PROCEEDINGS OF SPIE

SPIDigitalLibrary.org/conference-proceedings-of-spie

Front Matter: Volume 9257

, "Front Matter: Volume 9257," Proc. SPIE 9257, Sensors, MEMS and Electro-Optical Systems, 925701 (1 July 2014); doi: 10.1117/12.2073807

SPIE.

Event: Third Conference on Sensors, MEMS and Electro-Optic Systems, 2014, Skukuza, Kruger National Park, South Africa

PROCEEDINGS OF SPIE

Sensors, MEMS, and Electro-Optical Systems

Monuko du Plessis

Editor

17–19 March 2014

Skukuza, Kruger National Park, South Africa

Organized by

Denel Dynamics (South Africa)

Sponsored by

Denel Dynamics (South Africa)

National Research Foundation (South Africa)

University of Pretoria (South Africa)

INSiAVA (South Africa)

Technology Innovation Agency (South Africa)

Council for Scientific and Industrial Research (South Africa)

Cassidian Optronics (South Africa)

Solid State Technology (South Africa)

Published by

SPIE

Volume 9257

Proceedings of SPIE 0277-786X, V. 9257

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

Sensors, MEMS, and Electro-Optical Systems, edited by Monuko du Plessis, Proc. of SPIE
Vol. 9257, 925701 © 2014 SPIE · CCC code: 0277-786X/14/\$18 · doi: 10.1117/12.2073807

Proc. of SPIE Vol. 9257 925701-1

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 *Sensors, MEMS, and Electro-Optical Systems*, edited by Monuko du Plessis, Proceedings of SPIE Vol. 9257 (SPIE, Bellingham, WA, 2014) Article CID Number.

ISSN: 0277-786X
ISBN: 9781628413243

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 © 2014, 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/14/\$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	Conference Committees
ix	Introduction

SESSION 1 MATERIALS AND PHYSICAL PHENOMENA

- 9257 02 **Replacing TCO electrodes in dye sensitized solar cells by metal grids** [9257-100]
U. Hilleringmann, A. Kleine, Univ. Paderborn (Germany)
- 9257 03 **Photoluminescence of chemically treated InAs (111)A** [9257-14]
N. Eassa, Nelson Mandela Metropolitan Univ. (South Africa); E. Coetsee, H. C. Swart, Univ. of the Free State (South Africa); A. Venter, J. R. Botha, Nelson Mandela Metropolitan Univ. (South Africa)
- 9257 04 **Layer structure and material properties of an epitaxially grown InGaAs PIN photo-detector on an InP substrate** [9257-28]
J. W. Lambrechts, Denel Dynamics (South Africa)

SESSION 2 OPTICAL SYSTEMS AND MODELING

- 9257 05 **Theoretical analysis and system design of two-photon based optical frequency standards** [9257-18]
J. P. Burger, P. Jivan, C. Matthee, National Metrology Institute of South Africa (South Africa); R. Kritzinger, Mobile Telephone Networks (South Africa); H. Hussein, O. Terra, National Institute of Standards (Egypt)
- 9257 06 **How to make a digital laser** [9257-11]
L. Burger, Council for Scientific and Industrial Research (South Africa) and Stellenbosch Univ. (South Africa); I. Litvin, Council for Scientific and Industrial Research (South Africa); S. Ngcobo, Council for Scientific and Industrial Research (South Africa) and Univ. of KwaZulu-Natal (South Africa); A. Forbes, Council for Scientific and Industrial Research (South Africa), Univ. of Stellenbosch (South Africa), and Univ. of KwaZulu-Natal (South Africa)
- 9257 07 **Performance characterization of commercially available uncooled micro-bolometer thermal cameras for varying camera temperatures** [9257-5]
I. J. Minnaar, Denel Dynamics (South Africa)

SESSION 3 SPECTRAL CHARACTERIZATION

- 9257 08 **A transparent look at the measurement and application of colour rendering in the use of LED light sources** [9257-107]
F. W. Leuschner, Univ. of Pretoria (South Africa); J. G. J. Van Der Westhuyzen, Denel Dynamics (South Africa)

SESSION 4 FABRICATION AND SYSTEM PRODUCTION

- 9257 09 **Wafer bonding process for building MEMS devices** [9257-108]
E. F. Pabo, EV Group Inc. (United States); J. Meiler, T. Matthias, EV Group Inc. (Austria)
- 9257 0A **Low temperature solder process to join a copper tube to a silicon wafer** [9257-23]
C. Versteeg, Denel Dynamics (South Africa); M. Scarpim de Souza, Brazilian Army Technology Ctr. (Brazil)
- 9257 0B **Tailoring the mechanical properties of SU-8/clay nanocomposites: polymer microcantilever fabrication perspective** [9257-21]
H. Chen, V. Ojijo, H. Cele, T. Joubert, S. R. Suprakas, K. Land, Council for Scientific and Industrial Research (South Africa)

SESSION 5 IMAGE PROCESSING AND APPLICATIONS

- 9257 0C **Infrared recordings for characterizing an aircraft plume** [9257-16]
S. J. P. Retief, M. M. Dreyer, C. Brink, Denel Dynamics (South Africa)
- 9257 0D **Visual surveying platform for the automated detection of road surface distresses** [9257-9]
T. Naidoo, D. Joubert, T. Chiwewe, A. Tyatyantsi, B. Rancati, A. Mbizeni, Council for Scientific and Industrial Research (South Africa)
- 9257 0E **Fine-correlation: inter-sample template matching** [9257-27]
P. V. Reyneke, E. S. van der Berg, Denel Dynamics (South Africa); C. de Ridder, Stellenbosch Univ. (South Africa)
- 9257 0F **Rotational image correlation in the Gauss-Laguerre domain** [9257-25]
E. S. van der Berg, P. V. Reyneke, Denel Dynamics (South Africa); C. de Ridder, Stellenbosch Univ. (South Africa)

SESSION 6 SENSOR DESIGN

- 9257 0G **A HTS dc SQUID-NMR: fabrication of the SQUID and application to low-field NMR for fruit quality detection** [9257-114]
J. F. Isingizwe Nturambirwe, W. J. Perold, L. U. Opara, Stellenbosch Univ. (South Africa)

SESSION 7 OPTICAL COMMUNICATION LINKS

- 9257 0H **Precise verification of a fibre link for frequency transfer** [9257-113]
C. F. Matthee, J. P. Burger, National Metrology Institute of South Africa (South Africa); R. Kritzinger, MTN Group (South Africa)
- 9257 0I **Realization of 10 GHz minus 30dB on-chip micro-optical links with Si-Ge RF bi-polar technology** [9257-105]
K. A. Ogudo, Tshwane Univ. of Technology (South Africa) and Univ. Paris-Est Marne-la-Vallée (France); L. W. Snyman, Tshwane Univ. of Technology (South Africa); J.-L. Polleux, C. Viana, Z. Tegegne, Univ. Paris-Est Marne-la-Vallée (France)

POSTER SESSION

- 9257 0J **Analysis system for characterisation of simple, low-cost microfluidic components** [9257-6]
S. Smith, T. Naidoo, Z. Nxumalo, K. Land, E. Davies, L. Fourie, P. Marais, P. Roux, Council for Scientific and Industrial Research (South Africa)
- 9257 0K **Employing a microbolometer as a low pressure sensor** [9257-15]
J. Schoeman, Univ. of Pretoria (South Africa)
- 9257 0L **An instrumentation amplifier based readout circuit for a dual element microbolometer infrared detector** [9257-19]
D. J. de Waal, J. Schoeman, Univ. of Pretoria (South Africa)
- 9257 0M **Fabrication of a multiplexed microfluidic system for scaled up production of cross-linked biocatalytic microspheres** [9257-8]
M. B. Mbanjwa, Council for Scientific and Industrial Research (South Africa) and Univ. of the Witwatersrand (South Africa); H. Chen, L. Fourie, S. Ngwenya, K. Land, Council for Scientific and Industrial Research (South Africa)
- 9257 0N **Analysis of CMOS hot carrier light sources using back-end-of-line light directing structures for improved light extraction efficiency** [9257-26]
A. F. Bulling, P. J. Venter, M. du Plessis, Univ. of Pretoria (South Africa)
- 9257 0O **Design issues of a low cost lock-in amplifier readout circuit for an infrared detector** [9257-17]
L. Scheepers, J. Schoeman, Univ. of Pretoria (South Africa)
- 9257 0P **The modelling of a capacitive microsensor for biosensing applications** [9257-24]
P. H. Bezuidenhout, Univ. of Pretoria (South Africa) and Council for Scientific and Industrial Research (South Africa); J. Schoeman, Univ. of Pretoria (South Africa); T. H. Joubert, Council for Scientific and Industrial Research (South Africa)
- 9257 0Q **Thermal and flicker noise improvement in short-channel CMOS detectors** [9257-103]
J. Venter, Univ. of Pretoria (South Africa); S. Sinha, Univ. of Pretoria (South Africa) and Univ. of Johannesburg (South Africa)

Author Index

Conference Committees

Conference Chair

Christo Schutte, Denel Dynamics (South Africa)

Conference Co-chairs

Monuko du Plessis, University of Pretoria (South Africa)

Trudi-Heleen Joubert, Council for Scientific and Industrial Research
(South Africa)

Philip Minnaar, Denel Dynamics (South Africa)

Program Committee

Reinhardt Botha, Nelson Mandela Metropolitan University
(South Africa)

Johan Burger, National Metrology Institute of South Africa
(South Africa)

Monuko du Plessis, University of Pretoria (South Africa)

Trudi-Heleen Joubert, Council for Scientific and Industrial Research
(South Africa)

Editorial Committee

Reinhardt Botha, Nelson Mandela Metropolitan University
(South Africa)

Johan Burger, National Metrology Institute of South Africa
(South Africa)

Monuko du Plessis, University of Pretoria (South Africa)

Ulrich Hilleringmann, Universität Paderborn (Germany)

Trudi-Heleen Joubert, Council for Scientific and Industrial Research
(South Africa)

Pieter Rademeyer, INSiAVA (South Africa)

Christo Schutte, Denel Dynamics (South Africa)

Lukas Snyman, Tshwane University of Technology (South Africa)

Session Chairs

- 1 Materials and Physical Phenomena
Monuko du Plessis, University of Pretoria (South Africa)

- 2 Optical Systems and Modeling
Reinhardt Botha, Nelson Mandela Metropolitan University
(South Africa)

- 3 Spectral Characterization
Johan Steyl, Cassidian Optronics (South Africa)
- 4 Fabrication and System Production
Wilhelm Leuschner, University of Pretoria (South Africa)
- 5 Image Processing and Applications
Antho Botha, Technoscene (South Africa)
- 6 Sensor Design
Philip Minnaar, Denel Dynamics (South Africa)
- 7 Optical Communication Links
Johan Burger, National Metrology Institute of South Africa
(South Africa)
- 8 Poster Session
Trudi-Heleen Joubert, Council for Scientific and Industrial Research
(South Africa)

Introduction

The 3rd South African Conference on Sensors, MEMS, and Electro-Optical Systems (SMEOS 2014) was held from 17 to 19 March 2014 in Skukuza, the main rest camp in the Kruger National Park, South Africa, after a very successful SMEOS 2009 and SMEOS 2011. Sensors and Electro-Optical Systems are technologies with many applications worldwide, and are also identified as such by the South African government through the Departments of Science and Technology.

The aim of SMEOS 2014 was to provide a common forum for international researchers and developers to exchange information about their latest research findings, ideas, developments, and applications in all areas pertaining to design, fabrication, and application in the fields of interest to SMEOS 2014. This is a relatively small field of expertise in South Africa and working together with international colleagues is of the utmost importance.

Monuko du Plessis