PROCEEDINGS OF SPIE

Laser-based Micro- and Nanopackaging and Assembly IV

Wilhelm Pfleging
Yongfeng Lu
Kunihiko Washio
Jun Amako
Willem Hoving
Editors

26–28 January 2010
San Francisco, California, United States

Sponsored and Published by
SPIE

Volume 7585

Proceedings of SPIE, 0277-786X, v. 7585

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 *Laser-based Micro- and Nanopackaging and Assembly IV*, edited by Wilhelm Pfleging, Yongfeng Lu, Kunihiko Washio, Jun Amako, Willem Hoving, Proceedings of SPIE Vol. 7585 (SPIE, Bellingham, WA, 2010) Article CID Number.

ISSN 0277-786X
ISBN 9780819479815

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

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

Conference Committee

Symposium Chairs

Donald J. Harter, IMRA America, Inc. (United States)
Peter R. Herman, University of Toronto (Canada)

Symposium Cochairs

Alberto Piqué, Naval Research Laboratory (United States)
Friedhelm Dorsch, TRUMPF Photonics (United States)

Program Track Chairs

Henry Helvajian, The Aerospace Corporation (United States)
James S. Horwitz, U.S. Department of Energy (United States)

Conference Chairs

Wilhelm Pfleging, Karlsruhe Institute of Technology (Germany)
Yongfeng Lu, University of Nebraska, Lincoln (United States)
Kunihiko Washio, Paradigm Laser Research Ltd. (Japan)

Conference Cochairs

Jun Amako, Seiko Epson Corporation (Japan)
Willem Hoving, XiO Photonics B.V. (Netherlands)

Program Committee

Friedrich G. Bachmann, Rofin-Sinar Laser GmbH (Germany)
Ramona Eberhardt, Fraunhofer-Institute for Applied Optics and Precision Engineering (Germany)
Matthew Henry, Laser Materials Processing Specialist (United Kingdom)
Costas P. Grigoropoulos, University of California, Berkeley (United States)
Andreas Grohe, Fraunhofer Institute for Solar Energy Systems (Germany)
Bo Gu, IPG Photonics Corporation (United States)
Minghui Hong, National University of Singapore (Singapore)
Lan Jiang, Beijing Institute of Technology (China)
Nam Seong Kim, EO Technics Company, Ltd. (Korea, Republic of)
Udo Klotzbach, Fraunhofer-Institut für Werkstoff- und Strahltechnik (Germany)
Thomas Klotzbücher, Institut für Mikrotechnik Mainz GmbH (Germany)

Xinbing Liu, Panasonic Technologies Company (United States)
Tomoaki Matsushima, Panasonic Electric Works Company, Ltd. (Japan)
Akira Mori, Komatsu Electronics, Inc. (Japan)
Roberto Osellame, Istituto di Fotonica e Nanotecnologie, IFN-CNR, Politecnico di Milano (Italy)
Andreas Ostendorf, Ruhr- Universität Bochum (Germany)
Marius Przybylski, ATL Lasertechnik GmbH (Germany)
Gurinder P. Singh, Hitachi Global Storage Technologies, Inc. (United States)
Koji Sugioka, RIKEN (Japan)
Akira Watanabe, Tohoku University (Japan)

Session Chairs

1 Welding/Joining
Kunihiko Washio, Paradigm Laser Research Ltd. (Japan)

2 Advanced Deposition Processes
Friedrich G. Bachmann, Rofin-Sinar Laser GmbH (Germany)

3 Optical Components and Devices
Willem Hoving, XiO Photonics B.V. (Netherlands)

4 Micro- and Nanomachining
Jun Amako, Seiko Epson Corporation (Japan)

5 Direct-Write Processing and Surface Modification
Yongfeng Lu, University of Nebraska, Lincoln (United States)

6 Photovoltaics: Joint Session with Conference 7584
Wilhelm Pfleging, Karlsruhe Institute of Technology (Germany)

Introduction

At the present time, high-tech industries have increasingly stronger demands for advanced laser-based micro- and nano-packaging and assembly technologies which enable specialized prototypes and high-throughput devices with micro- and nanostructures to realize fluidic, biological, chemical, electronic, mechanical, and photonic functionalities. Cutting-edge designs and applications are increasingly based on micro- and nano-system technologies. However, the realization of such devices or functional prototypes imposes new challenges for patterning, packaging, and assembly.

Functional systems are continuously becoming more miniaturized and complicated during the course of performance improvement. Nano-materials and nano-patterning technologies become more closely associated with micro-materials and micro-structuring technologies, leading to new applications and research fields but at the same time imposing new challenges for appropriate assembly and packaging technologies. Due to the ever-increasing complexity of device structures, processing needs for wide varieties of materials and their combinations have been increasing in areas such as MEMS and optofluidics. Furthermore, in certain application fields such as large-area flexible displays and photovoltaics, aspect ratios between horizontal and vertical device features are rapidly increasing. Moreover, with increasing device complexity the laser-induced changes of material properties on micro- or nanometer scales become more and more important. Material and surface modifications such as chemical or structural changes must be avoided in some applications (e.g., photovoltaics) or can be used in other applications (e.g., TFT Annealing) for a goal-oriented surface functionalization. In both cases, a strong demand is to develop novel processing technologies with high efficiency and throughput.

The "Laser-based micro packaging" conference series was established in 2002. In 2007 the conference was renamed as Laser-Based Micro- and Nano-Packaging and Assembly (LBMP) to reflect the relevance of nanometer-scaled structures. The aim of this conference is to bring together scientists and engineers working on application-oriented aspects of laser-based micro- and nano-packaging for mechanical, electronic, photonic, chemical, biological, bio-active, or bio-compatible devices including MEMS/bio-MEMS, MOEMS, and OLED. Because of the great economical demand, material processing is playing an increasingly important role in current and future LBMP conferences, along with new green technologies such as photovoltaics and advanced energy storage systems.

The conference LBMP-IV was held 26–28 January 2010 as part of LASE 2010 at Photonics West in San Francisco, California. LBMP-IV comprised 28 oral and 3 poster presentations which were presented by speakers from the Canada, China, France, Italy, Japan, Germany, UK and USA. Presentations represented a number

of topics including: modeling and characterization of laser-mater interaction, laser welding and joining, ultrafast laser, advanced laser deposition, optical components and devices, micro- and nano-machining, direct-write processing and surface modification, and photovoltaics. The photovoltaics session was jointly organized with Conference 7584: Laser Applications in Microelectronic and Optoelectronic Manufacturing XV (LAMOM XV).

We would like to thank the program committee members and the SPIE technical staff for their great efforts during the planning and organization of LBMP-IV. We would also like to thank the invited speakers and presenters of the contributed papers for their contribution to the success of the conference. All of the manuscripts were peer reviewed in order to publish high-quality conference proceedings.

Wilhelm Pfleging
Yongfeng Lu
Kunihiko Washio