstract of corresponding document: WO2010027322 (A1)

The present invention provides a photodiode comprising a p-i-n or pn junction at least partly formed by first and second regions (2) made of semiconductor materials having opposite conductivity type, wherein the p-i-n or pn junction comprises a light absorption region (11) for generation of charge carriers from absorbed light. One section of the p-i-n or pn junction is comprised by one or more nanowires (7) that are spaced apart and arranged to collect charge carriers generated in the light absorption region (11). At least one low doped region (10) made of a low doped or intrinsic semiconductor material provided between the nanowires (7) and one of said first region (1) and said second region (2) enables custom made light absorption region and/or avalanche multiplication region of the active region (9).

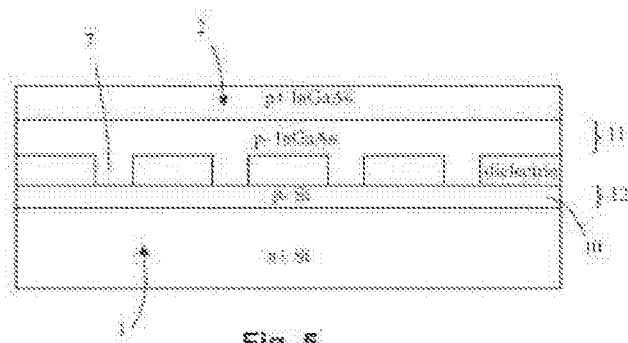


Fig. 5

(19) 日本国特許庁(JP)

(12) 公表特許公報(A)

(11) 特許出願公表番号

特表2012-502466

(P2012-502466A)

(43) 公表日 平成24年1月26日(2012.1.26)

(51) Int. Cl.	F I	テーマコード (参考)
H O 1 L 31/10 (2006.01)	H O 1 L 31/10 A	5 F O 4 9
H O 1 L 31/107 (2006.01)	H O 1 L 31/10 B	

審査請求 未請求 予備審査請求 未請求 (全 22 頁)

(21) 出願番号 特願2011-526011 (P2011-526011) (86) (22) 出願日 平成21年9月4日 (2009.9.4) (85) 翻訳文提出日 平成23年4月18日 (2011.4.18) (86) 国際出願番号 PCT/SE2009/050997 (87) 国際公開番号 W02010/027322 (87) 国際公開日 平成22年3月11日 (2010.3.11) (31) 優先権主張番号 0801906-9 (32) 優先日 平成20年9月4日 (2008.9.4) (33) 優先権主張国 スウェーデン (SE) (31) 優先権主張番号 0900498-7 (32) 優先日 平成21年4月15日 (2009.4.15) (33) 優先権主張国 スウェーデン (SE)	(71) 出願人 506177590 クナノ アーベ Q u N a n o A B スウェーデン国 ルント エスイー 2 2 3 7 0, イデオン パーク (番地無し) I d e o n P a r k, S E - 2 2 3 7 O L u n d, S w e d e n (74) 代理人 100076428 弁理士 大塚 康徳 (74) 代理人 100112508 弁理士 高柳 司郎 (74) 代理人 100115071 弁理士 大塚 康弘 (74) 代理人 100116894 弁理士 木村 秀二
---	--

最終頁に続く

(54) 【発明の名称】 ナノ構造のフォトダイオード

(57) 【要約】

本発明は、互いに逆の導電型を有する半導体材料から製造された第1の領域(1)及び第2の領域(2)により少なくとも部分的に形成され、吸収光から電荷キャリアを発生する光吸収領域(11)を備えるPIN接合又はPN接合を備えるフォトダイオードを提供する。PIN接合又はPN接合の一部は、互いに離間して配置され、光吸収領域(11)において発生される電荷キャリアを回収するように配列された1つ以上のナノワイヤ(7)を備える。ナノワイヤ(7)と前記第1の領域(1)及び前記第2の領域(2)のうち一方の領域との間に規定される低濃度不純物添加半導体材料又は真性半導体材料から製造された少なくとも1つの低濃度不純物領域(10)により、活性領域(9)の光吸収領域及び/又はアバランシェ増倍領域の個々の必要に合わせた形成が可能になる。

【選択図】 図5

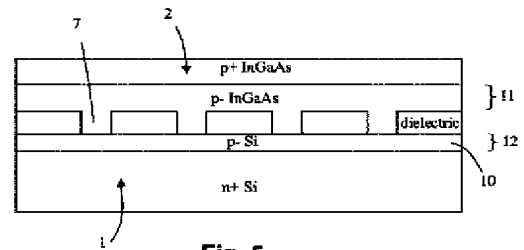


Fig. 5

【特許請求の範囲】

【請求項 1】

第 1 の導電型を有する半導体材料から製造された第 1 の領域 (1) 及び前記第 1 の導電型とは逆の第 2 の導電型を有する半導体材料から製造された第 2 の領域 (2) により少なくとも部分的に形成され、且つ、吸収光から電荷キャリアを発生する光吸収領域 (11) を備える P I N 接合又は P N 接合を備えるフォトダイオードであって、前記 P I N 接合又は P N 接合の一部分は、互いに離間して配置され、前記光吸収領域 (11) から前記電荷キャリアを搬送するように配列されたナノワイヤ (7) のアレイを備えることを特徴とするフォトダイオード。

【請求項 2】

前記 P I N 接合又は P N 接合は、前記ナノワイヤ (7) と前記第 1 の領域 (1) 及び前記第 2 の領域 (2) のうち一方の領域との間に規定される低濃度不純物添加半導体材料又は真性半導体材料から製造された第 1 の低濃度不純物領域 (10) を少なくとも備え、

前記光吸収領域 (11) は、前記第 1 の低濃度不純物領域に含まれていることを特徴とする請求項 1 に記載のフォトダイオード。

【請求項 3】

前記 P I N 接合又は P N 接合は、前記光吸収領域 (11) において発生される電荷キャリアを増倍するアバランシェ増倍領域 (12) を更に備えることを特徴とする請求項 1 又は 2 に記載のフォトダイオード。

【請求項 4】

前記アバランシェ増倍領域 (12) 及び前記光吸収領域 (11) は、前記第 1 の低濃度不純物領域 (10) に含まれることを特徴とする請求項 3 に記載のフォトダイオード。

【請求項 5】

前記ナノワイヤ (7) と前記第 1 の領域 (1) との間に規定される低濃度不純物添加半導体材料又は真性半導体材料から製造された第 1 の低濃度不純物領域と、前記ナノワイヤ (7) と前記第 2 の領域 (2) との間に規定される低濃度不純物添加半導体材料又は真性半導体材料から製造された第 2 の低濃度不純物領域とを備え、前記第 2 の低濃度不純物領域は、電荷キャリアを発生する光吸収領域 (11) を形成することに寄与するように配置され、前記第 1 の低濃度不純物領域は、アバランシェ増倍領域 (12) を形成することに寄与するように配置されることを特徴とする請求項 1 に記載のフォトダイオード。

【請求項 6】

前記ナノワイヤ (7) は、半導体基板 (3) 又は前記半導体基板 (3) の上に配置された表面層 (4) から突出し、前記半導体基板 (3) 又は前記表面層 (4) は、前記第 1 の領域 (1) を含むことを特徴とする請求項 1 乃至 5 のうちいずれか 1 項に記載のフォトダイオード。

【請求項 7】

前記第 1 の導電型の第 1 の領域 (1) は、前記半導体基板 (3) 又は前記表面層 (4) における不純物領域であり、前記第 1 の低濃度不純物領域 (10) は、前記第 1 の領域 (1) と前記ナノワイヤ (7) との間に規定されることを特徴とする請求項 6 に記載のフォトダイオード。

【請求項 8】

前記第 2 の導電型の第 2 の領域 (2) の少なくとも一部は、前記ナノワイヤ (7) のアレイにより形成され、

前記第 1 の領域 (1) の少なくとも一部は、前記第 1 の導電型の第 1 の不純物層により半導体基板 (3) に形成され、

前記第 1 の導電型の低濃度不純物添加半導体材料又は真性半導体材料から製造された第 1 の低濃度不純物層は、前記第 1 の低濃度不純物領域 (10) の少なくとも一部を形成するために、前記ナノワイヤ (7) のアレイと前記第 1 の領域 (1) との間に規定されることを特徴とする請求項 3 に記載のフォトダイオード。

【請求項 9】

前記第1の領域(1)は、前記第1の導電型の第1の不純物層により半導体基板(3)に形成され、

低濃度不純物添加半導体材料又は真性半導体材料から製造された第1の低濃度不純物層は、前記ナノワイヤ(7)と前記第1の領域(1)との間に規定され、

前記ナノワイヤ(7)は、誘電体層(15)、低濃度不純物添加半導体層又は真性半導体層における複数の開口を貫通して前記第2の導電型の第2の低濃度不純物層まで突出し、前記第2の低濃度不純物層は、前記光吸収領域(11)を形成し、

前記第2の領域(2)の少なくとも一部は、前記第2の低濃度不純物層の上に配置された前記第2の導電型の第2の不純物層により形成され、前記第2の低濃度不純物層における吸収光から発生される電荷キャリアは、前記ナノワイヤ(7)により回収され、前記第1の低濃度不純物層に搬送されることを特徴とする請求項2又は3に記載のフォトダイオード。

10

【請求項10】

前記第1の不純物層は N^+ 型Siからなり、前記第1の低濃度不純物層は P^- 型Siからなり、前記第2の低濃度不純物層は P^- 型InGaAsからなり、前記第2の不純物層は P^+ 型InGaAsからなることを特徴とする請求項9に記載のフォトダイオード。

【請求項11】

前記第1の不純物層は N^+ 型Siからなり、前記第1の低濃度不純物層は P^- 型Siからなり、前記第2の低濃度不純物層は P^- 型InGaAsからなり、前記第2の不純物層は P^+ 型InGaAsからなり、前記第1の不純物層はアバランシェ増倍領域(12)を形成するように構成されることを特徴とする請求項9に記載のフォトダイオード。

20

【請求項12】

各ナノワイヤ(7)の少なくとも一部は、第2の不純物層のオーバーグロースにより形成された低濃度不純物領域を含むシェル層により封入され、前記第2の不純物層の少なくとも一部は、前記PIN接合の前記第2の領域を形成することを特徴とする請求項1乃至6のうちいずれか1項に記載のフォトダイオード。

【請求項13】

電流制限構造を更に具備し、前記電流制限構造は、誘電体材料、絶縁材料、低濃度不純物添加材料又は真性材料に封入された各ナノワイヤ(7)の少なくとも一部分を備え、動作において、前記一部分は、所定の空間電荷効果が発生するために、少なくとも部分的に空乏状態となるように構成されることを特徴とする請求項1乃至5のうちいずれか1項に記載のフォトダイオード。

30

【請求項14】

前記電流制限構造の前記ナノワイヤの一部分には、不純物が添加されていることを特徴とする請求項13に記載のフォトダイオード。

【請求項15】

前記ナノワイヤ(7)は、低濃度不純物添加半導体材料又は真性半導体材料から製造されることを特徴とする請求項1乃至14のうちいずれか1項に記載のフォトダイオード。

【請求項16】

前記ナノワイヤ(7)は、第III族～第V族半導体材料から製造されることを特徴とする請求項1乃至15のうちいずれか1項に記載のフォトダイオード。

40

【請求項17】

前記光吸収領域(9)は、InGaAs、InAsP及びInGaAsPのグループから選択された1つ以上の半導体材料からなることを特徴とする請求項1又は2に記載のフォトダイオード。

【請求項18】

前記半導体基板は、Siからなることを特徴とする請求項1乃至17のうちいずれか1項に記載のフォトダイオード。

【請求項19】

前記第1の領域(1)及び前記第2の領域(2)のうち一方の領域に電氣的に接続され

50

た透明コンタクトを更に備えることを特徴とする請求項 1 に記載のフォトダイオード。

【請求項 20】

前記ナノワイヤ (7) は、アバランシェ増倍領域 (12) を規定するように配列されることを特徴とする請求項 1 に記載のフォトダイオード。

【請求項 21】

前記半導体基板 (3) 又は前記表面層 (4) は、各ナノワイヤ (7) と関連して半球形ドーピングプロファイルを有することを特徴とする請求項 6 に記載のフォトダイオード。

【発明の詳細な説明】

【技術分野】

【0001】

本発明は、PN 接合又は PIN 接合の一部としてナノワイヤを含むフォトダイオード及びアバランシェフォトダイオードに関する。

【背景技術】

【0002】

フォトダイオード (PD) は、光又は他の電磁エネルギーに暴露された場合に電荷キャリアを発生できる光検出器の一種である。アバランシェフォトダイオード (APD) は、電荷キャリアの発生に加えて、高感度を可能にする電荷キャリアの増倍、即ち、内部電流利得効果を含む別の種類の光検出器デバイスである。以下では、PD 及び APD の双方に共通する特徴を説明する場合、それら 2 種類の光検出器を単にフォトダイオードと呼ぶ。

【0003】

従来のプレーナ技術を使用して製造された半導体フォトダイオードは、縦型 PN 接合、即ち、N 型半導体層の上に P 型半導体層が配置される構造、又は、縦型 PIN 接合、即ち、2 つの電気コンタクトの間の P 型層と N 型層との間に 1 つ以上の中間真性半導体層又は中間低濃度不純物添加半導体層を含む構造を具備する。アバランシェフォトダイオードは、高電界の下でアバランシェ増倍を実現するために PIN 接合に逆バイアスを印加することにより吸収光から発生される光電流の増倍を実行する。大きい暗電流及び雑音により半導体フォトダイオードの性能が限定されることは周知である。例えば、光吸収領域及びアバランシェ増倍領域の性能を改善するために、APD の PIN 接合又は PN 接合の各部分は、典型的に、それぞれ異なる材料から形成される。例えば、Si は、雑音特性を低く抑えるが、検出可能な波長を制限する。但し、デバイス漏れ電流、即ち、暗電流の原因となる重要な特性の 1 つは、デバイス層における欠陥密度が相当に高いことである。これは、例えば、格子歪みに関して互いに適合しないデバイス材料が組み合わせられた場合、エピタキシャル成長又はウェハボンディングにより、顕著に現れる。更に、APD においては、高電界によるエッジブレイクダウンが起こる。ガードリングを使用することにより、エッジブレイクダウンを部分的に回避できる。但し、ガードリングの使用は、デバイスの活性領域を制限する。

【0004】

現在、高感度光検出器構造の大きさは、表面領域の拡大に伴う暗電流の不均衡な増加によって制限されている。更に、時間の経過につれて半導体材料が劣化するため、暗電流は増加する傾向にある。最終的に、デバイスは、短絡によって故障する。高い電流レベルは劣化を促進するため、内部電界が高い APD のようなデバイスでは、この影響が特に顕著である。

【発明の概要】

【課題を解決するための手段】

【0005】

従来の大型フォトダイオードは、暗電流が大きいこと、感度及びスケーラビリティが限定されること、及び、短絡によって信頼性が限定されることなどの欠点を有する。本発明の目的は、従来のフォトダイオードの欠点の少なくとも一部を克服するフォトダイオードを提供することである。

【0006】

本発明にかかるフォトダイオードは、第1の導電型を有する半導体材料から製造された第1の領域及び第1の導電型とは逆の第2の導電型を有する半導体材料から製造された第2の領域により少なくとも部分的に形成され、且つ、2つのコンタクトの間に配置されたPIN接合又はPN接合を具備する。PIN接合又はPN接合は、吸収光から電荷キャリアを発生する光吸収領域を具備する。PIN接合又はPN接合の一部分は、互いに離間して配置され、且つ、光吸収領域から電荷キャリアを回収するように配列された1つ以上のナノワイヤを具備する。好ましくは、ナノワイヤは、半導体基板又は半導体基板上に配置された表面層から突出し、且つ、半導体基板又は表面層は、前記第1の領域を含む。

【0007】

ナノワイヤと前記第1の領域及び前記第2の領域のうち一方の領域との間に規定される低濃度不純物添加半導体材料又は真性半導体材料から製造された少なくとも1つの低濃度不純物領域は、フォトダイオード及びアバランシェダイオードの設計及び性能の改善を可能にする。

【0008】

本発明の1つの側面において、軸フォトダイオード設計が提供される。第1の導電型の第1の領域は、半導体基板又は表面層における不純物領域であり、低濃度不純物領域は、第1の領域とナノワイヤとの間に規定される。

【0009】

本発明の別の側面において、放射フォトダイオード設計が提供される。低濃度不純物領域又はオプションである不純物領域は、各ナノワイヤにコアシェル構成で配置される。

【0010】

フォトダイオードは、これらの軸設計及び放射設計に限定されない。1つ以上の低濃度不純物領域は、ナノワイヤの両側に規定されてもよく、ナノワイヤの一方側の平面層は、ナノワイヤの他方側の放射層と組み合わせられてもよい。

【0011】

本発明の1つの実施形態にかかるアバランシェフォトダイオードにおいて、PIN接合は、半導体基板又は半導体基板の上に配置された表面層において第1の導電型の不純物領域に配置される低濃度不純物添加半導体材料又は真性半導体材料から製造された低濃度不純物領域により部分的に形成される。低濃度不純物領域は、アバランシェ増倍領域を具備し、光吸収領域を任意に具備する。PIN接合の別の部分は、低濃度不純物領域から突出する1つ以上のナノワイヤにより形成される。第1の導電型とは逆の第2の導電型の第2の領域を規定するためにナノワイヤに不純物が添加されてもよいし、ナノワイヤと共に又は独立して第2の領域を規定する隣接不純物層にナノワイヤが接続されてもよい。

【0012】

本発明にかかるアバランシェフォトダイオードの別の実施形態において、PIN接合は、半導体基板又は表面層における第1の導電型の第1の不純物層の上に配置される第2の導電型の低濃度不純物添加半導体材料又は真性半導体材料から製造された第1の低濃度不純物層、誘電体層の複数の開口を貫通し、第1の導電型とは逆の第2の導電型の低濃度不純物添加半導体材料又は真性半導体材料からなる第2の低濃度不純物層まで突出するナノワイヤ及び第2の低濃度不純物層の上に配置された第2の導電型の第2の不純物層により形成される。光吸収領域は、第2の低濃度不純物層により規定され、アバランシェ増倍領域は、第1の低濃度不純物層により規定される。第2の低濃度不純物層で吸収された光から発生される電荷キャリアは、ナノワイヤにより回収され、逆バイアスによって第1の低濃度不純物層に搬送される。

【0013】

一般的に使用されているプレーナ技術における制限の多くは、主に、格子整合に問題が起きるために材料の組み合わせを自由に選択できないことに起因すると考えられる。本発明にかかるフォトダイオードを製造するために、シリコンの上に、例えば、III～V族ナノワイヤを直接成長させることが可能であるので、一般的に使用されているウェハボンディング技術と比較して、大きな利点を得られる。

【0014】

本発明によれば、暗電流特性が改善されたフォトダイオードを提供することが可能である。時間が経過しても暗電流が実質的に一定に保持されるので、短絡による故障の危険を低減させたフォトダイオードを提供できることは本発明の更なる利点である。本発明にかかるフォトダイオードのナノワイヤは、短絡ではなく、回路遮断器の作用を提供するように設計されてもよい。

【0015】

ナノワイヤ部分における空間電荷蓄積に基づく電流制限構造としてナノワイヤの少なくとも一部を利用することにより、本発明にかかるフォトダイオードの性能及び信頼性を更に向上できる。この空間電荷効果は、非常に高く、且つ、設計可能な直列抵抗を実現し、それにより、過剰な電流漏れ及びデバイスの故障を防止することが可能になる。更に高いブレークダウン電圧を有し、アバランシェ機能が改善されたフォトダイオードを形成できるように、フォトダイオードの逆方向抵抗が増加されてもよい。

【0016】

本発明の実施形態は、従属請求項で定義される。本発明の他の目的、利点及び新規な特徴は、添付図面及び特許請求の範囲と関連させて以下の本発明の詳細な説明を考慮することにより明らかになるであろう。

【図面の簡単な説明】

【0017】

次に、添付図面を参照して、本発明の好適な実施形態を説明する。

【図1a】図1aは、不純物添加ナノワイヤと不純物添加基板との間の共通真性層に活性領域が配置されている本発明にかかるフォトダイオードを概略的に示す図である。

【図1b】図1bは、不純物添加ナノワイヤと不純物添加基板との間の共通真性層に活性領域が配置されている本発明にかかるフォトダイオードを概略的に示す図である。

【図2a】図2a及び図2bは、PIN接合の1つの領域を形成する不純物添加基板から突出するナノワイヤを具備し、活性領域が各ナノワイヤを封入する真性層に配置されている本発明にかかるフォトダイオードを概略的に示す図であり、図2aは、ナノワイヤから再成長された共通融合半導体層により形成されるPIN接合の他の不純物領域を示す図である。

【図2b】図2bは、個別の不純物添加半導体層に封入された各ナノワイヤを示す図である。

【図3a】図3aは、本発明にかかる軸フォトダイオード設計の1つの実施形態を模式的に示す図である。

【図3b】図3bは、本発明にかかるシリコンの上に成長されたInGaAsナノワイヤに基づく放射フォトダイオード設計を概略的に示す図である。

【図4】図4は、ナノワイヤにより分離された2つの低濃度不純物層を具備する本発明にかかるフォトダイオードを概略的に示す図である。

【図5】図5は、本発明にかかるInGaAs/Si SAM APDを概略的に示す図である。

【図6】図6は、(a)図5のInGaAs/Si SAM APDの電界図、(b)バイアスが印加されない場合の帯域図、及び、(c)逆バイアス時の帯域図を概略的に示す図である。

【図7】図7は、本発明にかかるナノワイヤの下での接合プロファイルを概略的に示す図である。

【発明を実施するための形態】

【0018】

本発明において、互いに離間して配置され、典型的には、 $1 \sim 10^8$ 本のナノワイヤを具備するナノワイヤアレイを使用することにより、半導体フォトダイオードの一部は分割される。基本的に、ナノワイヤアレイのナノワイヤは、フォトダイオードのP領域とN領域を互いに接続する。これにより、光吸収領域における吸収光から発生される電荷キャリ

アは、バイアスによってナノワイヤにより回収され、効率よく搬送される。この効果は、種々のフォトダイオードにおいて使用可能であり、以下、フォトダイオード（PD）、アバランシェフォトダイオード（APD）及び吸収－増倍分離型アバランシェフォトダイオード（SAM APD）に特定して説明される。

【0019】

本出願に関して、「ナノワイヤ」という用語は、幅又は直径の寸法が実質的にナノメートル単位であるような構造として解釈されるべきである。このような構造は、一般的に、ナノウィスカー、ナノロッドなどとも呼ばれる。粒子補助成長又は米国特許第7,335,908号公報に記載される、所謂、VLS（気体－液体－固体）機構、様々な種類の化学ビームエピタキシ法及び気相エピタキシ法により、基板の上にナノワイヤを形成する基本的な方法は既知である。但し、本発明は、そのようなナノワイヤ及びVLS処理に限定されない。ナノワイヤを成長させる他の適切な方法は、当技術分野において知られており、例えば、国際特許公開第WO2007/104781号に記載されている。この文献によれば、触媒として粒子を使用せずにナノワイヤが成長されてもよい。従って、選択的に成長されたナノワイヤ及びナノ構造、エッチングされた構造、他のナノワイヤ及びナノワイヤから製造される構造も含まれる。

【0020】

プレーナ技術を使用して製造される半導体デバイスには、連続する層の間の格子不整合など、ある特定の制限があるが、ナノワイヤ技術は、連続する層における半導体材料をより自由に選択できるため、バンド構造の適合性が更に向上する。その1つの例は、以下に説明される本発明の実施形態に利用されるSi基板の上のIII～V族半導体ナノワイヤの成長である。ナノワイヤは、平面層と比較して欠陥密度も低いいため、半導体デバイスにおける平面層の少なくともいくつかの部分ナノワイヤと置き換えることにより、欠陥に関する制限を軽減することができる。更に、ナノワイヤは、更なるエピタキシャル成長に使用するためのテンプレートとして欠陥密度の低い表面を提供する。

【0021】

図1乃至図4を参照するに、本発明にかかるフォトダイオードは、第1の導電型を有する半導体材料から製造された第1の領域1及び第1の導電型とは逆の第2の導電型を有する半導体材料から製造された第2の領域2により少なくとも部分的に形成されたPIN接合又はPN接合を具備する。例えば、第1の領域がP型であれば、第2の領域はN型であり、或いは、第1の領域がN型であれば、第2の領域はP型である。PIN接合又はPN接合は、吸収光から電荷キャリアを発生する光吸収領域11を更に具備する。PIN接合又はPN接合の一部分は、互いに離間して配置され、光吸収領域11から電荷キャリアを回収するように配列されたナノワイヤ7のアレイを具備する。ナノワイヤ間のギャップは、誘電体材料、真性半導体材料又は低濃度不純物添加半導体材料によって充填されてもよい。この材料は、透明であってもよい。

【0022】

典型的に、ナノワイヤは、半導体基板又は半導体基板の上に配置された表面層の上で成長される。半導体基板及び／又は表面層は、好ましくは、本発明にかかるフォトダイオードの一部である。フォトダイオードのナノワイヤ7は、半導体基板3又は半導体基板3の上に配置された表面層4から突出し、半導体基板3又は表面層4は、第1の領域1を含む。

【0023】

上述したように、フォトダイオードは、接合の両側に逆の導電型の半導体材料を備えたPN接合を具備してもよい。入射光の吸収によって発生される電荷キャリアは、接合により分離され、光電流の発生に寄与する。吸収は、空乏領域又はそのすぐ近くの領域で起こる。空乏領域の幅などの特性は、P型領域とN型領域との間、好ましくは、ナノワイヤに隣接する部分に低濃度不純物添加半導体材料又は真性半導体材料から製造された低濃度不純物領域を導入してPIN接合を形成することによって、変更してもよい。本質的に、PIN接合の低濃度不純物領域は、PN接合の空乏領域よりも幅の広い空乏領域を形成でき

る。従って、空乏領域及び光吸収領域は、完全に低濃度不純物領域に含まれていてもよいが、ナノワイヤ及び／又はP型領域又はN型領域などの任意の隣接領域まで延在してもよい。ナノワイヤの少なくとも一部は光を吸収するために使用されてもよいが、本発明におけるナノワイヤの主な用途は光吸収体ではない。そのため、光吸収領域は、ナノワイヤ7と重複してもよい。

【0024】

本発明の1つの実施形態において、PIN接合の光吸収領域11の少なくとも一部を形成するために、第1の領域1及びそれと逆の導電型の第2の領域2のうち一方の領域とナノワイヤ7との間に、低濃度不純物添加半導体材料又は真性半導体材料から製造された第1の低濃度不純物領域10が少なくとも規定される。低濃度不純物領域10は、ナノワイヤ7のいずれか一方側又は両側に規定されてもよい。本出願に関して、半導体基板又は半導体基板の上に配置された表面層に配置される低濃度領域10は軸設計と呼ばれ、各ナノワイヤ7の少なくとも一部を封入するシェル層として配置される低濃度不純物領域10は放射設計と呼ばれる。但し、本発明は、単なる軸設計又は放射設計に限定されない。例えば、半導体基板における低濃度不純物領域と種々のシェル層が組み合わせられてもよい。実質的に、半導体基板に隣接して又は半導体基板に配置される、或いは、ナノワイヤを取り囲むシェル層又はナノワイヤから成長された層に配置される低濃度不純物領域は、光吸収領域の形成に寄与するが、光吸収領域9は、ナノワイヤ7及び／又は第1の領域1及び第2の領域2まで延在してもよい。

【0025】

このような低濃度不純物領域は、フォトダイオードにおいて、PIN接合におけるアバランシェ増倍領域の形成にも使用することができる。アバランシェ増倍領域及び光吸収領域の少なくとも一部は、同一の低濃度不純物領域により形成されてもよいし、異なる低濃度不純物領域により形成されてもよい。更に、アバランシェ増倍領域の少なくとも一部は、ナノワイヤにより形成されてもよい。

【0026】

図1aは、低濃度不純物領域を具備する本発明にかかるフォトダイオードの1つの実施形態を概略的に示す図である。フォトダイオードは、半導体基板3の上に配置された表面層4から突出するナノワイヤ7のアレイを具備する。図1aに示されるように、各ナノワイヤ7の一方の端部は、第1の共通コンタクト手段5に接続されてもよい。PIN接合は、半導体基板3においてP型不純物添加半導体材料から製造された第1の領域1及び各ナノワイヤ7においてN型不純物添加半導体材料から製造された第2の領域2により形成され、表面層4において低濃度不純物添加材料又は真性材料から製造された低濃度不純物層10がある。吸収光から電荷キャリアを発生する光吸収領域11は、実質的に、低濃度不純物領域10により規定される。発生された電荷キャリアは、PIN接合が逆バイアスされることによってナノワイヤ7により回収される。光吸収領域11は、低濃度不純物領域10自体により形成されてもよいし、光吸収領域11は、ナノワイヤ7及び／又は第1の領域1まで延在してもよい。図1bは、第1の領域1及び第2の領域2が図1aのフォトダイオードと比較して逆の極性を有するフォトダイオード、即ち、半導体基板3がN型であり、ナノワイヤ7がP型であるフォトダイオードを概略的に示す図である。図1a及び図1bのナノワイヤ構造は、フォトダイオード又はアバランシェフォトダイオードとして動作するように設計されてもよい。アバランシェフォトダイオードは、逆バイアスによって動作され、低濃度不純物領域10は、光吸収領域に加えてアバランシェ増倍領域を規定する。第2のコンタクト手段（不図示）は、半導体基板の裏側又は他の任意の位置に電気的に接続されてもよい。

【0027】

図1に示される実施形態において、ナノワイヤ7の使用は、活性ボリュームを失うことなく、電気導通経路の分割を可能にする。この分割されたフォトダイオードは、対応するプレーナデバイスと比較して、量子効率を低下させることなく、暗電流を著しく減少させることを実証する。分割されたフォトダイオードは、容易に製造可能でありながら、プレ

ーナデバイスにおける大きな暗電流という基本的な問題を解決する単純な方法を提供する。

【0028】

図2a及び図2bは、本発明にかかるフォトダイオードの放射設計の実施形態を概略的に示す図である。フォトダイオードは、半導体基板3から突出するナノワイヤ7のアレイを具備する。PIN接合の少なくとも一部は、半導体基板において第1の導電型を有する半導体材料から製造された第1の領域1及び第1の導電型とは逆の第2の導電型を有する半導体材料から製造され、各ナノワイヤを取り囲む第2の領域2により形成される。電荷キャリアを発生する光吸収領域を規定するために、ナノワイヤ7のアレイと第2の領域2との間に、低濃度不純物領域又は真性領域10が規定される。活性領域の光吸収領域は、動作バイアス時に十分な空乏状態になるほど低い濃度で不純物が添加されている限り、P型又はN型のいずれであってもよい。第1の領域及び第2の領域は、互いに逆の添加不純物の極性を有し、本実施形態において、第1の領域はN型不純物を添加され、第2の領域はP型不純物を添加されるものとして例示されるが、本発明はそれに限定されない。放射真性領域の形成は、平面真性領域に代わる方法であり、放射設計方法は、適正に規定された真性領域の形成を簡単化する。更に、放射構成は、大きな空乏効果を実現し、ナノワイヤを中心として周囲のシェル層にまで延在する円筒形空乏領域を形成する。

【0029】

図2aにおいて、第1の領域1は、半導体基板3における第1のN型不純物層を具備し、各ナノワイヤ7の少なくとも一方の端部は、第2の領域2の少なくとも一部を形成する第2のP型不純物層のオーバーグロースにより形成された低濃度不純物領域10を含むシェル層により封入される。好ましくは、ナノワイヤ7は、低濃度不純物添加半導体材料又は真性半導体材料から製造される。第2の不純物層は、ナノワイヤのバンドギャップより広い1つのバンドギャップ又は複数のバンドギャップを具備する。誘電体層15、或いは、低濃度不純物添加半導体層又は真性半導体層は、半導体基板3の表面を被覆し、ナノワイヤ7を取り囲む。P型不純物層及びN型不純物層、中間真性領域及び真性ナノワイヤは、PIN接合を形成する。シェル層の低濃度不純物領域10に実質的に対応する光吸収領域11において、電荷キャリアが光発生される。図2aに示されるように、ナノワイヤから再成長され、ナノワイヤ7の間のギャップを充填する共通融合半導体層を形成するために、不純物層は、ナノワイヤ7から再成長されてもよい。これにより、不純物層の上における第1の共通コンタクト5の形成が容易になる。このフォトダイオード構造は、広範囲にわたる波長を検出可能であることに加えて高い光学密度を実現し、ナノワイヤを採用したことで暗電流を低レベルに保持する。

【0030】

図2bにおいて、第2の不純物層がナノワイヤ7から再成長される場合、ナノワイヤ7の間に、ギャップが残される。かかるギャップは、誘電体材料、真性半導体材料又は低濃度不純物添加半導体材料によって充填されてもよい。ギャップにおける材料は、透明であってもよい。各ナノワイヤ7は、互いに分離され、半導体基板によって隣接するナノワイヤフォトダイオードに接合されて第2の不純物層の上に配置された第1の共通コンタクトによって隣接するナノワイヤフォトダイオードに任意に接合される個別のフォトダイオードを規定する。

【0031】

特に、図2a及び図2bのフォトダイオードは、Si系のIII～V族の半導体材料、例えば、Siから製造された半導体基板におけるN⁺型Si層、真性InGaAsナノワイヤ、P⁻型InGaAs低濃度不純物領域及び低濃度不純物領域を封入するP⁺型InGaAs層を具備してもよい。このようなフォトダイオードは、N⁺型Si層が入射光子を透過するのであれば、N⁺型Si層を介して光に暴露されてもよいが、下方に位置する層より高いバンドギャップを有するP⁺型層が選択されるのであれば、P⁺型層を介して上面からの光に暴露されてもよい。図2に示されるフォトダイオードの光吸収領域11は、フォトダイオードのナノワイヤ側に配置されるため、多数の他のIII～V族材料を使用す

ることができ、長波長 I R (I n S b、0. 17 e V) ~ 高 U V (A l N、6. 2 e V) に至る帯域幅範囲を使用することができる。ナノワイヤが示す格子不整合の許容差が基本的に大きいため、広い範囲で材料を自由に選択できる。更に、近年、S i の上に III ~ V 族ナノワイヤをエピタキシャル成長させる技術が向上したため、大量生産が容易な広い S i 基板の上に高品質の III ~ V 族材料を製造することができるようになり、その結果、現在のウェハボンディング処理の欠点を回避しながらも、製造コストを著しく低減することができる。

【0032】

本発明のフォトダイオードは、第2の領域に電氣的に接続された上面コンタクトを具備する第1のコンタクト手段5を具備してもよい。フォトダイオードがナノワイヤ側から光を受け取るように構成される場合、上面コンタクトは透明であるのが好ましい。適切な透明コンタクト材料の例は、I T O 及び Z n O であるが、これに限定されない。上面コンタクトの別の例は、より広いバンドギャップを有し、入射放射に対して透明であり、オーミックコンタクトで終端する高濃度不純物添加半導体である。

【0033】

動作において、上述したフォトダイオードは、光吸収領域11における電荷キャリア発生によって、光電流を発生する。典型的に、活性領域は、低濃度不純物領域に含まれるが、その周囲のP型領域及び／又はN型領域及び／又はナノワイヤまで延在していてもよい。光発生された電荷キャリアは、逆バイアス極性によって、必然的にナノワイヤ7に引き寄せられ、他の場所に搬送される。

【0034】

電荷キャリアの発生がP I N 接合の基板部分において起こる場合、暗電流を減少するために、最大ナノワイヤ間隔を拡大すべきである。但し、ナノワイヤ間隔が広がるにつれて、トラッピング及び再結合が増加し、それにより、回収効率が低下するため、ナノワイヤ間隔は限定される。S i 基板から突出するナノワイヤ7は、2 μ m 未満、好ましくは、0. 1 ~ 1 μ m の最大間隔で互いに離間して配置されることが好ましい。一般に、最大間隔は、少数電荷キャリアの最大拡散長によって表されてもよい。1つの実施形態において、光吸収領域の一部が空乏状態ではない場合、ナノワイヤ7は、少数キャリアの拡散長よりも小さい隣接ナノワイヤ7間の最大間隔で位置決めされる。ナノワイヤ7は、隣接ナノワイヤ間の間隔が等しい順序正しいアレイとして配列されてもよいが、ナノワイヤ7は、平均間隔が好適な間隔を超えないようにした上で、ランダムに分散されてもよい。

【0035】

本発明にかかるフォトダイオードは、1つの横方向層 (l a t e r a l l a y e r) が多数の列に分割されるという点で従来のプレーナデバイスとは異なる。上述したように、この分割により得られる利点は、ナノワイヤを分割することで、材料、バンドギャップ、ドーピングプロファイル及び／又はドーピングレベルの選択肢が広がり、欠陥密度が低下するために漏れ電流、動作電圧及び耐用年数に関して改善が見られることである。

【0036】

本発明のナノワイヤフォトダイオードにより実現される基本的な利点は、活性ボリュームを失うことなく電流経路が分割されるので、量子効率を低下させずに暗電流を減少することである。デバイスの物理的特性は、放射設計及び軸設計で類似しており、放射P I N 構造では、界面がナノワイヤの全長に沿って延在し、半径方向において重要なキャリア分離が起こるといふ更なる利点が見られる。回収距離は、少数キャリアの拡散長よりも短くなると予測されるため、光発生キャリアは、大量の再結合を起こすことなく、非常に高い効率でP I N 接合に到達することができる。フォトダイオードの分割は、フォトダイオードのキャパシタンスも減少させ、それにより、動作速度を増加する。

【0037】

ナノワイヤ及びナノ構造の両方は、分割効果の利点を得るために、フォトダイオードにおいて使用することができる。換言すれば、ナノワイヤは、それぞれ異なる長さを有してもよく、即ち、ナノワイヤ又はナノスタブである。

【0038】

図3aを参照するに、フォトダイオードの活性領域は、実質的に、ナノワイヤに含まれてもよい。本発明の1つの実施形態において、フォトダイオードは、N型不純物添加半導体基板3の上の本質的に真性のナノワイヤ又は低濃度不純物添加ナノワイヤを具備する。基板3とは反対側のナノワイヤ7の端部は、第1のコンタクト手段5に接続されたP型半導体材料に封入される。これにより、空乏領域は、実質的に、ナノワイヤに形成される。空乏領域は、光吸収領域を具備し、アバランシェ増倍領域を任意に具備してもよい。ナノワイヤのバンドギャップは、組成及び／又はドーピングレベルの異なるヘテロ構造を使用することにより、設計されてもよい。

【0039】

図4は、第1の導電型を有する半導体材料から製造された第1の領域1及び第1の導電型とは逆の第2の導電型を有する半導体材料から製造された第2の領域2により少なくとも部分的に形成されるPIN接合を具備するナノワイヤ系フォトダイオードの1つの実施形態を概略的に示す図である。例えば、第1の領域がP型であれば、第2の領域はN型であり、第1の領域がN型であれば、第2の領域はP型である。PIN接合は、光吸収領域11を形成するために、第1の領域1と第2の領域2との間に低濃度不純物領域10を更に具備する。低濃度不純物領域10は、光吸収領域11において発生される電荷キャリアを回収するように配列されたナノワイヤ7のアレイにより、第1の低濃度不純物層と第2の低濃度不純物層とに分割される。第1の領域1は、第1の導電型の第1の不純物層により半導体基板3に形成される。第1の導電型の低濃度不純物添加半導体材料又は真性半導体材料から製造された第1の低濃度不純物層は、ナノワイヤアレイと第1の領域1との間に、典型的には半導体基板3の上に配置される表面層として規定される。各ナノワイヤ7は、誘電体層15、或いは、低濃度不純物添加半導体層又は真性半導体層における開口を貫通して第2の導電型の第2の低濃度不純物層まで突出する。第2の領域2の少なくとも一部は、第2の低濃度不純物層の上に配置された第2の導電型の第2の不純物層により形成される。動作において、第2の低濃度不純物層における吸収光から発生される電荷キャリアは、ナノワイヤ7により回収され、第1の低濃度不純物層に搬送される。

【0040】

1つの例として、図4のフォトダイオード構造において、第1の不純物層は N^+ 型Siから製造され、第1の低濃度不純物層は N^- 型Siから製造され、第2の低濃度不純物層は P^- 型InGaAsから製造され、第2の不純物層は P^+ 型InGaAsから製造される。

【0041】

図5は、第1の導電型を有する半導体材料から製造された第1の領域1及び第1の導電型とは逆の第2の導電型を有する半導体材料から製造された第2の領域2により少なくとも部分的に形成されるPIN接合を具備するナノワイヤ系APDの1つの実施形態を概略的に示す図である。例えば、第1の領域がP型であれば、第2の領域はN型であり、第1の領域がN型であれば、第2の領域はP型である。PIN接合又はPN接合は、吸収光から電荷キャリアを発生する活性領域を更に具備する。PIN接合は、活性領域を形成するために、第1の領域1と第2の領域2との間に低濃度不純物領域10を更に具備する。低濃度不純物領域10は、活性領域の光吸収領域11において発生される電荷キャリアを回収するように配列された1つ以上のナノワイヤ7により、第1の低濃度不純物層と第2の低濃度不純物層とに分割される。第1の領域1は、第1の導電型の第1の不純物層により半導体基板3に形成される。第1の導電型の低濃度不純物添加半導体材料又は真性半導体材料から製造された第1の低濃度不純物層は、アバランシェ増倍領域12を形成するために、各ナノワイヤ7と第1の領域1との間に、典型的には半導体基板3の上に配置される表面層として規定される。各ナノワイヤ7は、誘電体層15、或いは、低濃度不純物添加半導体層又は真性半導体層における開口を貫通して第2の導電型の第2の低濃度不純物領域まで突出し、第2の低濃度不純物層は、光吸収領域11を形成する。第2の領域2の少なくとも一部は、第2の低濃度不純物層の上に配置された第2の導電型の第2の不純物層

により形成される。動作において、第2の低濃度不純物層における吸収光から発生される電荷キャリアは、逆バイアスによってナノワイヤ7により回収され、第1の低濃度不純物層に搬送される。

【0042】

1つの例として、図5のAPD構造において、第1の不純物層は N^+ 型Siから製造され、第1の低濃度不純物層は P^- 型Siから製造され、第2の低濃度不純物層は P^- 型InGaAsから製造され、第2の不純物層は P^+ 型InGaAsから製造される。このようなAPDは、InGaAs材料の高い光吸収効率と共に、Siの低雑音増倍能力を利用する。動作において、典型的には、基板側から入射してシリコンを透過する赤外線領域における光子は、 P^- 型InGaAs層で吸収される。逆バイアスの下で、光発生電子は、Si部分に向かって移動し、高電界 P^- 型Si増倍領域に注入される。この概念の重要な利点は、高電界増倍領域が低電界光吸収領域から物理的に分離されていることである。2つの領域が分離されていないと、バンドギャップが狭くなり、且つ、電子有効質量が小さくなり、InGaAs領域においてツェナートンネリングが起こるため、暗電流が劇的に大きくなってしまう。この構造の更なる利点は、高電界にさらされるナノワイヤが短絡するよりも回路遮断作用を起こしやすいことである。

【0043】

SiナノワイヤAPDは、雑音（アバランシェ雑音）特性が低いために通信装置として興味深い。標準的な平面エピタキシャル成長技術において、格子不整合が大きいために、InGaAs-Si APDを形成することは不可能である。現時点において、これに代わる唯一の方法はウェハボンディングであるが、漏れ電流が多く、満足できる結果は得られていない。

【0044】

図6は、a) 逆バイアスを印加された場合の図5の実施形態の電界図、b) バイアスを印加されていない場合の図5のAPDのバンドギャップ図、及び、c) バイアス印加時の同じAPDのバンドギャップ図を概略的に示す。なお、 P^- 型Siの添加は、均一であってもよいし、低濃度 P^- 型不純物領域において高濃度 P^+ スパイク（厚さは数百nmを超えない）を含むように不均一であってもよい。電界が増倍領域においてほぼ均一になるため、所謂、ハイロー型APD構成は、増倍領域において、低い電界で高利得を実現するという利点を有する。低い電界ほどイオン化係数の比が大きくなるため、アバランシェ過剰雑音も小さくなる。 P^- 型Si層の代わりに真性Si層又は低濃度不純物添加Si層が使用される場合、境界面から P^- 型InGaAs層に向かってドーピングスパイクが導入されるべきである。

【0045】

このようなアバランシェフォトダイオードは、
 —ピーク電界がアバランシェを可能にするほど十分に高くなり、
 —ナノワイヤを封入する放射合体層であってもよい P^- 型InGaAs領域において光発生が起こり、電子が P^- 型Si領域に注入され、
 — P^- 型InGaAs領域が完全な空乏状態になり、且つ、
 —図6のAにおける P^- 型Si領域の電界がトンネリングを防止するほど十分に低くなる（約50%のGaAs及び50%のInAsを有するInGaAs組成の場合で $E_i < 1.5 \times 10^5 \text{ V/cm}$ ）ように、設計可能である。

【0046】

電界が高すぎると、バイアスの増加に伴って暗電流が急速に増加するため、最後の条件は重要である。更に、図5のCにおける勾配が小さくなるため、トンネリングは起こりにくくなる。

【0047】

本発明にかかるフォトダイオードは、図示される極性に限定されない。PN構成の代わりにNP構成が使用されてもよい。逆極性のデバイスの場合、製造の面から、N型ワイヤがより好適である。ナノワイヤAPDにおいて、デバイスの動作速度を低下させる可能性

があるキャリアパイルアップ効果をもたらすヘテロ接合バリアを低減するために、2つ以上の材料が使用される。例えば、ナノワイヤに沿ってGa及びPの含有量に変化するGaInAsPナノワイヤが使用されてもよい。これは、高速通信（～1Gb/s以上）において特に重要である。

【0048】

上述したように、暗電流特性を向上させたフォトダイオードを提供することにより、改良された大型デバイスの製造を可能にする。時間の経過に伴う暗電流の発生を実質的に一定にし、それにより、短絡による故障の危険を著しく低減させたフォトダイオードを提供することも本発明の利点である。特に、マイクロプラズマとしても知られる局所的な高電界スポットの形成によって半導体材料の劣化が加速されるため、暗電流特性の向上は、APDなどの高い逆バイアスレベルで動作されるフォトダイオードに有益である。マイクロプラズマは、電流フィラメンテーション及び局所加熱の原因となり、最終的には、デバイスの早期故障を引き起こす。本発明にかかるフォトダイオードのナノワイヤは、回路遮断器として動作するように設計可能である。この故障機構は、ナノワイヤに高電界が印加されるのに続いて、通常は、数桁の幅でナノワイヤ抵抗が大きく増加する現象として現れる。回路遮断によって大型アレイにおける1つ又は少数のナノワイヤが障害を起こしても性能に著しい影響は与えないが、短絡はデバイスに大きな害を与えるため、短絡作用と比較して、回路遮断器作用は有利である。更に、かかる回路遮断器作用は、ナノワイヤ部分における空間電荷蓄積に基づく電流制限構造としてナノワイヤの少なくとも一部を利用することにより、本発明にかかるフォトダイオードの性能及び信頼性を更に向上するために、使用されてもよい。空間電荷効果は、非常に高く、且つ、設計可能な直列抵抗を発生し、その結果、過剰な電流漏れ及びデバイスの故障を防止できる。フォトダイオードの逆方向抵抗は、更に高いブレークダウン電圧を有し、且つ、アバランシェ機能が改善されたフォトダイオードを実現するために、増加されてもよい。

【0049】

本発明にかかる基本的なナノワイヤフォトダイオードは、既に改善された電流漏れ特性及び暗電流特性を提供する。ナノワイヤに空乏領域を理想的な形態で拡散させるようにフォトダイオードを適正に設計することにより、本発明にかかるナノワイヤフォトダイオードの性能、特に、その電流漏れ特性及び暗電流特性を更に向上できる。以下では、フォトダイオードの重要部分は、電流制限構造と呼ばれ、以下の説明及び評価は、所望の特性を得るために、ナノワイヤの寸法、ドーピングレベル及び半導体材料などのいくつかのパラメータを変更できることを実証する。

【0050】

本発明の1つの実施形態において、本発明にかかるフォトダイオードは、電流制限構造を具備する。電流制限構造は、誘電体材料、或いは、低濃度不純物添加材料又は真性材料に封入された各ナノワイヤ7の少なくとも一部を具備し、動作において、ナノワイヤの封入部分は、所定の空間電荷効果を実現するために、少なくとも部分的に空乏状態になるように構成される。

【0051】

電流制限効果は、ナノワイヤの間隔、ドーピングレベル、ナノワイヤ部分の直径及び長さなどのいくつかのパラメータを変更することにより、又は、ナノワイヤにヘテロ構造を導入することにより、或いは、材料の組み合わせを変更することにより、設計することができる。

【0052】

電流制限構造は、フォトダイオードの活性領域に重大な影響を及ぼすことなく、設計することができる。従って、電流制限構造と組み合わせて、広い活性領域が得られる。逆バイアスモードにおいて、フォトダイオードの活性領域は、実質的に、本発明にかかる各ナノワイヤに隣接する低濃度不純物領域に形成される。フォトダイオードは、界面から低濃度不純物領域まで延在するナノワイヤの一部分により形成された電荷制限構造を具備する。高電界によって、ナノワイヤの少なくとも一部は空乏状態になり、空間電荷が蓄積され

る。所定の電流制限効果は、P I N接合の特性及び動作を制御することにより、得られる。基本的には、この効果は、空乏領域がナノワイヤにどの程度まで延在しているかに依存する。例えば、かかる効果は、ナノワイヤ及び隣接領域の不純物添加により、制御することができる。電流制限構造は、広い光吸収領域を有するが、小さくてもよい。

【0053】

ナノワイヤ中の空間電荷抵抗は、以下の式から大まかに推定することができる。

【0054】

【数1】

$$\nabla^2 V = \frac{J}{\epsilon V_D} \quad (1)$$

10

【0055】

【数2】

$$V = \frac{1}{2} \frac{J}{\epsilon V_D} l^2 = \frac{1}{2} \frac{I}{A} \frac{l^2}{\epsilon V_D} \quad (2)$$

20

【0056】

【数3】

$$R_s = \frac{V}{I} = \frac{1}{2} \frac{l^2}{A \epsilon V_D} = \frac{2}{\pi} \frac{(10^{-4})^2}{(10^{-3})^2 \times 8.85 \times 10^{-14} \times 10^8} \sim 10 M\Omega \quad (3)$$

30

【0057】

Vは、約1ミクロンと仮定されるワイヤ長さlに対する電圧であり、J及びIは、ナノワイヤの電流密度及び電流である。Aは、ナノワイヤの横断面面積（約100nmの直径に相当すると仮定される）であり、 v_D は、約 10^7 cm/sとみなされるキャリアドリフト速度である。半導体の誘電率NWは、約10と仮定される。

【0058】

上述した推定は、空間電荷抵抗が非常に高いことを示し、
 - 内部漏れ電流、即ち、暗電流を最小限に抑え、
 - プレーナ技術では容易に実現不可能なレベルまで抵抗を増加し、
 - 順方向バイアスP I Nデバイスにおいて、非常に大きな空間電荷効果を実現し、
 - サージ（ブレークダウン電圧付近の急速な電流上昇）が起こらない限り、空間電荷は逆バイアスデバイスに影響を与えないため、破壊的な局所デバイス障害を防止し、
 - I-V特性を設計するなどの目的で、この高い空間電荷抵抗を使用することができることを示している。

40

【0059】

本発明にかかるナノワイヤフォトダイオードは、
 - 通信、
 - Si系の大型低 I_D デバイス、特に、長波長デバイス、
 - 中間IR装置、特に、カメラ、及び、

50

ー放射硬化デバイス、特に、Ga₂Nなどの窒化物半導体を含むナノワイヤを使用するデバイスにおいて、種々の形態で実現可能である。

【0060】

図7を参照するに、プレーナ技術における既知の問題は、デバイスの周囲部分において局所的に高い電界を発生することにより、早期ブレイクダウンを引き起こすようなドーピングプロファイルが形成されることである。これを回避するために、プレーナアバランシェフォトダイオードでは、ガードリングが使用される。ナノワイヤを使用する方法は、基板における半球形ドーピングプロファイルを各ナノワイヤと組み合わせることによりナノワイヤから同一の距離において電界を均一にするため、ガードリングが不要になる。図7は、基板から突出し、各ナノワイヤの下方において半球形ドーピングプロファイルを有するナノワイヤのアレイを概略的に示す図である。この半球形ドーピングプロファイルは、例えば、ナノワイヤの成長中のドーパント拡散、或いは、ナノワイヤの成長前のドーパント注入又はドーパント拡散などの多くの方法により、実現することができる。これに代わる構成は、ガードリングを不要にするために、ナノワイヤの下方のドーピングプロファイルを均一、且つ、平坦にするようにナノワイヤの基部の間に延びるドーピングプロファイルを形成するものである。これにより、成長前に1つの製造ステップが追加される、或いは、ナノワイヤの製造前にその製造ステップが追加される。ガードリングを不要にするためにナノワイヤ及びナノスタブの両方が使用可能であるが、回路遮断器作用を得るためにはナノワイヤを使用すべきである。

【0061】

本発明は、実質的に、「あらゆる」半導体材料の組み合わせを使用可能なヘテロ接合PDを可能にする。これは、格子不整合にかかわらず、半導体基板又は半導体層の上にナノワイヤを成長させることができるからである。使用可能な材料は、少なくとも、遠赤外線から紫外線までの光電流応答が可能であるInSb(0.17 eV)~AlN(6.2 eV)の範囲にわたる。一般的に、吸収領域の材料は、ナノワイヤ又はナノスタブの材料と同一であるが、吸収材料のバンドギャップが狭い場合、ナノワイヤを介してキャリアを十分に回収するために、吸収層との界面に勾配をつけることで暗電流を更に減少するようにナノワイヤのバンドギャップを拡張することが有用である。

【0062】

InGaAs/Si構造を有する実施形態を1つの例として説明したが、例えば、InAsP及びIn、Ga、As及びPの種々の任意の組み合わせなどの他のIII~V族材料が使用されてもよく、他の半導体基板が使用されてもよい。当業者には理解されるように、化合物の化学量論的組成が変更されてもよい。不純物添加に適する材料は、当技術において既知である。

【0063】

重要なドーパント種を含有しない半導体材料は、一般的に、真性半導体材料と呼ばれ、PIN接合においてIとして示される。本出願に関して、真性領域又は真性材料は、意図的にP型又はN型不純物が添加されていないか又は不純物が低濃度で添加されており、実質的に真性値に見合う又はそれに等しいキャリア濃度を有する領域であってもよいと理解されるべきである。

【0064】

光検出器における種々の領域は、組成の異なるいくつかの層から構成される、或いは、組成勾配を有する又はドーピングプロファイルに勾配がつけられている層から構成されてもよい。本出願における実施形態は、そのようなヘテロ接合を含まない構造として説明されるが、ヘテロ接合は、本出願の範囲に含まれることを意図する。単なる1つの例として、上述したコアシェル構造を使用し、不純物添加半導体基板の代わりにナノワイヤにおけるヘテロ構造セグメントを使用することにより、PN接合又はPIN接合が形成されてもよい。更に、デバイスは、一般的に、アバランシェモードで動作するように設計されるが、これは明細書に明示して開示されていない。

【0065】

本出願を通して、表面層は、半導体基板の上に配置された半導体層を定義するために使用される。このような層は、一般的に、パツファ層と呼ばれ、層の厚さが限定されるため、一次元特性を提供することが多い。本発明にかかる表面層は、厚さに関して限定されず、一次元特性にも限定されない。一方、表面層は、バルク状特性を有してもよい。

【0066】

本発明は「上面」、「縦型」、「裏面」などの用語によって説明されたが、光検出器デバイスの空間における物理的な向きは重要ではない。それらの用語は、光検出器の種々の特徴の相互関係を説明するために使用されるにすぎない。

【0067】

現時点において最も実用的、且つ、好適な実施形態であると考えられるものに関連して本発明を説明したが、本発明は、開示された実施形態に限定するものではなく、特許請求の範囲に記載された範囲内で種々の変形及び同等の構成を含むことを意図すると理解されるべきである。

10

【図1a】

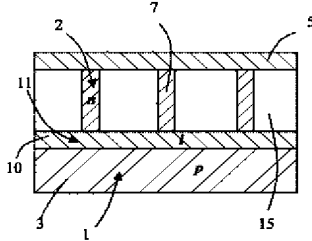


Fig. 1a

【図2a】

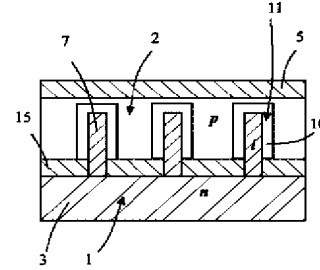


Fig. 2a

【図1b】

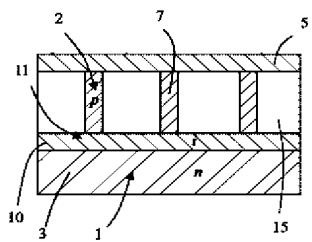


Fig. 1b

【国際調査報告】

INTERNATIONAL SEARCH REPORT

International application No.
PCT/SE2009/050997

A. CLASSIFICATION OF SUBJECT MATTER		
IPC: see extra sheet According to International Patent Classification (IPC) or to both national classification and IPC		
B. FIELDS SEARCHED		
Minimum documentation searched (classification system followed by classification symbols)		
IPC: H01L		
Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched		
SE,DK,FI,NO classes as above		
Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)		
EPO-INTERNAL, WPI DATA, PAJ		
C. DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	ZnO nanorod arrays as p-n heterojunction ultraviolet photodetectors, Knize R J et al. ELECTRONICS LETTER, 2006-10-26, Vol. 42 No. 22 page 1309 - 1310, see the whole document --	1,6,13-14,19
X	EP 1748494 A1 (INTERUNIVERSITAIR MICROELEKTRONICA CENTRUM), 31 January 2007 (31.01.2007), figure 4, paragraphs (0044)-(0045),(0063),(0068) --	1,2
X	WO 2008079077 A2 (QUNANO AB), 3 July 2008 (03.07.2008), page 10, line 27 - page 15, line 4; page 27, line 6 - page 28, line 20, claim 40 --	12
☒ 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		Date of mailing of the international search report
30 November 2009		01-12-2009
Name and mailing address of the ISA/ Swedish Patent Office Box 5055, S-102 42 STOCKHOLM Facsimile No. +46 8 666 02 86		Authorized officer Fredrik Wahlin / JA A Telephone No. +46 8 782 25 00

Form PCT/ISA/210 (second sheet) (July 2009)

INTERNATIONAL SEARCH REPORT

International application No.
PCT/SE2009/050997

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	EP 1703569 A2 (GENERAL ELECTRIC COMPANY), 20 Sept 2006 (20.09.2006), abstract, paragraphs (0062)-(0064) --	1
A	US 20080156366 A1 (KIM ET AL), 3 July 2008 (03.07.2008), claim 1, paragraphs (0020)-(0029) -- -----	1

Form PCT/ISA/210 (continuation of second sheet) (July 2009)

INTERNATIONAL SEARCH REPORT

International application No.
PCT/SE2009/050997

International patent classification (IPC)

H01L 31/0352 (2006.01)
H01L 31/12 (2006.01)
H01L 31/103 (2006.01)
H01L 31/105 (2006.01)

Download your patent documents at www.prv.se

The cited patent documents can be downloaded:

- From "Cited documents" found under our online services at www.prv.se (English version)
- From "Anförda dokument" found under "e-tjänster" at www.prv.se (Swedish version)

Use the application number as username. The password is **ZEUDHZVHWP**.

Paper copies can be ordered at a cost of 50 SEK per copy from PRV InterPat (telephone number 08-782 28 85).

Cited literature, if any, will be enclosed in paper form.

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/SE2009/050997

EP	1748494	A1	31/01/2007	DE 602005005985 D,T	28/05/2009
				US 7598482 B	06/10/2009
				US 20090266974 A	29/10/2009
WO	2008079077	A2	03/07/2008	NONE	
EP	1703569	A2	20/09/2006	CN 1855552 A	01/11/2006
				JP 2006261666 A	28/09/2006
				US 20060207647 A	21/09/2006
US	20080156366	A1	03/07/2008	NONE	

Form PCT/ISA/210 (patent family annex) (April 2005)

フロントページの続き

(81)指定国 AP(BW, GH, GM, KE, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM, ZW), EA(AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), EP(AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, SE, SI, SK, SM, TR), OA(BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG), AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PG, PH, PL, PT, RO, RS, RU, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW

(74)代理人 100130409

弁理士 下山 治

(72)発明者 サミュエルソン, ラーシュ

スウェーデン国 マルメ エス - 2 1 1 1 9, イスベルグス ガタ 2 8

(72)発明者 カパッソ, フェデリコ

アメリカ合衆国 マサチューセッツ州 0 2 1 3 8, ケンブリッジ, アpartment B, ウェンデル ストリート 5 6

(72)発明者 オールソン, ヨナス

スウェーデン国 マルメ エス - 2 1 2 1 3, クングスガタン 3 3

F ターム(参考) 5F049 MA02 MA04 MA07 MB07 NA05 PA03 PA14 QA20 SE02 SE04

SS03 WA01 WA03 WA05

PATENT COOPERATION TREATY

PCT

INTERNATIONAL SEARCH REPORT

(PCT Article 18 and Rules 43 and 44)

Applicant's or agent's file reference 88184-CIP-1-PCT	FOR FURTHER ACTION see Form PCT/ISA/220 as well as, where applicable, item 5 below.	
International application No. PCT/US18/43289	International filing date (day/month/year) 23 July 2018 (23.07.2018)	(Earliest) Priority Date (day/month/year) 21 July 2017 (21.07.2017)
Applicant W&WSens, Devices 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/US18/43289

A. CLASSIFICATION OF SUBJECT MATTER

IPC - H01L 31/105, 31/107, 31/0352, 31/0232, 27/144; G02B 6/122, 6/136 (2019.01)
CPC - H01L 31/105, 31/1075, 31/0204, 31/035281, 31/02005, 31/02327, 27/1443; G02B 6/122, 6/136

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

See Search History document

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 -- Y -- A	US 2016/0307939 A1 (WANG, S et al.) 20 October 2016; entire document	1-6, 9-14, 17-19, 21-23, 25-30, 33, 35-47, 49 -- 7-8, 15-16, 24, 31-32, 48 -- 20, 34, 50
Y -- A	US 2016/0254407 A1 (WANG, S et al.) 01 September 2016; entire document	7-8, 15-16, 24, 31-32 -- 20, 34, 50
Y	US 2004/0222357 A1 (KING, D et al.) 11 November 2004; abstract; figure 1; paragraph [0016]	48
A	US 5,525,828 A (BASSOUS, E et al.) 11 June 1996; entire document	1-50
A	US 2002/0097962 A1 (YOSHIMURA, T et al.) 25 July 2002; entire document	1-50
A	US 2015/0340538 A1 (CORIANT ADVANCED TECHNOLOGY, LLC) 26 November 2015; entire document	1-50
A	US 7,605,406 B2 (IGUCHI, Y) 20 October 2009; entire document	1-50

☐ 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

14 January 2019 (14.01.2019)

Date of mailing of the international search report

12 FEB 2019

Name and mailing address of the ISA/

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

Facsimile No. 571-273-8300

Authorized officer

Shane Thomas

PCT Helpdesk: 571-272-4300

PCT OSP: 571-272-7774

Form PCT/ISA/210 (second sheet) (January 2015)

Your Ref: 5176-86514-PCT-JP
Our Ref: PA1256

**Translation of Selected Portions of
Pat. Laid-open Official Gazette**

Appln. No: 5-132016
Appln. Date: June 2, 1993
Laid-open Pub. No: 6-53424
Laid-open Pub. Date: February 25, 1994
Priority: US 900881, June 18, 1992

Inventor(s): Chenmin Che (?); Ronal William Nepper;
Lawrence F. Wagner Jr.
Applicant(s): International Business Machines
Corporation
Attorney(s): Kiyoshi Goda et al.

1. Title of the Invention

LATERAL TYPE BIPOLAR TRANSISTOR MATCHING TO A VERTICAL
TYPE GATE CMOS

2. Claims

(omitted)

3. Detailed Description of the Invention (Selected Portions)

1)

(omitted)

(19)日本国特許庁(JP)

(12) 公開特許公報(A)

(11)特許出願公開番号

特開平6-53424

(43)公開日 平成6年(1994)2月25日

(51)Int.Cl. ⁵	識別記号	庁内整理番号	FI	技術表示箇所
H 0 1 L 27/06				
21/331				
29/73				
		9170-4M	H 0 1 L 27/ 06	3 2 1 C
		7377-4M	29/ 72	
			審査請求 有	請求項の数9(全 6 頁)

(21)出願番号 特願平5-132016

(22)出願日 平成5年(1993)6月2日

(31)優先権主張番号 9 0 0 8 8 1

(32)優先日 1992年6月18日

(33)優先権主張国 米国(US)

(71)出願人 390009531

インターナショナル・ビジネス・マシー
ズ・コーポレーション

INTERNATIONAL BUSIN
ESS MACHINES CORPO
RATION

アメリカ合衆国10504、ニューヨーク州
アーモンク (番地なし)

(72)発明者 チェンミン・シェ

アメリカ合衆国12524、ニューヨーク州フ
ィッシュキル、スターミル・ロード 78

(74)代理人 弁理士 合田 潔 (外1名)

最終頁に続く

(54)【発明の名称】 縦型ゲートCMOSと整合する横型バイポーラ・トランジスタ

(57)【要約】

【目的】 本発明の目的は、縦型バイポーラ・トランジスタに匹敵する電流利得と動作速度を有する横型バイポーラ・トランジスタを提供することである。

【構成】 シリコン・オン・インシュレータ(SOI)内部ベースとコレクタを有するトランジスタにおいて、これらの内部ベースとコレクタは、それぞれ低温エピタキシャル・プロセスによって形成され、それぞれがシリコン・オン・インシュレータ(SOI)基板に対して垂直に配向されている。

【効果】 ベース幅を、従来の縦型トランジスタと同じ位に小さくすることができる。同様に、コレクタ幅を正確に制御できる。

【特許請求の範囲】

【請求項1】外部ベース層縁部を画定する開口がその中に形成された外部ベース層と、
前記外部ベース層を覆い、前記外部ベース層縁部と位置合せされたエミッタ層縁部を画定する開口がその中に形成された、エミッタ層と、
低温エピタキシャル・プロセスによって形成され、前記外部ベース層縁部及び前記エミッタ層縁部の上に延び、前記外部ベース層及び前記エミッタ層に対して垂直に延びる、内部ベース層と、
低温エピタキシャル・プロセスによって形成され、前記内部ベース層の上に延び、前記外部ベース層及び前記エミッタ層に対して垂直に延びる、コレクタ層との組合せを有する、バイポーラ・トランジスタ。

【請求項2】前記外部ベース層がシリコン・オン・オキサイド基板上に形成されることを特徴とする、請求項1に記載のバイポーラ・トランジスタ。

【請求項3】前記エミッタ層が前記外部ベース層からのエピタキシャル横型過剰成長によって形成されることを特徴とする、請求項1に記載のバイポーラ・トランジスタ。

【請求項4】エミッタが非晶質シリコンの再結晶によって形成されることを特徴とする、請求項1に記載のバイポーラ・トランジスタ。

【請求項5】さらに、前記のエミッタ層を覆う追加の外部ベース層と、前記追加の外部ベース層を覆うコレクタ接点層とを含む、請求項1に記載のバイポーラ・トランジスタ。

【請求項6】外部ベース層縁部を画定する開口がその中に形成された、外部ベース層を形成する段階と、
前記の外部ベース層を覆い、前記外部ベース層縁部と位置合せされたエミッタ層縁部を画定する開口がその中に形成された、エミッタ層を形成する段階と、
低温エピタキシャル・プロセスによって形成され、前記外部ベース層縁部及び前記エミッタ層縁部の上に延び、前記外部ベース層及び前記エミッタ層に対して垂直に延びる、内部ベース層を形成する段階と、
低温エピタキシャル・プロセスによって形成され、前記内部ベース層の上に延び、前記外部ベース層及び前記エミッタ層に対して垂直に延びる、コレクタ層を形成する段階とを含む、バイポーラ・トランジスタの製造方法。

【請求項7】さらに、前記エミッタ層を覆う追加の外部ベース層を形成する段階と、
前記追加の外部ベース層を覆うコレクタ接点層を形成する段階とを含む、請求項6に記載のバイポーラ・トランジスタの製造方法。

【請求項8】外部ベース層と、
前記外部ベース層を覆うエミッタ層と、
前記外部ベース層及び前記エミッタ層を貫通して延びて、対向する第1及び第2の垂直壁を形成する、縦型開

口と、

低温エピタキシャル・プロセスによって前記第1及び第2の垂直壁上に同時に形成された内部ベース層と、
低温エピタキシャル・プロセスによって、前記第1及び第2の垂直壁上の前記内部ベース層の上に同時に形成されたコレクタ層との組合せを含み、
前記第1垂直壁上の内部ベース層及びコレクタ層が、第1垂直壁を形成する外部ベース層及びエミッタ層とあいまって、トランジスタ対の1方のトランジスタを構成し、前記第2垂直壁上の内部ベース層及びコレクタ層が、第2垂直壁を形成する外部ベース層及びエミッタ層とあいまって、トランジスタ対の他方のトランジスタを構成することを特徴とする、
1対のバイポーラ・トランジスタ。

【請求項9】さらに、前記トランジスタ対の前記一方のトランジスタ用の、ベース接点、エミッタ接点、及びコレクタ接点と、前記トランジスタ対の前記他方のトランジスタ用の、ベース接点、エミッタ接点、及びコレクタ接点とを含み、前記トランジスタ対の前記一方のトランジスタ用のベース接点、エミッタ接点、及びコレクタ接点が、第1の軸に沿って整列し、前記トランジスタ対の前記他方のトランジスタ用の、ベース接点、エミッタ接点、及びコレクタ接点が、前記第1の軸に平行な第2の軸に沿って整列することを特徴とする、請求項8に記載の1対のバイポーラ・トランジスタ

【発明の詳細な説明】

【0001】

【産業上の利用分野】本発明は、横型バイポーラトランジスタと、そのようなトランジスタを作成する方法に関し、さらに詳しくは、安価で高速の大規模集積回路に適した新型の縦型ベース・トランジスタに関する。

【0002】

【従来の技術】現在、商用に広範に使用されているバイポーラ・トランジスタは縦型である。しかし、周知の横型バイポーラ・トランジスタは、それを製造する工程段階が縦型バイポーラ・トランジスタに較べて比較的簡単であるため、多くの応用分野で潜在的に魅力がある。しかし、現況技術の縦型バイポーラ・トランジスタに較べて、従来技術による横型バイポーラ・トランジスタの設計は、電流利得が比較的低く、また寄生キャパシタンスと本来的に厚いベース幅のために動作速度が比較的遅い。

【0003】

【発明が解決しようとする課題】本発明の目的は、安価で高速の大規模集積回路に適した横型バイポーラ・トランジスタ、すなわち縦型バイポーラ・トランジスタに匹敵する電流利得と動作速度を有する横型バイポーラ・トランジスタを提供することである。本発明のもう1つの目的は、相補形金属酸化膜半導体(CMOS)工程段階に匹敵する横型バイポーラ・トランジスタを提供するこ

とである。

【0004】

【課題を解決するための手段】簡単に言えば、本発明は、それぞれ低温エピタキシャル工程段階によって形成され、シリコン・オン・インシュレータ(SOI)ウェーハに対して垂直に配向された、シリコン・オン・インシュレータ(SOI)、内部ベース、及びコレクタを有するトランジスタを提供することを企図する。トランジスタのベース幅は、それに匹敵する縦型トランジスタのベース幅と同じ位に狭くすることができる。同様に、コレクタ幅は正確に制御することができる。この横型トランジスタの、エミッタ、ベース、及びコレクタの各接合プロファイルなどのドーピング・プロファイルは、縦型トランジスタと同じにすることができ、このようなドーピング・プロファイルが小さな寄生キャパシタンス及び直列抵抗とあいまって、縦型バイポーラ設計に匹敵する性能特性を提供することを理解されたい。

【0005】

【実施例】ここで図面、具体的には図1と図2を参照すると、シリコン・オン・オキサイド・ウェーハは、半導体ウェーハ(図示せず)で支えられた酸化物層14の上に、薄いシリコン層12(厚さ約5000オングストローム)を有する。図1に示す段階では、シリコン層12がパターン付けされ、エッチングされ、外周誘電体13が形成されて、当技術分野では通例のようにその後のデバイス製造のためのシリコン・アイランドを作成する。本明細書に記載する本発明の特定の実施例は横型NPNデバイスであるが横型PNPデバイスも同様に製造できることを理解されたい。

【0006】シリコン層12はトランジスタの外部ベース層となる。すなわち、本発明のこの実施例では、これは 5×10^{19} 原子/cm³のドーピング濃度を有するp⁺層である。厚さ約300オングストロームの熱酸化物16Aをシリコン層12の露光領域上に成長させ、CVD酸化物などの誘電体被膜16(厚さ約2500オングストローム)を付着する。適当なエッチング工程によって酸化物層16、16A中にウィンドウ18を開ける(このウィンドウを通して、エピタキシャル横型過剰成長によってエミッタを形成する)。この状態のデバイスを図2に示す。

【0007】窒化物層20をデバイスの表面上に付着し、パターン付けし、エッチングして、図3に示すように所望のエミッタ境界を画定する。

【0008】次いで、ウィンドウ18を通じてエピタキシャル横型過剰成長によってシリコン・エミッタ22を形成する。エミッタ層は酸化物層16の上に延びて、それを覆う。エピタキシャル横型過剰成長法は、L・ヤシチェブスキー(Jastrzeboki)の論文"Epitaxial Lateral Overgrowth(ELO) Process"、Journal of Crystal Growth 63 (1983年)、pp.493~526に詳述されている。エミ

ッタはまた、その場でドーピングされた非結晶シリコン層を付着し、シード形成用ウィンドウとしての開口18を通じて層12を使用して、560℃で5時間かけて再結晶させることによって形成することができる。図5のエミッタ層22は、窒化物層20の厚さ(例えば約4000オングストローム)まで化学機械的に研磨されており、約 5×10^{20} 原子/cm³のドーピング濃度を有する。図5の平面図を図4に示す。

【0009】次いで、熱酸化物層26を、図6に示すようにシリコン層22の上面に深さ約3000オングストロームまで形成する。次に、CVD段階によって、p型ポリシリコン層28を頂部外部ベース層として形成する。この頂部外部ベース層は全体的ベース抵抗を小さくする。次いで、このポリシリコン・ベース層を、乾式エッチングによって層12すなわち底部外部ベースと同じサイズにパターン付けする。この頂部外部ベース層28の上に、高圧酸化物法(HIPOX)によって、厚さ約3000オングストロームの酸化物30を成長させる。この状態におけるデバイスを図7に示す。

【0010】図8及び図9では、開口36がエッチングされている。開口36は各層(酸化物層30、頂部外部ベース層28、熱酸化物層26シリコン・エミッタ層22、酸化物16、及びシリコン層12)を貫通して、SOI酸化物層14まで延びている。この開口はシリコン・アイランド12を2つの同じ区域に分離するが、これは図8に最も良く示されている。この分離によって、2つのバイポーラ・トランジスタの同時形成が可能になる。

【0011】開口36をエッチングした後、低温エピタキシャル(LTE)工程段階によって、2つのシリコン層をそれぞれ順次形成する。低温エピタキシャル工程段階については、B・S・メイヤーソン(Meyerson)の論文"Low-temperature Silicon Epitaxi by Ultrahigh Vacuum/Chemical Vapor Deposition"、Appl. Phys. Lett. 48(12) (1986年3月24日)、pp.797~799に詳しく論じられている。最初に形成されたLTE層38はp型層であり、内部ベースとして使用される。次のLTE層40はn型層であり、コレクタとして使用される。2つのLTE層が配置される構造を図10に示す。

【0012】次に、方向性反応性イオン・エッチングを使用して、図11に示すように、各層の開口36の垂直壁面上にある部分を除き、LTE層38、40を除去する。次いで構造全体をアニールする。

【0013】図12、図13、図14では、n⁺ポリシリコン層がLTEコレクタ層40の上に付着され、コレクタ接点を形成する。次にPECVD酸化物層44を形成し、パターン付けとエッチングによってコレクタ領域42を画定する。シリコン側壁をHIPOX酸化物46でシールする。この段階におけるデバイスの平面図と断面図を、それぞれ図12と図13に示す。

【0014】図14、図15、及び図16を見ると明らかなように、本発明の教示による横型バイポーラ・トランジスタの製造における残りの段階は従来通りであり、エミッタ接点領域、ベース接点領域、コレクタ接点領域に開口を形成すること、及びエミッタ接点、ベース接点、コレクタ接点を形成することを含む。これらの接点の製造には、従来の工程段階を使用する。

【0015】本発明を単一の実施例について記述したが、当業者には、本発明を頭記の特許請求の趣旨及び範囲内で変更を加えて実施できることが認識できよう。

【図面の簡単な説明】

【図1】本発明の教示による横型バイポーラ・トランジスタの製造における最初の工程段階とその製造段階におけるデバイスの状態を示す断面図である。

【図2】本発明の教示による横型バイポーラ・トランジスタの製造における図1に続く工程段階とその製造段階におけるデバイスの状態を示す断面図である。

【図3】本発明の教示による横型バイポーラ・トランジスタの製造における図2に続く工程段階とその製造段階におけるデバイスの状態を示す断面図である。

【図4】本発明の教示による横型バイポーラ・トランジスタの製造における図3に続く工程段階とその製造段階におけるデバイスの状態を示す平面図である。

【図5】図4のデバイスの状態を示す断面図である。

【図6】本発明の教示による横型バイポーラ・トランジスタの製造における図4に続く工程段階とその製造段階におけるデバイスの状態を示す断面図である。

【図7】本発明の教示による横型バイポーラ・トランジスタの製造における図6に続く工程段階とその製造段階におけるデバイスの状態を示す断面図である。

【図8】本発明の教示による横型バイポーラ・トランジスタの製造における図7に続く工程段階とその製造段階におけるデバイスの状態を示す平面図である。

【図9】図8のデバイスの状態を示す断面図である。

【図10】本発明の教示による横型バイポーラ・トラン*

*ジスタの製造における図8に続く工程段階とその製造段階におけるデバイスの状態を示す断面図である。

【図11】本発明の教示による横型バイポーラ・トランジスタの製造における図10に続く工程段階とその製造段階におけるデバイスの状態を示す断面図である。

【図12】本発明の教示による横型バイポーラ・トランジスタの製造における図11に続く工程段階とその製造段階におけるデバイスの状態を示す平面図である。

【図13】図12のデバイスの状態を示す断面図である。

【図14】図13の部分拡大図である。

【図15】本発明の教示による完成したトランジスタの平面図である。

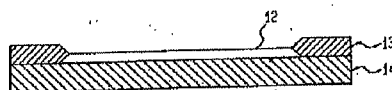
【図16】図15の線16-16'に沿った断面図である。

【図17】図15の線17-17'に沿った断面図である。

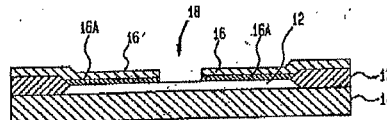
【符号の説明】

- 12 シリコン薄層（シリコン・アイランド）
- 13 外周誘電体
- 14 酸化物層
- 16 酸化物層
- 16A 熱酸化物
- 18 開口（ウィンドウ）
- 20 窒化物層
- 22 シリコン・エミッタ層
- 26 熱酸化物層
- 28 p型ポリシリコン層（頂部外部ベース層）
- 30 酸化物層
- 36 開口
- 38 L T E層
- 40 L T E層
- 42 コレクタ領域
- 44 P E C V D酸化物層
- 46 H I P O X酸化物

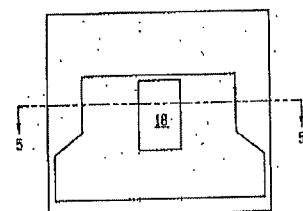
【図1】



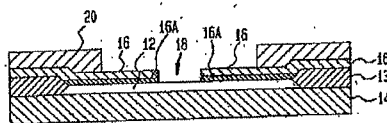
【図2】



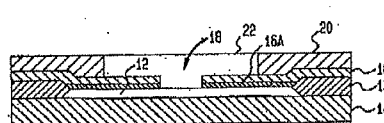
【図4】



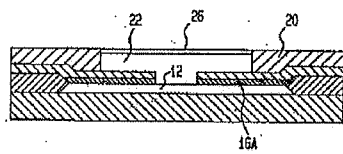
【図3】



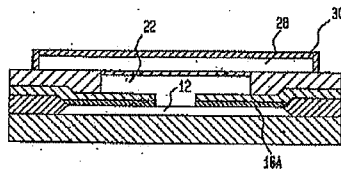
【図5】



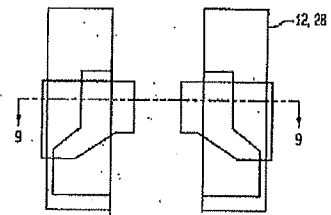
【図6】



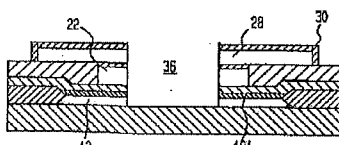
【図7】



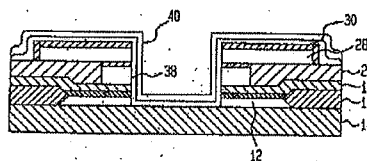
【図8】



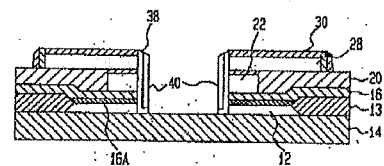
【図9】



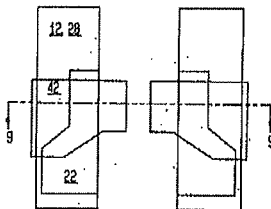
【図10】



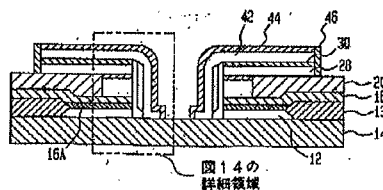
【図11】



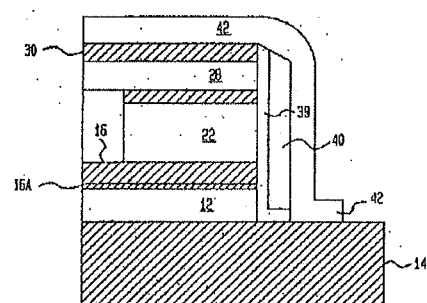
【図12】



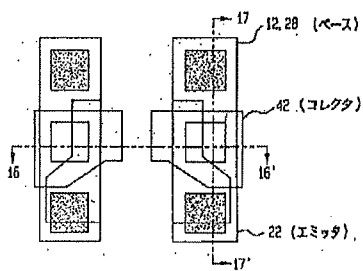
【図13】

図14の
詳細領域

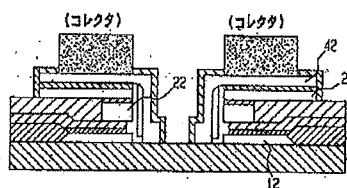
【図14】



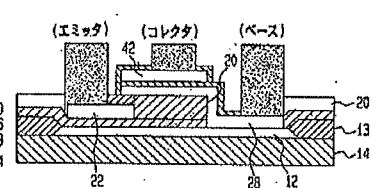
【図15】



【図16】



【図17】



フロントページの続き

(72)発明者 ルイス・エル＝シー・シュ
アメリカ合衆国12524、ニューヨーク州フ
イッシュキル、クロスビー・コート 7

(72)発明者 ショーニン・メイ
アメリカ合衆国12590、ニューヨーク州ワ
ッピンガーズ・フォールズ、ローズウッ
ド・コート 7

(6)

特開平6-53424

(72)発明者 ロナルド・ウィリアム・ネッパー
アメリカ合衆国12540、ニューヨーク州ラ
グランジュビル、アンドリュース・ロード
352

(72)発明者 ローレンス・エフ・ワグナー・ジュニア
アメリカ合衆国12524、ニューヨーク州フ
イッシュキル、コンコード・ロード 22

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)	Application Number		15797821
	Filing Date		2017-10-30
	First Named Inventor	Shih-Yuan WANG	
	Art Unit	2893	
	Examiner Name	Eduardo A. Rodela	
	Attorney Docket Number	5176/88184-CIP	

U.S. PATENTS

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	6724798		2004-04-20	Liu et al.	
	2	5244749		1993-09-14	Bean et al.	
	3	6,845,034		2005-01-18	Bhattacharyya	
	4	9818893		2017-11-14	Wang et al.	
	5	9496435		2016-11-15	Wang et al.	
	6	9525084		2016-12-20	Wang et al.	
	7	9530905		2016-12-27	Wang et al.	
	8	5525828		1996-06-11	Bassous et al.	

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

Application Number	15797821
Filing Date	2017-10-30
First Named Inventor	Shih-Yuan WANG
Art Unit	2893
Examiner Name	Eduardo A. Rodela
Attorney Docket Number	5176/88184-CIP

9	7605406		2009-10-20	Iguchi	
10	9360554		2016-06-07	Facet Technology Corp	
11	8728847		2014-05-20	Maruyama et al.	

If you wish to add additional U.S. Patent citation information please click the Add button.

U.S.PATENT APPLICATION PUBLICATIONS

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	20030059820		2003-03-27	Vo-Dinh	
	2	20100059822		2010-03-11	Pinguet et al.	
	3	20080079022		2008-04-03	Yamamoto et al.	
	4	20070170536		2007-07-26	Hsu et al.	
	5	20060267054		2006-11-30	Martin et al.	
	6	20150054997		2015-02-26	Aptina Imaging Corporation	

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)	Application Number		15797821
	Filing Date		2017-10-30
	First Named Inventor	Shih-Yuan WANG	
	Art Unit	2893	
	Examiner Name	Eduardo A. Rodela	
	Attorney Docket Number	5176/88184-CIP	

7	20160254407		2016-09-01	Wang et al.	
8	20040222357		2004-11-11	King et al.	
9	20020097962		2002-07-25	Yoshimura et al.	
10	20150340538		2015-11-26	Coriant Advanced Technology, LLC	

If you wish to add additional U.S. Published Application citation information please click the Add button.

FOREIGN PATENT DOCUMENTS

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	6-53424	JP		1994-02-25	International Business Machines Corporation		☐
	2	2003-142778	JP		2003-05-16	Samuelson et al.		☒
	3	2012-502466	JP		2012-01-26	Alcatel		☐

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
--------------------	---------	---	----------------

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

Application Number	15797821
Filing Date	2017-10-30
First Named Inventor	Shih-Yuan WANG
Art Unit	2893
Examiner Name	Eduardo A. Rodela
Attorney Docket Number	5176/88184-CIP

1	July 16, 2018 European Search Report issued by the European Patent Office in connection with European Patent Application No. 15861593.0	☐
2	ACKERT et al., "10 Gbps silicon waveguide-integrated infrared avalanche photodiode." Optics Express, 12 August 2013, pp. 19530-19537	☐
3	January 8, 2019 official action issued by the Japanese Patent Office in connection with Japanese Patent Application No. 2016-515097	☐
4	January 15, 2019 International Search Report of the International Searching Authority in connection with PCT/US2018/057963	☐
5	February 12, 2019 International Search Report of the International Searching Authority in connection with PCT/US2018/043289	☐
6	Houng et al., "Characterization of the Nanoporous Template Using Anodic Alumina Method", Journal of Nanomaterials, Vol. 2014, Article ID 130716, pp. 1-7.	☐

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.

REMARKS

By this Amendment, the Cross Reference to Related Applications section of the specification has been amended.

The March 1, 2019 Notice indicated that the Application Data Sheet submitted November 14, 2017 contained the following error: 620181538 should be 62081538. The Notice indicates that a proper response would include any one of: (1) a corrected Application Data Sheet pursuant to 37 CFR 1.76(c) which provides benefit information that complies with 37 CFR 1.78(d)(2) or 37 CFR 1.78(a)(3); or (2) a petition under 37 CFR 1.78(e) or 37 CFR 1.78(c), including a corrected Application Data Sheet.

The corrected Application Data Sheet submitted concurrently herewith corrects the above-mentioned error (i.e. changes 620181538 to 62081538) to provide the reference required by 35 U.S.C. §119(e) and 37 CFR 1.78(a)(3) to the prior-filed provisional application, and a petition pursuant to 37 CFR 1.78(c) for acceptance of an unintentionally delayed claim under 35 U.S.C. §119(e) for the benefit of prior-filed provisional application(s) is submitted herewith.

On October 30, 2017, concurrently with the filing of the present application, applicant submitted an Application Data Sheet setting forth claims for benefit of prior-filed applications, and presented claims for benefit of prior-filed applications in the specification. However, the October 30, 2017 Application Data Sheet inadvertently and unintentionally omitted information indicating that the present application claims benefit to the following provisional applications, although such information was provided in the Cross Reference to Related Applications section of the specification filed October 30, 2017:

- (i) U.S. Prov. Ser. No. 62/465,734 filed March 1, 2017;
- (ii) U.S. Prov. Ser. No. 62/474,179 filed March 21, 2017;
- (iii) U.S. Prov. Ser. No. 62/484,474 filed April 12, 2017;
- (iv) U.S. Prov. Ser. No. 62/487,606 filed April 20, 2017;
- (v) U.S. Prov. Ser. No. 62/488,998 filed April 24, 2017;
- (vi) U.S. Prov. Ser. No. 62/500,581 filed May 3, 2017;

- (vii) U.S. Prov. Ser. No. 62/505,974 filed May 14, 2017;
- (viii) U.S. Prov. Ser. No. 62/509,093 filed May 20, 2017;
- (ix) U.S. Prov. Ser. No. 62/510,249 filed May 23, 2017;
- (x) U.S. Prov. Ser. No. 62/514,889 filed June 4, 2017;
- (xi) U.S. Prov. Ser. No. 62/521,504 filed June 18, 2017;
- (xii) U.S. Prov. Ser. No. 62/522,169 filed June 20, 2017;
- (xiii) U.S. Prov. Ser. No. 62/527,962 filed June 30, 2017;
- (xiv) U.S. Prov. Ser. No. 62/530,281 filed July 09, 2017;
- (xv) U.S. Prov. Ser. No. 62/533,078 filed July 16, 2017;
- (xvi) U.S. Prov. Ser. No. 62/533,603 filed July 17, 2017;
- (xvii) U.S. Prov. Ser. No. 62/535,801 filed July 21, 2017;
- (xviii) U.S. Prov. Ser. No. 62/540,524 filed August 2, 2017;
- (xix) U.S. Prov. Ser. No. 62/542,243 filed August 7, 2017;
- (x) U.S. Prov. Ser. No. 62/547,728 filed August 18, 2017;
- (xxi) U.S. Prov. Ser. No. 62/553,844 filed September 2, 2017;
- (xxii) U.S. Prov. Ser. No. 62/556,426 filed September 10, 2017; and
- (xxiii) U.S. Prov. Ser. No. 62/561,869 filed September 22, 2017.

In addition, the October 30, 2017 Application Data Sheet indicated that the present application is a continuation-in-part of International Patent Appl. No. PCT/US16/67977, but inadvertently and unintentionally omitted information indicating that such International Patent Appl. No. PCT/US16/67977 claims benefit to the following provisional applications:

- (a) U.S. Prov. Ser. No. 62/290,391 filed February 02, 2016;
- (b) U.S. Prov. Ser. No. 62/304,907 filed March 07, 2016;
- (c) U.S. Prov. Ser. No. 62/334,934 filed May 11, 2016;
- (d) U.S. Prov. Ser. No. 62/338,263 filed May 18, 2016;
- (e) U.S. Prov. Ser. No. 62/346,850 filed June 07, 2016;
- (f) U.S. Prov. Ser. No. 62/359,349 filed July 07, 2016;

- (g) U.S. Prov. Ser. No. 62/366,188 filed July 25, 2016;
- (h) U.S. Prov. Ser. No. 62/368,109 filed July 28, 2016;
- (i) U.S. Prov. Ser. No. 62/374,828 filed August 13, 2016;
- (j) U.S. Prov. Ser. No. 62/376,869 filed August 18, 2016;
- (k) U.S. Prov. Ser. No. 62/380,364 filed August 27, 2016;
- (l) U.S. Prov. Ser. No. 62/383,391 filed September 03, 2016;
- (m) U.S. Prov. Ser. No. 62/383,479 filed September 04, 2016;
- (n) U.S. Prov. Ser. No. 62/394,222 filed September 14, 2016;
- (o) U.S. Prov. Ser. No. 62/398,607 filed September 23, 2016;
- (p) U.S. Prov. Ser. No. 62/401,126 filed September 28, 2016;
- (q) U.S. Prov. Ser. No. 62/406,999 filed October 12, 2016; and
- (r) U.S. Prov. Ser. No. 62/414,671 filed October 29, 2016.

The corrected Application Data Sheet submitted concurrently herewith indicates that the present application claims the benefit of the aforementioned twenty-three provisional applications (i) through (xxiii), and that International Patent Appl. No. PCT/US16/67977 claims benefit to the aforementioned eighteen provisional applications (a) through (r), to provide the reference required by 35 U.S.C. §119(e) and 37 CFR 1.78(a)(3) to the prior-filed provisional applications.

A petition pursuant to 37 CFR 1.78(c) for acceptance of an unintentionally delayed claim under 35 U.S.C. §119(e) for the benefit of prior-filed provisional application(s) requires: (I) the reference required by 35 U.S.C. §119(e) and 37 CFR 1.78(a)(3) to the prior-filed applications; (II) the petition fee set forth in 37 CFR 1.17(m); and (III) a statement that the entire delay between the date the benefit claim was due under 37 CFR 1.78(a)(4) and the date the benefit claim was filed was unintentional.

Regarding requirement (I), as mentioned *supra*, the required references are being submitted via the corrected Application Data Sheet filed concurrently herewith. Regarding requirement (II), the Patent Office is hereby authorized to charge the \$1,000.00 small entity fee under 37 C.F.R. 1.78 to Deposit Account No. 03-3125. Regarding requirement (III), applicant submits that the entire delay between the

Applicant: W&WSens, Devices Inc.
Application No.: 15/797,821
Filed: October 30, 2017
Page 8

Dkt. 5176/88184-CIP

date the benefit claims were due and the filing of the present Petition was unintentional.

In addition to the aforementioned changes, the corrected Application Data Sheet submitted concurrently herewith also makes the following changes: corrects the filing date of Application No. 62188876, from which International Application No. PCT/US2015/061120 claims benefit, from 2015-06-21 to 2015-07-06; corrects the filing date of Application No. 14945003, from which Application No. 15309922 claims benefit, from 2015-11-17 to 2015-11-18; removes one of the benefit claims of 14945003 to 62157876, since the corrected Application Data Sheet submitted November 14, 2017 listed two of such benefit claims; corrects the filing date of Application No. 62270577, from which International Application No. PCT/US2015/061120 claims the benefit, from 2016-12-21 to 2015-12-21; and corrects the filing date of Application No. 61826446, from which International Application No. PCT/US2014/039208 claims the benefit, from 2013-05-05 to 2013-05-22.

In addition, it is respectfully pointed out that the Filing Receipt mailed January 4, 2018 in connection with the present application erroneously indicated that Application No. 14/945,003 claims the benefit of 62/009,311 filed 06/08/2014. However, the corrected Application Data Sheet submitted November 14, 2017 correctly indicated that Application No. 14/945,003 claims the benefit of 62/209,311 filed 08/24/2015. Applicant hereby requests the Patent Office to issue a corrected filing receipt which corrects such error and which reflects the aforementioned changes on the corrected Application Data Sheet submitted concurrently herewith.

The corrected Application Data Sheet is marked to show the information being changed, with underlining for information being inserted and strikethrough for information being removed.

As this Petition is being filed after payment of the Issue Fee, applicant is submitting herewith a petition to withdraw the application from issuance pursuant to 37 C.F.R. §1.313(c)(2) and a Request for Continued Examination. The Office is hereby authorized to charge the \$650 small entity fee under §1.17(e)(1) for a first RCE to Deposit Account No. 03-3125 and the \$70.00 small entity fee under § 1.17(h) for the petition to withdraw the application from issue.

If a telephone interview would be of assistance in advancing prosecution of the subject application, Applicant's undersigned attorney invites the Examiner to telephone him at the telephone

Applicant: W&WSens, Devices Inc.
Application No.: 15/797,821
Filed: October 30, 2017
Page 9

Dkt. 5176/88184-CIP

number provided below.

Respectfully submitted,

/Ivan Kavrukov/
Ivan Kavrukov, Reg. No. 25,161
Attorney for Applicant
COOPER & DUNHAM LLP
30 Rockefeller Plaza, 20th Floor
New York, New York 10112
Tel.: (212) 278-0400

Amendments to the Specification:

Please amend the Cross-Reference to Related Applications section at page 1, lines 1-25, in the following manner:

This application is a continuation-in-part of each of:

- U.S. Patent Appl. Ser. No. 15/309,922 ~~filed November 9, 2016, now Patent No. 9,818,893, which is a §371 national stage of International Patent Appl. No. PCT/US15/061120 filed November 17, 2015; allowed 6/30/2017.~~
- ~~This application also is a continuation-in-part of each of~~ U.S. Patent Appl. Ser. No. 14/947,718 filed November 20, 2015; [[,]] and
- International Patent Appl. No. PCT/US16/67977 filed December 21, 2016 published as WO 2017/112747.

This application incorporates by reference and claims the benefit of the filing date of each of the above-identified ~~three patent application applications~~, as well as of the applications that they incorporate by reference, directly or indirectly, and the benefit of which they claim, including U.S. provisional applications, U.S. non-provisional applications, and International applications.

Said Appl. Ser. No. 15/309,922 is a continuation of each of (i) U.S. Patent Appl. Ser. No. 14/943,898 (now Patent 9,530,905), (ii) U.S. Patent Appl. Ser. No. 14/945,003 (now Patent No. 9,525,084), and is a §371 national stage of International Patent Appl. No. PCT/US15/061120, and incorporates each by reference and claims the benefit of the filing date of each as well as of each of the U.S. Provisional Patent applications the benefit of which they claim, including:

U.S. Prov. Ser. No. 62/081,538 filed November 18, 2014;

U.S. Prov. Ser. No. 62/090,879 filed December 11, 2014;

U.S. Prov. Ser. No. 62/100,025 filed January 05, 2015;

U.S. Prov. Ser. No. 62/111,582 filed February 03, 2015;

Applicant: W&WSens, Devices Inc.
Application No.: 15/797,821
Filed: October 30, 2017
Page 3

Dkt. 5176/88184-CIP

U.S. Prov. Ser. No. 62/139,511 filed March 27, 2015;
U.S. Prov. Ser. No. 62/153,443 filed April 27, 2015
U.S. Prov. Ser. No. 62/154,675 filed April 29, 2015;
U.S. Prov. Ser. No. 62/157,876 filed May 06, 2015;
U.S. Prov. Ser. No. 62/171,915 filed June 05, 2015;
U.S. Prov. Ser. No. 62/174,498 filed June 11, 2015
U.S. Prov. Ser. No. 62/175,855 filed June 15, 2015;
U.S. Prov. Ser. No. 62/182,602 filed June 21, 2015;
U.S. Prov. Ser. No. 62/188,876 filed July 06, 2015;
U.S. Prov. Ser. No. 62/197,120 filed July 27, 2015;
U.S. Prov. Ser. No. 62/199,607 filed July 31, 2015;
U.S. Prov. Ser. No. 62/205,717 filed August 15, 2015;
U.S. Prov. Ser. No. 62/209,311 filed August 24, 2015;
U.S. Prov. Ser. No. 62/213,556 filed September 02, 2015; and
U.S. Prov. Ser. No. 62/232,716 filed September 25, 2015.

Said Appl. Ser. No. 14/947,718 is a continuation of International Patent Appl. No. PCT/US14/39208, published as WO 2014/190189, and incorporates each by reference and claims the benefit of the filing date thereof and of each of the U.S. Provisional Patent applications the benefit of which it claims including:

U.S. Prov. Ser. No. 61/826,446 filed May 22, 2013;
U.S. Prov. Ser. No. 61/834,873 filed June 13, 2013;
U.S. Prov. Ser. No. 61/843,021 filed July 4, 2013; and
U.S. Prov. Ser. No. 61/905,109 filed November 15, 2013.

Please insert the following paragraphs at page 1, line 26:

Said International Patent Appl. No. PCT/US16/67977 claims the benefit of the filing date of each of the following U.S. Provisional Patent applications:

U.S. Prov. Ser. No. 62/270,577 filed December 21, 2015;

U.S. Prov. Ser. No. 62/290,391 filed February 02, 2016;
U.S. Prov. Ser. No. 62/304,907 filed March 07, 2016;
U.S. Prov. Ser. No. 62/334,934 filed May 11, 2016;
U.S. Prov. Ser. No. 62/338,263 filed May 18, 2016;
U.S. Prov. Ser. No. 62/346,850 filed June 07, 2016;
U.S. Prov. Ser. No. 62/359,349 filed July 07, 2016;
U.S. Prov. Ser. No. 62/366,188 filed July 25, 2016;
U.S. Prov. Ser. No. 62/368,109 filed July 28, 2016;
U.S. Prov. Ser. No. 62/374,828 filed August 13, 2016;
U.S. Prov. Ser. No. 62/376,869 filed August 18, 2016;
U.S. Prov. Ser. No. 62/380,364 filed August 27, 2016;
U.S. Prov. Ser. No. 62/383,391 filed September 03, 2016;
U.S. Prov. Ser. No. 62/383,479 filed September 04, 2016;
U.S. Prov. Ser. No. 62/394,222 filed September 14, 2016;
U.S. Prov. Ser. No. 62/398,607 filed September 23, 2016;
U.S. Prov. Ser. No. 62/401,126 filed September 28, 2016;
U.S. Prov. Ser. No. 62/406,999 filed October 12, 2016;
U.S. Prov. Ser. No. 62/414,671 filed October 29, 2016; and
U.S. Prov. Ser. No. 62/415,339 filed October 31, 2016.

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant: W&WSens, Devices Inc.

Inventors: Shih-Yuan WANG et al.

Application No.: 15/797,821

Art Unit: 2893

Filed: October 30, 2017

Examiner: Eduardo A. Rodela

For: MICROSTRUCTURE ENHANCED ABSORPTION PHOTSENSITIVE DEVICES

Confirmation No.: 1009

This correspondence is being filed electronically with the U.S. Patent and Trademark Office via EFS-Web.

/Thomas Trainor/

March 14, 2019

Thomas Trainor

Date

30 Rockefeller Plaza, 20th Floor
New York, New York 10112
Tel.: (212) 278-0400

AMENDMENT IN RESPONSE TO MARCH 1, 2019 NOTICE TO FILE CORRECTED APPLICATION PAPERS, PETITION TO ADD UNINTENTIONALLY DELAYED BENEFIT CLAIMS, AND REQUEST FOR CORRECTED FILING RECEIPT ACCOMPANYING PETITION TO WITHDRAW APPLICATION FROM ISSUANCE PURSUANT TO 37 C.F.R. §1.313(C)(2) AND REQUEST FOR CONTINUED EXAMINATION (RCE)

This Amendment is being submitted concurrently with a Request for Continued Examination under 37 C.F.R. §1.114 and a petition to withdraw the application from issue under 37 C.F.R. §1.313(c)(2) in response to the March 1, 2019 Notice To File Corrected Application Papers in connection with the above-identified applications.

Amendments to the **Specification** begin on page 2 of this paper.

Remarks begin on page 5 of this paper.

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant: W&WSens, Devices Inc.

Inventors: Shih-Yuan WANG et al.

Application No.: 15/797,821

Art Unit: 2893

Filed: October 30, 2017

Examiner: Eduardo A. Rodela

For: MICROSTRUCTURE ENHANCED ABSORPTION PHOTSENSITIVE DEVICES

Confirmation No.: 1009

This correspondence is being filed electronically with the U.S. Patent and Trademark Office via EFS-Web.

/Thomas Trainor/

March 14, 2019

Thomas Trainor

Date

30 Rockefeller Plaza, 20th Floor
New York, New York 10112
Tel.: (212) 278-0400

INFORMATION DISCLOSURE STATEMENT

This Information Disclosure Statement is being filed concurrently with a Request for Continued Examination (RCE) under 37 C.F.R. §1.114, and pursuant to 37 C.F.R. §1.97(b)(4), no fee or certification is due or required.

It is respectfully requested that the information cited in the annexed Form PTO-1449 be considered by the Examiner in connection with the above-identified patent application, and that such art be made of record in said application. The citation of the listed items is not a representation that they constitute a complete or exhaustive listing of the relevant art or that these items are prior art. The filing of this Information Disclosure Statement is not an admission that the information cited here in, or is considered to be, material to patentability as defined in 37 CFR 1.56(b).

No fees, other than the separately paid fees for filing the RCE, for filing a petition to withdraw from issue under 37 C.F.R. §1.313(c)(2), and for filing a petition to accept unintentionally

Applicant: W&WSens, Devices Inc.
Application No.: 15/797,821
Filed: October 30, 2017
Page 2

Dkt. 5176/88184-CIP

delayed benefit claims under 37 CFR 1.78(c), are deemed necessary in connection with this filing. Nevertheless, if any additional fee is required, the Patent Office is hereby authorized to charge any fees that are required to Deposit Account No. 03-3125.

Respectfully submitted,

/Ivan Kavrukov/
Ivan Kavrukov, Reg. No. 25,161
Attorney for Applicant
COOPER & DUNHAM LLP
30 Rockefeller Plaza, 20th Floor
New York, New York 10112
Tel.: (212) 278-0400

REQUEST FOR CONTINUED EXAMINATION(RCE)TRANSMITTAL (Submitted Only via EFS-Web)

Application Number	15797821	Filing Date	2017-10-30	Docket Number (if applicable)	5176/88184-CIP	Art Unit	2893
First Named Inventor	Shih-Yuan WANG			Examiner Name	Eduardo A. Rodela		

This is a Request for Continued Examination (RCE) under 37 CFR 1.114 of the above-identified application.

Request for Continued Examination (RCE) practice under 37 CFR 1.114 does not apply to any utility or plant application filed prior to June 8, 1995, or to any design application. The Instruction Sheet for this form is located at WWW.USPTO.GOV

SUBMISSION REQUIRED UNDER 37 CFR 1.114

Note: If the RCE is proper, any previously filed unentered amendments and amendments enclosed with the RCE will be entered in the order in which they were filed unless applicant instructs otherwise. If applicant does not wish to have any previously filed unentered amendment(s) entered, applicant must request non-entry of such amendment(s).

☐ Previously submitted. If a final Office action is outstanding, any amendments filed after the final Office action may be considered as a submission even if this box is not checked.

☐ Consider the arguments in the Appeal Brief or Reply Brief previously filed on _____

☐ Other _____

☒ Enclosed

☒ Amendment/Reply

☒ Information Disclosure Statement (IDS)

☐ Affidavit(s)/ Declaration(s)

☒ Other Petition Under 37 C.F.R. 1.78 To Add Unintentionally Delayed Benefit Claims, corrected Application Data Sheet, and Petition under 1.313(c)(2) to withdraw application from issuance

MISCELLANEOUS

☐ Suspension of action on the above-identified application is requested under 37 CFR 1.103(c) for a period of months _____
(Period of suspension shall not exceed 3 months; Fee under 37 CFR 1.17(i) required)

☐ Other _____

FEES

☒ **The RCE fee under 37 CFR 1.17(e) is required by 37 CFR 1.114 when the RCE is filed.**

☒ The Director is hereby authorized to charge any underpayment of fees, or credit any overpayments, to Deposit Account No 033125

SIGNATURE OF APPLICANT, ATTORNEY, OR AGENT REQUIRED

☒ Patent Practitioner Signature

Applicant Signature

Signature of Registered U.S. Patent Practitioner			
Signature	Ivan Kavrukov/	Date (YYYY-MM-DD)	2019-03-14
Name	Ivan Kavrukov	Registration Number	25161

This collection of information is required by 37 CFR 1.114. The information is required to obtain or retain a benefit by the public which is a benefit of a patent (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.11 and 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.

If you need assistance in completing the form, call 1-800-PTO-9199 and select option 2.

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.



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.
15/797,821	10/30/2017	Shih-Yuan WANG	5176/88184-CIP	1009
23432	7590	03/12/2019		
COOPER & DUNHAM, LLP			EXAMINER	
30 Rockefeller Plaza			RODELA, EDUARDO A	
20th Floor				
NEW YORK, NY 10112			ART UNIT	PAPER NUMBER
			2893	
			MAIL DATE	DELIVERY MODE
			03/12/2019	PAPER

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.

**UNITED STATES DEPARTMENT OF COMMERCE****U.S. Patent and Trademark Office**

Address: COMMISSIONER FOR PATENTS

P.O. Box 1450

Alexandria, Virginia 22313-1450

APPLICATION NO./ CONTROL NO.	FILING DATE	FIRST NAMED INVENTOR/ PATENT IN REEXAMINATION	ATTORNEY DOCKET NO.
15/797,821	10/30/2017	WANG et al.	5176/88184-CIP

COOPER & DUNHAM, LLP 30 Rockefeller Plaza 20th Floor NEW YORK, NY 10112		EXAMINER	
		Eduardo A Rodela	
		ART UNIT	PAPER
		2893	20190312

DATE MAILED: _____

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

Commissioner for Patents

This communication is being sent to correct the PTO-892 form dated July 26, 2018, which includes the various pertinent prior art, however does not include the details regarding each referenced prior art. Attachment: PTO-892

/EDUARDO A RODELA/
Primary Examiner, Art Unit 2893

<i>Notice of References Cited</i>	Application/Control No. 15/797,821		Applicant(s)/Patent Under Reexamination WANG et al.	
	Examiner Eduardo A Rodela		Art Unit 2893	Page 1 of 1

U.S. PATENT DOCUMENTS

*		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Name	CPC Classification	US Classification
*	A	US-20090321868-A1	12-2009	Nakaji; Masaharu	H01L31/105	257/458
*	B	US-20130114629-A1	05-2013	Firth; Paul	G02B6/4201	372/20
*	C	US-20080080854-A1	04-2008	Tian; Cechan	H04L27/22	398/9
*	D	US-7251386-B1	07-2007	Dickinson; Alexander G.	B82Y20/00	385/129
*	E	US-20100288341-A1	11-2010	KIM; Seheon	B82Y20/00	136/252
*	F	US-20100308428-A1	12-2010	Okamoto; Daisuke	H01L31/03529	257/432
*	G	US-20090230498-A1	09-2009	Iwai; Takaki	H01L27/1443	257/461
*	H	US-9045418-B2	06-2015	Jordan; Robert	C07D209/50	1/1
*	I	US-20120153260-A1	06-2012	KIM; Seheon	B82Y40/00	257/14
*	J	US-6879014-B2	04-2005	Wagner; Sigurd	H01L31/03682	257/434
*	K	US-4814847-A	03-1989	Tabatabaie; Nader	G02B6/4202	257/186
*	L	US-20100148318-A1	06-2010	Wang; David Xuan-Qi	H01L31/0236	257/627
*	M	US-8319241-B2	11-2012	Na; Min Gyu	H01L33/20	257/98

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.

U.S. Patent and Trademark Office
PTO-892 (Rev. 01-2001)

Notice of References Cited

Part of Paper No. 20190312



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.
15/797,821	10/30/2017	Shih-Yuan WANG	5176/88184-CIP	1009
23432 7590 03 01 2019 COOPER & DUNHAM, LLP 30 Rockefeller Plaza 20th Floor NEW YORK, NY 10112			EXAMINER RODELA, EDUARDO A	
			ART UNIT 2893	PAPER NUMBER
			MAIL DATE 03/01/2019	DELIVERY MODE PAPER

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.



UNITED STATES PATENT AND TRADEMARK OFFICE

Commissioner for Patents
United States Patent and Trademark Office
P.O. Box 1450
Alexandria, VA 22313-1450
www.uspto.gov

Application No. : 15797821
Applicant : Wang
Filing Date : 10/30/2017
Date Mailed : 03/01/2019

NOTICE TO FILE CORRECTED APPLICATION PAPERS

Notice of Allowance Mailed

This application has been accorded an Allowance Date and is being prepared for issuance. The application, however, is incomplete for the reasons below.

Applicant is given two (2) months from the mail date of this Notice within which to respond. This time period for reply is extendable under 37 CFR 1.136(a) for only TWO additional MONTHS.

The application is not in compliance with 37 CFR 1.78, as indicated in the attachment. The consequences of failure to respond within the above-identified time period are set forth in the attachment.

Even if the Office has recognized a benefit claim and has entered it into the Office's database and included it on applicant's filing receipt, the benefit claim is not a proper benefit claim unless the reference in compliance with 37 CFR 1.78 is included, depending upon the application's filing date and as indicated in the attachment, in an application data sheet or in the first sentence(s) of the specification and all other requirements are met.

See attachment.

*A copy of this notice **MUST** be returned with the reply. Please address response to
"Mail Stop Issue Fee, Commissioner for Patents,
P.O. Box 1450, Alexandria, VA 22313-1450".*

/Nran Hem/
Publication Branch
Office of Data Management
(571) 272-4200

**APPLICATION FILED ON OR AFTER SEPTEMBER 16, 2012,
NOT IN COMPLIANCE WITH 37 CFR 1.78**

- ☐ The 37 CFR 1.78(d)(2) reference on the application data sheet does not indicate the relationship (continuation, division, continuation-in-part) to the prior U.S. nonprovisional application or international application designating the U.S. See document coded dated , listing application number(s) .
- ☐ The 37 CFR 1.78(d)(2) reference on the application data sheet does not indicate the relationship (continuation, division, continuation-in-part) to the prior international application designating the U.S. but instead indicates that an application is the national stage of the prior international application. However, the application was filed as a 35 U.S.C. 111 application and was not processed as a 35 U.S.C. 371 application, thus removing the validating link under 35 U.S.C. 119(a)-(d) to a prior foreign application or under 35 U.S.C. 119(e) to a prior U.S. provisional application. See document coded dated , listing application number(s) .
- ☐ The 37 CFR 1.78(d)(2) reference on the application data sheet does not provide the U.S. nonprovisional application number (series code and serial number) or, with respect to an international PCT application designating the U.S., it provides the international application number or international filing date but not both. See document coded dated , in which the following is missing: .
- ☐ The 37 CFR 1.78(d)(2) reference on the application data sheet shows an incorrect, incomplete, or illegible U.S. nonprovisional application number, international PCT application number, or international PCT filing date. See document coded dated , in which the following error was made: .
- ☐ The 37 CFR 1.78(d)(2) reference to the prior U.S. nonprovisional application or international application designating the U.S. is not present on an application data sheet, thus removing the validating link under 35 U.S.C. 119(a)-(d) to a prior foreign application or under 35 U.S.C. 119(e) to a prior U.S. provisional application. See document coded dated , in which the following is missing: .
- ☐ The 37 CFR 1.78(d)(2) reference to the prior U.S. nonprovisional application or international application designating the U.S. is not present on an application data sheet.
- ☐ The 37 CFR 1.78(a)(3) reference to the prior U.S. provisional application is not present on an application data sheet.
- ☐ The 37 CFR 1.78(a)(3) reference to the prior U.S. provisional application on an application data sheet does not provide the provisional application number (series code and serial number). See document coded dated , in which the following is missing: .
- ☒ The 37 CFR 1.78(a)(3) reference to the prior U.S. provisional application on an application data sheet shows an incorrect, incomplete, or illegible U.S. provisional application number. See document coded ADS dated 11/14/2017, in which the following error was made: 620181538 should be 62081538 (see page 5 of 16).
- ☐ Other: .

HOW TO RESPOND

A proper response to this notice would include any one of: (1) a corrected Application Data Sheet (ADS) pursuant to 37 CFR 1.76(c) which provides benefit information that complies with 37 CFR 1.78(d)(2) or 37 CFR 1.78(a)(3) or (2) a petition filed pursuant to the provisions of 37 CFR 1.78(e) or 37 CFR 1.78(c) if the benefit information from the document identified above by code and date does not accurately reflect the benefits under 35 U.S.C. 119(e), 120, 121, 365(c) or 386(c) as claimed by applicant (a grantable petition would include a corrected ADS pursuant to 37 CFR 1.76(c)). In general, a petition would be required unless the proper benefit claim information was included on a properly signed ADS submitted with the application on filing, or a properly signed corrected ADS in compliance with 37 CFR 1.76(c) (e.g., with underlining to show insertions) that was filed within the time period in 37 CFR 1.78 for making the benefit claim(s), or the Office recognized the benefit claim(s) on the initial filing receipt. Such response may be filed after payment of the issue fee if limited to informalities noted herein. See Waiver of 37 CFR 1.312 for Document Required by Office of Patent Publication, 1280 Off. Gaz. Patent Office 918 (March 23, 2004).

WARNING: If Applicant fails to timely submit a proper response, the benefit information will be deleted and the patent will be printed without the benefit information present.

Electronic Patent Application Fee Transmittal				
Application Number:		15797821		
Filing Date:		30-Oct-2017		
Title of Invention:		MICROSTRUCTURE ENHANCED ABSORPTION PHOTOSENSITIVE DEVICES		
First Named Inventor/Applicant Name:		Shih-Yuan WANG		
Filer:		Ivan Kavrukov/Maria Arap		
Attorney Docket Number:		5176/88184-CIP		
Filed as Small 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	2501	1	500	500

Description	Fee Code	Quantity	Amount	Sub-Total in USD(\$)
Extension-of-Time:				
Miscellaneous:				
Total in USD (\$)				500

Electronic Acknowledgement Receipt

EFS ID:	35270691
Application Number:	15797821
International Application Number:	
Confirmation Number:	1009
Title of Invention:	MICROSTRUCTURE ENHANCED ABSORPTION PHOTOSENSITIVE DEVICES
First Named Inventor/Applicant Name:	Shih-Yuan WANG
Customer Number:	23432
Filer:	Ivan Kavrukov/Maria Arap
Filer Authorized By:	Ivan Kavrukov
Attorney Docket Number:	5176/88184-CIP
Receipt Date:	27-FEB-2019
Filing Date:	30-OCT-2017
Time Stamp:	15:27:18
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	DA
Payment was successfully received in RAM	\$ 500
RAM confirmation Number	022819INTEFSW00002246033125
Deposit Account	
Authorized User	

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

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)	Issue-FeeTransmittal_FeesPaid. pdf	85955	no	1
			abf36e73a975948bb9f097b459258104a846c466		
Warnings:					
Information:					
2	Fee Worksheet (SB06)	fee-info.pdf	30658	no	2
			a6b426b39d9a58b8bc5bf5f8622aad773fb6c8a		
Warnings:					
Information:					
Total Files Size (in bytes):			116613		
<p>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.</p> <p><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.</p> <p><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.</p> <p><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.</p>					

PART B - FEE(S) TRANSMITTAL

Complete and send this form, together with applicable fee(s), by mail or fax, or via EFS-Web.

By mail, send to: Mail Stop ISSUE FEE
Commissioner for Patents
P.O. Box 1450
Alexandria, Virginia 22313-1450

By fax, send to: (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)

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.

23432 7590 02/06/2019
COOPER & DUNHAM, LLP
30 Rockefeller Plaza
20th Floor
NEW YORK, NY 10112

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 transmitted to the USPTO via EFS-Web or by facsimile to (571) 273-2885, on the date below.

Maria Antonakis	(Typed or printed name)
/Maria Antonakis/	(Signature)
2/27/2019	(Date)

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
15/797,821	10/30/2017	Shih-Yuan WANG	5176/88184-CIP	1009

TITLE OF INVENTION: MICROSTRUCTURE ENHANCED ABSORPTION PHOTOSENSITIVE DEVICES

APPLN. TYPE	ENTITY STATUS	ISSUE FEE DUE	PUBLICATION FEE DUE	PREV. PAID ISSUE FEE	TOTAL FEE(S) DUE	DATE DUE
nonprovisional	SMALL	\$500	\$0.00	\$0.00	\$500	05/06/2019

EXAMINER	ART UNIT	CLASS-SUBCLASS
RODELA, EDUARDO A	2893	257-431000

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 03-09 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 Cooper& Dunham LLP
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 must have been previously recorded, or filed for recordation, as set forth in 37 CFR 3.11 and 37 CFR 3.81(a). Completion of this form is NOT a substitute for filing an assignment.

(A) NAME OF ASSIGNEE

W&WSENS DEVICES, INC.

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

LOS ALTOS, CALIFORNIA

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

4a. Fees submitted: ☐ Issue Fee ☐ Publication Fee (if required) ☐ Advance Order - # of Copies

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

- ☐ Electronic Payment via EFS-Web ☐ Enclosed check ☐ Non-electronic payment by credit card (Attach form PTO-2038)
- ☐ The Director is hereby authorized to charge the required fee(s), any deficiency, or credit any overpayment to Deposit Account No. _____

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 /Ivan S. Kavrukov/

Date February 27, 2019

Typed or printed name Ivan S. Kavrukov

Registration No. 25,161

Bibliographic Data

Application No: 15/797,821

Foreign Priority claimed: ☐ Yes ☒ No

35 USC 119 (a-d) conditions met: ☐ Yes ☐ No ☐ Met After Allowance

Verified and Acknowledged: /EDUARDO A RODELA/

Examiner's Signature

Initials

Title:

MICROSTRUCTURE ENHANCED ABSORPTION
PHOTOSENSITIVE DEVICES

FILING or 371(c) DATE	CLASS	GROUP ART UNIT	ATTORNEY DOCKET NO.
10/30/2017	257	2893	5176/88184-CIP
RULE			

APPLICANTS

W&WSens, Devices Inc., Los Altos, CA,

INVENTORS

Shih-Yuan WANG Palo Alto, CA, UNITED STATES

Shih-Ping WANG Los Altos, CA, UNITED STATES

M. Saif Islam Davis, CA, UNITED STATES

CONTINUING DATA

This application is a CIP of PCT/US2016/067977 12/21/2016

This application is a CIP of 15309922 11/09/2016 PAT 9818893

PCT/US2016/067977 has PRO of 62415339 10/31/2016

PCT/US2016/067977 has PRO of 62270577 12/21/2015

This application is a CIP of 14947718 11/20/2015

15309922 is a CON of 14945003 11/18/2015 PAT 9525084

15309922 is a 371 of PCT/US2015/061120 11/17/2015

15309922 is a CON of 14943898 11/17/2015 PAT 9530905

14943898 has PRO of 62232716 09/25/2015

14945003 has PRO of 62232716 09/25/2015

PCT/US2015/061120 has PRO of 62232716 09/25/2015

14945003 has PRO of 62213556 09/02/2015

PCT/US2015/061120 has PRO of 62213556 09/02/2015

14943898 has PRO of 62213556 09/02/2015

14943898 has PRO of 62209311 08/24/2015

PCT/US2015/061120 has PRO of 62209311 08/24/2015

14943898 has PRO of 62205717 08/15/2015
PCT/US2015/061120 has PRO of 62205717 08/15/2015
14945003 has PRO of 62205717 08/15/2015
14945003 has PRO of 62199607 07/31/2015
PCT/US2015/061120 has PRO of 62199607 07/31/2015
14943898 has PRO of 62199607 07/31/2015
14945003 has PRO of 62197120 07/27/2015
14943898 has PRO of 62197120 07/27/2015
PCT/US2015/061120 has PRO of 62197120 07/27/2015
14945003 has PRO of 62188876 07/06/2015
14943898 has PRO of 62188876 07/06/2015
PCT/US2015/061120 has PRO of 62188876 07/06/2015
14943898 has PRO of 62182602 06/21/2015
14945003 has PRO of 62182602 06/21/2015
PCT/US2015/061120 has PRO of 62182602 06/21/2015
14943898 has PRO of 62175855 06/15/2015
14945003 has PRO of 62175855 06/15/2015
PCT/US2015/061120 has PRO of 62175855 06/15/2015
14945003 has PRO of 62174498 06/11/2015
14943898 has PRO of 62174498 06/11/2015
PCT/US2015/061120 has PRO of 62174498 06/11/2015
PCT/US2015/061120 has PRO of 62171915 06/05/2015
14943898 has PRO of 62171915 06/05/2015
14945003 has PRO of 62171915 06/05/2015
14945003 has PRO of 62157876 05/06/2015
14943898 has PRO of 62157876 05/06/2015
PCT/US2015/061120 has PRO of 62157876 05/06/2015
PCT/US2015/061120 has PRO of 62154675 04/29/2015
14945003 has PRO of 62154675 04/29/2015
14943898 has PRO of 62154675 04/29/2015
PCT/US2015/061120 has PRO of 62153443 04/27/2015
14943898 has PRO of 62153443 04/27/2015
14945003 has PRO of 62153443 04/27/2015
14943898 has PRO of 62139511 03/27/2015
14945003 has PRO of 62139511 03/27/2015
PCT/US2015/061120 has PRO of 62139511 03/27/2015
14945003 has PRO of 62111582 02/03/2015
14943898 has PRO of 62111582 02/03/2015

PCT/US2015/061120 has PRO of 62111582 02/03/2015
14945003 has PRO of 62100025 01/05/2015
PCT/US2015/061120 has PRO of 62100025 01/05/2015
14943898 has PRO of 62100025 01/05/2015
14943898 has PRO of 62090879 12/11/2014
PCT/US2015/061120 has PRO of 62090879 12/11/2014
14945003 has PRO of 62090879 12/11/2014
PCT/US2015/061120 has PRO of 62081538 11/18/2014
14945003 has PRO of 62081538 11/18/2014
14945003 has PRO of 62009311 06/08/2014
14947718 is a CON of PCT/US2014/039208 05/22/2014
PCT/US2014/039208 has PRO of 61905109 11/15/2013
PCT/US2014/039208 has PRO of 61843021 07/04/2013
PCT/US2014/039208 has PRO of 61834873 06/13/2013
PCT/US2014/039208 has PRO of 61826446 05/22/2013

FOREIGN APPLICATIONS

IF REQUIRED, FOREIGN LICENSE GRANTED**

11/27/2017

**** SMALL ENTITY ****

STATE OR COUNTRY

UNITED STATES

ADDRESS

COOPER & DUNHAM, LLP
30 Rockefeller Plaza
20th Floor
NEW YORK, NY 10112
UNITED STATES

FILING FEE RECEIVED

\$4,410

Issue Classification 	Application/Control No. 15/797,821	Applicant(s)/Patent Under Reexamination WANG et al.
	Examiner Eduardo A Rodela	Art Unit 2893

CPC						
Symbol					Type	Version
H01L	/	31	/	02327	F	2013-01-01
H01L	/	31	/	1808	I	2013-01-01
H01L	/	31	/	1804	I	2013-01-01
H01L	/	31	/	035281	I	2013-01-01
H01L	/	31	/	035218	I	2013-01-01
G02B	/	1	/	002	I	2013-01-01
H01L	/	31	/	107	I	2013-01-01
H01L	/	27	/	1446	I	2013-01-01
H01L	/	31	/	103	I	2013-01-01
H04B	/	10	/	6971	I	2013-01-01
H01L	/	27	/	14625	I	2013-01-01
H01L	/	27	/	1443	I	2013-01-01
H01L	/	31	/	02325	I	2013-01-01
H01L	/	31	/	028	I	2013-01-01
H01L	/	31	/	02	I	2013-01-01
H01L	/	31	/	0232	I	2013-01-01
H01L	/	31	/	0236	I	2013-01-01
H01L	/	31	/	02363	I	2013-01-01
H01L	/	31	/	09	I	2013-01-01
H04B	/	10	/	801	I	2013-01-01
H04B	/	10	/	25	I	2013-01-01
H04B	/	10	/	40	I	2013-01-01
H04B	/	10	/	691	I	2013-01-01
H01L	/	31	/	02016	I	2013-01-01
H01L	/	31	/	02002	I	2013-01-01
G02B	/	1	/	005	I	2013-01-01
Y02E	/	10	/	547	A	2013-01-01

NONE		Total Claims Allowed:	
(Assistant Examiner)	(Date)	40	
/EDUARDO A RODELA/ Primary Examiner, Art Unit 2893	16 January 2019	O.G. Print Claim(s)	O.G. Print Figure
(Primary Examiner)	(Date)	1	9B, 21

<i>Issue Classification</i> 	Application/Control No. 15/797,821	Applicant(s)/Patent Under Reexamination WANG et al.
	Examiner Eduardo A Rodela	Art Unit 2893

CPC Combination Sets				
Symbol	Type	Set	Ranking	Version

NONE (Assistant Examiner) _____ (Date) _____		Total Claims Allowed: 40	
/EDUARDO A RODELA/ Primary Examiner, Art Unit 2893 (Primary Examiner) _____ (Date) _____		16 January 2019 O.G. Print Claim(s) 1	O.G. Print Figure 9B, 21

<i>Issue Classification</i> 	Application/Control No. 15/797,821	Applicant(s)/Patent Under Reexamination WANG et al.
	Examiner Eduardo A Rodela	Art Unit 2893

INTERNATIONAL CLASSIFICATION			
CLAIMED			
H01L	/	31	/ 0232
NON-CLAIMED			
/		/	

US ORIGINAL CLASSIFICATION	
CLASS	SUBCLASS

CROSS REFERENCES(S)						
CLASS	SUBCLASS (ONE SUBCLASS PER BLOCK)					

NONE		Total Claims Allowed:	
(Assistant Examiner)	(Date)	40	
/EDUARDO A RODELA/ Primary Examiner, Art Unit 2893	16 January 2019	O.G. Print Claim(s)	O.G. Print Figure
(Primary Examiner)	(Date)	1	9B, 21

Issue Classification 	Application/Control No. 15/797,821	Applicant(s)/Patent Under Reexamination WANG et al.
	Examiner Eduardo A Rodela	Art Unit 2893

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

CLAIMS															
Final	Original	Final	Original	Final	Original	Final	Original	Final	Original	Final	Original	Final	Original	Final	Original
1	1	10	10	19	19	28	28	37	37						
2	2	11	11	20	20	29	29	38	38						
3	3	12	12	21	21	30	30	39	39						
4	4	13	13	22	22	31	31	40	40						
5	5	14	14	23	23	32	32								
6	6	15	15	24	24	33	33								
7	7	16	16	25	25	34	34								
8	8	17	17	26	26	35	35								
9	9	18	18	27	27	36	36								

NONE (Assistant Examiner) _____ (Date) _____		Total Claims Allowed: 40	
/EDUARDO A RODELA/ Primary Examiner, Art Unit 2893 (Primary Examiner) _____ (Date) _____		16 January 2019 (Date)	O.G. Print Claim(s) 1 O.G. Print Figure 9B, 21

<i>Search Notes</i> 	Application/Control No. 15/797,821	Applicant(s)/Patent Under Reexamination WANG et al.
	Examiner Eduardo A Rodela	Art Unit 2893

CPC - Searched*		
Symbol	Date	Examiner
H01L31/02002,02016,0203,0232,0237,12	01/16/2019	EAR

CPC Combination Sets - Searched*		
Symbol	Date	Examiner

US Classification - Searched*			
Class	Subclass	Date	Examiner

* 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 history for complete details	01/16/2019	EAR
Inventor's name and assignee search	01/16/2019	EAR

Interference Search			
US Class/CPC Symbol	US Subclass/CPC Group	Date	Examiner
noted CPC search area	in conjunction with a text search	01/16/2019	EAR

	/EDUARDO A RODELA/ Primary Examiner, Art Unit 2893
--	---

EAST Search History

EAST Search History (Prior Art)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
L1	0	(wang near shih near yuan).in. and (W&W near sens).as.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	AND	ON	2019/01/16 16:33
L4	21798	(optical same electrical same communication same circuit\$1)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2019/01/16 16:33
L6	133755	apd or (avalanche near photo near diode)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2019/01/16 16:33
L7	51558	micro adj (cavity or structure or aperture\$1 or hole\$1)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2019/01/16 16:33
L8	116	((@pd<="20141118" or @rlpd<="20141118" or @ad<="20141118" or @rlad<="20141118") and L6 and L7	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2019/01/16 16:33
L9	24677	H01L31/02002,02016,0203,0232,02327,12.cpc.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2019/01/16 16:40
L10	76	((@pd<="20130522" or @rlpd<="20130522" or @ad<="20130522" or @rlad<="20130522") and L9 and L4	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2019/01/16 16:40

EAST Search History (Interference)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
L11	0	H01L31/02002,02016,0203,0232,02327,12.cpc. and ((single-chip near device)(substrate) (microstructure-enhanced near photodetector) (reverse-bias)(operation)(optical near input) (electrical near output)(holes)(transverse) (layers)(silicon or germanium)(doped near material)(undoped)(first)(second)(layers) (intermediate)(reverse-bias near contacts) (amplification)(process)(active near electronic near circuit)(deliver)).clm.	US- PGPUB; USPAT	AND	ON	2019/01/16 16:43

1/ 16/ 2019 4:44:53 PM
C:\ Users\ erodela\ Documents\ EASTold\ EAST\ Workspaces\ 15797821.wsp

Doc code: IDS

Doc description: Information Disclosure Statement (IDS) Filed

PTO/SB/08a (02-18)

Approved for use through 11/30/2020. OMB 0651-0031

U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE

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

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

Application Number	15979821
Filing Date	2017-30-10
First Named Inventor	Shih-Yuan WANG et al.
Art Unit	2893
Examiner Name	RODELA, EDUARDO A
Attorney Docket Number	5176-88184-CIP

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							
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	
FOREIGN PATENT DOCUMENTS							Remove	
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							
If you wish to add additional Foreign Patent Document citation information please click the Add button								Add
NON-PATENT LITERATURE DOCUMENTS								Remove
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

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

Application Number	15979821
Filing Date	2017-30-10
First Named Inventor	Shih-Yuan WANG et al.
Art Unit	2893
Examiner Name	RODELA, EDUARDO A
Attorney Docket Number	5176-88184-CIP

1	Yokogawa, s., et al., IR sensitivity enhancement of CMOS Image Sensor with diffractive light trapping pixels, Scientific Reports/7:3832/DOI:10.1038/s41598-017-04200-y, 19 June 2017.
---	---

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

Add**EXAMINER SIGNATURE**

Examiner Signature	/EDUARDO A RODELA/	Date Considered	01/16/2019
--------------------	--------------------	-----------------	------------

*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	15979821
Filing Date	2017-30-10
First Named Inventor	Shih-Yuan WANG et al.
Art Unit	2893
Examiner Name	RODELA, EDUARDO A
Attorney Docket Number	5176-88184-CIP

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	/IVAN KAVRUKOV/	Date (YYYY-MM-DD)	2018-11-01
Name/Print	Ivan Kavrukov	Registration Number	25,161

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.

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /E.A.R/



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

NOTICE OF ALLOWANCE AND FEE(S) DUE

23432 7590 02/06/2019
COOPER & DUNHAM, LLP
30 Rockefeller Plaza
20th Floor
NEW YORK, NY 10112

EXAMINER	
RODELA, EDUARDO A	
ART UNIT	PAPER NUMBER

2893

DATE MAILED: 02/06/2019

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
15/797,821	10/30/2017	Shih-Yuan WANG	5176/88184-CIP	1009

TITLE OF INVENTION: MICROSTRUCTURE ENHANCED ABSORPTION PHOTSENSITIVE DEVICES

APPLN. TYPE	ENTITY STATUS	ISSUE FEE DUE	PUBLICATION FEE DUE	PREV. PAID ISSUE FEE	TOTAL FEE(S) DUE	DATE DUE
nonprovisional	SMALL	\$500	\$0.00	\$0.00	\$500	05/06/2019

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), by mail or fax, or via EFS-Web.

By mail, send to: Mail Stop ISSUE FEE
Commissioner for Patents
P.O. Box 1450
Alexandria, Virginia 22313-1450

By fax, send to: (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)

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.

23432 7590 02/06/2019
COOPER & DUNHAM, LLP
30 Rockefeller Plaza
20th Floor
NEW YORK, NY 10112

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 transmitted to the USPTO via EFS-Web or by facsimile to (571) 273-2885, on the date below.

(Typed or printed name)
(Signature)
(Date)

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
15/797,821	10/30/2017	Shih-Yuan WANG	5176/88184-CIP	1009

TITLE OF INVENTION: MICROSTRUCTURE ENHANCED ABSORPTION PHOTSENSITIVE DEVICES

APPLN. TYPE	ENTITY STATUS	ISSUE FEE DUE	PUBLICATION FEE DUE	PREV. PAID ISSUE FEE	TOTAL FEE(S) DUE	DATE DUE
nonprovisional	SMALL	\$500	\$0.00	\$0.00	\$500	05/06/2019

EXAMINER	ART UNIT	CLASS-SUBCLASS
RODELA, EDUARDO A	2893	257-431000

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 03-09 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 _____
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 must have been previously recorded, or filed for recordation, as set forth in 37 CFR 3.11 and 37 CFR 3.81(a). 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. Fees submitted: ☐ Issue Fee ☐ Publication Fee (if required) ☐ Advance Order - # of Copies _____

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

- ☐ Electronic Payment via EFS-Web ☐ Enclosed check ☐ Non-electronic payment by credit card (Attach form PTO-2038)
- ☐ The Director is hereby authorized to charge the required fee(s), any deficiency, or credit any overpayment to Deposit Account No. _____

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 _____ 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.
15/797,821	10/30/2017	Shih-Yuan WANG	5176/88184-CIP	1009
23432 7590 02/06/2019 COOPER & DUNHAM, LLP 30 Rockefeller Plaza 20th Floor NEW YORK, NY 10112			EXAMINER RODELA, EDUARDO A	
			ART UNIT 2893	PAPER NUMBER
DATE MAILED: 02/06/2019				

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 30 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. 15/797,821	Applicant(s) WANG et al.	
	Examiner Eduardo A Rodela	Art Unit 2893	AIA 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 10/26/2018.
☐ 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 1-40. 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 areply 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 <u>10/25/2018, 11/01/2018, 11/29/2017</u> . 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 _____.
--	---

	/EDUARDO A RODELA/ Primary Examiner, Art Unit 2893
--	---

DETAILED ACTION

This office action is in response to the communications received October 26, 2018.

Claims 1-40 are under consideration.

Notice of Pre-AIA or AIA Status

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

Election/Restrictions

Claims 41-112 are withdrawn from further consideration pursuant to 37 CFR 1.142(b) as being drawn to a nonelected Group II and Species claims, there being no allowable generic or linking claim. Election was made **without** traverse in the reply filed on April 25, 2018

Claim Rejections - 35 USC § 112

Amendments to claim 1 have overcome the previous 112 rejection.

Double Patenting

Applicant's arguments do not address the double patenting rejection. However, upon re-inspection of the double patenting rejection in light of the applicant's amendment, the prior referenced patents do not have details regarding the reverse bias oriented contacts.

EXAMINER'S AMENDMENT

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:

In the Claims:

Please cancel claims 41-112. The claims are directed to an un-elected apparatus group embodiment without traverse, as detailed in the Applicant's response dated April 25, 2018.

REASONS FOR ALLOWANCE

Claims 1-40 are allowed.

The following is an Examiner's statement of reasons for allowance: The photodetector system as recited in the claims of the instant invention fail to be taught by the prior art cited of interest.

Regarding claim 1, the prior art teaches a photodetector system, but fails to disclose the specific characteristic recited in the claims of the instant invention e.g. the single chip device with combination of photodetector as detailed in communication with active electronic unit which processes the information gathered by the photodetector, in conjunction with the details of the photodetector being configured to be operated in reverse bias, in addition to the contacts which are arranged for reverse bias.

Fax / Telephone Information

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Eduardo A Rodela whose telephone number is (571)272-8797. The examiner can normally be reached on M-F, 8:30-5:00pm ET.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Ken Parker can be reached on (571) 272-2298. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see <http://pair-direct.uspto.gov>. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

/EDUARDO A RODELA/
Primary Examiner, Art Unit 2893

Doc code: IDS

PTO/SB/08a (02-18)

Doc description: Information Disclosure Statement (IDS) Filed

Approved for use through 11/30/2020. OMB 0651-0031

U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE

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

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

Application Number	15797821
Filing Date	2017-10-30
First Named Inventor	Shih-Yuan WANG
Art Unit	2893
Examiner Name	Eduardo A. Rodela
Attorney Docket Number	5176/88184-CIP

U.S.PATENTS

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					

If you wish to add additional U.S. Patent citation information please click the Add button.

U.S.PATENT APPLICATION PUBLICATIONS

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.

FOREIGN PATENT DOCUMENTS

Examiner Initial*	Cite No	Foreign Document Number ³	Country Code ^{2j}	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							☐

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

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /E.A.R./

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

Application Number	15797821
Filing Date	2017-10-30
First Named Inventor	Shih-Yuan WANG
Art Unit	2893
Examiner Name	Eduardo A. Rodela
Attorney Docket Number	5176/88184-CIP

1	Wada et al. "Very high speed GaInAs metal-semiconductor-metal photodiode incorporating an AlInAs/GaInAs graded superlattice" Appl. Phys. Lett. 54, 16 (1989). American Institute of Physics.	☐
2	Liu et al. "140-GHz metal-semiconductor-metal photodetectors on silicon-on-insulator substrate with a scaled active layer" Appl. Phys. Lett. 65, 887 (1994). American Institute of Physics.	☐
3	Zang et al. "Application of dopant segregation to metal-germanium-metal photodetectors and its dark current suppression mechanism" Appl. Phys. Lett. 92, 051110 (2008). American Institute of Physics.	☐
4	Ghanbarzadeh, et al. "Low Dark Current Amorphous SiliconMetal-Semiconductor-Metal Photodetector for Digital Imaging Applications" IEEE ELECTRON DEVICE LETTERS, VOL. 35, NO. 2, FEBRUARY 2014. pp. 234-237.	☐
5	Assefa, et al. "A 90nm CMOS Integrated Nano-Photonics Technology for 25Gbps WDM Optical Communications Applications" IEEE International Electron Devices Meeting (IEDM), postdeadline session 33.8, December 10-12, 2012.	☐
6	Anderson et al. "HPSM4 Technology & Relative Cost Analysis Update" IEEE P802.3bm TF, Phoenix, AZ, January 21-24, 2013.	☐
7	Xi et al. "Optical thin-film materials with low refractive index for broadband elimination of Fresnel reflection" Nature Photonics, VOL. 1, MARCH 2007.	☐
8	Assefa et al. "CMOS-integrated high-speed MSM germanium waveguide photodetector" 1 March 2010 / Vol. 18, No. 5 / OPTICS EXPRESS pp. 4986-4999.	☐
9	Zheng et al. "Fluidic Heterogeneous Microsystems Assembly and Packaging" Journal of Microelectromechanical Systems VOL. 15, NO. 4, AUGUST 2006, pp. 864-870.	☐
10	Xue et al. "1 X 4 Ge-on-SOI PIN Photodetector Array forParallel Optical Interconnects" JOURNAL OF LIGHTWAVE TECHNOLOGY, VOL. 27, NO. 24, DECEMBER 15, 2009, pp. 5687-5689.	☐
11	DiLello et al. "Characterization of dark current in Ge-on-Si photodiodes" JOURNAL OF APPLIED PHYSICS 112, 054506 (2012).	☐

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /E.A.R/

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

Application Number	15797821
Filing Date	2017-10-30
First Named Inventor	Shih-Yuan WANG
Art Unit	2893
Examiner Name	Eduardo A. Rodela
Attorney Docket Number	5176/88184-CIP

12	Dong et al., "Suppression of dark current in germanium-tin on silicon p-i-n photodiode by a silicon surface passivation technique", Optical Society of America, 13 Jul 2015 Vol. 23, No. 14 DOI:10.1364/OE.23.018611 OPTICS EXPRESS, pp. 18611-18619.	☐
13	Koester et al., "Ge-on-SOI-Detector/Si-CMOS-Amplifier Receivers for High-Performance Optical-Communication Applications", JOURNAL OF LIGHTWAVE TECHNOLOGY, VOL. 25, NO. 1, JANUARY 2007, pp. 46-57.	☐
14	Pearson et al., "Germanium Photodetectors on Amorphous Substrates for Electronic-Photonic Integration", 2016 IEEE, pp. 20-21.	☐
15	Michel et al., "High-performance Ge-on-Si photodetectors," NATURE PHOTONICS VOL 4 AUGUST 2010, pp. 527-534.	☐
16	Knoll et al., "Monolithically Integrated 25Gbit/sec Receiver for 1.55µm in Photonic BiCMOS Technology", Optical Society of America 2014.	☐
17	XIAO et al., "A 2 Gb/s optical receiver with monolithically integrated MSM photodetector in standard CMOS process", Chinese Science Bulletin, July 2011, Vol. 56, No. 21, pp. 2281-2285.	☐
18	Nishimura et al., "A Significant Shift of Schottky Barrier Heights at Strongly Pinned Metal/Germanium Interface by Inserting an Ultra-Thin Insulating Film", The Japan Society of Applied Physics, Applied Physics Express 1 (2008), pp. 051406-1-051406-3.	☐
19	Urino et al., "Demonstration of 12.5-Gbps optical interconnects integrated with lasers, optical splitters, optical modulators and photodetectors on a single silicon substrate", Optical Society of America, 10 December 2012 / Vol. 20, No. 26 / OPTICS EXPRESS B256.	☐
20	Miura et al., "Differential receivers with highly -uniform MSM Germanium photodetectors capped by SiGe layer", Optical Society of America, 7 October 2013 Vol. 21, No. 20 DOI:10.1364/OE.21.023295 OPTICS EXPRESS 23295.	☐
21	Kang et al. "Suppression of dark current in GeOx-passivated germanium metal-semiconductor-metal photodetector by plasma post-oxidation", Optical Society of America, 29 Jun 2015 Vol. 23, No. 13 DOI:10.1364/OE.23.016967 OPTICS EXPRESS 16967.	☐
22	Dushaq et al. "Metal-germanium-metal photodetector grown on silicon using low temperature RF-PECVD", Vol. 25, No. 25 11 Dec 2017 OPTICS EXPRESS, pp. 32110-32119.	☐

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /E.A.R/

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

Application Number	15797821
Filing Date	2017-10-30
First Named Inventor	Shih-Yuan WANG
Art Unit	2893
Examiner Name	Eduardo A. Rodela
Attorney Docket Number	5176/88184-CIP

23	Zang et al. "Asymmetrically contacted germanium photodiode using a metal–interlayer–semiconductor–metal structure for extremely large dark current suppression", Optical Society of America, Vol. 41, No. 16 / August 15 2016 / Optics Letters, pp. 3686-3689.	☐
24	Liu et al. "Tensile strained Ge photodetectors on Si platform for C and L band telecommunications", Appl. Phys. Lett. 87 (2005). American Institute of Physics. pp. 011110-1-011110-3.	☐
25	Chen et al. "Ultra-low capacitance and high speed germanium photodetectors on silicon", Optical Society of America, 11 May 2009 / Vol. 17, No. 10 / OPTICS EXPRESS pp. 7901-7906.	☐
26	Gao et al. "High Speed Surface Illuminated Si Photodiode Using Microstructured Holes for Absorption Enhancements at 900–1000 nm Wavelength" ACS Photonics, pages A-H, July 18, 2017.	☐
27	Zang et al., "Silicon single-photon avalanche diodes with nanostructured light trapping" NATURE COMMUNICATIONS 8: 628 (September 20 2017)	☐

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

EXAMINER SIGNATURE

Examiner Signature	/EDUARDO A RODELA/	Date Considered	01/16/2019
--------------------	--------------------	-----------------	------------

*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.

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /E.A.R/

Doc code: IDS

Doc description: Information Disclosure Statement (IDS) Filed

PTO/SB/08a (01-10)

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

U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE

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

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)	Application Number		15797821	
	Filing Date		2017-10-30	
	First Named Inventor	Shih-Yuan WANG et al.		
	Art Unit			
	Examiner Name			
	Attorney Docket Number		5176/88184-CIP	

U.S.PATENTS						
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					

If you wish to add additional U.S. Patent citation information please click the Add button.

U.S.PATENT APPLICATION PUBLICATIONS						
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.

FOREIGN PATENT DOCUMENTS								
Examiner Initial*	Cite No	Foreign Document Number ³	Country Code ²	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							☐

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

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

Application Number	15797821
Filing Date	2017-10-30
First Named Inventor	Shih-Yuan WANG et al.
Art Unit	
Examiner Name	
Attorney Docket Number	5176/88184-CIP

1	Y. G. WANG, Y. X. KANG, W. J. ZHAO, S. YAN, P. J. ZHAI, and X. W. TANG, "Studies on surface damage induced by ion bombardment," Journal of Applied Physics, Vol. 83, pp. 1341-1344, Feb 1 1998.	☐
2	LIU AY et al., High performance continuous wave 1.3 μm quantum dot lasers on silicon, Appl. Phys. Letters, 2014, 104, 041104.	☐
3	European Patent Office Supplementary Search Report issued in European Application No. 14801543 on December 6, 2016.	☐
4	"JOSHI et al., "25 Gbps 850 nm photodiode for emerging 100 Gb ethernet applications" SPIE Proceedings Vol 8054, 04 May 2011, (04.05.2011), Abstract http://proceedings.spiedigitallibrary.org/proceeding.aspx?articleid=1351039	☐
5	"DOSUNMU et al., "Germanium on double-SOI photodetectors for 1550 nm operation." Conference: Lasers and Electro-Optics Society, November 2003, (11.2003). https://www.researchgate.net/publication/224745299 "	☐
6	FAN et al. "Differences in etching characteristics of TMAH and KOH on preparing inverted pyramids for silicon solar cells", Applied Surface Science, 2013, 264, 761-766	☐
7	WU et al. "High aspect ratio silicon etch: A review" J. Appl. Phys. 2010, 108, 051101.	☐
8	SINGH et al. "Silicon on Insulator technology review", International Journal of Engineering Sciences & Emerging Technologies, 2011, 1, 1, 1-16.	☐
9	MONTALENTI et al. "Fully coherent growth of Ge on free-standing Si(001) nanomesas", PHYSICAL REVIEW B 89, 014101 (2014).	☐
10	COLLOT et al. "Dry-etch monitoring of III-V heterostructures using laser reflectometry and optical emission spectroscopy", J. Vac. Sci. Technol. B9 (5) Sep/Oct 1991.	☐
11	INGHAM "Future of Short-Reach Optical Interconnects based on MMF Technologies" OFC 2017.	☐

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

Application Number	15797821
Filing Date	2017-10-30
First Named Inventor	Shih-Yuan WANG et al.
Art Unit	
Examiner Name	
Attorney Docket Number	5176/88184-CIP

12	SUN et al. "SWDM PAM4 Transmission Over Next Generation Wide-Band Multimode Optical Fiber" Journal of Lightwave Technology, Vol 35, No. 4, February 15, 2017.	☐
13	TEKIN "Review of packaging of Optoelectronic, Photonic and MEMS Components" IEEE Journal of Selected Topics in Quantum Electronics, Vol. 17, No. 3, 2011	☐
14	ORCUTT et al. "Monolithic Silicon Photonics at 25 Gb/s" OFC 2016 © OSA (2016)	☐
15	ESHAGHI et al., "Optical and electrical properties of indium tin oxide (ITO) nanostructured thin films deposited on polycarbonate substrates "thickness effect"", Optik 125 (2014) 1478–1481 .	☐
16	UDDIN et al. "Highly efficient color filter array using resonant Si3N4 gratings" OPTICS EXPRESS 20 May 2013, Vol. 21, No. 10, 12497.	☐
17	JACOB et al., "Normally incident resonant grating reflection filters for efficient narrow-band spectral filtering of finite beams" J. Opt. Soc. Am. A, Vol. 18, No. 9, September 2001	☐
18	ZHOU et al., "Surface-normal emission of a high-Q resonator using a subwavelength high-contrast grating" OPTICS EXPRESS, 27 October 2008, Vol. 16, No. 22, 17282	☐
19	POULTON et al., "MIT and DARPA Pack Lidar Sensor Onto Single Chip" http://spectrum.ieee.org/tech-talk/semiconductors/optoelectronics/mit-lidar-on-a-chip , IEEE Spectrum, 2016.	☐
20	RASSHOFFER et al., "Influences of weather phenomena on automotive laser radar systems" Adv. Radio Sci., 9, 49–60, 2011	☐
21	YOUN et al. "10-Gb/s 850-nm CMOS OEIC Receiver with a Silicon Avalanche Photodetector" IEEE JOURNAL OF QUANTUM ELECTRONICS, VOL. 48, NO. 2, FEBRUARY 2012	☐
22	SWOBODA et al., "11Gb/s Monolithically Integrated Silicon Optical Receiver for 850nm Wavelength" 006 IEEE International Solid-State Circuits Conference.	☐

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

Application Number	15797821
Filing Date	2017-10-30
First Named Inventor	Shih-Yuan WANG et al.
Art Unit	
Examiner Name	
Attorney Docket Number	5176/88184-CIP

23	TAVERNIER et al. "Power Efficient 4.5Gbit/s Optical Receiver in 130nm CMOS with Integrated Photodiode" 34th European Solid-State Circuits Conference, 2008.	☐
24	CMOS Manufacturing Process, EE141 UC Berkeley, http://bwrcs.eecs.berkeley.edu/Classes/icdesign/ee141_s02/Lectures/Lecture5-Manufacturing.pdf	☐
25	WILLIAMS "Ion Implantation of Semiconductors, Materials Science and Engineering" A253 (1998) 8-15.	☐
26	GIBBONS "Ion Implantation in Semiconductors-Part I Range Distribution Theory and Experiments" PROCEEDINGS OF THE IEEE, VOL. 56, NO. 3, 1968	☐
27	ASSEFA et al. "Monolithically Integrated Silicon Nanophotonics Receiver in 90nm CMOS Technology Node" OFC/NFOEC Technical Digest © 2013 OSA	☐
28	TAUBENBLATT "Optical Interconnects for High-Performance Computing" JOURNAL OF LIGHTWAVE TECHNOLOGY, VOL. 30, NO. 4, FEBRUARY 15, 2012 .	☐
29	CHEN et al. "A 1.8-V 10-Gb/s Fully Integrated CMOS Optical Receiver Analog Front-End" IEEE JOURNAL OF SOLID-STATE CIRCUITS, VOL. 40, NO. 6, JUNE 2005	☐
30	KUCHTA et al., "A 55Gb/s Directly Modulated 850nm VCSEL-Based Optical Link" IEEE Photonics Conference 2012 (IPC 2012) Post Deadline Paper PD 1.5 .	☐
31	LENGYEL et al. "Sensitivity Improvements in an 850-nm VCSEL-Based Link Using a Two-Tap Pre-Emphasis Electronic Filter" JOURNAL OF LIGHTWAVE TECHNOLOGY, VOL. 35, NO. 9, MAY 1, 2017.	☐
32	GHOSH et al. "On Integrated CMOS-MEMS System-on-Chip" IEEE-NEWCAS Conference, 2005.	☐
33	KALOGERAKIS et al. "A Quad 25Gb/s 270mW TIA in 0.13µm BiCMOS with <0.15dB Crosstalk Penalty" ISSCC 2013, SESSION 7, OPTICAL TRANSCEIVERS AND SILICON PHOTONICS, 7.1.	☐

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

Application Number	15797821
Filing Date	2017-10-30
First Named Inventor	Shih-Yuan WANG et al.
Art Unit	
Examiner Name	
Attorney Docket Number	5176/88184-CIP

34	KNOCHENHAUER et al. "40 Gbit/s transimpedance amplifier with high linearity range in 0.13 mm SiGe BiCMOS" ELECTRONICS LETTERS 12th May 2011 Vol. 47 No. 10.	☐
35	NISHIHARA et al. "10.3 Gbit/s burst-mode PIN-TIA module with high sensitivity, wide dynamic range and quick response" ELECTRONICS LETTERS 31st January 2008 Vol. 44 No. 3.	☐
36	RACANELLI et al. "SiGe BiCMOS Technology for Communication Products" IEEE 2003 CUSTOM INTEGRATED CIRCUITS CONFERENCE.	☐
37	General Properties of Silicon, http://www.pveducation.org/pvcdrom/materials/general-properties-of-silicon	☐
38	WEGRZECKA et al. "Design and properties of silicon avalanche photodiodes" OPTO-ELECTRONICS REVIEW 12(1), 95-104 (2004)	☐
39	XIE et al. "Post-CMOS Processing for High-Aspect-Ratio Integrated Silicon Microstructures" JOURNAL OF MICROELECTROMECHANICAL SYSTEMS, VOL. 11, NO. 2, APRIL 2002.	☐
40	HUANG et al. "A 10-Gb/s OEIC with Meshed Spatially-Modulated PhotoDetector in 0.18- umCMOSTechnology" IEEE JOURNAL OF SOLID-STATE CIRCUITS, VOL. 46, NO. 5, MAY 2011	☐
41	TAVERNIER et al. "High-Speed Optical Receivers With Integrated Photodiode in 130 nm CMOS" IEEE JOURNAL OF SOLID-STATE CIRCUITS, VOL. 44, NO. 10, OCTOBER 2009.	☐
42	KAO et al. "A 5-Gbit/s CMOS Optical Receiver With Integrated Spatially Modulated Light Detector and Equalization" IEEE TRANSACTIONS ON CIRCUITS AND SYSTEMS—I: REGULAR PAPERS	☐
43	HARTMAN et al. "A Monolithic Silicon Photodetector/Amplifier IC for Fiber and Integrated Optics Application" Journal of Lightwave TECHNOLOGY, VOL. LT-3, NO. 4, AUGUST 1985	☐
44	RADOVANOVIC et al. "A 3-Gb/s Optical Detector in Standard CMOS for 850-nm Optical Communication" IEEE JOURNAL OF SOLID-STATE CIRCUITS, VOL. 40, NO. 8, AUGUST 2005.	☐

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

Application Number	15797821
Filing Date	2017-10-30
First Named Inventor	Shih-Yuan WANG et al.
Art Unit	
Examiner Name	
Attorney Docket Number	5176/88184-CIP

45	CSUTAK et al. "High-Speed Monolithically Integrated Silicon Photoreceivers Fabricated in 130-nm CMOS Technology" JOURNAL OF LIGHTWAVE TECHNOLOGY, VOL. 20, NO. 9, SEPTEMBER 2002.	☐
46	YIN et al. "Integrated ARROW waveguides with hollow cores" OPTICS EXPRESS, 14 June 2004, Vol. 12, No. 12, 2710	☐
47	MICHEL et al. "High-performance Ge-on-Si photodetectors" Nature Photonics, 30 JULY 2010, DOI: 10.1038/NPHOTON.2010.157	☐
48	Analog Devices, Inc. data sheet ADN3010-11 11.3 Gbps Optical Receiver	☐
49	YASHIKI et al. "5 mW/Gbps hybrid-integrated Si-photonics-based optical I/O cores and their 25-Gbps/ch error-free operation with over 300-m MMF" OFC 2015 © OSA 2015	☐
50	PYO et al., "3D Printed Nanophotonic Waveguides" Adv. Optical Mater. 2016, 4, 1190–1195.	☐

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

EXAMINER SIGNATURE

Examiner Signature	/EDUARDO A RODELA/	Date Considered	01/16/2019
--------------------	--------------------	-----------------	------------

*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.

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.

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /E.A.R./



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.
15/797,821	10/30/2017	Shih-Yuan WANG	5176/88184-CIP	1009
23432	7590	11/02/2018		
COOPER & DUNHAM, LLP			EXAMINER	
30 Rockefeller Plaza			RODELA, EDUARDO A	
20th Floor				
NEW YORK, NY 10112				
			ART UNIT	PAPER NUMBER
			2893	
			MAIL DATE	DELIVERY MODE
			11/02/2018	PAPER

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.

<i>Applicant-Initiated Interview Summary</i>	Application No. 15/797,821		Applicant(s) WANG et al.	
	Examiner EDUARDO A RODELA		Art Unit 2893	AIA Status Yes

All participants (applicant, applicants representative, PTO personnel):

(1) Eduardo A. Rodela, Examiner. (3) ____.

(2) Ivan Kavrukov, Applicant's Representative. (4) ____.

Date of Interview: 01 November 2018.

Type: ☒ Telephonic ☐ Video Conference
 ☐ Personal [copy given to: ☐ applicant ☐ applicant's representative]

Exhibit shown or demonstration conducted: ☐ Yes ☒ No.
 If Yes, brief description: ____.

Issues Discussed ☐101 ☐112 ☐102 ☒103 ☐Others
 (For each of the checked box(es) above, please describe below the issue and detailed description of the discussion)

Claim(s) discussed: 1.

Identification of prior art discussed: Kim (US 2010/0288341).

Substance of Interview
 (For each issue discussed, provide a detailed description and indicate if agreement was reached. Some topics may include: identification or clarification of a reference or a portion thereof, claim interpretation, proposed amendments, arguments of any applied references etc...)

Applicant's Representative pointed out that the Kim reference appears to be an emission device rather than the claimed detection device. Further, Applicant's Representative pointed out the differences which the amendments exhibit over the prior art. Examiner agreed that the prior art rejection is overcome for at least the reasons noted with regard to the Kim reference..

Applicant recordation instructions: The formal written reply to the last Office action must include the substance of the interview. (See MPEP section 713.04). If a reply to the last Office action has already been filed, applicant is given a non-extendable period of the longer of one month or thirty days from this interview date, or the mailing date of this interview summary form, whichever is later, to file a statement of the substance of the interview

Examiner recordation instructions: Examiners must summarize the substance of any interview of record. A complete and proper recordation of the substance of an interview should include the items listed in MPEP 713.04 for complete and proper recordation including the identification of the general thrust of each argument or issue discussed, a general indication of any other pertinent matters discussed regarding patentability and the general results or outcome of the interview, to include an indication as to whether or not agreement was reached on the issues raised.

☐ Attachment

/EDUARDO A RODELA/ Primary Examiner, Art Unit 2893	
---	--

Summary of Record of Interview Requirements

Manual of Patent Examining Procedure (MPEP), Section 713.04, Substance of Interview Must be Made of Record

A complete written statement as to the substance of any face-to-face, video conference, or telephone interview with regard to an application must be made of record in the application whether or not an agreement with the examiner was reached at the interview.

Title 37 Code of Federal Regulations (CFR) 1.133 Interviews

Paragraph (b)

In every instance where reconsideration is requested in view of an interview with an examiner, a complete written statement of the reasons presented at the interview as warranting favorable action must be filed by the applicant. An interview does not remove the necessity for reply to Office action as specified in §§ 1.111, 1.135. (35 U.S.C. 132)

37 CFR §1.2 Business to be transacted in writing.

All business with the Patent or Trademark Office should be transacted in writing. The personal attendance of applicants or their attorneys or agents at the Patent and Trademark Office is unnecessary. The action of the Patent and Trademark Office will be based exclusively on the written record in the Office. No attention will be paid to any alleged oral promise, stipulation, or understanding in relation to which there is disagreement or doubt.

The action of the Patent and Trademark Office cannot be based exclusively on the written record in the Office if that record is itself incomplete through the failure to record the substance of interviews.

It is the responsibility of the applicant or the attorney or agent to make the substance of an interview of record in the application file, unless the examiner indicates he or she will do so. It is the examiners responsibility to see that such a record is made and to correct material inaccuracies which bear directly on the question of patentability.

Examiners must complete an Interview Summary Form for each interview held where a matter of substance has been discussed during the interview by checking the appropriate boxes and filling in the blanks. Discussions regarding only procedural matters, directed solely to restriction requirements for which interview recordation is otherwise provided for in Section 812.01 of the Manual of Patent Examining Procedure, or pointing out typographical errors or unreadable script in Office actions or the like, are excluded from the interview recordation procedures below. Where the substance of an interview is completely recorded in an Examiners Amendment, no separate Interview Summary Record is required.

The Interview Summary Form shall be given an appropriate Paper No., placed in the right hand portion of the file, and listed on the "Contents" section of the file wrapper. In a personal interview, a duplicate of the Form is given to the applicant (or attorney or agent) at the conclusion of the interview. In the case of a telephone or video-conference interview, the copy is mailed to the applicants correspondence address either with or prior to the next official communication. If additional correspondence from the examiner is not likely before an allowance or if other circumstances dictate, the Form should be mailed promptly after the interview rather than with the next official communication.

The Form provides for recordation of the following information:

- Application Number (Series Code and Serial Number)
- Name of applicant
- Name of examiner
- Date of interview
- Type of interview (telephonic, video-conference, or personal)
- Name of participant(s) (applicant, attorney or agent, examiner, other PTO personnel, etc.)
- An indication whether or not an exhibit was shown or a demonstration conducted
- An identification of the specific prior art discussed
- An indication whether an agreement was reached and if so, a description of the general nature of the agreement (may be by attachment of a copy of amendments or claims agreed as being allowable). Note: Agreement as to allowability is tentative and does not restrict further action by the examiner to the contrary.
- The signature of the examiner who conducted the interview (if Form is not an attachment to a signed Office action)

It is desirable that the examiner orally remind the applicant of his or her obligation to record the substance of the interview of each case. It should be noted, however, that the Interview Summary Form will not normally be considered a complete and proper recordation of the interview unless it includes, or is supplemented by the applicant or the examiner to include, all of the applicable items required below concerning the substance of the interview.

A complete and proper recordation of the substance of any interview should include at least the following applicable items:

- 1) A brief description of the nature of any exhibit shown or any demonstration conducted,
- 2) an identification of the claims discussed,
- 3) an identification of the specific prior art discussed,
- 4) an identification of the principal proposed amendments of a substantive nature discussed, unless these are already described on the Interview Summary Form completed by the Examiner,
- 5) a brief identification of the general thrust of the principal arguments presented to the examiner,
(The identification of arguments need not be lengthy or elaborate. A verbatim or highly detailed description of the arguments is not required. The identification of the arguments is sufficient if the general nature or thrust of the principal arguments made to the examiner can be understood in the context of the application file. Of course, the applicant may desire to emphasize and fully describe those arguments which he or she feels were or might be persuasive to the examiner.)
- 6) a general indication of any other pertinent matters discussed, and
- 7) if appropriate, the general results or outcome of the interview unless already described in the Interview Summary Form completed by the examiner.

Examiners are expected to carefully review the applicants record of the substance of an interview. If the record is not complete and accurate, the examiner will give the applicant an extendable one month time period to correct the record.

Examiner to Check for Accuracy

If the claims are allowable for other reasons of record, the examiner should send a letter setting forth the examiners version of the statement attributed to him or her. If the record is complete and accurate, the examiner should place the indication, Interview Record OK on the paper recording the substance of the interview along with the date and the examiners initials.

Electronic Acknowledgement Receipt

EFS ID:	34184668
Application Number:	15797821
International Application Number:	
Confirmation Number:	1009
Title of Invention:	MICROSTRUCTURE ENHANCED ABSORPTION PHOTSENSITIVE DEVICES
First Named Inventor/Applicant Name:	Shih-Yuan WANG
Customer Number:	23432
Filer:	Ivan Kavrukov/maria arap
Filer Authorized By:	Ivan Kavrukov
Attorney Docket Number:	5176/88184-CIP
Receipt Date:	01-NOV-2018
Filing Date:	30-OCT-2017
Time Stamp:	13:32:11
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	no
------------------------	----

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Transmittal Letter	IDS_15797821.pdf	67753	no	1
			9dc27b052edddb085c9af56eba2a5ec2d42456fc		

Warnings:

Information:					
2	Information Disclosure Statement (IDS) Form (SB08)	1449.pdf	1034441	no	4
			134dcb7de97d106222f534da1c93aa3373c3e8a0		
Warnings:					
Information:					
A U.S. Patent Number Citation or a U.S. Publication Number Citation is required in the Information Disclosure Statement (IDS) form for autoloading of data into USPTO systems. You may remove the form to add the required data in order to correct the Informational Message if you are citing U.S. References. If you chose not to include U.S. References, the image of the form will be processed and be made available within the Image File Wrapper (IFW) system. However, no data will be extracted from this form. Any additional data such as Foreign Patent Documents or Non Patent Literature will be manually reviewed and keyed into USPTO systems.					
3	Non Patent Literature	IRsensitivityenhancementofCMOSImageSensorwithdiffractiveimage trappingpixels_.pdf	2706020	no	9
			0ce35c2f331b567bc78c768f0dd36e09ca740458		
Warnings:					
Information:					
Total Files Size (in bytes):			3808214		
<p>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.</p> <p><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.</p> <p><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.</p> <p><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.</p>					

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

Application Number	15979821
Filing Date	2017-30-10
First Named Inventor	Shih-Yuan WANG et al.
Art Unit	2893
Examiner Name	RODELA, EDUARDO A
Attorney Docket Number	5176-88184-CIP

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							
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	
FOREIGN PATENT DOCUMENTS							Remove	
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							
If you wish to add additional Foreign Patent Document citation information please click the Add button								Add
NON-PATENT LITERATURE DOCUMENTS								Remove
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

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

Application Number	15979821
Filing Date	2017-30-10
First Named Inventor	Shih-Yuan WANG et al.
Art Unit	2893
Examiner Name	RODELA, EDUARDO A
Attorney Docket Number	5176-88184-CIP

1	Yokogawa, s., et al., IR sensitivity enhancement of CMOS Image Sensor with diffractive light trapping pixels, Scientific Reports/7:3832/DOI:10.1038/s41598-017-04200-y, 19 June 2017.
---	---

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

Add

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	15979821
Filing Date	2017-30-10
First Named Inventor	Shih-Yuan WANG et al.
Art Unit	2893
Examiner Name	RODELA, EDUARDO A
Attorney Docket Number	5176-88184-CIP

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	/IVAN KAVRUKOV/	Date (YYYY-MM-DD)	2018-11-01
Name/Print	Ivan Kavrukov	Registration Number	25,161

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.

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Application of: Shih-Yuan WANG et al.

Application No.: 15/797,821

Filed: October 30, 2017

Confirmation No.: 1009

For: MICROSTRUCTURE ENHANCED ABSORPTION PHOTOSENSITIVE DEVICES

This correspondence is being transmitted by facsimile transmission and/or EFS-Web to the U.S. Patent and Trademark Office.

/Maria Antonakis/ November 1, 2018

Maria Antonakis

Date

30 Rockefeller Plaza, 20th Floor
New York, New York 10112
Tel.: (212) 278-0400

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

INFORMATION DISCLOSURE STATEMENT

It is respectfully requested that the information cited in the annexed Form PTO-1449 be considered by the Examiner in connection with the above-identified patent application, and that such art be made of record in said application.

No fee is believed to be required for the filing of this Communication. However, the Commissioner is hereby authorized to charge any fees required regarding this Communication to Deposit Account No. 03-3125.

Respectfully submitted,

/Ivan Kavrukov /

Ivan Kavrukov, Reg. No. 25,161
Attorney for Applicant
COOPER & DUNHAM LLP
30 Rockefeller Plaza, 20th Floor
New York, New York 10112
Tel.: (212) 278-0400

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 15/797,821		Filing Date 10/30/2017		☐ To be Mailed				
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), (j), 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	10/26/2018		CLAIMS REMAINING AFTER AMENDMENT			HIGHEST NUMBER PREVIOUSLY PAID FOR		PRESENT EXTRA		RATE (\$)		ADDITIONAL FEE (\$)	
	Total (37 CFR 1.16(i))		* 112		Minus	** 112		= 0		X \$50 =		0	
	Independent (37 CFR 1.16(h))		* 3		Minus	***3		= 0		X \$230 =		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			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			
<p>* If the entry in column 1 is less than the entry in column 2, write "0" in column 3.</p> <p>** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 20, enter "20".</p> <p>*** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 3, enter "3".</p> <p>The "Highest Number Previously Paid For" (Total or Independent) is the highest number found in the appropriate box in column 1.</p>											LIE ANITA JOHNSON		

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.**

If you need assistance in completing the form, call 1-800-PTO-9199 and select option 2.

REMARKS

This paper responds to the non-final Office Action mailed 07/26/2018. Claims 1-40 and 42-44 were examined; the remaining claims (45-112) were withdrawn from consideration as non-elected.

Section 112 Issue.

The phrase “some of the time” has been deleted from claim 1 to make the claim clearer.

Section 103 Issues.**Claim 1:**

The Office Action applied four references to claim 1: **Dickinson** US 7,251,386, **Kim** US 2010/0288341, **Okamoto** US 2010/0308428, and **Iwai** US 2009/0230498.

Applicant submits that an MSPD configured as claimed for reverse-bias photodetection and having the hole structure and other features of claim 1 is not shown in these references.

Regarding **Dickinson**, the Office Action notes in page 5:

Dickinson does not teach:

- the photodetector is a microstructure-enhanced photodetector (MSPD).

The Office Action refers in page 6 to **Kim** Figures 5A and 12 as teaching the feature missing from Dickinson, namely MSPD, but applicant submits that Kim’s Figure 5A shows “a vertical emitting cavity” rather than photodetector and Figure 12 shows “a photovoltaic device” operating without an external bias rather than a photoconductor with reverse bias contacts that establish an electrical field therein when energized. See for example the following portions of Kim:

[0028] FIGS. 5A-C show respectively an exploded view, a cross-sectional side view, and a top view of a photonic crystal vertical emitting cavity.

* * *

[0035] FIG. 12 shows a photovoltaic device according to an embodiment of the present invention.

Claim 1 describes an MSPD and further emphasizes its nature as “configured for reverse-bias operation” and expressly recites “reverse-bias contacts coupled therewith to thereby sweep in a selected direction electrical charges generated in the MSPD by said optical input.”

Support for this clarification of claim 1 is found throughout the original application, for example in paragraphs 167, 182, 201, 230, and 235, in original claim 24, as well as elsewhere.

A further difference from Kim is that Kim’s Fig. 5A shows quantum wells 535 and air holes 51 in “defect region” 52 of a photonic crystal slab and Fig. 12 shows a “photonic crystal cavity” 1250. Kim explains:

[0036] Throughout the present disclosure the term ‘defect region’ intends to indicate a section of a perfectly periodic photonic crystal wherein light localization is enabled, the section being formed as a result of breaking the periodicity of the air-holes of the photonic crystal.

Applicant submits that the very different purpose of the air holes in Kim would not have motivated the skilled person at the time of the subject invention to add air holes in the Dickinson device. There is no suggestion of such a motivation in either reference, or of a recognition of benefits of adding air holes in the Dickinson device. Indeed, it would have been counterintuitive to the skilled person at the time to damage the Dickinson device with air holes.

The Office Action notes in page 9 that Kim does not teach that “each of the layers comprises Silicon, Germanium, or an alloy thereof” and cites **Okamoto** as showing such material in Figure 2. Applicant submits that Okamoto also lacks the teaching missing from Dickinson and Kim discussed above. Okamoto pertains to a structure fundamentally different from the invention of claim 1. According to Okamoto:

[0033] In the present invention, light that is incident on a conductive layer (or a second electrode) having periodic openings excites surface plasmons at a semiconductor interface with the conductive layer, and forms a resonance state. . .

The invention of claim 1 includes an MSPD structure configured to operate differently – not through surface plasmons effects as Okamoto explains but as a photodetector with reverse-bias contact for reverse-bias operation. The surface plasmon resonance operation of Okamoto would not have motivated the skilled person at the relevant time to modify the Dickinson structure still further by using surface plasmon features.

The remaining reference concerning claims 1 is **Iwai**, cited for a teaching of amplifying a photodetector output. Applicant submits that Iwai also lacks the teaching missing from Dickinson, Kim, and Okamoto discussed above.

The **remaining claims** all depend from claim 1, include its subject matter, and should be patentable at least for that reason, although at least some add features that enhance patentability. Applicant proposes to defer a detailed discussion of the dependent claims and the additional references cited only regarding dependent claims, as the presentation above regarding parent claim 1 may obviate a need for such a discussion.

If a petition for an extension of time is required to make this response timely, this paper should be taken as such petition. The Patent Office is hereby authorized to charge any fees that are required in connection with this response, and to credit any overpayment, to our Deposit Account No. 03-3125.

If a telephone interview could advance the prosecution of this application, the Examiner is respectfully requested to call the undersigned attorney.

Respectfully submitted,

Dated: October 26, 2018

By: /ivan kavrukov /
Ivan Kavrukov, Reg. 25, 161
Attorney for Applicant
COOPER & DUNHAM LLP
30 Rockefeller Plaza, 20th Floor
New York, New York 10112
Tel.: (212) 278-0400

Listing of Claims

The following listing of claims will replace all prior versions, and listings, of claims in the subject application:

1. (currently amended) A single-chip device comprising an integrated combination of a microstructure-enhanced photodetector (MSPD) configured for reverse-bias operation and an active electronic circuit, both formed on or in a single substrate and configured to receive an optical input that in cross-section is substantially continuous spatially ~~at least some of the time~~, convert the optical input to an electrical output, and process the electrical output into a processed output, wherein:

the MSPD on or in said single substrate comprises an intermediate layer, a first layer at one side of the intermediate layer, and a second layer at an opposite side of the intermediate layer, wherein:

each of the layers comprises Silicon, Germanium, or an alloy thereof;
at least one of said layers, or an overlying covering layer that may be present, has holes intentionally formed therein, extending in directions transverse to the layers;

each of the first and second layers comprises a doped material;

the intermediate layer comprises a material that is less doped than at least one of the first and second layers or is undoped, wherein the degree of doping is the same or different for different positions in the intermediate layer;

an input portion configured to concurrently receive at a plurality of said holes said optical input that has said substantially continuous cross-section; and

an output portion configured to provide said electrical output from the MSPD;

the MSPD includes reverse-bias contacts coupled therewith to establish an electrical field therein when energized to thereby sweep in a selected direction electrical charges generated in the MSPD by said optical input; and

the active electronic circuit on or in said single substrate is configured to process the electrical output from the MSPD by applying thereto:

amplification to form said processed output from the single-chip device;

processing other than or in addition to amplification to form said processed output from the single-chip device; and
routing to one or more selected destinations; and
a communication channel on or in said single-chip device, configured to deliver the electrical output from the MSPD to the active electronic circuit.

2. (currently amended) The single-chip device of claim 1, in which said active electronic circuit ~~a~~ at least partly extends beyond said substrate.

3. (previously presented) The single-chip device of claim 1, in which said active electronic circuit is at least partly inside said substrate.

4. (previously presented) The single-chip device of claim 1, in which said overlying layer is present as a superstrate at one side of said first, intermediate, and second layers, and contains said holes.

5. (previously presented) The single-chip device of claim 1, in which said MSPD comprises a III-V materials family photodiode.

6. (previously presented) The single-chip device of claim 1, further including an air-filled volume between the substrate and the MSPD.

7. (previously presented) The single-chip device of claim 1, further including a layer of a dielectric material that covers the holes and is in the propagation path of said optical input.

8. (previously presented) The single-chip device of claim 1, further including an avalanche region at one side of the MSPD, forming therewith an avalanche microstructured photodiode (MSAPD).

9. (previously presented) The single-chip device of claim 1, in which said holes are present in said intermediate layer.

10. (previously presented) The single-chip device of claim 1, in which said holes are present in said intermediate layer as well as in at least one of the first and second layers.

11. (previously presented) The single-chip device of claim 1, in which said holes are present in each of the first, second, and intermediate layer.

12. (previously presented) The single-chip device of claim 1, in which each of said first and second layers and said intermediate layer has a thickness and at least some of said holes extend through the entire thickness of said intermediate layer and of one of said first layer and second layer and through at least a part of the thickness of the other one of said first and second layers.

13. (previously presented) The single-chip device of claim 1, in which at least some of said holes are shaped as inverted pyramids.

14. (previously presented) The single-chip device of claim 1, in which at least some of said holes have triangular sections in planes transverse to said layers.

15. (previously presented) The single-chip device of claim 1, in which at least some of said holes have triangular sections in planes transverse to said layers, with vertices within the intermediate layer.

16. (previously presented) The single-chip device of claim 1, in which at least some of said holes have sidewalls that slope in planes transverse to said layers.

17. (previously presented) The single-chip device of claim 1, in which at least some of said holes have sidewalls with plural different slopes along the inside walls of the holes.
18. (previously presented) The single-chip device of claim 1, in which at least some of said holes differ from each other in at least one of (i) distance by which the holes extend in said directions, (ii) shape of the holes, and (iii) spacing of the holes from each other.
19. (previously presented) The single-chip device of claim 1, in which the holes are in the intermediate layer and wherein one of said first and second layers conformally covers inside walls of the holes as well as spaces between the holes.
20. (previously presented) The single-chip device of claim 1, in which the holes are at least partly filled with a dielectric material.
21. (previously presented) The single-chip device of claim 1, in which the holes are entirely filled with a dielectric material.
22. (previously presented) The single-chip device of claim 1, in which said optical input enters the MSPD through one or both of said first and second layers, and each of the first and second layers through which the optical input enters is no more than 500 nanometers thick.
23. (previously presented) The single-chip device of claim 1, in which at least one of the first layer, the second layer, and the intermediate layer comprises a material represented by $\text{Ge}_x\text{Si}_{1-x}$, where x is greater than zero.

24. (previously presented) The single-chip device of claim 1, in which said MSPD further comprises ohmic contacts configured for reverse-biasing the MSPD.

25. (previously presented) The single-chip device of claim 1, in which the MSPD further includes ohmic contacts to said first and second layers, at least one of said ohmic contact being through a via in said substrate.

26. (previously presented) The single-chip device of claim 1, further comprising a light guide to said MSPD for directing said optical input thereto, and electrical contacts from the active electronic circuit configured to carry said processed output out of the single-chip device.

27. (previously presented) The single-chip device of claim 1, further comprising a light guide to said MSPD configured to bend the optical input from an initial propagation direction to a propagation direction transverse to said layers, and electrical contacts from the active electronic circuit configured to carry said processed output out of the single-chip device.

28. (previously presented) The single-chip device of claim 1, further comprising one or more additional MSPD on or in the same substrate, and respective different optical bandpass filters coupled with at least two of the MSPDs on or in said single substrate, whereby at least two of said MSPDs are configured to respond to different wavelength ranges that are within said optical input.

29. (previously presented) The single-chip device of claim 1, further comprising one or more additional MSPDs on or in said single substrate, one or more additional active electronic circuits on or in the said single substrate, and one or more additional communication channels configured to supply electrical outputs from the MSPDs to the one or more of the active electronic circuits.

30. (previously presented) The single-chip device of claim 1, further comprising one or more additional active electronic circuits that are formed on or in the said single substrate.

31. (previously presented) The single-chip device of claim 1, further comprising one or more additional active electronic circuits that are formed on or in the said single substrate and comprise one or more transimpedance amplifiers (TIAs) and one or more application specific integrated circuits (ASICs).

32. (previously presented) The single-chip device of claim 1, further comprising one or more additional active electronic circuits that are formed on or in the said single substrate and comprise one or more of CMOS, BiCMOS, and bipolar active devices.

33. (previously presented) The single-chip device of claim 1, further comprising one or more additional MSPDs in an array on or in said single substrate and one or more additional active electronic circuits also on or in said single substrate, said MSPDs and active electronic circuits being configured into an optical communication structure or a light distance and ranging (LIDAR) structure.

34. (previously presented) The single-chip device of claim 1, further comprising a laser emitter formed on or in said single substrate.

35. (previously presented) The single-chip device of claim 1, further including a layer of selected material that is over a side of one of the first and second layers facing away from the intermediate layer and is configured to reduce sheet resistance.

36. (previously presented) The single-chip device of claim 1, further including a layer of selected material that is over a side of one of the first and second layers facing away from

the intermediate layer and is configured to reflect light that has passed through the intermediate layer back toward the intermediate layer.

37. (previously presented) The single-chip device of claim 1, further including a deliberately textured surface at a side of one of said first and second layers facing away from the intermediate layer.

38. (previously presented) The single-chip device of claim 1, further including a layer of micro-nano structures formed at one of said first and second facing, at a surface thereof facing away from the intermediate layer.

39. (previously presented) The single-chip device of claim 1, further including one or more distributed Bragg reflectors formed at one of said first and second layers, at a surface thereof away from the intermediate layer.

40. (previously presented) The single-chip device of claim 1, further including an isolation trench between the MSPD and the active electronic circuit.

41. (non-elected) The single-chip device of claim 1, further including a light shield layer over said active electronic circuit.

42. (non-elected) The single-chip device of claim 1, wherein the optical input and the electrical output are each modulated at a frequency of at least 30 Gigabits per second.

43. (non-elected) The single-chip device of claim 1, wherein the quantum efficiency of the MSPD that is at least 1.5 times greater than that of an otherwise same photodetector that does not include said holes.

44. (non-elected) The single-chip device of claim 1, further including a hermetic seal integral with the device.

45. (non-elected) A microstructure-enhanced photodetector (MSPD) configured to convert to an electrical output an optical input that in cross-section is essentially continuous spatially at least some of the time, comprising:

a substrate and a top layer, a bottom layer, and an intermediate layer between the top and bottom layers formed on or in the substrate, wherein:
at least one of the layers has holes intentionally formed therein,
extending in directions transverse to the layers;
each of the top and bottom layers comprises a doped material;
the intermediate layer comprises a material that is undoped or is less doped than the top or bottom layer, wherein the degree of doping is the same or different for different positions in the intermediate layer;
an input portion configured to receive, concurrently at a plurality of said holes, said optical input that has said essentially continuous cross-section; and
an output portion configured to provide said electrical output.

46. (non-elected) The MSPD of claim 45, in which the top layer is no more than 500 nm thick and the holes are at least in the top layer.

47. (non-elected) The MSPD of claim 45, further including an air-filled volume between the substrate and the MSPD.

48. (non-elected) The MSPD of claim 45, further including a layer of a dielectric material that is at a surface of said substrate, over the holes and spaces between the holes, and in the path of said optical input.

49. (non-elected) The MSPD of claim 45, further including an avalanche region under the MSPD, forming therewith an avalanche microstructured photodiode (MSAPD).

50. (non-elected) The MSPD of claim 45, in which said holes are present in said intermediate layer.

51. (non-elected) The MSPD of claim 45, in which said holes are present in said intermediate layer as well as in at least one of the top and bottom layers.

52. (non-elected) The MSPD of claim 45, in which said holes are present in each of the top, bottom, and intermediate layer.

53. (non-elected) The MSPD of claim 45, in which each of said top and bottom layers and said intermediate layer has a thickness and at least some of said holes extend through the entire thickness of said intermediate layer and of one of said top and bottom layers and through at least a part of the thickness of the other one of said top and bottom layers.

54. (non-elected) The MSPD of claim 45, in which at least some of said holes are shaped as inverted pyramids.

55. (non-elected) The MSPD of claim 45, in which at least some of said holes have triangular sections in planes transverse to said layers.

56. (non-elected) The MSPD of claim 45, in which at least some of said holes have triangular sections in planes transverse to said layers, with vertices within the intermediate layer.

57. (non-elected) The MSPD of claim 45, in which at least some of said holes have sidewalls that slope in planes transverse to said layers.

58. (non-elected) The MSPD of claim 45, in which at least some of said holes have sidewalls with plural different slopes along inside walls of the holes.

59. (non-elected) The MSPD of claim 45, in which at least some of said holes differ from each other in at least one of (i) distance by which the holes extend in said directions, (ii) shape of the holes, and (iii) spacing of the holes from each other.

60. (non-elected) The MSPD of claim 45, in which the holes are in the intermediate layer and wherein one of said top and bottom layers conformally covers inside walls of the holes as well as spaces between the holes.

61. (non-elected) The MSPD of claim 45, in which the holes are at least partly filled with a dielectric material.

62. (non-elected) The MSPD of claim 45, in which the holes are entirely filled with a dielectric material.

63. (non-elected) The MSPD of claim 45, in which at least one of the top and bottom layers and the intermediate layer comprises a material represented by $\text{Ge}_x \text{Si}_{1-x}$, where x is greater than zero but less than unity.

64. (non-elected) The MSPD of claim 45, in which at least one of the top and bottom layers and the intermediate layer comprises a material represented by $\text{Ge}_x \text{Si}_{1-x}$, where x is zero or unity or a value between zero and unity.

65. (non-elected) The MSPD of claim 45, in which said MSPD further comprises ohmic contacts configured for reverse-biasing the MSPD.

66. (non-elected) The MSPD of claim 45, in which the MSPD further includes ohmic contacts to said top and bottom layers, wherein at least one of said ohmic contact being through a via in said substrate.

67. (non-elected) The MSPD of claim 451, further comprising a light guide to said MSPD for directing said optical input thereto.

68. (non-elected) The MSPD of claim 45, further comprising a light guide to said MSPD configured to bend the optical input from an initial propagation direction to a propagation direction transverse to at least some of said layers.

69. (non-elected) The MSPD of claim 45, further comprising one or more additional MSPDs formed on or in the single substrate, and respective different optical bandpass filters coupled with respective ones of the MSPDs, whereby at least two of said MSPDs are configured to respond to different wavelength ranges that are within said optical input.

70. (non-elected) The MSPD of claim 45, further comprising one or more additional MSPDs in an array on or in said single substrate, said MSPDs being configured into an optical communication structure or a light distance and ranging (LIDAR) structure.

71. (non-elected) The MSPD of claim 45, further comprising a laser emitter formed on or in said single substrate.

72. (non-elected) The MSPD of claim 45, further including a material that is over a side of one of the top and bottom layers facing away from the intermediate layer and is configured to reduce sheet resistance.

73. (non-elected) The MSPD of claim 45, further including a material that is over a side of one of the top and bottom layers facing away from the intermediate layer and is configured to reflect light that has passed through the intermediate layer back toward the intermediate layer.

74. (non-elected) The MSPD of claim 45, further including a deliberately textured surface at a side of one of said top and bottom layers facing away from the intermediate layer.

75. (non-elected) The MSPD of claim 45, further including a layer of micro-nano structures formed at a side of one of said top and bottom layers facing away from the intermediate layer.

76. (non-elected) The MSPD of claim 45, further including one or more distributed Bragg reflectors formed at a surface of one of said top and bottom layers facing away from the intermediate layer.

77. (non-elected) The MSPD of claim 45, further including one or more active electronic circuits formed on or in said substrate and coupled to said MSPD to receive said electrical output therefrom and process it into a processed output, thereby constituting a single-chip integrated circuit configured to receive said optical input, convert it to said electrical output, and provide said processed output.

78. (non-elected) The MSPD of claim 45, wherein the optical input and the electrical output are each modulated at a frequency of at least 30 Gigabits per second.

79. (non-elected) The MSPD of claim 45, wherein the quantum efficiency of the MSPD is at least 1.5 times greater than that of an otherwise the same photodetector lacking said holes.

80. (non-elected) The MSPD of claim 45, further including a hermetic seal integral with the MSPD.

81. (non-elected) A method of making a microstructure-enhanced photodetector (MSPD) configured to convert an optical input that at least some of the time has a cross-section that is essentially continuous spatially to an electrical output, comprising:

providing a substrate and forming on or in said substrate a top layer, a bottom layer, and an intermediate layer between the top and bottom layers, wherein:

at least one of the layers has holes intentionally formed therein, extending in directions transverse to the layers;
each of the top and bottom layers comprises a doped material;
the intermediate layer comprises a material that is undoped or is less doped than the top or bottom layer, wherein the degree of doping is the same or different for different positions in the intermediate layer;

forming an input portion configured to receive, concurrently at a plurality of said holes, said optical input that has said essentially continuous cross-section;
and

forming an output configured to provide said electrical output.

82. (non-elected) The method of claim 81, in which the step of forming the top layer comprises limiting the top layer to a thickness of no more than 500 nm, and the step of forming the holes comprises forming the holes at least in the top layer.

83. (non-elected) The method of claim 81, further including forming an air-filled volume between the substrate and the MSPD.
84. (non-elected) The method of claim 81, further including a layer of a dielectric material that is at a surface of said substrate, over the holes and spaces between holes, and in the path of said optical input.
85. (non-elected) The method of claim 81, further including forming on or in said substrate an avalanche region under the MSPD, forming therewith an avalanche microstructured photodiode (MSAPD).
86. (non-elected) The method of claim 81, in which forming said holes comprises including the holes in said intermediate layer.
87. (non-elected) The method of claim 81, in which forming said holes comprises including said holes in said intermediate layer as well as in at least one of the first and second layers.
88. (non-elected) The method of claim 81, in which forming said holes comprises forming the holes in each of the top, bottom, and intermediate layer.
89. (non-elected) The method of claim 81, in which each of said top and bottom layers and said intermediate layer has a thickness and the forming of the holes comprises extending the holes through the entire thickness of said intermediate layer and of one of said top layer and bottom layer and through at least a part of the thickness of the other one of said top and bottom layers.

90. (non-elected) The method of claim 81, in which forming of the holes comprises forming at least some of said holes in the shape of inverted pyramids.
91. (non-elected) The method of claim 81, in which at least some of said holes have triangular sections in planes transverse to said layers.
92. (non-elected) The method of claim 81, in which forming the holes comprises forming at least some of said holes with triangular sections in planes transverse to said layers, with vertices within the intermediate layer.
93. (non-elected) The method of claim 81, in which forming said holes comprises forming at least some of said holes with sidewalls that slope in planes transverse to said layers.
94. (non-elected) The method of claim 81, in which forming said holes comprises forming at least some of said holes with sidewalls that have plural different slopes along inside walls of the holes.
95. (non-elected) The method of claim 81, in which forming said holes comprises forming at least some of said holes such that they differ from each other in at least one of (i) distance by which the holes extend in said directions, (ii) shape of the holes, and (iii) spacing of the holes from each other.
96. (non-elected) The method of claim 81, in which forming said holes comprises forming at least some of the holes in the intermediate layer and forming said top and bottom layers comprises forming at least one of the top and bottom layers to conformally cover inside walls of the holes as well as spaces between the holes.

97. (non-elected) The method of claim 81, including at least partially filling the holes with a dielectric material.
98. (non-elected) The method of claim 81, including completely filling the holes with a dielectric material.
99. (non-elected) The method of claim 81, in which forming the layers comprises forming at least one of the top layer, the bottom layer, and the intermediate layer of a material represented by $\text{Ge}_x \text{Si}_{1-x}$, where x is greater than zero.
100. (non-elected) The method of claim 81, in which forming the layers comprises forming at least one of the top layer, the bottom layer, and the intermediate layer of a material represented by $\text{Ge}_x \text{Si}_{1-x}$, where x is zero or unity or a value between zero and unity.
101. (non-elected) The method of claim 81, further comprising forming ohmic contacts configured for reverse-bias the MSPD.
102. (non-elected) The method of claim 81, further comprising forming a light guide to said MSPD for directing said optical input thereto, said light guide bending the optical input from an initial propagation direction to a propagation direction transverse to said layers.
103. (non-elected) The method of claim 81, further comprising forming one or more additional MSPD on or in said substrate for receiving respective optical inputs, and forming respective different bandpass filters for said optical inputs, thereby configuring different MSPDs on said substrate to respond to different wavelength ranges that are within said optical input.

104. (non-elected) The method of claim 81, further comprising forming one or more additional MSPDs in an array on or in said substrate, said MSPDs being configured into an optical communication structure or a light distance and ranging structure (LIDAR).
105. (non-elected) The method of claim 81, further comprising forming a laser emitter on or in said substrate.
106. (non-elected) The method of claim 81, further including forming a layer of selected material that is over a side of one of the top and bottom layers facing away from the intermediate layers and is configured to reduce sheet resistance.
107. (non-elected) The method of claim 81, further including forming a layer of selected material that is over a side of one of the first and second layers facing away from the intermediate layer and is configured to reflect light that has passed through the intermediate layer back toward the intermediate layer.
108. (non-elected) The method of claim 81, further including deliberately texturing a surface at a side of one of said top and bottom layers facing away from the intermediate layer.
109. (non-elected) The method of claim 81, further including forming a layer of micro-nano structures formed at one of said top and bottom layers, at a surface thereof facing away from the intermediate layer.
110. (non-elected) The method of claim 81, further including forming one or more distributed Bragg reflectors at one of said top and bottom layers, at a surface thereof away from the intermediate layer.

111. (non-elected) The method of claim 81, further including forming, on or in said substrate, one or more active electronic circuits configured to process the electrical output from the MSPD into a processed output, thereby forming a single-chip integrated circuit configured to receive said optical input, convert it to said electrical output, and provide said processed output.
112. (non-elected) The method of claim 81, further including hermetically sealing the MSPD with a coating integral therewith.

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Application of: Shih-Yuan WANG et al.

Application No.: 15/797,821

Filed: October 30, 2017

Confirmation No.: 1009

Examiner: Rodela, Eduardo A.

For: MICROSTRUCTURE ENHANCED ABSORPTION PHOTSENSITIVE DEVICES

This correspondence is being transmitted by facsimile transmission and/or EFS-Web to the U.S. Patent and Trademark Office.

/erin finnegan/

October 26, 2018

Date

30 Rockefeller Plaza, 20th Floor
New York, New York 10112
Tel.: (212) 278-0400

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

RESPONSE TO NON-FINAL OFFICE ACTION

Sir:

This paper responds to the Office Action mailed July 26, 2018.

Amendments to the Claims are reflected in the **Listing of Claims** beginning on page 2.

Remarks begin on page 20 of this paper.

Electronic Acknowledgement Receipt

EFS ID:	34124788
Application Number:	15797821
International Application Number:	
Confirmation Number:	1009
Title of Invention:	MICROSTRUCTURE ENHANCED ABSORPTION PHOTSENSITIVE DEVICES
First Named Inventor/Applicant Name:	Shih-Yuan WANG
Customer Number:	23432
Filer:	Ivan Kavrukov/Erin Finnegan
Filer Authorized By:	Ivan Kavrukov
Attorney Docket Number:	5176/88184-CIP
Receipt Date:	26-OCT-2018
Filing Date:	30-OCT-2017
Time Stamp:	11:24:42
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	no
------------------------	----

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Claims	Amendment_Response_2_Non Final_OA_15797821.pdf	154778 9b28347f7cbf98367a4aae14acb9dd043e23827c	no	22

Warnings:

Information:	
Total Files Size (in bytes):	154778
<p>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.</p> <p><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.</p> <p><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.</p> <p><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.</p>	

Electronic Patent Application Fee Transmittal				
Application Number:		15797821		
Filing Date:		30-Oct-2017		
Title of Invention:		MICROSTRUCTURE ENHANCED ABSORPTION PHOTOSENSITIVE DEVICES		
First Named Inventor/Applicant Name:		Shih-Yuan WANG		
Filer:		Ivan Kavrukov/Thomas Trainor		
Attorney Docket Number:		5176/88184-CIP		
Filed as Small 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	2806	1	120	120
Total in USD (\$)				120

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)	Application Number		15797821	
	Filing Date		2017-10-30	
	First Named Inventor	Shih-Yuan WANG		
	Art Unit	2893		
	Examiner Name	Eduardo A. Rodela		
	Attorney Docket Number	5176/88184-CIP		

U.S.PATENTS						
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					

If you wish to add additional U.S. Patent citation information please click the Add button.

U.S.PATENT APPLICATION PUBLICATIONS						
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.

FOREIGN PATENT DOCUMENTS								
Examiner Initial*	Cite No	Foreign Document Number ³	Country Code ^{2j}	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							☐

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.

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

Application Number	15797821
Filing Date	2017-10-30
First Named Inventor	Shih-Yuan WANG
Art Unit	2893
Examiner Name	Eduardo A. Rodela
Attorney Docket Number	5176/88184-CIP

1	Wada et al. "Very high speed GaInAs metal-semiconductor-metal photodiode incorporating an AlInAs/GaInAs graded superlattice" Appl. Phys. Lett. 54, 16 (1989). American Institute of Physics.	☐
2	Liu et al. "140-GHz metal-semiconductor-metal photodetectors on silicon-on-insulator substrate with a scaled active layer" Appl. Phys. Lett. 65, 887 (1994). American Institute of Physics.	☐
3	Zang et al. "Application of dopant segregation to metal-germanium-metal photodetectors and its dark current suppression mechanism" Appl. Phys. Lett. 92, 051110 (2008). American Institute of Physics.	☐
4	Ghanbarzadeh, et al. "Low Dark Current Amorphous SiliconMetal-Semiconductor-Metal Photodetector for Digital Imaging Applications" IEEE ELECTRON DEVICE LETTERS, VOL. 35, NO. 2, FEBRUARY 2014. pp. 234-237.	☐
5	Assefa, et al. "A 90nm CMOS Integrated Nano-Photonics Technology for 25Gbps WDM Optical Communications Applications" IEEE International Electron Devices Meeting (IEDM), postdeadline session 33.8, December 10-12, 2012.	☐
6	Anderson et al. "HPSM4 Technology & Relative Cost Analysis Update" IEEE P802.3bm TF, Phoenix, AZ, January 21-24, 2013.	☐
7	Xi et al. "Optical thin-film materials with low refractive index for broadband elimination of Fresnel reflection" Nature Photonics, VOL. 1, MARCH 2007.	☐
8	Assefa et al. "CMOS-integrated high-speed MSM germanium waveguide photodetector" 1 March 2010 / Vol. 18, No. 5 / OPTICS EXPRESS pp. 4986-4999.	☐
9	Zheng et al. "Fluidic Heterogeneous Microsystems Assembly and Packaging" Journal of Microelectromechanical Systems VOL. 15, NO. 4, AUGUST 2006, pp. 864-870.	☐
10	Xue et al. "1 X 4 Ge-on-SOI PIN Photodetector Array forParallel Optical Interconnects" JOURNAL OF LIGHTWAVE TECHNOLOGY, VOL. 27, NO. 24, DECEMBER 15, 2009, pp. 5687-5689.	☐
11	DiLello et al. "Characterization of dark current in Ge-on-Si photodiodes" JOURNAL OF APPLIED PHYSICS 112, 054506 (2012).	☐

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

Application Number	15797821
Filing Date	2017-10-30
First Named Inventor	Shih-Yuan WANG
Art Unit	2893
Examiner Name	Eduardo A. Rodela
Attorney Docket Number	5176/88184-CIP

12	Dong et al., "Suppression of dark current in germanium-tin on silicon p-i-n photodiode by a silicon surface passivation technique", Optical Society of America, 13 Jul 2015 Vol. 23, No. 14 DOI:10.1364/OE.23.018611 OPTICS EXPRESS, pp. 18611-18619.	☐
13	Koester et al., "Ge-on-SOI-Detector/Si-CMOS-Amplifier Receivers for High-Performance Optical-Communication Applications", JOURNAL OF LIGHTWAVE TECHNOLOGY, VOL. 25, NO. 1, JANUARY 2007, pp. 46-57.	☐
14	Pearson et al., "Germanium Photodetectors on Amorphous Substrates for Electronic-Photonic Integration", 2016 IEEE, pp. 20-21.	☐
15	Michel et al., "High-performance Ge-on-Si photodetectors," NATURE PHOTONICS VOL 4 AUGUST 2010, pp. 527-534.	☐
16	Knoll et al., "Monolithically Integrated 25Gbit/sec Receiver for 1.55µm in Photonic BiCMOS Technology", Optical Society of America 2014.	☐
17	XIAO et al., "A 2 Gb/s optical receiver with monolithically integrated MSM photodetector in standard CMOS process", Chinese Science Bulletin, July 2011, Vol. 56, No. 21, pp. 2281-2285.	☐
18	Nishimura et al., "A Significant Shift of Schottky Barrier Heights at Strongly Pinned Metal/Germanium Interface by Inserting an Ultra-Thin Insulating Film", The Japan Society of Applied Physics, Applied Physics Express 1 (2008), pp. 051406-1-051406-3.	☐
19	Urino et al., "Demonstration of 12.5-Gbps optical interconnects integrated with lasers, optical splitters, optical modulators and photodetectors on a single silicon substrate", Optical Society of America, 10 December 2012 / Vol. 20, No. 26 / OPTICS EXPRESS B256.	☐
20	Miura et al., "Differential receivers with highly -uniform MSM Germanium photodetectors capped by SiGe layer", Optical Society of America, 7 October 2013 Vol. 21, No. 20 DOI:10.1364/OE.21.023295 OPTICS EXPRESS 23295.	☐
21	Kang et al. "Suppression of dark current in GeOx-passivated germanium metal-semiconductor-metal photodetector by plasma post-oxidation", Optical Society of America, 29 Jun 2015 Vol. 23, No. 13 DOI:10.1364/OE.23.016967 OPTICS EXPRESS 16967.	☐
22	Dushaq et al. "Metal-germanium-metal photodetector grown on silicon using low temperature RF-PECVD", Vol. 25, No. 25 11 Dec 2017 OPTICS EXPRESS, pp. 32110-32119.	☐

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

Application Number		15797821
Filing Date		2017-10-30
First Named Inventor	Shih-Yuan WANG	
Art Unit	2893	
Examiner Name	Eduardo A. Rodela	
Attorney Docket Number	5176/88184-CIP	

23	Zang et al. "Asymmetrically contacted germanium photodiode using a metal–interlayer–semiconductor–metal structure for extremely large dark current suppression", Optical Society of America, Vol. 41, No. 16 / August 15 2016 / Optics Letters, pp. 3686-3689.	☐
24	Liu et al. "Tensile strained Ge photodetectors on Si platform for C and L band telecommunications", Appl. Phys. Lett. 87 (2005). American Institute of Physics. pp. 011110-1-011110-3.	☐
25	Chen et al. "Ultra-low capacitance and high speed germanium photodetectors on silicon", Optical Society of America, 11 May 2009 / Vol. 17, No. 10 / OPTICS EXPRESS pp. 7901-7906.	☐
26	Gao et al. "High Speed Surface Illuminated Si Photodiode Using Microstructured Holes for Absorption Enhancements at 900–1000 nm Wavelength" ACS Photonics, pages A-H, July 18, 2017.	☐
27	Zang et al., "Silicon single-photon avalanche diodes with nanostructured light trapping" NATURE COMMUNICATIONS 8: 628 (September 20 2017)	☐

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.

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant: Shih-Yuan WANG et al.

Application No.: 15/797,821

Art Unit: 2893

Filed: October 30, 2017

Examiner: Eduardo A. Rodela

For: MICROSTRUCTURE ENHANCED ABSORPTION PHOTSENSITIVE DEVICES

Confirmation No.: 1009

This correspondence is being filed electronically with the U.S. Patent and Trademark Office via EFS-Web.

/Thomas Trainor/

October 25, 2018

Thomas Trainor

Date

30 Rockefeller Plaza, 20th Floor
New York, New York 10112
Tel.: (212) 278-0400

INFORMATION DISCLOSURE STATEMENT

This Information Disclosure Statement is being filed pursuant to 37 C.F.R. §1.97(c)(2), after the mailing of a first Office Action (dated July 26, 2018), to bring to the Examiner's attention the items listed on the Form PTO-1449 attached hereto.

The Patent Office is hereby authorized to charge to Deposit Account No. 03-315 the \$120.00 fee required under 37 C.F.R. §1.17(p) for filing an Information Disclosure Statement by a small entity pursuant to 37 C.F.R. §1.97(c)(2).

No fees are believed to be required in connection with this filing. Nevertheless, the Patent Office is hereby authorized to charge any fees that are required for consideration of this Information Disclosure Statement, and to credit any overpayment during prosecution of this application, to our Deposit Account No. 03-3125.

It is respectfully requested that the information cited in the annexed Form PTO-1449 be considered by the Examiner in connection with the above-identified patent application, and that such

art be made of record in said application. The citation of the listed items is not a representation that they constitute a complete or exhaustive listing of the relevant art or that these items are prior art. The filing of this Information Disclosure Statement is not an admission that the information cited here in, or is considered to be, material to patentability as defined in 37 CFR 1.56(b).

The Patent Office is hereby authorized to charge any fees that are required for consideration of this Information Disclosure Statement, and to credit any overpayment during prosecution of this patent application, to Deposit Account No. 03-3125.

Respectfully submitted,

/Ivan Kavrukov/

Ivan Kavrukov, Reg. No. 25,161
Attorney for Applicant
COOPER & DUNHAM LLP
30 Rockefeller Plaza, 20th Floor
New York, New York 10112
Tel.: (212) 278-0400

Electronic Acknowledgement Receipt

EFS ID:	34120955
Application Number:	15797821
International Application Number:	
Confirmation Number:	1009
Title of Invention:	MICROSTRUCTURE ENHANCED ABSORPTION PHOTOSENSITIVE DEVICES
First Named Inventor/Applicant Name:	Shih-Yuan WANG
Customer Number:	23432
Filer:	Ivan Kavrukov/Thomas Trainor
Filer Authorized By:	Ivan Kavrukov
Attorney Docket Number:	5176/88184-CIP
Receipt Date:	25-OCT-2018
Filing Date:	30-OCT-2017
Time Stamp:	19:06:54
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	DA
Payment was successfully received in RAM	\$ 120
RAM confirmation Number	102618INTEFSW00009454033125
Deposit Account	
Authorized User	

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

File Listing:					
Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Transmittal Letter	5176-88184- CIP_IDS_Transmittal.pdf	68245	no	2
			90b8030cab3af3ec4894efdd096efc126c32d0a7		
Warnings:					
Information:					
2	Information Disclosure Statement (IDS) Form (SB08)	5176-88184_IDS.pdf	247218	no	4
			f0d69a037e7e507e5dda18a9648f634dc27cbf8		
Warnings:					
Information:					
This is not an USPTO supplied IDS fillable form					
3	Non Patent Literature	1_Wada.pdf	1077516	no	3
			e78eb2962c87984b0be83d6c8c17ea57c78f4745		
Warnings:					
Information:					
4	Non Patent Literature	2_Liu.pdf	1025592	no	3
			ccd439e10ef8efb51516683a2a14149d4a784052		
Warnings:					
Information:					
5	Non Patent Literature	3_Zang.pdf	2679437	no	4
			83827b2ff20d4b1d1b9de82c583d9348a849a2d9		
Warnings:					
Information:					
6	Non Patent Literature	4_Ghanbarzadeh.pdf	317849	no	3
			104bd52674bb261b3698f4c5b1985e36bd314757		
Warnings:					

Information:					
7	Non Patent Literature	5_Assefa.pdf	2055996	no	3
			7e35b37d01881ec97ceaf366273132dd4c7f7cb0		
Warnings:					
Information:					
8	Non Patent Literature	6_Anderson.pdf	3587694	no	15
			1870b560698d78ea49e8be4463c0a4a0db7a327c		
Warnings:					
Information:					
9	Non Patent Literature	7_Xi.pdf	428340	no	4
			8d12acfa6e45d0c479e0b36610ffb0d0e094d5d7		
Warnings:					
Information:					
10	Non Patent Literature	8_Assefa.pdf	5662812	no	14
			f4841efaafa8fe67c0f578728d309cbf48053340		
Warnings:					
Information:					
11	Non Patent Literature	9_Zheng.pdf	7266170	no	8
			b8d65c53efd1eefb49a58884d061a0071b622531		
Warnings:					
Information:					
12	Non Patent Literature	10_Xue.pdf	453407	no	3
			9fdc0ad04fd1a7b76b7255ed4803599b4fa125c2		
Warnings:					
Information:					
13	Non Patent Literature	11_DiLello.pdf	5718955	no	9
			64871fa982f634f808bb1839a0e59a45d5238aaf		
Warnings:					
Information:					

14	Non Patent Literature	12_Dong.pdf	1255698	no	9
			5fba2418156b89f900060b765a1e99586a460b84		
Warnings:					
Information:					
15	Non Patent Literature	13_Koester.pdf	618231	no	12
			d9e9b4b214d9041e727277cebe980cc15fd070b		
Warnings:					
Information:					
16	Non Patent Literature	14_Pearson.pdf	504514	no	2
			317f924a5750532a7219e4c79ed8afc050cabaa7		
Warnings:					
Information:					
17	Non Patent Literature	15_Michel.pdf	583416	no	8
			c04449ef76729be6e99777215e44eecb8779d85b		
Warnings:					
Information:					
18	Non Patent Literature	16_Knoll.pdf	630405	no	3
			5aaf3f0f0dde5c0e38e843d3bf0debe36f405aee		
Warnings:					
Information:					
19	Non Patent Literature	17_Xiao.pdf	1254560	no	5
			e69d63bf00f1470ffb64dd5ff7ec003b04e5403		
Warnings:					
Information:					
20	Non Patent Literature	18_Nishimura.pdf	251836	no	4
			db691093ac81094a0be73885e87be2b6b998971c		
Warnings:					
Information:					

21	Non Patent Literature	19_Urino.pdf	4141469	no	8
			de1f140d37be51de596cbc69cfc67fd114bbab9		
Warnings:					
Information:					
22	Non Patent Literature	20_Miura.pdf	6662353	no	12
			f1505fc6b1695762ae17e1eead9e3da8848bc41		
Warnings:					
Information:					
23	Non Patent Literature	21_Kang.pdf	5080592	no	10
			76966aa5a26a79b7b1939e7874595c9889a5239b		
Warnings:					
Information:					
24	Non Patent Literature	22_Dushaq.pdf	5092458	no	10
			cc4e7a5afc6e0eb308aec33d7daa643bf105ee0		
Warnings:					
Information:					
25	Non Patent Literature	23_Zang.pdf	1775300	no	4
			84f10cab17aa539ea1ab78aa0de0340b5c648161		
Warnings:					
Information:					
26	Non Patent Literature	24_Liu.pdf	2789054	no	4
			d261916f1d3ad33f3105cafc140cc5197ec7176f		
Warnings:					
Information:					
27	Non Patent Literature	25_Chen.pdf	1909218	no	6
			8b76bb32e6c18f6bd0ae649aa2b80494220b1a2d		
Warnings:					
Information:					

28	Non Patent Literature	26_Gao.pdf	6904960	no	8
			6f773f58de2bdea490d3e5dfcb42e181b8a4b8aa		
Warnings:					
Information:					
29	Non Patent Literature	27_Zang.pdf	1119252	no	6
			15307ac56e3f680a46e620c32ab23f535e109cae		
Warnings:					
Information:					
30	Fee Worksheet (SB06)	fee-info.pdf	30628	no	2
			7cd74194f7e892e6962cde180ca6dac07e909ddc		
Warnings:					
Information:					
Total Files Size (in bytes):			71193175		
<p>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.</p> <p><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.</p> <p><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.</p> <p><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.</p>					

Doc code: IDS

Doc description: Information Disclosure Statement (IDS) Filed

PTO/SB/08a (01-10)

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

U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE

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

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)	Application Number		15797821	
	Filing Date		2017-10-30	
	First Named Inventor	Shih-Yuan WANG et al.		
	Art Unit			
	Examiner Name			
	Attorney Docket Number		5176/88184-CIP	

U.S.PATENTS						
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					

If you wish to add additional U.S. Patent citation information please click the Add button.

U.S.PATENT APPLICATION PUBLICATIONS						
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.

FOREIGN PATENT DOCUMENTS								
Examiner Initial*	Cite No	Foreign Document Number ³	Country Code ²	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							☐

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

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

Application Number	15797821
Filing Date	2017-10-30
First Named Inventor	Shih-Yuan WANG et al.
Art Unit	
Examiner Name	
Attorney Docket Number	5176/88184-CIP

1	BERENSCHOT et al. "Fabrication of 3D fractal structures using nanoscale anisotropic etching of single crystalline silicon" J. Micromech. Microeng. 2013, 23,055024 (10pp).	☐
2	SATO "Basic 2 Anisotropic Wet-etching of Silicon: Characterization and Modeling of Changeable Anisotropy" http://gcoe.mech.nagoya-u.ac.jp/basic/pdf/basic-02.pdf	☐
3	SATO et al. "Anisotropic etching rates of single-crystal silicon for TMAH water solution as a function of crystallographic orientation" Sensors and Actuators, 73(1999) 131-137.	☐
4	BASSOUS "Fabrication of Novel Three Dimensional Microstructures by the Anisotropic Etching of (100) and (110) Silicon" IEEE Transactions of Electron Devices, ED-25, 10, 1978.	☐
5	ZUBEL "Anisotropic etching of silicon in solutions containing tensioactive compounds" Proc. of SPIE Vol. 10175 101750L-1.	☐
6	HSIAO et al. "Compact and passive-alignment 4-channel × 2.5- Gbps optical interconnect modules based on silicon optical benches with 45° micro-reflectors" OPTICS EXPRESS, 21 December 2009, Vol. 17, No. 26, 24250	☐
7	ROLA "Anisotropic etching of silicon in KOH + Triton X-100 for 45° micromirror applications" Microsyst Technol (2017) 23:1463–1473	☐
8	ROLA et al "Triton Surfactant as an Additive to KOH Silicon Etchant" JOURNAL OF MICROELECTROMECHANICAL SYSTEMS, VOL. 22, NO. 6, DECEMBER 2013	☐
9	IZUMI et al. "C.M.O.S. DEVICES FABRICATED ON BURIED SiO2 LAYERS FORMED BY OXYGEN IMPLANTATION INTO SILICON" ELECTRONICS LETTERS, 31st August 1978 Vol.14 No. 1	☐
10	HAUTHAN et al. "Improvement in buried silicon nitride silicon-on-insulator structures by fluorine-ion implantation" J. Appl. Phys., Vol. 83, No. 7, 1 April 1998	☐
11	JUDY "Microelectromechanical systems (MEMS): fabrication, design and applications" Smart Mater. Struct. 10 (2001) 1115–1134	☐

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

Application Number	15797821
Filing Date	2017-10-30
First Named Inventor	Shih-Yuan WANG et al.
Art Unit	
Examiner Name	
Attorney Docket Number	5176/88184-CIP

12	SMITH et al. "Embedded Micromechanical Devices for the Monolithic Integration of MEMS with CMOS" Proc. 1995 IEDM, pp. 609-612.	☐
13	GAO et al. "High Speed Surface Illuminated Si Photodiode Using Microstructured Holes for Absorption Enhancements at 900-1000 nm Wavelength" DOI: 10.1021/acsphotonics.7b00486	☐
14	FIORI et al. "Electronics based on two-dimensional materials" PUBLISHED ONLINE: 6 OCTOBER 2014 DOI: 10.1038/NNANO.2014.207	☐
15	MOLLE et al. "Buckled two-dimensional Xene sheets" PUBLISHED ONLINE: 16 JANUARY 2017 DOI: 10.1038/NMAT4802	☐
16	MAK et al. "Photonics and optoelectronics of 2D semiconductor transition metal dichalcogenides" PUBLISHED ONLINE: 31 MARCH 2016 DOI: 10.1038/NPHOTON.2015.282.	☐
17	TAKAI et al. "Single-Photon Avalanche Diode with Enhanced NIR-Sensitivity for Automotive LIDAR Systems" Sensors 2016, 16, 459; doi:10.3390/s16040459.	☐
18	CAREY K.W., et al. "Characterization of InP/GaInAs/InP heterostructures grown by organometallic vapor phase epitaxy for high-speed pin photodiode" Journal of Crystal Growth 1986.	☐
19	CHEN et al. "Optimization of InGaAs/InAlAs Avalanche Photodiodes" Nanoscale Research Letters (2017) 12:33.	☐
20	MIURA et al. "Modeling and Fabrication of Hollow Optical Waveguide for Photonic Integrated Circuits" Jpn. J. Appl. Phys. Vol. 41 (2002) pp. 4785-4789	☐
21	Germanium Electrical Properties: http://www.ioffe.ru/SVA/NSM/Semicond/Ge/electric.html	☐
22	Rylyakov et al. "A 40-Gb/s, 850-nm, VCSEL-Based Full Optical Link" 2012	☐

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

Application Number	15797821
Filing Date	2017-10-30
First Named Inventor	Shih-Yuan WANG et al.
Art Unit	
Examiner Name	
Attorney Docket Number	5176/88184-CIP

23	Kenneth et al. "A BiCMOS Process Utilizing Selective Epitaxy for Analog/Digital Applications", IEEE TRANSACTIONS ON ELECTRON DEVICES. VOL. 36. NO. 7. JULY 1989	☐
24	Litchinitser et al. "Antiresonant reflecting photonic crystal optical waveguides" OPTICS LETTERS 2002, Vol. 27, No. 18, 1592.	☐
25	Tatarczak et al. "Reach Extension and Capacity Enhancement of VCSEL-Based Transmission Over Single-Lane MMF Links" JOURNAL OF LIGHTWAVE TECHNOLOGY, VOL. 35, NO. 4, FEBRUARY 15, 2017.	☐
26	Paneva et al. "Nitrogen implanted etch-stop layers in silicon" Microelectronic Engineering 27 (1995) 509-512.	☐

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

EXAMINER SIGNATURE

Examiner Signature	/EDUARDO A. RODELA/	Date Considered	07/18/2018
--------------------	---------------------	-----------------	------------

*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.

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.

Search Notes 	Application/Control No. 15797821	Applicant(s)/Patent Under Reexamination WANG ET AL.
	Examiner EDUARDO A RODELA	Art Unit 2893

CPC- SEARCHED		
Symbol	Date	Examiner
H01L31/02002,02016,0203,0232,0237,12	7/18/2018	EAR

CPC COMBINATION SETS - SEARCHED		
Symbol	Date	Examiner

US CLASSIFICATION SEARCHED			
Class	Subclass	Date	Examiner

* 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 history for complete details	7/18/2018	EAR
Inventor's name and assignee search	7/18/2018	EAR

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

--	--



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.
15/797,821	10/30/2017	Shih-Yuan WANG	5176/88184-CIP	1009
23432 7590 07/26/2018 COOPER & DUNHAM, LLP 30 Rockefeller Plaza 20th Floor NEW YORK, NY 10112			EXAMINER RODELA, EDUARDO A	
			ART UNIT	PAPER NUMBER
			2893	
			MAIL DATE	DELIVERY MODE
			07/26/2018	PAPER

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.

Office Action Summary	Application No. 15/797,821	Applicant(s) WANG ET AL.	
	Examiner Eduardo A. Rodela	Art Unit 2893	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 4/25/2018.
☐ 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) 1-112 is/are pending in the application.
5a) Of the above claim(s) 41 and 45-112 is/are withdrawn from consideration.

6) ☐ Claim(s) _____ is/are allowed.

7) ☒ Claim(s) 1-40 and 42-44 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 10/30/2017 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)

2) ☒ Information Disclosure Statement(s) (PTO/SB/08a and/or PTO/SB/08b)
Paper No(s)/Mail Date 11/29/2017.

3) ☐ Interview Summary (PTO-413)
Paper No(s)/Mail Date. _____.

4) ☐ Other: _____.

DETAILED ACTION

This office action is in response to the communications received April 25, 2018. Claims 1-40 and 42-44 are under consideration.

Notice of Pre-AIA or AIA Status

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

Election/Restrictions

Claims 41 and 45-112 are withdrawn from further consideration pursuant to 37 CFR 1.142(b) as being drawn to a nonelected Group II and Species claims, there being no allowable generic or linking claim. Election was made **without** traverse in the reply filed on April 25, 2018

Claim Rejections - 35 USC § 112

The following is a quotation of 35 U.S.C. 112(b):

(b) CONCLUSION.—The specification shall conclude with one or more claims particularly pointing out and distinctly claiming the subject matter which the inventor or a joint inventor regards as the invention.

The following is a quotation of 35 U.S.C. 112 (pre-AIA), second paragraph:

The specification shall conclude with one or more claims particularly pointing out and distinctly claiming the subject matter which the applicant regards as his invention.

Claim 1 is rejected under 35 U.S.C. 112(b) or 35 U.S.C. 112 (pre-AIA), second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which the inventor or a joint inventor, or for pre-AIA the applicant regards as the invention. The limitation, "that in cross-section is substantially continuous spatially at least some of time" is somewhat confusing. The cross section continuity concept makes sense, however the inclusion of "some of time" does not clearly convey a concrete meaning. How does time relate to the cross sectional geometry. Examiner assumes this has something to do with implying holes in the photodetector. In that case, it is suggested that the claim language of "some of time" be removed, because it is unduly redundant, in that the holes are established later in the claim.

Claim Rejections - 35 USC § 103

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.

Claims 1-3, 9-12, 22, 24, 26, 28, 29, 32-36 and 39 are rejected under 35 U.S.C. 103 as being unpatentable over Dickinson et al. (US 7,251,386) in view of Kim et al. (US 2010/0288341) in view of Okamoto et al. (US 2010/0308428) in view of Iwai et al. (US 2009/0230498).

Regarding claim 1, Dickinson teaches in Figures 1 and 7, a single-chip device (200, “integrated photonic-electronic ... DRAM chip”, column 11, last paragraph) comprising an integrated combination of a photodetector (203) and an active electronic circuit (various other devices included on 200), both formed on or in a single substrate (chip 200) and configured to receive an optical input (fibers 206-209 allow for light signal I/O) that in cross-section is substantially continuous spatially at least some of time (holes in photodetector to be addressed in the teaching of Iwai immediately below), convert the optical input to an electrical output (columns 11 and 12 describe the conversion of the optical signals to electrical signals), and process the electrical output into a processed output (transmitter portion of 203/204, which outputs data from DRAM Cores 201/202), wherein:

the active electronic circuit on or in said single substrate is configured to process the electrical output from the photodetector by applying thereto (input through receiver cell with detector array, which converts the optical signals from the fiber at the detector array, then an electrical signal is sent to the CMOS Logic Module where processing takes place, column 5, lines 29-55):

processing other than or in addition to amplification to form said processed output from the single-chip device (column 5, lines 29-55, amplification discussed below by teaching of Iwai); and

routing to one or more selected destinations; and (either of the DRAM Cores and output)

a communication channel on or in said single-chip device, configured to deliver the electrical output from the MSPD to the active electronic circuit (circuit paths in both Figs. 1 and 7, from Detector Array to CMOS Logic Module and output).

Dickinson does not teach:

- the photodetector is a microstructure-enhanced photodetector (MSPD).

the photodetector on or in said single substrate comprises an intermediate layer, a first layer at one side of the intermediate layer, and a second layer at an opposite side of the intermediate layer, wherein:

each of the layers comprises Silicon, Germanium, or an alloy thereof;

at least one of said layers, or an overlying covering layer that may be present (it is noted that the claim language regarding the overlying layer is not a positive recitation, nor does the claim language require the presence, but merely states the overlying layer as an optional component), has holes intentionally formed therein, extending in directions transverse to the layers; each of the first and second layers comprises a doped material;

the intermediate layer comprises a material that is less doped than at least one of the first and second layers or is undoped, wherein the degree of doping is the same or different for different positions in the intermediate layer;

an input portion configured to concurrently receive at a plurality of said holes said optical input that has said substantially continuous cross-section; and

an output portion configured to provide said electrical output from the MSPD.

Kim teaches in Figures 5A-B and 12:

- the photodetector is a microstructure-enhanced photodetector (MSPD) (detector shown is enhanced by holes 51 formed in the material layers),

the photodetector (device including mesa 550, n-type layer 510, ¶ 0042, intrinsic layer 59, ¶ 0042, and p-type layer 520, ¶ 0042) on or in said single substrate (this feature as taught by Dickinson above) comprises an intermediate layer (59), a first layer (520) at one side of the intermediate layer (beneath 59), and a second layer at an opposite side of the intermediate layer (510 over 59), wherein:

at least one of said layers, or an overlying covering layer that may be present, has holes intentionally formed therein (51), extending in directions transverse to the layers

Art Unit: 2893

(vertically); each of the first and second layers comprises a doped material (510 and 520 doped oppositely paragraph 0042);

the intermediate layer comprises a material that is less doped than at least one of the first and second layers or is undoped (59 is undoped, ¶ 0042), wherein the degree of doping is the same or different for different positions in the intermediate layer (as the intermediate layer is shown to be undoped, the positions all have no doping);

an input portion configured to concurrently receive at a plurality of said holes said optical input that has said substantially continuous cross-section (top of mesa with holes in it, 1201 connecting 1203); and

an output portion configured to provide said electrical output from the MSPD (electrical output from the device, paragraph 0037, 0038, 1204 to 1202).

Therefore it would have been obvious to one of ordinary skill in the art at the time the invention was made (for Pre-AIA) or before the effective filing date of the claimed invention (for the AIA FITF practice) to have used:

- the photodetector is a microstructure-enhanced photodetector (MSPD).

the photodetector on or in said single substrate comprises an intermediate layer, a first layer at one side of the intermediate layer, and a second layer at an opposite side of the intermediate layer, wherein:

each of the layers comprises Silicon, Germanium, or an alloy thereof;

at least one of said layers, or an overlying covering layer that may be present, has holes intentionally formed therein, extending in directions transverse to the layers; each of the first and second layers comprises a doped material;

the intermediate layer comprises a material that is less doped than at least one of the first and second layers or is undoped, wherein the degree of doping is the same or different for different positions in the intermediate layer;

an input portion configured to concurrently receive at a plurality of said holes said optical input that has said substantially continuous cross-section; and

an output portion configured to provide said electrical output from the MSPD,

in the invention of Dickinson as taught by Kim, for the purpose of providing a light signal detector which can be used to convert light signals into electrical signals.

Kim does not teach:

- each of the layers comprises Silicon, Germanium, or an alloy thereof.

Okamoto et al. (US 2010/0308428) teaches in Figure 2, wherein:

- each of the layers comprises Silicon, Germanium, or an alloy thereof (paragraph 0063 describes layers 3-6 as being Si, Ge or SiGe).

Therefore it would have been obvious to one of ordinary skill in the art at the time the invention was made (for Pre-AIA) or before the effective filing date of the claimed invention (for the AIA FITF practice) to have used:

- each of the layers comprises Silicon, Germanium, or an alloy thereof,

in the invention of Dickinson as taught by Okamoto, for the purpose of utilizing industry standard materials which are less costly and function as semiconductors to allow for the detection of incoming light signals.

Dickinson does not specify:

- amplification to form said processed output from the single-chip device.

Iwai teaches the optical device is subjected to amplification and processing performed by electronic circuits, as discussed in paragraph 0010.

Therefore it would have been obvious to one of ordinary skill in the art at the time the invention was made (for Pre-AIA) or before the effective filing date of the claimed invention (for the AIA FITF practice) to have used:

- amplification to form said processed output from the single-chip device,

in the invention of Dickinson as taught by Iwai, for at least the purpose of allowing for the increase in sensitivity of the optical detectors.

Regarding claim 2, Dickinson et al. teach the single-chip device of claim 1, in which said active electronic circuit is at least partly extends beyond said substrate (fiber portions extend past the perimeter of 200).

Regarding claim 3, Dickinson et al. teach the single-chip device of claim 1, in which said active electronic circuit is at least partly inside said substrate (components of the circuit are all within the confines of the perimeter of 200, with the exception of the fibers).

Regarding claim 9, Dickinson et al. teach the single-chip device of claim 1, in which said holes are present in said intermediate layer (all of 510, 59, 520 have holes 51 formed in them).

Regarding claim 10, Dickinson et al. teach the single-chip device of claim 1, in which said holes are present in said intermediate layer as well as in at least one of the first and second layers (all of 510, 59, 520 have holes 51 formed in them).

Regarding claim 11, Dickinson et al. teach the single-chip device of claim 1, in which said holes are present in each of the first, second, and intermediate layer (all of 510, 59, 520 have holes 51 formed in them).

Regarding claim 12, Dickinson et al. teach the single-chip device of claim 1, in which each of said first and second layers and said intermediate layer has a thickness and at least some of said holes extend through the entire thickness of said intermediate layer and of one of said first layer and second layer and through at least a part of the thickness of the other one of said first and second layers (all of 510, 59, 520 have holes 51 formed in them).

Regarding claim 22, Dickinson et al. teach the single-chip device of claim 1, in which said optical input enters the MSPD through one or both of said first and second layers, and each of the first and second layers through which the optical input enters is no more than 500 nanometers thick (Kim teaches this in paragraph 0043, wherein the device region is 426 or 325 nanometers).

Regarding claim 24, Dickinson et al. teach the single-chip device of claim 1, and Okamoto teaches in paragraph 0062, in which said MSPD further comprises ohmic contacts

Art Unit: 2893

configured for reverse-biasing the MSPD. Regarding the limitation of “configured for reverse-biasing the MSPD”, it is noted that, it has been held that a recitation with respect to the manner in which a claimed apparatus is intended to be employed does not differentiate the claimed apparatus from a prior art apparatus satisfying the claimed structural limitations. *Ex Parte Masham, 2 USPQ F.2d 1647 (1987)*. Therefore since the device of Kim is structurally the same as the claimed structure, then it would be able to be used in the same fashion.

Regarding claim 26, Dickinson et al. teach the single-chip device of claim 1, further comprising a light guide to said MSPD for directing said optical input thereto, and electrical contacts from the active electronic circuit configured to carry said processed output out of the single-chip device (light guides are fibers 206-209, and electrical signals further carried out by schematically represented electrodes in Fig. 1 of lines leaving the “Detector Array 9”).

Regarding claim 28, Dickinson teaches the single-chip device of claim 1, further comprising one or more additional MSPD (microstructured cavity taught by Kim, two detectors shown in Fig. 7 of Dickinson as the optical busses which contain arrays of detectors) on or in the same substrate (on 200), and respective different optical bandpass filters coupled with at least two of the MSPDs on or in said single substrate (discussion which addresses the “demultiplexer” which splits and routes various wavelengths in multiple routing paths is carried out by selectively allowing certain wavelengths to traverse certain pathways, e.g. bandpass), whereby at least two of said MSPDs are configured to respond to different wavelength ranges that are within said

Art Unit: 2893

optical input (204/203 respond to various wavelengths incoming from 206-209 fibers, at least columns 5 and 6 discuss this topic).

Regarding claim 29, Dickinson et al. teach the single-chip device of claim 1, further comprising one or more additional MSPDs (microstructured cavity taught by Kim, two detectors shown in Fig. 7 of Dickinson as the optical busses which contain arrays of detectors) on or in said single substrate (200), one or more additional active electronic circuits (cross bar and DRAM CORES and discussed processor circuitries) on or in the said single substrate (on 200), and one or more additional communication channels configured to supply electrical outputs from the MSPDs to the one or more of the active electronic circuits (shown as arrows in Fig. 7 and as schematic wirings in Fig. 1).

Regarding claim 30, Dickinson et al. teach the single-chip device of claim 1, further comprising one or more additional active electronic circuits that are formed on or in the said single substrate (further circuitries present in addition to the optical devices on 200).

Regarding claim 32, Dickinson et al. teach the single-chip device of claim 1, further comprising one or more additional active electronic circuits (at least as shown in) that are formed on or in the said single substrate and comprise one or more of CMOS, BiCMOS, and bipolar active devices (discussed in at least, lines 1-27, col. 8).

Regarding claim 33, Dickinson et al. teach the single-chip device of claim 1, further comprising one or more additional MSPDs in an array on or in said single substrate (this limitation is addressed several times in the claims above) and one or more additional active electronic circuits also on or in said single substrate (this limitation is addressed several times in the claims above), said MSPDs and active electronic circuits being configured into an optical communication structure (optical communication structure as shown in Figs. 1 and 7, where light is input via the fibers and processed by the circuitries on 200) or a light distance and ranging (LIDAR) structure (previous option addressed).

Regarding claim 34, Dickinson et al. teach the single-chip device of claim 1, further comprising a laser emitter formed on or in said single substrate (in I/O section 203/204, lasers are present to output optical communication signals, see col. 8, lines 40-65).

Regarding claim 35, Dickinson et al. teach the single-chip device of claim 1, further including a layer of selected material that is over a side of one of the first and second layers facing away from the intermediate layer and is configured to reduce sheet resistance (Okomoto teaches in Fig. 1 and ¶ 0062, the desire for ohmic contacts, which inherently reduce sheet resistance by lowering resistance at the interface of the electrodes and the semiconductor material).

Regarding claim 36, Dickinson teaches the single-chip device of claim 1, further including a layer of selected material that is over a side of one of the first and second layers

Art Unit: 2893

facing away from the intermediate layer and is configured to reflect light that has passed through the intermediate layer back toward the intermediate layer (shows an optical device with a DBR filter (32) on the back side of the active regions and over the substrate).

Regarding claim 39, Dickinson teaches the single-chip device of claim 1, and Okamoto teaches in Fig. 9 further including one or more distributed Bragg reflectors formed at one of said first and second layers, at a surface thereof away from the intermediate layer (shows an optical device with a DBR filter (32) on the back side of the active regions and over the substrate).

Claim 5 is rejected under 35 U.S.C. 103 as being unpatentable over Dickinson et al. (US 7,251,386) in view of Kim et al. (US 2010/0288341) in view of Okamoto et al. (US 2010/0308428) in view of Iwai et al. (US 2009/0230498) in view of Kim et al. (US 9,045,418).

Regarding claim 5, Dickinson teaches the single-chip device of claim 1, however Dickinson does not specify:

- in which said MSPD comprises a III-V materials family photodiode.

Kim teaches in Figure 1 wherein the P-I-N region (145, 140, 135) are formed of III-V (see Figure 1).

Therefore it would have been obvious to one of ordinary skill in the art at the time the invention was made (for Pre-AIA) or before the effective filing date of the claimed invention (for the AIA FITF practice) to have used:

- in which said MSPD comprises a III-V materials family photodiode,

in the invention of Dickinson et al. as taught by Kim, for the purpose of using a material which performs well under high power and high frequency electronics because of its high electron mobility.

Claim 6 is rejected under 35 U.S.C. 103 as being unpatentable over Dickinson et al. (US 7,251,386) in view of Kim et al. (US 2010/0288341) in view of Okamoto et al. (US 2010/0308428) in view of Iwai et al. (US 2009/0230498) in view of Kim et al. (US 2012/0153260).

Regarding claim 6, Dickinson teaches the single-chip device of claim 1, however Dickinson does not teach:

- further including an air-filled volume between the substrate and the MSPD.

Kim teaches in Figure 20H:

- further including an air-filled volume between the substrate and the MSPD (“Air gap”).

Therefore it would have been obvious to one of ordinary skill in the art at the time the invention was made (for Pre-AIA) or before the effective filing date of the claimed invention (for the AIA FITF practice) to have used:

in the invention of Dickinson et al. as taught by Kim, for the purpose of refocusing light back to the active region.

Claim 7 is rejected under 35 U.S.C. 103 as being unpatentable over Dickinson et al. (US 7,251,386) in view of Kim et al. (US 2010/0288341) in view of Okamoto et al. (US 2010/0308428) in view of Iwai et al. (US 2009/0230498) in view of Wanger et al. (US 6,879,014).

Regarding claim 7, Dickinson teaches the single-chip device of claim 1, however Dickinson et al. do not teach:

- further including a layer of a dielectric material that covers the holes and is in the propagation path of said optical input.

Wagner teaches in Figure 9 wherein an optical device is ultimately covered in an insulating / passivating layer (801).

Therefore it would have been obvious to one of ordinary skill in the art at the time the invention was made (for Pre-AIA) or before the effective filing date of the claimed invention (for the AIA FITF practice) to have used:

- further including a layer of a dielectric material that covers the holes and is in the propagation path of said optical input,

in the invention of Dickinson as taught by Wagner, for the purpose of passivating the surface to protect the active device from external damage or environmental degradation.

Claim 8 is rejected under 35 U.S.C. 103 as being unpatentable over Dickinson et al. (US 7,251,386) in view of Kim et al. (US 2010/0288341) in view of Okamoto et al. (US 2010/0308428) in view of Iwai et al. (US 2009/0230498) in view of Tabatabaie (US 4,814,847).

Regarding claim 8, Dickinson teaches the single-chip device of claim 1, however Dickinson does not teach:

- further including an avalanche region at one side of the MSPD, forming therewith an avalanche microstructured photodiode (MSAPD).

Tabatabaie teaches on column 2, lines 18-45 teach an APD as a light sensitive device.

Therefore it would have been obvious to one of ordinary skill in the art at the time the invention was made (for Pre-AIA) or before the effective filing date of the claimed invention (for the AIA FITF practice) to have used:

- further including an avalanche region at one side of the MSPD, forming therewith an avalanche microstructured photodiode (MSAPD),

in the invention of Dickinson et al. as taught by Tabatabaie, for the purpose of using a diode which is a very sensitive to light and thus allows for a highly sensitive device which can detect minute amounts of light.

Claim 13 is rejected under 35 U.S.C. 103 as being unpatentable over Dickinson et al. (US 7,251,386) in view of Kim et al. (US 2010/0288341) in view of Okamoto et al. (US 2010/0308428) in view of Iwai et al. (US 2009/0230498) in view of Wang et al. (US 2010/0148318)

Regarding claim 13, Dickinson teaches the single-chip device of claim 1, however Dickinson et al. do not teach:

- in which at least some of said holes are shaped as inverted pyramids.

Wang teaches in Fig. 6D and 7 holes that are inverted pyramid shaped.

Therefore it would have been obvious to one of ordinary skill in the art at the time the invention was made (for Pre-AIA) or before the effective filing date of the claimed invention (for the AIA FITF practice) to have used:

- in which at least some of said holes are shaped as inverted pyramids,

in the invention of Dickinson et al. as taught by Wang, for the purpose of utilizing a shape which could improve device sensitivity by altering the shape to have more surface area presented to the normal and incoming optical signal.

Claims 14-17 are rejected under 35 U.S.C. 103 as being unpatentable over Dickinson et al. (US 7,251,386) in view of Kim et al. (US 2010/0288341) in view of Okamoto et al. (US 2010/0308428) in view of Iwai et al. (US 2009/0230498) in view of Na et al. (US 8,319,241).

Regarding claim 14, Dickinson teaches the single-chip device of claim 1, however Dickinson et al. do not teach:

- in which at least some of said holes have triangular sections in planes transverse to said layers.

Na teaches in Figures 2 and 6 wherein the undoped layer 160 and one of the doped layers 170 have holes in them, as can be seen clearly Fig. 2 and cross sectionally in Fig. 6.

Therefore it would have been obvious to one of ordinary skill in the art at the time the invention was made (for Pre-AIA) or before the effective filing date of the claimed invention (for the AIA FITF practice) to have used:

- in which at least some of said holes have triangular sections in planes transverse to said layers,

in the invention of Dickinson et al. as taught by Na, for the purpose of increasing surface area for improving sensitivity in the device of Dickinson et al.

Regarding claim 15, Dickinson teaches the single-chip device of claim 1, however Dickinson et al. do not teach:

- in which at least some of said holes have triangular sections in planes transverse to said layers, with vertices within the intermediate layer.

Na teaches in Figures 2 and 6 wherein the undoped layer 160 and one of the doped layers 170 have holes in them, as can be seen clearly Fig. 2 and cross sectionally in Fig. 6.

Therefore it would have been obvious to one of ordinary skill in the art at the time the invention was made (for Pre-AIA) or before the effective filing date of the claimed invention (for the AIA FITF practice) to have used:

- in which at least some of said holes have triangular sections in planes transverse to said layers, with vertices within the intermediate layer,

in the invention of Dickinson et al. as taught by Na, for the purpose of increasing surface area for improving sensitivity in the device of Dickinson et al.

Regarding claim 16, Dickinson teaches the single-chip device of claim 1, however Dickinson et al. do not teach:

- in which at least some of said holes have sidewalls that slope in planes transverse to said layers.

Na teaches in Figures 2 and 6 wherein the undoped layer 160 and one of the doped layers 170 have holes in them, as can be seen clearly Fig. 2 and cross sectionally in Fig. 6.

Therefore it would have been obvious to one of ordinary skill in the art at the time the invention was made (for Pre-AIA) or before the effective filing date of the claimed invention (for the AIA FITF practice) to have used:

- in which at least some of said holes have sidewalls that slope in planes transverse to said layers,

in the invention of Dickinson et al. as taught by Na, for the purpose of increasing surface area for improving sensitivity in the device of Dickinson et al.

Regarding claim 17, Dickinson teaches the single-chip device of claim 1, however Dickinson et al. do not teach:

- in which at least some of said holes have sidewalls with plural different slopes along the inside walls of the holes.

Na teaches in Figures 2 and 6 wherein the undoped layer 160 and one of the doped layers 170 have holes in them, as can be seen clearly Fig. 2 and cross sectionally in Fig. 6.

Therefore it would have been obvious to one of ordinary skill in the art at the time the invention was made (for Pre-AIA) or before the effective filing date of the claimed invention (for the AIA FITF practice) to have used:

- in which at least some of said holes have sidewalls with plural different slopes along the inside walls of the holes,

in the invention of Dickinson et al. as taught by Na, for the purpose of increasing surface area for improving sensitivity in the device of Dickinson et al.

Claims 20 and 21 are rejected under 35 U.S.C. 103 as being unpatentable over Dickinson et al. (US 7,251,386) in view of Kim et al. (US 2010/0288341) in view of Okamoto et al. (US 2010/0308428) in view of Iwai et al. (US 2009/0230498) in view of Sasahata et al. (US 2009/0225804).

Regarding claim 20, Dickinson teaches the single-chip device of claim 1, however they do not teach:

- in which the holes are at least partly filled with a dielectric material.

Sasahata teaches in Figure 1, where an optical device with holes are filled dielectric material, see paragraph 0050.

Therefore it would have been obvious to one of ordinary skill in the art at the time the invention was made (for Pre-AIA) or before the effective filing date of the claimed invention (for the AIA FITF practice) to have used:

- in which the holes are at least partly filled with a dielectric material,

Art Unit: 2893

in the invention of Dickinson et al. as taught by Sasahata, for the purpose of passivating the surfaces to prevent mechanical damage or environmental corrosion.

Regarding claim 21, Dickinson teaches the single-chip device of claim 1, however they do not teach:

- in which the holes are entirely filled with a dielectric material.

Sasahata teaches in Figure 1, where an optical device with holes are filled dielectric material, see paragraph 0050.

Therefore it would have been obvious to one of ordinary skill in the art at the time the invention was made (for Pre-AIA) or before the effective filing date of the claimed invention (for the AIA FITF practice) to have used:

- in which the holes are entirely filled with a dielectric material,

in the invention of Dickinson et al. as taught by Sasahata, for the purpose of passivating the surfaces to prevent mechanical damage or environmental corrosion.

Claim 23 is rejected under 35 U.S.C. 103 as being unpatentable over Dickinson et al. (US 7,251,386) in view of Kim et al. (US 2010/0288341) in view of Okamoto et al. (US

Art Unit: 2893

2010/0308428) in view of Iwai et al. (US 2009/0230498) in view of Shan et al. (US 2007/0277869).

Regarding claim 23, Dickinson teaches the single-chip device of claim 1, however they do not teach:

- in which at least one of the first layer, the second layer, and the intermediate layer comprises a material represented by $\text{Ge}_x\text{Si}_{1-x}$, where x is greater than zero.

Shan teaches in paragraph 0093 discusses SiGe in this manner for use as a light sensitive pn junction device.

Therefore it would have been obvious to one of ordinary skill in the art at the time the invention was made (for Pre-AIA) or before the effective filing date of the claimed invention (for the AIA FITF practice) to have used:

- in which at least one of the first layer, the second layer, and the intermediate layer comprises a material represented by $\text{Ge}_x\text{Si}_{1-x}$, where x is greater than zero,

in the invention of Dickinson as taught by Shan, for the purpose of using a material with high electron mobility which can aid in improving the sensitivity of the device.