# PROCEEDINGS OF SPIE

# MOEMS and Miniaturized Systems XVII

Wibool Piyawattanametha Yong-Hwa Park Hans Zappe Editors

30–31 January 2018 San Francisco, California, United States

Sponsored by SPIE

Cosponsored by Samsung Advanced Institute of Technology (Korea, Republic of)

Published by SPIE

Volume 10545

Proceedings of SPIE 0277-786X, V. 10545

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

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 SPIEDigitalLibrary.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 *MOEMS* and *Miniaturized* Systems XVII, edited by Wibool Piyawattanametha, Yong-Hwa Park, Hans Zappe, Proceedings of SPIE Vol. 10545 (SPIE, Bellingham, WA, 2018) Seven-digit Article CID Number.

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

ISBN: 9781510615755 ISBN: 9781510615762 (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 © 2018, 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/18/\$18.00.

Printed in the United States of America Vm7 i ffUb 5 ggc WUHY gž & Wži bXYf`}WY bgY Zfca 'GD-9.

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



**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 Authors
- ix Conference Committee

#### SESSION 1 FABRICATION

10545 02	Towards fabrication and application of polymer based photonics networks and sensors (Invited Paper) [10545-1]
10545 04	Direct laser writing of tunable diffractive micro-optics on graphene oxide film [10545-3]

- 10545 05 New way to realize miniaturized complex optical systems in high volume [10545-4]
- 10545 06 All-optical probing of GHz acoustic waves in multiferroic MEMS [10545-5]

#### SESSION 2 CAMERAS AND IMAGERS

- 10545 07 Lightweight smart autofocusing eyeglasses (Invited Paper) [10545-6]
- 10545 08 A miniaturized camera objective with 2X optical zoom [10545-7]
- 10545 09 Compact array camera using hybrid technology for automotive application [10545-8]
- 10545 0A Folded multi-aperture camera system for thin mobile devices [10545-9]
- 10545 0B Compact wide-angle array camera for presence detection [10545-10]

#### SESSION 3 SPECTROMETERS I

- 10545 0C Handheld spectrometers in 2018 and beyond: MOEMS, photonics, and smartphones (Invited Paper) [10545-11]
- 10545 0D **Tunable bandpass filter for mid-infrared wavelengths using liquid crystal elastomer** actuators [10545-12]
- 10545 0E MEMS FTIR spectrometer with enhanced resolution for low cost gas sensing in the NIR [10545-13]
- 10545 OF Bringing NIR spectrometers into mobile phones [10545-14]

### SESSION 4 MOEMS DEVICES

10545 0G	A low-cost 25-actuator electrostatic deformable mirror with polyimide membrane for adaptive optics microscopy (Best Student Paper Award) [10545-15]
10545 OH	Silicon photonic MEMS variable optical attenuator (Invited Paper) [10545-43]
10545 OI	Novel micro-fabricated Fabry-Perot filters in infrared [10545-16]
10545 OJ	MEMS-based widely tunable external cavity diode laser [10545-17]
10545 OK	Fluorescence lifetime determination by miniaturized LED ns-pulser and ASIC detector unit [10545-18]
10545 OL	Optical MEMS notch filter based on the multi-mode interference in a butterfly metallic waveguide [10545-19]
10545 OM	Silicon photonics based on-chip vibrometer [10545-20]
SESSION 5	MEDICAL APPLICATIONS
10545 0O	Every aspect of advanced retinal imaging laser eyewear: principle, free focus, resolution, laser safety, and medical welfare applications (Invited Paper) [10545-22]
10545 OQ	Integration and biocompatible packaging of multi-modal endoscopic imagers using 3D glass micro structuring [10545-24]
SESSION 6	HYPERSPECTRAL IMAGING
10545 OR	Hand-held MEMS hyperspectral imager for VNIR mobile applications (Invited Paper, Best Paper Award) [10545-25]
10545 OS	Portable LWIR hyperspectral imager based on MEMS Fabry-Perot interferometer and broadband microbolometric detector array (Invited Paper) [10545-26]
10545 OU	Wide-band large-aperture Ag surface-micro-machined MEMS Fabry-Perot interferometers (AgMFPIs) for miniaturized hyperspectral imaging [10545-28]
10545 0U	
	(AgMFPIs) for miniaturized hyperspectral imaging [10545-28]
SESSION 7	(AgMFPIs) for miniaturized hyperspectral imaging [10545-28] SPECTROMETERS II
<b>SESSION 7</b> 10545 OV	(AgMFPIs) for miniaturized hyperspectral imaging [10545-28] SPECTROMETERS II Ultra-compact micro-optical system for multispectral imaging (Invited Paper) [10545-29] Translatory MEMS actuator with wafer level vacuum package for miniaturized NIR Fourier

### SESSION 8 MICRO-MIRRORS

10545 10	A single-coil driven two-axis water-immersible micro scanning mirror [10545-34]
10545 11	Repetitive nonlinear control for linear scanning micro mirrors [10545-35]
10545 13	Iterative learning control algorithm for greatly increased bandwidth and linearity of MEMS mirrors in LiDAR and related imaging applications [10545-37]
10545 14	Digital micromirror array enabled integral field spectroscopy for far-ultraviolet astronomy [10545-38]
10545 15	MEMS tunable-finesse slotted micromirror resonator [10545-39]
	POSTER SESSION
10545 16	POSTER SESSION Effects of liquid property and substrate roughness on the response time of an electrowetting liquid lens [10545-40]
10545 16 10545 17	Effects of liquid property and substrate roughness on the response time of an