PROCEEDINGS OF SPIE

SPIDigitalLibrary.org/conference-proceedings-of-spie

Front Matter: Volume 9429

, "Front Matter: Volume 9429," Proc. SPIE 9429, Bioinspiration, Biomimetics, and Bioreplication 2015, 942901 (4 May 2015); doi: 10.1117/12.2195670

SPIE.

Event: SPIE Smart Structures and Materials + Nondestructive Evaluation and Health Monitoring, 2015, San Diego, California, United States

PROCEEDINGS OF SPIE

Bioinspiration, Biomimetics, and Bioreplication 2015

Akhlesh Lakhtakia
Mato Knez
Raúl J. Martín-Palma
Editors

9–11 March 2015
San Diego, California, United States

Sponsored by
SPIE

Cosponsored by
American Society of Mechanical Engineers (United States)
Optical Society of Southern California (United States)

Cooperating Organizations
Intelligent Materials Forum (Japan)
Jet Propulsion Laboratory (United States)
National Science Foundation (United States)

Published by
SPIE

Volume 9429

Proceedings of SPIE 0277-786X, V. 9429

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

Bioinspiration, Biomimetics, and Bioreplication 2015, edited by Akhlesh Lakhtakia,
Mato Knez, Raúl J. Martín-Palma, Proc. of SPIE Vol. 9429, 942901 · © 2015 SPIE
CCC code: 0277-786X/15/\$18 · doi: 10.1117/12.2195670

Proc. of SPIE Vol. 9429 942901-1

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 *Bioinspiration, Biomimetics, and Bioreplication 2015*, edited by Akhlesh Lakhtakia, Mato Knez, Raúl J. Martín-Palma, Proceedings of SPIE Vol. 9429 (SPIE, Bellingham, WA, 2015) Article CID Number.

ISSN: 0277-786X

ISBN: 9781628415322

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 © 2015, 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/15/\$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. Papers are published as they are submitted and meet publication criteria. A unique 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.

Contents

vii	<i>Authors</i>
ix	<i>Conference Committee</i>

BIOMATERIALS I

9429 07	Paradigm for design of biomimetic adaptive structures (Keynote Paper) [9429-1]
---------	---

OPTICS AND PHOTONICS I

9429 09	Exploring polarization features in light reflection from beetles with structural colors (Invited Paper) [9429-3]
9429 0A	In_xAl_{1-x}N chiral nanorods mimicking the polarization features of scarab beetles [9429-4]
9429 0B	The artificial beetle, or a brief manifesto for engineered biomimicry [9429-5]
9429 0C	Light emission from compound eye with conformal fluorescent coating [9429-6]
9429 0D	Electromagnetic response of the protective pellicle of Euglenoids: influence of the surface profile [9429-7]

ADHESION

9429 0F	Switchable bio-inspired adhesives (Invited Paper) [9429-9]
---------	---

VISUAL AND ACOUSTIC SENSING

9429 0K	A predictive model for artificial mechanical cochlea [9429-14]
---------	---

FLIGHT

9429 0L	A low cost simulation platform for flapping wing MAVs [9429-15]
9429 0M	A three dimensional unsteady iterative panel method with vortex particle wakes and boundary layer model for bio-inspired multi-flap wings [9429-16]
9429 0O	Dynamic response of a piezoelectric flapping wing [9429-58]

ROBOTICS I

- 9429 0P **Fin propulsion on a human-powered submarine** [9429-19]
- 9429 0Q **Biologically inspired robots elicit a robust fear response in zebrafish** [9429-20]
- 9429 0R **Artificial heart for humanoid robot using coiled SMA actuators** [9429-21]
- 9429 0S **Modeling of the energy savings of variable recruitment McKibben muscle bundles**
[9429-22]
- 9429 0T **Design and fabrication of a three-finger prosthetic hand using SMA muscle wires** [9429-23]

ROBOTICS II

- 9429 0U **An insect-inspired flapping wing micro air vehicle with double wing clap-fling effects and capability of sustained hovering** [9429-24]
- 9429 0V **Soap film flow visualization investigations of oscillating wing energy harvesters** [9429-25]

OPTICS AND PHOTONICS II

- 9429 0X **Characterization of natural photonic structures by means of optimization strategies**
[9429-27]

OPTICS AND PHOTONICS III

- 9429 0Z **Biomimetics, color, and the arts (Invited Paper)** [9429-29]
- 9429 12 **Simple mass-production method of substrate-free powders for applications of the *Morpho*-colored materials** [9429-32]

SYSTEMS AND DEVICES

- 9429 13 **Development of a frequency-modulated ultrasonic sensor inspired by bat echolocation (Invited Paper)** [9429-33]
- 9429 15 **A synthetic leaf: the biomimetic potential of graphene oxide** [9429-35]
- 9429 16 **Efficiency testing of hydraulic artificial muscles with variable recruitment using a linear dynamometer** [9429-36]
- 9429 17 **Variable deflection response of sensitive CNT-on-fiber artificial hair sensors from CNT synthesis in high aspect ratio microcavities** [9429-37]

BIOMATERIALS III

9429 19 **Behavior of an adaptive bio-inspired spider web** [9429-39]

POSTER SESSION

- 9429 1D **Motion generation of peristaltic mobile robot with particle swarm optimization algorithm** [9429-44]
- 9429 1E **Effects of contact cap dimension on dry adhesion of bioinspired mushroom-shaped surfaces** [9429-45]
- 9429 1F **Electrowetting of liquid polymer on petal-mimetic microbowl-array surfaces for formation of microlens array with varying focus on a single substrate (Best Student Paper Award)** [9429-46]
- 9429 1K **The effect of the abdomen deformation on the longitudinal stability of flying insects (Best Student Paper Award)** [9429-55]
- 9429 1L **Exploration of electric properties of cement compared to bone: streaming potential and piezoelectric properties** [9429-56]
- 9429 1M **Improving energy efficiency in robot limbs through hydraulic dangle (Best Student Paper Award)** [9429-57]

Authors

Numbers in the index correspond to the last two digits of the six-digit citation identifier (CID) article numbering system used in Proceedings of SPIE. The first four digits reflect the volume number. Base 36 numbering is employed for the last two digits and indicates the order of articles within the volume. Numbers start with 00, 01, 02, 03, 04, 05, 06, 07, 08, 09, 0A, 0B...0Z, followed by 10-1Z, 20-2Z, etc.

Abaid, Nicole, 13	Kok, J. M., 0L
Adiba, Afifa, 0K	Kondash, Corey, 17
Ahmed, Riaz U., 0K	Kroner, Elmar, 0F
Akai-Kasaya, Megumi, 12	Kumar, Alok, 0O
Algie, Cam, 0P	Kuwahara, Yuji, 12
Anderson, Iain A., 0P	Ladu, Fabrizio, 0Q
Arwin, Hans, 09, 0A	Lakhtakia, Akhlesh, 0B, 0C
Banerjee, Sourav, 0K	Lamb, Marilla, 15
Bartl, Michael H., 0B	Landin, Jan, 09
Bartolini, Tiziana, 0Q	Li, Xiangmeng, 1F
Baur, Jeff, 17	Li, Xiangming, 1E, 1F
Behrooz, Majid, 19	Lu, Benjamin, 0P
Birch, J., 0A	Luna, Ana, 0X
Blower, Christopher, 0M	Macías, Demetrio, 0X
Bryant, Matthew J., 0S, 0V	Macri, Simone, 0Q
Butail, Sachit, 0Q	Magnusson, Roger, 09, 0A
Chahl, J. S., 0L	Mahapatra, D. Roy, 0O
Chan, Woei Leong, 0U	Martín-Palma, Raúl J., 0C
Chao, Ryan, 0P	Maschmann, Matthew R., 17
Chipka, Jordan B., 0S, 16	Meller, Michael A., 0S, 16, 1M
Choi, Sang-Yeon, 1K	Mendoza-Galván, Arturo, 09
Conforti, Visitación, 0D	Miller, Amy E., 0C
Debiasi, Marco, 0U	Morgan, Eric R., 15
Dhruv, Akash, 0M	Nguyen, Quoc-Viet, 0U
Dickinson, Benjamin T., 17	Panitz, Sarah G., 0Q
Ding, Yucheng, 1E	Phillips, David, 17
Dry, Carolyn, 07, 1L	Pocock, Benjamin, 0P
Dutta, S., 0O	Porfiri, Maurizio, 0Q
Fernández del Río, Lía, 09	Potnuru, Akshay, 0R
Garcia, Ephraim, 0S, 16, 1M	Pulsifer, Drew P., 0C
Gigli, Miriam L., 0D	Reich, Gregory, 17
Gordaninejad, Faramarz, 19	Saito, Akira, 12
Han, Jae-Hung, 1K	Sandström, P., 0A
Han, Jong-seob, 1K	Schenk, Franziska, 0Z
Harbuz, Antoni, 0P	Seelecke, Stefan, 0T
Hartman, Alex, 19	Severin, Benjamin, 17
Homma, Takahiro, 1D	Shafer, Michael W., 15
Hsiao, C.-L., 0A	Shao, Jinyou, 1E, 1F
Hu, Hong, 1E	Simone, Filomena, 0T
Huie, Andrew, 19	Skigin, Diana C., 0D, 0X
Inchaussandague, Marina E., 0D, 0X	Slinker, Keith, 17
Ishibashi, Kosei, 12	Tadesse, Yonas, 0R
Järrendahl, Kenneth, 09, 0A	Tian, Hongmiao, 1E, 1F
Kamamichi, Norihiro, 1D	Tolivia, Analía, 0D
Kepa, Krzysztof, 13	Venkatesh, S., 0O
Khandwekar, Gaurang, 0O	Vial, Alexandre, 0X
Kim, Joong-Kwan, 1K	Vochezer, Daniel, 0P
Kirschmeier, Benjamin, 0V	Wang, Yue, 1E
Koch, George W., 15	Whitman, Julian S., 1M

Wickenheiser, Adam M., 0M
York, Alexander, 0T
Zheng, Lingyue, 19

Conference Committee

Symposium Chairs

Victor Giurgiutiu, University of South Carolina (United States)
Christopher S. Lynch, University of California, Los Angeles
(United States)

Symposium Co-chairs

Jayanth N. Kudva, NextGen Aeronautics, Inc. (United States)
Theodoros E. Matikas, University of Ioannina (Greece)

Conference Chair

Akhlesh Lakhtakia, The Pennsylvania State University (United States)

Conference Co-chairs

Mato Knez, CIC nanoGUNE Consolider (Spain)
Raúl J. Martín-Palma, Universidad Autónoma de Madrid (Spain)

Conference Program Committee

Yoseph Bar-Cohen, Jet Propulsion Laboratory (United States)
Steven F. Barrett, University of Wyoming (United States)
Michael H. Bartl, The University of Utah (United States)
Javaan S. Chahl, Defence Science and Technology Organisation
(Australia)
Francesco Chiadini, Università degli Studi di Salerno (Italy)
Susan A. Frost, NASA Ames Research Center (United States)
Marina Inchaussandague, Universidad de Buenos Aires (Argentina)
Sunghoon Kwon, Seoul National University (Korea, Republic of)
Gabriel A. Miller, San Diego Zoo (United States)
Bert Müller, Basel University Hospital (Switzerland)
Maurizio Porfiri, Polytechnic Institute of New York University
(United States)
Akira Saito, Osaka University (Japan)
Jayant Sirohi, The University of Texas at Austin (United States)
Diana C. Skigin, Universidad de Buenos Aires (Argentina)

Session Chairs

- 1 **Biomaterials I**
Akhlesh Lakhtakia, The Pennsylvania State University (United States)

- 2 Optics and Photonics I
Kellar Autumn, Lewis & Clark (United States)
- 3 Adhesion
Carolyn Dry, Natural Process Design, Inc. (United States)
- 4 Biomaterials II
Akira Saito, Osaka University (Japan)
- 5 Visual and Acoustic Sensing
Javaan S. Chahl, University of South Australia (Australia)
- 6 Flight
Maurizio Porfiri, New York University (United States)
- 7 Robotics I
Nicole Abaid, Virginia Polytechnic Institute and State University
(United States)
- 8 Robotics II
Shad J. Roundy, University of Utah (United States)
- 9 Optics and Photonics II
Mato Knez, CIC nanoGUNE Consolider (Spain)
- 10 Optics and Photonics III
Hans Arwin, Linköping University (Sweden)
- 11 Systems and Devices
Iain A. Anderson, The University of Auckland (New Zealand)
- 12 Biomaterials III
Masatsugu Shimomura, Chitose Institute of Science and Technology
(Japan)