

PROCEEDINGS OF SPIE

Reliability, Packaging, Testing, and Characterization of MEMS/MOEMS and Nanodevices X

**Sonia Garcia-Blanco
Rajeshuni Ramesham**
Editors

**24–25 January 2011
San Francisco, California, United States**

Sponsored by
SPIE

Cosponsored by
INO (Canada)
DALSA Corporation (Canada)
SET—Smart Equipment Technology (France)

Published by
SPIE

Volume 7928

Proceedings of SPIE, 0277-786X, v. 7928

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 *Reliability, Packaging, Testing, and Characterization of MEMS/MOEMS and Nanodevices X*, edited by Sonia Garcia-Blanco, Rajeshuni Ramesham, Proceedings of SPIE Vol. 7928 (SPIE, Bellingham, WA, 2011) Article CID Number.

ISSN 0277-786X
ISBN 9780819484659

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 © 2011, 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/11/\$18.00.

Printed in the United States of America.

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

SPIE 
Digital Library

SPIEDigitalLibrary.org

Printed in the United States of America by Curran Associates, Inc., under license from SPIE.

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	Conference Committee
ix	Introduction
xi	<i>Lateral spread of MEMS WDM technologies (Plenary Paper) [7930-202]</i> H. Toshiyoshi, The Univ. of Tokyo (Japan)
xxiii	<i>Toy Story: what I have learned from playing with toys about the physics of living cells (Plenary Paper) [7929-203]</i> R. H. Austin, Princeton Univ. (United States)

SESSION 1 PACKAGING AND INTEGRATION TECHNOLOGIES OF MOEMS/MEMS/NEMS I

7928 02	Atomic layer deposition/molecular layer deposition for packaging and interconnect of N/MEMS (Keynote Paper) [7928-01] Y. C. Lee, Univ. of Colorado at Boulder (United States)
7928 03	Revolutionary innovation in system interconnection: a new era for the IC (Invited Paper) [7928-02] M. S. Bakir, P. A. Thadesar, C. King, J. Zaveri, H. S. Yang, C. Zhang, Y. Zhang, Georgia Institute of Technology (United States)
7928 04	Spherical and non-spherical high fill-factor microlens arrays fabricated by polymer coating on isotropically etched quartz [7928-03] M. Nam, H. Oh, G. Kim, Ajou Univ. (Korea, Republic of); H. Seo, Y. Song, Opto FineTech Inc. (Korea, Republic of); S. S. Yang, K.-K. Lee, Ajou Univ. (Korea, Republic of)

SESSION 2 PACKAGING AND INTEGRATION TECHNOLOGIES OF MOEMS/MEMS/NEMS II

7928 05	Packaging of MEMS/MOEMS and nanodevices: reliability, testing, and characterization aspects (Invited Paper) [7928-04] T. Tekin, H.-D. Ngo, Technische Univ. Berlin (Germany); O. Wittler, Fraunhofer-Institut für Zuverlässigkeit und Mikrointegration (Germany); B. Bouhlal, Technische Univ. Berlin (Germany); K.-D. Lang, Technische Univ. Berlin (Germany) and Fraunhofer-Institut für Zuverlässigkeit und Mikrointegration (Germany)
7928 06	Silicon TSV interposers for photonics and VLSI packaging (Invited Paper) [7928-05] N. Vodrahalli, C. Y. Li, V. Kosenko, ALLVIA, Inc. (United States)

SESSION 3 TEST METHODOLOGY AND RELIABILITY

- 7928 08 **Fiber-based multi-beam laser Doppler vibrometer for measuring transient vibrations** [7928-07]
M. Guo, Y. Fu, Nanyang Technological Univ. (Singapore); P. B. Phua, Nanyang Technological Univ. (Singapore) and DSO National Labs. (Singapore)
- 7928 09 **Infrared scanning white light interferometry using a solid state light source** [7928-08]
V. Heikkinen, Univ. of Helsinki (Finland); J. Aaltonen, Helsinki Institute of Physics (Finland); B. Wälchli, H. Rökkönen, Univ. of Helsinki (Finland); I. Kassamakov, Univ. of Helsinki (Finland) and Helsinki Institute of Physics (Finland); T. Cholakova, Central Lab. of Applied Physics (Finland); K. Grigoros, S. Franssila, Aalto Univ. (Finland); R. Kakanakov, Central Lab. of Applied Physics (Finland); E. Hæggström, Univ. of Helsinki (Finland)
- 7928 0A **ESD testing and combdrive snap-in in a MEMS tunable grating under shock and vibration** [7928-09]
S. Sundaram, Ecole Polytechnique Fédérale de Lausanne (Switzerland) and Birla Institute of Technology and Science (India); M. Tormen, B. Timotijevic, R. Lockhart, R. P. Stanley, Ctr. Suisse d'Electronique et de Microtechnique SA (Switzerland); H. R. Shea, Ecole Polytechnique Fédérale de Lausanne (Switzerland)
- 7928 0B **Reliability of MEMS (Invited Paper)** [7928-10]
A. Dommann, A. Neels, Ctr. Suisse d'Electronique et de Microtechnique SA (Switzerland)
- 7928 0C **Reliability enhancement of Ohmic RF MEMS switches** [7928-11]
S. Kurth, S. Leidich, Fraunhofer-Institut für Elektronische Nanosysteme (Germany); A. Bertz, M. Nowack, Technische Univ. Chemnitz (Germany); J. Frömel, Fraunhofer-Institut für Elektronische Nanosysteme (Germany); C. Kaufmann, Technische Univ. Chemnitz (Germany); W. Faust, T. Gessner, Fraunhofer-Institut für Elektronische Nanosysteme (Germany); A. Akiba, K. Ikeda, Sony Corp. (Japan)
- 7928 0D **Crack growth and reliability modeling of multi-layer capacitors in microelectronics applications** [7928-12]
G. Sharon, D. Barker, Univ. of Maryland, College Park (United States)

SESSION 4 RELIABILITY OF MEMS FOR SPACE APPLICATIONS

- 7928 0E **Effects of radiation on MEMS (Invited Paper)** [7928-13]
H. R. Shea, Ecole Polytechnique Fédérale de Lausanne (Switzerland)
- 7928 0F **Reliability of Sn/Pb and lead-free (SnAgCu) solders of surface mounted miniaturized passive components for extreme temperature (-185°C to +125°C) space missions** [7928-14]
R. Ramesham, Jet Propulsion Lab. (United States)
- 7928 0G **Displacement damage effects in silicon MEMS at high proton doses** [7928-15]
J. Gomes, H. R. Shea, Ecole Polytechnique Fédérale de Lausanne (Switzerland)

SESSION 5 DEVICES FOR SPACE APPLICATIONS I

- 7928 OH **MEMS technology to achieve miniaturization, redundancy, and new functionality in space (Invited Paper)** [7928-16]
T.-A. Grönland, M. Bendixen, J. Bejhed, H. Johansson, K. Jonsson, P. Rangsten, NanoSpace AB (Sweden)
- 7928 OI **MOEMS for prospective space applications (Invited Paper)** [7928-17]
T. Viard, C. Buisset, Thales Alenia Space (France); F. Zamkotsian, Lab. d'Astrophysique de Marseille (France); V. Costes, Ctr. National d'Études Spatiales (France); L. Venancio, European Space Research and Technology Ctr. (Netherlands)
- 7928 OJ **Expanding the spacecraft application base with MEMS gyros (Invited Paper)** [7928-18]
T. Brady, The Charles Stark Draper Lab., Inc. (United States)

SESSION 6 DEVICES FOR SPACE APPLICATIONS II: JOINT SESSION WITH CONFERENCE 7930 AND 7931

- 7928 OK **Improved coupling to integrated spatial heterodyne spectrometers with applications to space** [7928-19]
A. Scott, COM DEV Ltd. (Canada) and York Univ. (Canada); P. Bock, National Research Council Canada (Canada) and York Univ. (Canada); C. A. Ramos, Univ. of Malaga (Spain); B. Lamontagne, P. Cheben, National Research Council Canada (Canada); M. Florjańczyk, National Research Council Canada (Canada) and York Univ. (Canada); I. M. Fernandez, Univ. of Malaga (Spain); S. Janz, National Research Council Canada (Canada); A. Ortega-Monux, Univ. of Malaga (Spain); B. Solheim, York Univ. (Canada); D.-X. Xu, National Research Council Canada (Canada)
- 7928 OL **Integration of optical waveguides and microfluidics in a miniaturized antibody micro-array system for life detection in the NASA/ESA ExoMars mission** [7928-20]
A. Prak, H. Leeuwis, R. G. Heideman, A. Leinse, LioniX BV (Netherlands); G. Borst, Dutch Space B.V. (Netherlands)

POSTER SESSION

- 7928 ON **The interference effect of the Rayleigh wave and two intersecting shear-horizontal waves** [7928-22]
H. Lee, H. Oh, K. Lee, S. S. Yang, Ajou Univ. (Korea, Republic of)
- 7928 OO **A novel wireless Love wave biosensor platform for multifunctional detection** [7928-23]
T. Song, M. Nam, S. Song, H. C. Yoon, K. Lee, Ajou Univ. (Korea, Republic of)
- 7928 OP **An investigation into graphene exfoliation and potential graphene application in MEMS devices** [7928-25]
G. Fercana, Clemson Univ. (United States) and NASA Goddard Space Flight Ctr. (United States); G. Kletetschka, Catholic Univ. of America (United States), NASA Goddard Space Flight Ctr. (United States), and Geologic Institute (Czech Republic); V. Mikula, Catholic Univ. of America (United States) and NASA Goddard Space Flight Ctr. (United States); M. Li, NASA Goddard Space Flight Ctr. (United States)

- 7928 0Q **Optoelectronic properties and interfacial durability of CNT and ITO on boro-silicate glass and PET substrates with nano- and heterostructural aspects** [7928-26]
J.-M. Park, Gyeongsang National Univ. (Korea, Republic of) and The Univ. of Utah (United States); Z.-J. Wang, D.-J. Kwon, Gyeongsang National Univ. (Korea, Republic of); L. DeVries, The Univ. of Utah (United States)

Author Index