

PROCEEDINGS OF SPIE

Emerging Liquid Crystal Technologies VIII

**Liang-Chy Chien
Dick J. Broer
Vladimir Chigrinov
Tae-Hoon Yoon**
Editors

**5–6 February 2013
San Francisco, California, United States**

Sponsored and Published by
SPIE

Volume 8642

Proceedings of SPIE 0277-786X, V.8642

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

Emerging Liquid Crystal Technologies VIII, edited by Liang-Chy Chien, Dick J. Broer, Vladimir Chigrinov, Tae-Hoon Yoon,
Proc. of SPIE Vol. 8642, 864201 · © 2013 SPIE · CCC code: 0277-786X/13/\$18 · doi: 10.1117/12.2022291

Proc. of SPIE Vol. 8642 864201-1

The papers included 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. The papers published in these proceedings 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 this book:

Author(s), "Title of Paper," in *Emerging Liquid Crystal Technologies VIII*, edited by Liang-Chy Chien, Dick J. Broer, Vladimir Chigrinov, Tae-Hoon Yoon, Proceedings of SPIE Vol. 8642 (SPIE, Bellingham, WA, 2013) Article CID Number.

ISSN: 0277-786X

ISBN: 9780819494115

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 © 2013, 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. 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/13/\$18.00.

Printed in the United States of America.

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



SPIDigitalLibrary.org

Paper Numbering: Proceedings of SPIE follow an e-First publication model, with papers published first online and then in print and on CD-ROM. Papers are published as they are submitted and meet publication criteria. A unique, consistent, permanent citation identifier (CID) number is assigned to each article at the time of the first 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, print, and electronic versions of the publication. SPIE uses a six-digit CID article numbering system in which:

- The first four 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. The complete citation is used on the first page, and an abbreviated version on subsequent pages. Numbers in the index correspond to the last two digits of the six-digit CID Number.

Contents

vii	<i>Conference Committee</i>
ix	<i>Introduction</i>
x	<i>Group IV photonics for the mid infrared (Plenary Paper) [8629-1]</i> <i>R. Soref, The Univ. of Massachusetts at Boston (United States)</i>
xxv	<i>Light in a twist: optical angular momentum (Plenary Paper) [8637-2]</i> <i>M. J. Padgett, Univ. of Glasgow (United Kingdom)</i>

SESSION 1 NEW MATERIALS AND EFFECTS

8642 03	Investigation of the interaction of alkali ions with surfactant head groups for the formation of lyotropic biaxial nematic phase via optical birefringence measurements (Invited Paper) [8642-1] E. Akpınar, Abant İzzet Baysal Üniv. (Turkey); D. Reis, A. M. Figueiredo Neto, Univ. de São Paulo (Brazil)
8642 04	Engineered complex molecular order in liquid crystals towards unusual optics and responsive mechanics (Invited Paper) [8642-3] C. Sánchez-Somolinos, CSIC-Univ. de Zaragoza (Spain); L. T. de Haan, A. P.H. J. Schenning, Eindhoven Univ. of Technology (Netherlands); C. W. M. Bastiaansen, Eindhoven Univ. of Technology (Netherlands) and Queen Mary Univ. of London (United Kingdom); D. J. Broer, Eindhoven Univ. of Technology (Netherlands)

SESSION 2 TUNABLE FILTERS

8642 05	Advanced finite-element methods for design and analysis of nanooptical structures: applications (Invited Paper) [8642-4] S. Burger, JCMwave GmbH (Germany) and Zuse Institute Berlin (Germany); L. Zschiedrich, J. Pomplun, JCMwave GmbH (Germany); M. Blome, Zuse Institute Berlin (Germany); F. Schmidt, JCMwave GmbH (Germany) and Zuse Institute Berlin (Germany)
8642 06	High-frequency performance extending to millimeter-waves in inverted-microstrip-line-type LC phase shifter (Invited Paper) [8642-5] T. Nose, Y. Ito, T. Iisaka, Akita Prefectural Univ. (Japan); L.-C. Chien, O. Catanescu, A. Golvin, Kent State Univ. (United States); Y. Isota, T. Sasamori, R. Ito, M. Honma, Akita Prefectural Univ. (Japan)
8642 07	Submillisecond-response IR spatial light modulators with polymer network liquid crystal [8642-6] J. Sun, Y. Chen, S.-T. Wu, CREOL, Univ. of Central Florida (United States)

SESSION 3 LASERS, LASING, AND LENS

- 8642 09 **Liquid crystal lasers: recent advances (Invited Paper)** [8642-8]
J. Schmidtke, L. Lu, H.-S. Kitzerow, Univ. of Paderborn (Germany); E. M. Terentjev, Univ. of Cambridge (United Kingdom)
- 8642 0A **Liquid crystals under high-power nanosecond laser irradiation (Invited Paper)** [8642-9]
S. G. Lukishova, Univ. of Rochester (United States)
- 8642 0C **Electrically-tunable liquid crystal lenses and applications (Invited Paper)** [8642-11]
Y.-H. Lin, H.-S. Chen, M.-S. Chen, National Chiao Tung Univ. (Taiwan)
- 8642 0D **Multi-domain vertical alignment of nematic liquid crystals for reduced off-axis gamma shift (Invited Paper)** [8642-12]
T.-H. Yoon, B. W. Park, K.-H. Kim, Pusan National Univ. (Korea, Republic of); H. Kim, K.-C. Shin, H. S. Kim, Samsung Display Co. Ltd. (Korea, Republic of)

SESSION 4 WAVEGUIDES, GRATINGS, AND BEAM STEERING DEVICES

- 8642 0E **Resonant transfer of light from a planar waveguide into a tunable nematic liquid crystal microcavity (Invited Paper)** [8642-13]
V. S. R. Jampani, M. Humar, J. Stefan Institute (Slovenia); I. Muševič, J. Stefan Institute (Slovenia) and Univ. of Ljubljana (Slovenia)
- 8642 0F **Bichromatic optical switch of diffractive light from a BCT photonic crystal based on an azo component-doped HPDLC (Invited Paper)** [8642-14]
M. S. Li, A. Y.-G. Fuh, J.-H. Liu, S.-T. Wu, National Cheng Kung Univ. (Taiwan)
- 8642 0G **Fabrication of liquid crystal gratings based on photoalignment technology (Invited Paper)** [8642-15]
Y. Lu, W. Hu, Nanjing Univ. (China); A. Srivastava, V. G. Chigrinov, Hong Kong Univ. of Science and Technology (Hong Kong, China)
- 8642 0H **θ -2 θ diffractometry of anisotropic holographic gratings composed of liquid crystal and polymer phases** [8642-16]
H. Kakiuchida, M. Tazawa, K. Yoshimura, National Institute of Advanced Industrial Science and Technology (Japan); A. Ogiwara, Kobe City College of Technology (Japan)
- 8642 0I **Beam shaping to improve holography techniques based on spatial light modulators** [8642-17]
A. Laskin, V. Laskin, AdlOptica GmbH (Germany)

SESSION 5 NANOPHOTONICS, PLASMONICS AND METAMATERIALS

- 8642 0J **Liquid crystal plasmonic metamaterials (Invited Paper)** [8642-18]
T. Scharf, J. Dintinger, Ecole Polytechnique Fédérale de Lausanne (Switzerland); B.-J. Tang, G. H. Mehl, The Univ. of Hull (United Kingdom); X. Zeng, G. Ungar, S. Mühlig, T. Kienzler, C. Rockstuhl, The Univ. of Sheffield (United Kingdom)

8642 OK **Terahertz waves and liquid crystals: prospects and challenges (Invited Paper)** [8642-19]
N. Vieweg, A. Deninger, TOPTICA Photonics AG (Germany)

8642 OL **Optically switchable second harmonic generation in a liquid crystal thin film within femtoliter volume** [8642-20]
K.-C. Chen, G.-Y. Zhuo, S.-W. Chu, National Taiwan Univ. (Taiwan)

SESSION 6 PHOTOALIGNMENT AND EMERGING APPLICATIONS

8642 OM **Optical properties of NTN-FSC-LCD and ECB cells with the doping of nanoparticles (Invited Paper)** [8642-27]
S. Kobayashi, Y. Shiraishi, H. Sawai, N. Toshima, Tokyo Univ. of Science (Japan); H. Takatsu, K. Kotani, DIC Corp. (Japan)

8642 OO **Fast switching of a nematic liquid crystal cell with neither alignment materials nor alignment process** [8642-35]
J.-W. Kim, D. H. Song, K.-H. Kim, T.-H. Yoon, Pusan National Univ. (Korea, Republic of)

8642 OP **Liquid crystal based biosensors for bile acid detection** [8642-24]
S. He, CREOL, Univ. of Central Florida (United States); W. Liang, C. Tanner, J. Fang, Univ. of Central Florida (United States); S.-T. Wu, CREOL, Univ. of Central Florida (United States)

SESSION 7 EMERGING ELECTRO-OPTICAL MATERIALS AND DEVICES

8642 OS **Liquid crystals for microwave applications (Invited Paper)** [8642-36]
A. Manabe, Merck KGaA (Germany)

8642 OT **Resonance in quantum dot fluorescence on a band-edge of a 1-D photonic bandgap cholesteric structure under cw-laser excitation** [8642-37]
S. G. Lukishova, J. M. Winkler, Univ. of Rochester (United States); L. J. Bissell, Air Force Research Lab. (United States); C. R. Stroud Jr., Univ. of Rochester (United States)

POSTER SESSION

8642 OW **Colloids mediated liquid crystal blue phases** [8642-32]
M. Wang, E. Rhinehalt, E. Kemiklioglu, J.-Y. Hwang, L.-C. Chien, Kent State Univ. (United States)

Author Index

Conference Committee

Symposium Chair

David L. Andrews, University of East Anglia Norwich (United Kingdom)

Symposium Cochairs

Alexei L. Glebov, OptiGrate Corporation (United States)

Klaus P. Streubel, OSRAM GmbH (Germany)

Program Track Chair

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

Conference Chair

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

Conference CoChairs

Dick J. Broer, Technische University Eindhoven (Netherlands)

Vladimir Chigrinov, Hong Kong University of Science and Technology
(Hong Kong, China)

Tae-Hoon Yoon, Pusan National University (Korea, Republic of)

Conference Program Committee

Harry J. Coles, University of Cambridge (United Kingdom)

Gregory Philip Crawford, University of Notre Dame (United States)

Andy Y. Fuh, National Cheng Kung University (Taiwan)

Wolfgang Haase, Technische Universität Darmstadt (Germany)

Jun-ichi Hanna, Tokyo Institute of Technology (Japan)

Hirotsugu Kikuchi, Kyushu University (Japan)

Heinz S. Kitzerow, Universität Paderborn (Germany)

Shunsuke Kobayashi, Tokyo University of Science (Japan)

Seung Hee Lee, Chonbuk National University (Korea, Republic of)

Antonio Martins Figueiredo Neto, Universidade de São Paulo (Brazil)

Kristiaan Neyts, Universiteit Gent (Belgium)

Masanori Ozaki, Osaka University (Japan)

Ci-Ling Pan, National Tsing Hua University (Taiwan)

Ryo Sakurai, Bridgestone Corporation (Japan)

Ivan Smalyukh, University of Colorado at Boulder (United States)

Richard L. Sutherland, Mount Vernon Nazarene University (United States)

Ming Hsien Wu, Hamamatsu Corporation (United States)

Shin-Tson Wu, CREOL, The College of Optics and Photonics, University of Central Florida (United States)
Hiroshi Yokoyama, Kent State University (United States)

Session Chairs

- 1 New Materials and Effects
Liang-Chy Chien, Kent State University (United States)
- 2 Tunable Filters
Timothy J. Bunning, Air Force Research Laboratory (United States)
- 3 Lasers, Lasing, and Lens
Antonio Martins Figueiredo Neto, Universidade de São Paulo (Brazil)
Andy Y. Fuh, National Cheng Kung University (Taiwan)
- 4 Waveguides, Gratings, and Beam Steering Devices
Shin-Tson Wu, CREOL, The College of Optics and Photonics, University of Central Florida (United States)
- 5 Nanophotonics, Plasmonics and Metamaterials
Masanori Ozaki, Osaka University (Japan)
- 6 Photoalignment and Emerging Applications
Liang-Chy Chien, Kent State University (United States)
- 7 Emerging Electro-Optical Materials and Devices
Dick J. Broer, Technische Universiteit Eindhoven (Netherlands)

Introduction

The 2013 SPIE Photonics West conference “Emerging Liquid Crystal Technologies VIII” successfully drew a large and enthusiastic audience who are interested in emerging liquid crystal materials, devices, and applications. The scope of two-day meeting took the form of a summit, bringing together prominent scientists as well as students and postdoctoral fellows. It was held in conjunction with the Exhibition, Career Workshop, and Outreach Day for Start-up business events. The main goal of the conference was to enable the researchers working at the forefront of materials science, optics, photonics, and engineering to discuss the current state and to explore promising future optic and photonic applications of liquid crystals. Strong contributions from conference co-chairs and program committee members were very important for the success of the conference.

The scientific sessions showcased the achievements in the research frontiers of liquid crystal science and technology. There was a keynote speech given by Prof. Shin-Tson Wu (CREOL, University of Central Florida), 10 Invited lectures, and the rest where oral contributed talks. The research topics discussed the most intensively were non-mechanical beam steering devices, tunable photonic crystals, spatial light modulators, emerging display technologies, and switching elements in optical telecommunication networks and sensors. There was a great deal of interest in the liquid crystals composed of or doped with nano-sized particles which are important for emerging new applications. Students participated at both the oral and poster sessions also drew large attendance and heavy traffic.

We look forward to hosting the next successful conference in this series, “Emerging Liquid Crystal Technologies IX,” in 2014.

Liang-Chy Chien