PROCEEDINGS OF SPIE

SPIDigitalLibrary.org/conference-proceedings-of-spie

Front Matter: Volume 6912

, "Front Matter: Volume 6912," Proc. SPIE 6912, Practical Holography XXII: Materials and Applications, 691201 (22 February 2008); doi: 10.1117/12.791649

SPIE.

Event: Integrated Optoelectronic Devices 2008, 2008, San Jose, California, United States

PROCEEDINGS OF SPIE

Practical Holography XXII: Materials and Applications

**Hans I. Bjelkhagen
Raymond K. Kostuk**
Editors

**20–23 January 2008
San Jose, California, USA**

Sponsored and Published by
SPIE

Volume 6912

Proceedings of SPIE, 0277-786X, v. 6912

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

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 *Practical Holography XXII: Materials and Applications*, edited by Hans I. Bjelkhagen, Raymond K. Kostuk, Proceedings of SPIE Vol. 6912 (SPIE, Bellingham, WA, 2008) Article CID Number.

ISSN 0277-786X
ISBN 9780819470874

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 © 2008, 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/08/\$18.00.

Printed in the United States of America.

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

SPIEDigitalLibrary.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 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

ix	Conference Committee
xi	Introduction

SESSION 1 RECORDING MATERIALS

6912 02	Application of liquid crystal polymer films for photolithographic fabrication of 3D structures [6912-01] A. E. Fox, A. K. Fontecchio, Drexel Univ. (USA)
6912 03	Dichromated gelatin holograms with triphenyl dyes [6912-02] G. Páez-Trujillo, A. Olivares-Pérez, N. Mejias-Brizuela, M. P. Garay-Hernández, R. Fontanilla-Urdaneta, S. Toxqui-López, I. Fuentes-Tapia, Instituto Nacional de Astrofísica, Óptica y Electrónica (Mexico)
6912 04	Dichromated polyvinyl alcohol films doped with organic colorants [6912-03] G. Páez-Trujillo, A. Olivares-Pérez, N. Mejias-Brizuela, M. P. Garay-Hernández, R. Fontanilla-Urdaneta, I. Fuentes-Tapia, S. Toxqui-López, Instituto Nacional de Astrofísica, Óptica y Electrónica (Mexico)
6912 05	Optical properties of composite organic conductive films by holographic storage [6912-04] M. P. Hernández-Garay, A. Olivares-Pérez, R. Fontanilla-Urdaneta, G. Páez-Trujillo, N. Mejias-Brizuela, I. Fuentes-Tapia, Instituto Nacional de Astrofísica Óptica y Electrónica (Mexico)
6912 06	Diffraction efficiency study of holographic gratings in dichromated poly(vinyl alcohol) $\text{NiCl}_2 \cdot 6\text{H}_2\text{O}$ doped [6912-05] R. C. Fontanilla-Urdaneta, M. P. Hernández-Garay, A. Olivares-Pérez, G. Páez-Trujillo, I. Fuentes-Tapia, Instituto Nacional de Astrofísica Óptica y Electrónica (Mexico)
6912 07	New trends on photopolymers [6912-06] M. Ortuño, E. Fernández, S. Gallego, A. Márquez, C. Neipp, I. Pascual, A. Beléndez, Univ. de Alicante (Spain)
6912 08	Crystal beginnings II: the mind map of holography [6912-53] M. Richardson, De Montfort Univ. (United Kingdom)
6912 09	Fabrication of ultra-fine-grain silver halide recording material for color holography [6912-08] H. I. Bjelkhagen, North East Wales Institute of Higher Education (United Kingdom) and OpTIC Technium (United Kingdom); P. G. Crosby, North East Wales Institute of Higher Education (United Kingdom); D. P. M. Green, Consultant (United Kingdom); E. Mirlis, North East Wales Institute of Higher Education (United Kingdom); N. J. Phillips, North East Wales Institute of Higher Education (United Kingdom) and OpTIC Technium (United Kingdom)

SESSION 2 TECHNIQUES AND APPLICATIONS

- 6912 0A **Multiplexing volume holographic gratings for a spectral-spatial imaging system** [6912-09]
Y. Luo, Univ. of Arizona (USA) and College of Optical Sciences, Univ. of Arizona (USA);
P. J. Gelsinger, College of Optical Sciences, Univ. of Arizona (USA); J. K. Barton, Univ. of
Arizona (USA) and College of Optical Sciences, Univ. of Arizona (USA); G. Barbastathis,
Massachusetts Institute of Technology (USA); R. K. Kostuk, Univ. of Arizona (USA) and
College of Optical Sciences, Univ. of Arizona (USA)
- 6912 0B **Propagation vector analysis of digital holography and its application for three-dimensional
angle measurement** [6912-10]
L. Yu, Beckman laser Institute, Univ. of California, Irvine (USA); G. Pedrini, W. Osten, Univ.
Stuttgart (Germany)
- 6912 0D **Broadband diffuser for an IR illumination system** [6912-12]
R. E. Hutchins, Tessera North America (USA); S. Tidwell, Aculight Corp. (USA); J. L. Wargats,
Tessera North America (USA)
- 6912 0G **Research of the file system of volume holographic storage based on virtual storage layer**
[6912-15]
F. Wu, F. Yi, C. Xie, Huazhong Univ. of Science and Technology (China)

SESSION 3 DISPLAY AND COLOR HOLOGRAPHY

- 6912 0H **Progress in holographic video displays based on guided-wave acousto-optic devices**
[6912-16]
Q. Y. J. Smithwick, D. E. Smalley, V. M. Bove, Jr., J. Barabas, MIT Media Lab. (USA)
- 6912 0I **Horizontal resolution enhanced hologram to increase horizontal viewing angle** [6912-17]
Y. Hayashi, Y. Takaki, Tokyo Univ. of Agriculture and Technology (Japan)
- 6912 0J **Luminous presence** [6912-18]
P. Dawson, The Univ. of New South Wales (Australia)
- 6912 0L **Effects of nonlinear characteristics of LCD panel on image reconstruction in electro-
holography** [6912-20]
K. Sato, K. Tsuji, Univ. of Hyogo (Japan)
- 6912 0M **Electronic generation of holograms by using depth maps of real scenes** [6912-21]
R. Oi, K. Yamamoto, M. Okui, National Institute of Information and Communications
Technology (Japan)
- 6912 0N **High-density recording of full-color full-parallax holographic stereogram** [6912-22]
S. Maruyama, TOPPAN Printing Co., Ltd. (Japan); Y. Ono, M. Yamaguchi, Tokyo Institute of
Technology (Japan)
- 6912 0O **A method to increase the hologram viewing angle by the beam reconfiguration** [6912-23]
N. Ohmura, H. Kang, T. Yamaguchi, H. Yoshikawa, Nihon Univ. (Japan)

SESSION 4 DIGITAL AND COMPUTER GENERATED HOLOGRAPHY

- 6912 0P **Capabilities of diffractive optical elements for real-time holographic displays** [6912-24]
S. Reichelt, H. Sahm, N. Leister, A. Schwerdtner, SeeReal Technologies GmbH (Germany)
- 6912 0Q **Half-zone-plate processing for objects on both sides of hologram display** [6912-25]
K. Yamamoto, R. Oi, T. Mishina, M. Okui, National Institute of Information and Communications Technology (Japan)
- 6912 0S **Development of a fully functioning digital hologram system** [6912-27]
M. Alcaraz-Rivera, J. J. Báez-Rojas, Instituto Nacional de Astrofísica Óptica y Electrónica (Mexico); K. Der-Kuan, Holotec, Inc. (USA)
- 6912 0T **Large holographic displays for real-time applications** [6912-28]
A. Schwerdtner, R. Häussler, N. Leister, SeeReal Technologies GmbH (Germany)
- 6912 0U **One-shot digital holography for recording color 3D images** [6912-29]
H. Toge, H. Fujiwara, K. Sato, Univ. of Hyogo (Japan)

POSTER SESSION

- 6912 0V **Development of a simple user-friendly commercial digital holographic microscope** [6912-30]
O. C. Chee, V. R. Singh, E. Sim, Ngee Ann-AEM Ctr. of Innovation (Singapore); A. Asundi, Nanyang Technological Univ. (Singapore)
- 6912 0W **Volume holograms in polyvinyl alcohol with $\text{CuCl}_2 \cdot 2\text{H}_2\text{O}$** [6912-31]
M. P. Hernández-Garay, A. Olivares-Pérez, R. Fontanilla-Urdaneta, I. Fuentes-Tapia, G. Páez-Trujillo, Instituto Nacional de Astrofísica Óptica y Electrónica (Mexico)
- 6912 0X **Hydrophobic sugar holograms** [6912-32]
N. Y. Mejias-Brizuela, A. Olivares-Pérez, G. Páez-Trujillo, M. P. Hernández-Garay, R. Fontanilla-Urdaneta, I. Fuentes-Tapia, Instituto Nacional de Astrofísica, Óptica y Electrónica (Mexico)
- 6912 0Y **Voltage effect in holographic gratings by organic conductive materials** [6912-33]
R. C. Fontanilla-Urdaneta, M. P. Hernández-Garay, A. Olivares-Pérez, G. Páez-Trujillo, I. Fuentes-Tapia, Instituto Nacional de Astrofísica Óptica y Electrónica (Mexico)
- 6912 10 **Holograms with corn honey and erioglaucine dye** [6912-35]
A. Grande-Grande, Instituto Tecnológico Superior de Atlixco (Mexico); N. Y. Mejias-Brizuela, A. Olivares-Pérez, G. Páez-Trujillo, I. Fuentes-Tapia, Instituto Nacional de Astrofísica, Óptica y Electrónica (Mexico)
- 6912 12 **Holograms in thermoplastic nail varnish** [6912-37]
S. Toxqui-López, A. Olivares-Pérez, A. R. Hernández-Sosa, Instituto Nacional de Astrofísica Óptica y Electrónica (Mexico)

- 6912 13 **Holograms with egg albumin** [6912-38]
P. Pérez-Salinas, Instituto Tecnológico Superior de Atlixco (Mexico); N. Y. Mejias-Brizuela, A. Olivares-Perez, Instituto Nacional de Astrofísica, Óptica y Electrónica (Mexico); A. Grande-Grande, Instituto Tecnológico Superior de Atlixco (Mexico); G. Páez-Trujillo, M. P. Hernández- Garay, I. Fuentes-Tapia, Instituto Nacional de Astrofísica, Óptica y Electrónica (Mexico)
- 6912 14 **Multiplexing holograms for data page storage as a holographic memory in a PVA/AA photopolymer** [6912-39]
E. Fernández, M. Ortuño, S. Gallego, C. García, A. Márquez, A. Beléndez, I. Pascual, Univ. de Alicante (Spain)
- 6912 16 **Secure holographic storage using single phase encoding** [6912-41]
T. V. Vu, S.-W. Lee, N. Kim, Chungbuk National Univ. (South Korea); S.-K. Gil, Suwon Univ. (South Korea); E.-K. Kim, Yonsei Univ. (South Korea)
- 6912 17 **Real-time interferometric characterization of a PVA based photopolymer** [6912-42]
A. Márquez, S. Gallego, D. Méndez, M. Ortuño, E. Fernández, M. L. Álvarez, C. Neipp, A. Beléndez, I. Pascual, Univ. de Alicante (Spain)
- 6912 18 **Quality evaluation of Lippmann-type hologram using CGH** [6912-43]
T. Yamauchi, M. Kurashige, T. Kumasawa, M. Kitamura, M. Watanabe, K. Ueda, Dai Nippon Printing Co., Ltd. (Japan)
- 6912 19 **Theoretical model of the diffraction efficiency of Norland Optical Adhesive No. 65 and crystal violet as temperature function** [6912-44]
M. Ortiz-Gutiérrez, L. Aparicio-Ixta, Univ. Michoacana de San Nicolás de Hidalgo (Mexico); J. C. Ibarra-Torres, Univ. de Guadalajara (Mexico); M. Pérez-Cortés, Univ. Autónoma de Yucatán (Mexico)
- 6912 1A **Enlargement of visual field with an LCD in computer generated holograms** [6912-45]
Y. Yabe, Y. Sakamoto, Hokkaido Univ. (Japan)
- 6912 1B **Digital holographic interference analysis using a 2-step phase-shifting technique** [6912-46]
S. K. Gil, Univ. of Suwon (South Korea); S. H. Jeon, Univ. of Incheon (South Korea); J. R. Jeong, Suwon Science College (South Korea)
- 6912 1C **Computer-generated cylindrical rainbow hologram** [6912-47]
T. Yamaguchi, T. Fujii, H. Yoshikawa, Nihon Univ. (Japan)
- 6912 1D **Large viewing angle projection type electro-holography using new type mist 3-D screen** [6912-48]
K. Sato, H. Zhao, Shonan Institute of Technology (Japan); K. Takano, Tokyo Metropolitan College of Aeronautical Engineering (Japan)
- 6912 1E **Efficient generation of CGH for video images using LUT method** [6912-49]
J.-H. Yoon, S.-C. Kim, E.-S. Kim, Kwangwoon Univ. (South Korea)
- 6912 1F **Reconstruction of digital hologram generated by sub-image of integral imaging** [6912-50]
S.-H. Lee, S.-C. Kim, E.-S. Kim, Kwangwoon Univ. (South Korea)

- 6912 1G **Phase modulation in holographic gratings recorder in Norland 65** [6912-51]
J. C. Ibarra, M. Ortiz-Gutiérrez, L. Aparicio, M. Pérez-Cortes, Univ. de Guadalajara (Mexico)
- 6912 1H **Fourier holograms in Norland 65** [6912-52]
J. C. Ibarra, Univ. de Guadalajara (Mexico); M. Ortiz-Gutiérrez, L. Aparicio-Ixta, Univ. Michoacana de San Nicolás de Hidalgo (Mexico); M. Pérez-Corte, Univ. Autónoma de Yucatán (Mexico)

Author Index

Conference Committee

Symposium Chair

Ali Adibi, Georgia Institute of Technology (USA)

Symposium Cochair

James G. Grote, Air Force Research Laboratory (USA)

Program Track Chair

Liang-Chy Chien, Kent State University (USA)

Conference Chairs

Hans I. Bjelkhagen, North East Wales Institute of Higher Education
(United Kingdom) and Technium OpTIC (United Kingdom)

Raymond K. Kostuk, The University of Arizona (USA)

Program Committee

Jean-Marc R. Fournier, École Polytechnique Fédérale de Lausanne
(Switzerland)

Gerald L. Heidt, Wasatch Photonics, Inc. (USA)

Toshio Honda, Chiba University (Japan)

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

Tung H. Jeong, Lake Forest College (USA)

Gaylord E. Moss, MossOptics (USA)

Albert O. Okorogu, The Aerospace Corporation (USA)

Nadya O. Reingand, Celight, Inc. (USA)

Martin J. Richardson, De Montfort University (United Kingdom)

Christopher W. Slinger, QinetiQ Ltd. (United Kingdom)

Fred D. Unterseher, Columbia Career Center (USA)

Ichirou Yamaguchi, Gunma University (Japan)

Toyohiko Yatagai, University of Tsukuba (Japan)

Session Chairs

1 Recording Materials

Hans I. Bjelkhagen, North East Wales Institute of Higher Education
(United Kingdom) and Technium OpTIC (United Kingdom)

2 Techniques and Applications

Gerald L. Heidt, Wasatch Photonics, Inc. (USA)

- 3 Display and Color Holography
Koki Sato, Shonan Institute of Technology (Japan)
- 4 Digital and Computer Generated Holography
Christopher W. Slinger, QinetiQ Ltd. (United Kingdom)

Introduction

The SPIE Holography Conference which takes place every year in January is an important international event in the field of practical holography and holographic materials. This year marks the 60th anniversary of Dennis Gabor's landmark invention of holography and the 22nd meeting of the Practical Holography Conference. To commemorate the very first paper on holography, a short presentation on Dennis Gabor and his work was given at the SPIE Holography Group meeting. The paper, "A New Microscopic Principle" in *Nature*, Vol. 161, May 15, 1948, pp 777-778, was the first publication on holography.

Dennis Gabor 1900 – 1979

Gabor's patent drawings

Gabor in-line holography

Hungarian-born Dennis Gabor got his PhD in Germany but left Germany in the 1930s and moved to England. He became employed at British Thompson-Houston Co. Ltd., in Rugby. There he conceived "wavefront reconstruction" while working on improving the resolution of the electron microscope. He won the Nobel Prize for Physics in 1971 for his invention of holography.

Gabor next to a laser transmission holographic portrait of him.
The 50 by 60 cm hologram plate was recorded by R. Reinhart at McDonnell Douglas commemorating Gabor's winning of the 1971 Physics Nobel Prize

The conference provides a venue for all aspects of holography from art forms to microscopy. The conference also brings together participants from all over the world including Europe, Australia, Asia, and America. This year's meeting consisted of 29 oral and 23 poster papers. In addition, the Holography Working Group had a standing room only crowd discussing new developments in materials, applications such as solar concentrators, and a plan for the 8th International Symposium on Display Holography to take place in July 2009 in China.

This year's conference featured many interesting contributions in various fields during two days of oral presentations. It was divided into four main sessions: Recording Materials, Techniques and Applications, Display and Color Holography, and Digital and Computer-generated Holography. We had an average of about 40 people in the meeting room during the two days.

The amount of papers on photopolymer materials and other materials such as dichromated gelatin (DCG), polyvinyl alcohol (PVA), methyl methacrylate (MMA), and photo-thermo-refractive (PTR) glass are increasing every year. HOEs and holographic projection screens are improved and finding important applications. Digital holography systems are now able to generate full-color real-time displays. A paper from MIT covered the progress on holographic video. This work started when Stephen Benton was responsible for the holographic R&D program at MIT, and is now being carried out by M. Bove and his team. Holographic data storage is another field which is now a reality.

We would like to thank all the authors and the Practical Holography XXII Program Committee members for their contribution. The session chairmen: G. Heidt, D. Speer, K. Sato, and C. Slinger are acknowledged for helping with the paper presentations during the four sessions. The Practical Holography Conference, the Holography Working Group meeting, and the Short Course on Holographic Techniques for Advanced Photonics Systems provide a good collection of activities for those interested in holography.

We look forward to seeing you in San Jose in January 2009.

Hans I. Bjelkhagen
Raymond K. Kostuk