PROCEEDINGS OF SPIE

SPIDigitalLibrary.org/conference-proceedings-of-spie

Front Matter: Volume 11303

, "Front Matter: Volume 11303," Proc. SPIE 11303, Emerging Liquid Crystal Technologies XV, 1130301 (4 March 2020); doi: 10.1117/12.2570035

SPIE.

Event: SPIE OPTO, 2020, San Francisco, California, United States

PROCEEDINGS OF SPIE

Emerging Liquid Crystal Technologies XV

Liang-Chy Chien
Dirk J. Broer
Igor Mušević
Editors

3–5 February 2020
San Francisco, California, United States

Sponsored and Published by
SPIE

Volume 11303

Proceedings of SPIE 0277-786X, V. 11303

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

Emerging Liquid Crystal Technologies XV, edited by Liang-Chy Chien, Dirk J. Broer,
Igor Mušević, Proc. of SPIE Vol. 11303, 1130301 · © 2020 SPIE
CCC code: 0277-786X/20/\$21 · doi: 10.1117/12.2570035

Proc. of SPIE Vol. 11303 1130301-1

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 SPIEDigitalLibrary.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 *Emerging Liquid Crystal Technologies XV*, edited by Liang-Chy Chien, Dirk J. Broer, Igor Muševič, Proceedings of SPIE Vol. 11303 (SPIE, Bellingham, WA, 2020) Seven-digit Article CID Number.

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

ISBN: 9781510633698
ISBN: 9781510633704 (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

Copyright © 2020, 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 \$21.00 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. 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/20/\$21.00.

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**

SPIEDigitalLibrary.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 *Authors*
vii *Conference Committee*

SESSION 1 LIQUID CRYSTAL LENSES AND MICROLENS ARRAYS

11303 04 **Modeling liquid crystal lenses (Invited Paper)** [11303-3]

SESSION 2 PHASE AND SPATIAL LIGHT MODULATORS

11303 08 **Finite element method for 3D optical modeling of liquid crystal on silicon spatial light modulator** [11303-7]

11303 0B **Controlling light with hyperbolic metamaterial director profiles** [11303-10]

SESSION 3 POLYMER AND LIQUID CRYSTAL COMPOSITES

11303 0C **Simple-structure thermoresponsive PNLCs for smart windows (Invited Paper)** [11303-11]

SESSION 4 PHOTO-PATTERNING AND PHOTOALIGNMENT

11303 0F **Shaping and positioning of topological defects in nematic liquid crystal cells equipped with patterned electrodes (Invited Paper)** [11303-14]

11303 0I **Novel photo-vertical alignment materials for low pre-tilt angle and low temperature cure process application** [11303-17]

11303 0J **Bistable liquid crystal phase grating device for smart window and window display applications (Invited Paper)** [11303-18]

SESSION 5 LASERS, FILTERS, AND OTHER OPTICAL COMPONENTS

11303 0K **Electric field tuning of ferroelectric liquid crystal microlaser (Invited Paper)** [11303-19]

11303 0L **Influence of liquid crystal molecular stacking structure on in-plane, out-of-plane retardation switching (Invited Paper)** [11303-20]

- 11303 OM **Improved terahertz phase sensing by using liquid crystal phase shifter (Invited Paper)**
[11303-21]
- 11303 ON **Advanced antenna design using radio frequency liquid crystals and LCD manufacturing (Invited Paper)** [11303-22]

SESSION 6 DIFFRACTIVE, LIGHT-FIELD, CHIRAL, AND HOLOGRAPHIC OPTICAL ELEMENTS

- 11303 OO **Near zero laser speckle liquid crystal device (Invited Paper)** [11303-23]
- 11303 OS **Tunable liquid crystal beam steering device based on Pancharatnam phase** [11303-27]

POSTER SESSION

- 11303 OV **All-optical cryptography through metasurface based on phase changeable nanoantenna**
[11303-30]
- 11303 OW **Mechano-thermo-chromic device with supersaturated salt hydrate crystal for next-generation smart window applications** [11303-31]
- 11303 OX **Fabrication of self-assembled nanoparticle cluster array using the surface affinity difference of isotropic droplets in nematic medium** [11303-32]
- 11303 12 **Enhanced flexoelectric anisotropy of nematic liquid crystal with hydrogen bonded dimer**
[11303-37]

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.

Abélard, Clément, 08	Sova, O., 04
Bos, Philip J., 0S	Stevenson, Ryan, 0N
Chang, Kai-Han, 0O	Sugiyama, Fumitaka, 0I
Chen, Bo-Yao, 0F	Sullivan, Philip, 0N
Chen, Po-Ju, 08	Sung, Jangwoon, 0V
Chien, Liang-Chy, 0O	Tokuhisa, Hiroaki, 0I
Cho, Hyunmin, 0W	Tsung, Jieh-Wen, 0F
Choi, Chulsoo, 0V	Urbach, H. Paul, 08
Choi, Tae-Hoon, 0J	Van Rynbach, Andre, 0S
Do, Su-Min, 0J	Wang, Ya-Zi, 0F
Engel, Philip, 08	Wang, Yu-Jen, 04
Ha, Inho, 0W	Woo, Jae-Hyeon, 0J
Harden, John, 0O	Yoon, Tae-Hoon, 0J
Hong, Sukjoon, 0W	Yousefzadeh, Comrun, 0S
Honma, Michinori, 0M	
Huh, Jae-Won, 0J	
Ito, Ryota, 0M	
Jeong, Kwang-Un, 12	
Kakiuchida, Hiroshi, 0C	
Kim, Jin-Hun, 0J	
Kim, Jongyoon, 12	
Ko, Seung Hwan, 0W	
Koo, Jahyeon, 12	
Kwon, Jinhyeong, 0W	
Lee, Byoungcho, 0V	
Lee, Habeom, 0W	
Lee, Ji-Hoon, 12	
Lee, Jun-Seo, 0X	
Lin, Yi-Hsin, 04	
Mazur, Adam, 08	
Miyachi, Koichi, 0I	
Mochizuki, Akihiro, 0L	
Mun, Sang-Eun, 0V	
Mušević, Igor, 0K	
Nikkhou, Maryam, 0K	
Nose, Toshiaki, 0M	
Ogiwara, Akifumi, 0C	
Okada, Takashi, 0I	
Park, Jimin, 12	
Petrovich Panov, Vitaly, 0X	
Pusovnik, Anja, 0B	
Ramarao, Pratibha, 0K	
Ravnik, Miha, 0B	
Reshetnyak, V. Yu., 04	
Ryzhkova, Anna V., 0K	
Sazegar, Mohsen, 0N	
Seder, Thomas, 0O	
Seo, Jeong-Ho, 0J	
Song, Jang-Kun, 0X	

Conference Committee

Symposium Chairs

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

Symposium Co-chairs

Connie J. Chang-Hasnaian, University of California, Berkeley (United States)
Graham T. Reed, Optoelectronics Research Centre, University of Southampton (United Kingdom)

Program Track Chair

Liang-Chy Chien, Kent State University (United States)

Conference Chairs

Liang-Chy Chien, Kent State University (United States)
Dirk J. Broer, Technische Universiteit Eindhoven (Netherlands)

Conference Co-Chair

Igor Muševič, Jožef Stefan Institute (Slovenia)

Conference Program Committee

Etienne Brasselet, Université de Bordeaux (France)
Cheng-Huan Chen, National Chiao Tung University (Taiwan)
Vladimir G. Chigrinov, Foshan University (China)
Michael J. Escuti, North Carolina State University (United States)
Antônio M. Figueiredo Neto, Universidade de São Paulo (Brazil)
Jun-ichi Fukuda, Kyushu University (Japan)
Tigran Galstian, Centre d'optique, photonique et laser (Canada)
Linda S. Hirst, University of California, Merced (United States)
Hirotsugu Kikuchi, Kyushu University (Japan)
Heinz S. Kitzerow, Universität Paderborn (Germany)
Jan P. F. Lagerwall, Université du Luxembourg (Luxembourg)
Byoung-ho Lee, Seoul National University (Korea, Republic of)
Chia-Rong Lee, National Cheng Kung University (Taiwan)
Yi-Hsin Lin, National Chiao Tung University (Taiwan)
Akihiro Mochizuki, i-CORE Technology, LLC (United States)

Kristiaan Neyts, Universiteit Gent (Belgium)
Toshiaki Nose, Akita Prefectural University (Japan)
Masanori Ozaki, Osaka University (Japan)
Miha Ravnik, University of Ljubljana (Slovenia)
Ivan I. Smalyukh, University of Colorado Boulder (United States)
Nelson V. Tabiryan, BEAM Engineering for Advanced Measurements
 Company (United States)
Timothy J. White, University of Colorado Boulder (United States)
Michael Wittek, Merck KGaA (Germany)
Shin-Tson Wu, CREOL, The College of Optics and Photonics, University
 of Central Florida (United States)
Jun Yamamoto, Kyoto University (Japan)
Tae-Hoon Yoon, Pusan National University (Korea, Republic of)

Session Chairs

- 1 Liquid Crystal Lenses and Microlens Arrays
Yi-Hsin Lin, National Chiao Tung University (Taiwan)
- 2 Phase and Spatial Light Modulators
Chia-Rong Lee, National Cheng Kung University (Taiwan)
- 3 Polymer and Liquid Crystal Composites
Tae-Hoon Yoon, Pusan National University (Korea, Republic of)
- 4 Photo-Patterning and Photoalignment
Akihiro Mochizuki, i-CORE Technology, LLC (United States)
- 5 Lasers, Filters, and Other Optical Components
Tigran Galstian, Centre d'optique, photonique et laser (Canada)
- 6 Diffractive, Light-Field, Chiral, and Holographic Optical Elements
Liang-Chy Chien, Kent State University (United States)