

PROCEEDINGS OF SPIE

Practical Holography XXXIII: Displays, Materials, and Applications

**Hans I. Bjelkhagen
V. Michael Bove Jr.**
Editors

**4–5 February 2019
San Francisco, California, United States**

Sponsored and Published by
SPIE

Volume 10944

Proceedings of SPIE 0277-786X, V. 10944

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

Practical Holography XXXIII: Displays, Materials, and Applications, edited by Hans I. Bjelkhagen,
V. Michael Bove, Proc. of SPIE Vol. 10944, 1094401 · © 2019 SPIE
CCC code: 0277-786X/19/\$18 · doi: 10.1117/12.2531382

Proc. of SPIE Vol. 10944 1094401-1

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.

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 *Practical Holography XXXIII: Displays, Materials, and Applications*, edited by Hans I. Bjelkhagen, V. Michael Bove Jr., Proceedings of SPIE Vol. 10944 (SPIE, Bellingham, WA, 2019) Seven-digit Article CID Number.

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

ISBN: 9781510625303
ISBN: 9781510625310 (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 © 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. 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

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

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

SESSION 1 MATERIALS AND PROCESSES I

10944 02	Integration of volume holographic optical elements (vHOE) made with Bayfol® HX into plastic optical parts [10944-1]
10944 03	Azo-polymers for holographic recording: photo-assisted holography and surface relief gratings [10944-2]
10944 05	High efficiency diffractive optical element design and fabrication in a two-stage photopolymer [10944-4]

SESSION 2 MATERIALS AND PROCESSES II

10944 08	Lasers for holographic applications: important performance parameters and relevant laser technologies [10944-7]
10944 09	Study of the behavior of diffraction gratings with twin grooves [10944-8]
10944 0A	Complex amplitude modulation metasurface with dual resonance in transmission mode [10944-9]

SESSION 3 ART AND PERCEPTION

10944 0C	A comparative analysis of virtual-reality art-making software for the production of VR digital holograms [10944-11]
10944 0D	A holographic representation of three-dimensional J_9 space [10944-12]
10944 0E	Design and implementation of a full-color holographic thaumatrope [10944-13]

SESSION 4 APPLICATIONS

10944 0F	Manufacturable transparent holographic components for HUD applications [10944-14]
----------	--

- 10944 OG **Compact augmented-reality glasses using holographic optical element combiner** [10944-15]
- 10944 OH **Improving head-up display with waveguides and holographic optical elements** [10944-16]
- 10944 OI **Proper autofocus for better particle measurements** [10944-17]
- 10944 OJ **Three-dimensional particle localization with common-path digital holographic microscopy** [10944-18]
- 10944 OL **Digital holographic camera for plankton monitoring** [10944-20]

SESSION 5 DIGITAL HOLOGRAPHY I

- 10944 OM **Holographic stereogram printing based on digitally computed content generation platform** [10944-21]
- 10944 ON **Multiplexed pixelated hologram recording process for retinal projection device** [10944-22]
- 10944 OO **Expressible-depth control method in digital holographic display** [10944-23]
- 10944 OQ **Algorithm for phase-displacement conversion from reflection digital holographic interferometry** [10944-25]
- 10944 OR **Effect of point pitch on speckle noise in computer-generated hologram using point-based method** [10944-26]

SESSION 6 DIGITAL HOLOGRAPHY II

- 10944 OT **Quasi noise-free reconstruction of long-wavelength digital holograms** [10944-28]
- 10944 OU **Kilohertz dynamic Fourier filter for synthetic-aperture binary hologram reconstruction** [10944-29]
- 10944 OV **Experimental characterization of leaky-mode spatial light modulators fabricated via direct laser writing** [10944-30]
- 10944 OW **Simulating the effects of statistical characteristics of random phases on speckle noise in computer-generated hologram** [10944-31]

POSTER SESSION

- 10944 OX **Holographic camera for non-contact measurement of nanoscale surface heights** [10944-32]

- 10944 0Y **Study of holographic gratings of ammonium dichromate varying the hydrolysis concentration of the PVA (poly (vinyl alcohol))** [10944-33]
- 10944 0Z **Holographic gratings recorded with pineapple juice and artificial dye** [10944-34]
- 10944 10 **Fourier holograms in grenetina doped with potassium dichromate** [10944-35]
- 10944 11 **Three-dimensional wavefronts implementation** [10944-36]
- 10944 12 **3D image encryption based on computer-generated hologram in the fractional Fourier domain** [10944-37]
- 10944 13 **Near-eye holographic display device by simple optical system using HOE** [10944-38]
- 10944 14 **Wide axial dynamic range digital holography using multicascade-linked synthetic wavelengths and optical wavelength** [10944-39]
- 10944 15 **Nopal adhesive with natural pigment films for holographic recording** [10944-40]
- 10944 16 **Image quality enhancement for digital holographic display using multiple wavefront recording planes method** [10944-41]

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.

Abraham, E., 14
Ahn, Sunggyun, 00
Alim, Marvin D., 05
Ambrosio-González, Mario A., 0Z
Amos, Vivian, 0D
Bablumyan, Arkady, 0H
Baselt, T., 0U
Bianco, Vittorio, 0T
Bigler, Colton M., 0H
Blanche, Pierre-Alexandre, 0H
Bolotova, Anastasiia, 0G
Bougáid, Y., 03
Bove Jr., V. Michael, 0V
Bruder, Friedrich-Karl, 02
Cao, Liangcai, 0A
Carson, Jeffrey J. L., 0Q, 0X
Chung, Jae-Seung, 0G
Coe-Sullivan, Seth, 0F
Conde-Cuatzo, María G., 0Y, 0Z
Dashdavaa, Erkhembaatar, 0M, 16
Datta, Bianca, 0V
Davydova, A. Yu., 0L
Dimov, Fedor, 0F
Diop, Mamadou, 0Q, 0X
Draper, Craig, 0H
Druzhin, Vladislav, 0G
Dubynin, Sergey, 0G
Dyomin, V. V., 0L
Elgcróna, Gunnar, 08
Ferraro, Pietro, 0T
Finizio, Andrea, 0T
Fuentes-Tapia, Israel, 09, 0Y, 0Z
Furuta, Kazuya, 13
Gentet, Philippe, 0E
Gentet, Yves, 0E
Gerhardt, Nils C., 0J
Glugla, David J., 05
Göring, Lena, 0J
Hahn, Joonku, 00
Halim, M., 03
Hansen, Sven, 02
Hartmann, P., 0U
He, Zehao, 0A
Hens, Korbinian, 08
Hergert, John E., 05
Hofmann, Martin R., 0J
Horimai, Hideyoshi, 13
Ibarra-Torres, Juan Carlos, 10
Ibrahim, D. G. A., 14
Iwata, T., 14
Jadav, Prashant, 0D
Jeon, Seok-Hee, 0M
Jeong, Jong-Rea, 16
Jiang, Qiang, 0A
Jin, Guofan, 0A
Jolly, Sundeeep, 0V
Joung, Jinbeom, 0E
Kabardiadi-Virkovski, A., 0U
Kasezawa, Toshihiro, 13
Kawahito, Y., 14
Khuderchuluun, Anar, 0M, 16
Kim, Mugeon, 0O
Kim, Nam, 0M, 12, 16
Kim, Sunil, 0G
Kim, Yun-Tae, 0G
Kiss, M. Zs., 0I
Kleinschmidt, Tim, 02
Kopenkin, Sergey, 0G
Künzel, Roland, 02
Lee, Chang-Kun, 0G
Lee, Hong-Seok, 0G
Lee, Seung-Hyun, 0E
Lee, Yann, 0N
Lewis, Jonathan, 08
Lim, Sungjin, 0O
Lim, Young-Tae, 0M
Mahfoud, T., 03
Malinina, Polina, 0G
Manecke, Christel, 02
Mann, Micah S., 0H
Martinez, Christophe, 0N
McLeod, Robert R., 05
Mejias-Brísuela, Nidia Yamilet, 09
Memmolo, Pasquale, 0T
Meynard, Basile, 0N
Minamikawa, T., 14
Minoshima, K., 14
Mitobe, Masaya, 0R, 0W
Mizuno, T., 14
Mizutani, Y., 14
Montaño-Flores, Beatriz, 10
Moujdi, S., 03
Nelsen, B., 0U
Nesterenko, D., 03
Neutsch, Krisztian, 0J
Oe, R., 14
Ogawa, T., 14
Olivares-Pérez, Arturo, 09, 0Y, 0Z, 10, 11, 15

Olshukov, A. S., 0L
Omidi, Parsa, 0Q, 0X
Orselli, Enrico, 02
Ortiz-Gutiérrez, Mauricio, 09, 10
Padilla-Velasco, A. L., 15
Padiyar, Joy, 0F
Parthiban, Vik, 0V
Paturzo, Melania, 0T
Pérez-Cortés, Mario, 10
Piao, Mei-Lan, 12
Piao, Yan-Ling, 12, 16
Pioaru, Ioana, 0C
Polovtsev, I. G., 0L
Putilin, Andrey, 0G
Rahmouni, A., 03
Rewitz, Christian, 02
Richardson, Martin, 0D
Ricks, Allen, 08
Rölle, Thomas, 02
Russo, Juan M., 0F
Sakamoto, Yuji, 0R, 0W, 13
Salgado-Verduzco, Marco Antonio, 10
Sanchez, Martin, 0F
Sekkat, Z., 03
Seo, Juwon, 0G
Seo, Wontaek, 0G
Sherliker, Ben, 08
Shibuya, K., 14
Shin, Bongsu, 0G
Smalley, Daniel, 0V
Sperling, Jaroslaw, 08
Stokes, David Taliesin, 0C
Sullivan, Amy C., 05
Sung, Geeyoung, 0G
Tamagawa, Kohei, 0W
Taudt, Ch., 0U
Toxqui-López, Santa, 09, 0Y, 0Z, 15
Tranelis, Marion J., 0J
Trovato, C., 14
Villa Hernández, Joan Manuel, 09, 11
Waasem, Niklas, 08
Wang, Hui, 0Q, 0X
Wu, Hui-Ying, 16
Yamagiwa, M., 14
Yamamoto, H., 14
Yasui, T., 14
Zhao, Yu, 16

Conference Committee

Symposium Chairs

Connie J. Chang-Hasnain, University of California, Berkeley
(United States)

Graham T. Reed, Optoelectronics Research Centre, University of
Southampton (United Kingdom)

Symposium Co-chairs

Sailing He, KTH Royal Institute of Technology (Sweden) and Zhejiang
University (China)

Yasuhiro Koike, Keio University (Japan)

Program Track Chair

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

Conference Chairs

Hans I. Bjelkhagen, Glyndwr University (United Kingdom) and
Hansholo Consulting Ltd. (United Kingdom)

V. Michael Bove Jr., MIT Media Laboratory (United States)

Conference Program Committee

Maria Isabel Azevedo, Universidade de Aveiro (Portugal)

David Brotherton-Ratcliffe, Geola Technologies Ltd. (United Kingdom)

Frank C. Fan, Dymek Company Ltd. (China)

Gerald L. Heidt, Wasatch Photonics, Inc. (United States)

Toshio Honda, Toppan Printing Company, Ltd. (Japan)

Fujio Iwata, Toppan Printing Company, Ltd. (Japan)

Michael A. Klug, Magic Leap, Inc. (United States)

Alkiviadis Lembessis, The Hellenic Institute of Holography (Greece)

Deanna McMillen, EOTech, Inc. (United States)

Martina L. Mrongovius, RMIT University (Australia) and Center for the
Holographic Arts (United States) and Academy of Media Arts,
Cologne KHM (Germany)

Hiroshi Yoshikawa, Nihon University (Japan)

Session Chairs

- 1 Materials and Processes I

Hans I. Bjelkhagen, Glyndwr University (United Kingdom)

- 2 Materials and Processes II
Hans I. Bjelkhagen, Glyndwr University (United Kingdom)
- 3 Art and Perception
Hans I. Bjelkhagen, Glyndwr University (United Kingdom)
- 4 Applications
V. Michael Bove Jr., MIT Media Laboratory (United States)
- 5 Digital Holography I
V. Michael Bove Jr., MIT Media Laboratory (United States)
- 6 Digital Holography II
V. Michael Bove Jr., MIT Media Laboratory (United States)