

# PROCEEDINGS OF SPIE

## ***2D Photonic Materials and Devices II***

**Arka Majumdar**  
**Carlos M. Torres Jr.**  
**Hui Deng**  
*Editors*

**6–7 February 2019**  
**San Francisco, California, United States**

*Sponsored and Published by*  
SPIE

**Volume 10920**

Proceedings of SPIE 0277-786X, V. 10920

SPIE is an international society advancing an interdisciplinary approach to the science and application of light.

2D Photonic Materials and Devices II, edited by Arka Majumdar, Carlos M. Torres, Hui Deng, Proc. of SPIE Vol. 10920,  
1092001 · © 2019 SPIE · CCC code: 0277-786X/19/\$18 · doi: 10.1117/12.2531383

Proc. of SPIE Vol. 10920 1092001-1

The papers in this volume were part of the technical conference cited on the cover and title page. Papers were selected and subject to review by the editors and conference program committee. Some conference presentations may not be available for publication. Additional papers and presentation recordings may be available online in the SPIE Digital Library at [SPIDigitalLibrary.org](http://SPIDigitalLibrary.org).

The papers reflect the work and thoughts of the authors and are published herein as submitted. The publisher is not responsible for the validity of the information or for any outcomes resulting from reliance thereon.

Please use the following format to cite material from these proceedings:

Author(s), "Title of Paper," in *2D Photonic Materials and Devices II*, edited by Arka Majumdar, Carlos M. Torres Jr., Hui Deng, Proceedings of SPIE Vol. 10920 (SPIE, Bellingham, WA, 2019) Seven-digit Article CID Number.

ISSN: 0277-786X  
ISSN: 1996-756X (electronic)

ISBN: 9781510624825  
ISBN: 9781510624832 (electronic)

Published by

**SPIE**

P.O. Box 10, Bellingham, Washington 98227-0010 USA  
Telephone +1 360 676 3290 (Pacific Time) · Fax +1 360 647 1445

[SPIE.org](http://SPIE.org)

Copyright © 2019, Society of Photo-Optical Instrumentation Engineers.

Copying of material in this book for internal or personal use, or for the internal or personal use of specific clients, beyond the fair use provisions granted by the U.S. Copyright Law is authorized by SPIE subject to payment of copying fees. The Transactional Reporting Service base fee for this volume is \$18.00 per article (or portion thereof), which should be paid directly to the Copyright Clearance Center (CCC), 222 Rosewood Drive, Danvers, MA 01923. Payment may also be made electronically through CCC Online at [copyright.com](http://copyright.com). Other copying for republication, resale, advertising or promotion, or any form of systematic or multiple reproduction of any material in this book is prohibited except with permission in writing from the publisher. The CCC fee code is 0277-786X/19/\$18.00.

Printed in the United States of America by Curran Associates, Inc., under license from SPIE.

Publication of record for individual papers is online in the SPIE Digital Library.

**SPIE. DIGITAL  
LIBRARY**

[SPIDigitalLibrary.org](http://SPIDigitalLibrary.org)

---

**Paper Numbering:** *Proceedings of SPIE* follow an e-First publication model. A unique citation identifier (CID) number is assigned to each article at the time of publication. Utilization of CIDs allows articles to be fully citable as soon as they are published online, and connects the same identifier to all online and print versions of the publication. SPIE uses a seven-digit CID article numbering system structured as follows:

- The first five digits correspond to the SPIE volume number.
- The last two digits indicate publication order within the volume using a Base 36 numbering system employing both numerals and letters. These two-number sets start with 00, 01, 02, 03, 04, 05, 06, 07, 08, 09, 0A, 0B ... 0Z, followed by 10-1Z, 20-2Z, etc. The CID Number appears on each page of the manuscript.

# Contents

v	<i>Authors</i>
vii	<i>Conference Committee</i>

---

## ATOMICALLY THIN CLASSICAL AND QUANTUM LIGHT SOURCES

---

10920 05	<b>Developing ultrathin light emitters and metalenses based on Van der Waals materials (Invited Paper) [10920-4]</b>
----------	--

---

## 2D MATERIAL EXCITON-POLARITON

---

10920 07	<b>Manipulating valley-sensitive light-matter states in monolayer transition metal dichalcogenides (Invited Paper) [10920-6]</b>
----------	--

---

## GRAPHENE OPTOELECTRONICS

---

10920 0F	<b>Crumple nanostructuring of atomically thin 2D materials for flexible optoelectronic devices and plasmonic metamaterials [10920-14]</b>
----------	---

---

## 2D MATERIAL OPTOELECTRONICS + INTEGRATED NANOPHOTONICS I

---

10920 0I	<b>Carrier dynamics in TMDCs for optical applications [10920-17]</b>
10920 0J	<b>Low-power four-wave mixing in graphene-on-SiN micro-ring resonator [10920-18]</b>
10920 0K	<b>Enhanced four-wave mixing in hybrid integrated waveguides with graphene oxide [10920-19]</b>

---

## 2D MATERIAL OPTOELECTRONICS + INTEGRATED NANOPHOTONICS III

---

10920 0R	<b>Efficient defect healing of transition metal dichalcogenides by phthalocyanines [10920-28]</b>
----------	---

---

## POSTER SESSION

---

10920 0X	<b>CNT micro-heater on SOI micro-ring resonator [10920-34]</b>
----------	--



## Authors

Numbers in the index correspond to the last two digits of the seven-digit citation identifier (CID) article numbering system used in Proceedings of SPIE. The first five digits reflect the volume number. Base 36 numbering is employed for the last two digits and indicates the order of articles within the volume. Numbers start with 00, 01, 02, 03, 04, 05, 06, 07, 08, 09, 0A, 0B...0Z, followed by 10-1Z, 20-2Z, etc.

Ahn, H., 0R  
Chen, Yen-Jung, 07  
Chen, Yueyang, 05  
Chu, Sai T., 0K  
Clark, Genevieve, 05  
Colburn, Shane, 05  
Dash, Aneesh, 0J, 0X  
Fryett, Taylor, 05  
Hader, J., 0I  
Jia, Baohua, 0K  
Jia, Linnan, 0K  
Kang, Pilgyu, 0F  
Kim, Kyoung-Ho, 0F  
Knapp, Peter M., 0F  
Koch, S. W., 0I  
LaMountain, Trevor, 07  
Lee, G.-H., 0R  
Liang, Yao, 0K  
Little, Brent E., 0K  
Liu, Chang-Hua, 05  
Majumdar, Arka, 05  
Meckbach, L., 0I  
Mere, V., 0X  
Moloney, J. V., 0I  
Morandotti, Roberto, 0K  
Moss, David, 0K  
Naik, Akshay, 0J, 0X  
Nam, SungWoo, 0F  
Nambiar, Siddharth R., 0J, 0X  
Pandey, Mrityunjay, 0J  
Park, Hong-Gyu, 0F  
Raghavan, Srinivasan, 0J  
Selvaraja, Shankar Kumar, 0J, 0X  
Stanev, Teodor K., 07  
Stern, Nathaniel P., 07  
Stroucken, T., 0I  
Wang, Michael Cai, 0F  
Wu, Jiayang, 0K  
Xu, Xiaodong, 05  
Xu, Xingyuan, 0K  
Yang, Yunyi, 0K  
Yasasvi, G. P. R., 0X  
Zheng, Jiajiu, 05



# Conference Committee

## *Symposium Chairs*

**Connie J. Chang-Hasnain**, University of California, Berkeley  
(United States)  
**Graham T. Reed**, Optoelectronics Research Center (United Kingdom)

## *Symposium Co-chairs*

**Sailing He**, KTH Royal Institute of Technology (Sweden) and Zhejiang  
University (China)  
**Yasuhiro Koike**, Keio University (Japan)

## *Program Track Chairs*

**James G. Grote**, Photonics Consultant (United States)  
**Shibin Jiang**, AdValue Photonics, Inc. (United States)

## *Conference Chairs*

**Arka Majumdar**, University of Washington (United States)  
**Carlos M. Torres Jr.**, SPAWAR Systems Center Pacific (United States)  
**Hui Deng**, University of Michigan (United States)

## *Conference Program Committee*

**Ritesh Agarwal**, University of Pennsylvania (United States)  
**Joshua R. Hendrickson**, Air Force Research Laboratory (United States)  
**Nathaniel P. Stern**, Northwestern University (United States)  
**A. Nick Vamivakas**, University of Rochester (United States)  
**Feng Wang**, University of California, Berkeley (United States)  
**Fengnian Xia**, Yale University (United States)  
**Xiaodong Xu**, University of Washington (United States)

## *Session Chairs*

- 1 Atomically Thin Classical and Quantum Light Sources  
**Carlos M. Torres Jr.**, SPAWAR Systems Center Pacific (United States)
- 2 2D Material Exciton-Polariton  
**Arka Majumdar**, University of Washington (United States)  
**Ritesh Agarwal**, University of Pennsylvania (United States)

- 3 Graphene Optoelectronics  
**Nathaniel P. Stern**, Northwestern University (United States)
- 4 2D Material Optoelectronics + Integrated Nanophotonics I  
**Carlos M. Torres Jr.**, SPAWAR Systems Center Pacific (United States)
- 5 2D Material Optoelectronics + Integrated Nanophotonics II  
**Volker J. Sorger**, The George Washington University (United States)
- 6 2D Material Optoelectronics + Integrated Nanophotonics III  
**Hui Deng**, University of Michigan (United States)