PROCEEDINGS OF SPIE

SPIDigitalLibrary.org/conference-proceedings-of-spie

Front Matter: Volume 9058

, "Front Matter: Volume 9058," Proc. SPIE 9058, Behavior and Mechanics of Multifunctional Materials and Composites 2014, 905801 (29 April 2014); doi: 10.1117/12.2064683

SPIE.

Event: SPIE Smart Structures and Materials + Nondestructive Evaluation and Health Monitoring, 2014, San Diego, California, United States

PROCEEDINGS OF SPIE

Behavior and Mechanics of Multifunctional Materials and Composites 2014

**Nakhiah C. Goulbourne
Hani E. Naguib**
Editors

**10–12 March 2014
San Diego, California, United States**

Sponsored by
SPIE

Cosponsored by
American Society of Mechanical Engineers (United States)

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

Published by
SPIE

Volume 9058

Proceedings of SPIE 0277-786X, V. 9058

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

Behavior and Mechanics of Multifunctional Materials and Composites 2014, edited
by Nakhiah C. Goulbourne, Hani E. Naguib, Proc. of SPIE Vol. 9058, 905801
© 2014 SPIE · CCC code: 0277-786X/14/\$18 · doi: 10.1117/12.2064683

Proc. of SPIE Vol. 9058 905801-1

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 *Behavior and Mechanics of Multifunctional Materials and Composites 2014*, edited by Nakhiah C. Goulbourne, Hani E. Naguib, Proceedings of SPIE Vol. 9058 (SPIE, Bellingham, WA, 2014) Article CID Number.

ISSN: 0277-786X

ISBN: 9780819499844

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.

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 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

SESSION 1 MODELING OF SMA

- 9058 02 **Stable crack growth during actuation in shape memory alloys (Invited Paper)** [9058-1]
S. Jape, T. Baxevanis, D. C. Lagoudas, Texas A&M Univ. (United States)
- 9058 03 **Modeling size effect in the SMA response: a gradient theory (SPIE/ASME Best Student Paper Award)** [9058-2]
M. Tabesh, J. G. Boyd, D. C. Lagoudas, Texas A&M Univ. (United States)
- 9058 04 **Iterative calibration of a shape memory alloy constitutive model from 1D and 2D data using optimization methods** [9058-3]
D. Whitten, D. Hartl, Texas A&M Univ. (United States)
- 9058 05 **Three-dimensional constitutive model considering transformation-induced damage and resulting fatigue failure in shape memory alloys** [9058-4]
D. J. Hartl, Texas A&M Univ. (United States); Y. Chemisky, F. Meraghni, Lab. d'Etude des Microstructures et de Mécanique des Matériaux, CNRS, Ecole Nationale Supérieure d'Arts et Métiers (France)
- 9058 06 **Interfacial stresses in shape memory alloy-reinforced composites** [9058-6]
S. R. Hiremath, M. Prajapati, S. Rakesh, D. Roy Mahapatra, Indian Institute of Science (India)

SESSION 2 MULTIFUNCTIONAL COMPOSITES

- 9058 07 **Hierarchical multifunctional nanocomposites** [9058-7]
M. N. Ghasemi-Nejhad, Univ. of Hawaii at Manoa (United States)
- 9058 08 **Multifunctional composites for energy storage** [9058-8]
M. A. I. Shuvo, H. Karim, Md. Rajib, D. Delfin, Y. Lin, The Univ. of Texas at El Paso (United States)
- 9058 09 **Design of a multifunctional composite material with enhanced structural and power storage capability** [9058-9]
S. Doyle-Lawrence, K. Carroll, R. Guiel, C. Browder, C. Ciocanel, Northern Arizona Univ. (United States)

SESSION 3 SMART GELS AND POLYMERS

- 9058 0A **3D jet printer of edible gels for food creation** [9058-10]
R. Serizawa, M. Shitara, J. Gong, M. Makino, M. H. Kabir, H. Furukawa, Yamagata Univ. (Japan)

- 9058 0B **Fabrication and characterization of a foamed polylactic acid (PLA)/ thermoplastic polyurethane (TPU) shape memory polymer (SMP) blend for biomedical and clinical applications** [9058-11]
J. J. Song, I. Srivastava, J. Kowalski, H. E. Naguib, Univ. of Toronto (Canada)
- 9058 0C **Frictional properties of gel engineering materials with laser surface texturing** [9058-12]
N. Yamada, J. Gong, M. H. Kabir, M. Makino, K. Maekawa, M. Wada, H. Furukawa, Yamagata Univ. (Japan)
- 9058 0D **Frictional properties of high functional gel materials** [9058-13]
M. Wada, K. Yamada, N. Yamada, M. Makino, J. Gong, H. Furukawa, Yamagata Univ. (Japan)
- 9058 0E **Facile fabrication of uniaxial nanopatterns on shape memory polymer substrates using a complete bottom-up approach** [9058-14]
Z. Chen, S. Krishnaswamy, Northwestern Univ. (United States)
- 9058 0F **Designing light responsive bistable arches for rapid, remotely triggered actuation** [9058-15]
M. L. Smith, Hope College (United States); M. R. Shankar, Univ. of Pittsburgh (United States); R. Backman, Hope College (United States); V. P. Tondiglia, K. M. Lee, M. E. McConney, D. H. Wang, L.-S. Tan, T. J. White, Air Force Research Lab. (United States)
- 9058 0G **Development of a standard method to observe the surface friction of high-strength gels** [9058-16]
K. Yamada, Y. Watanabe, N. Yamada, M. Wada, J. Gong, M. Makino, M. H. Kabir, H. Furukawa, Yamagata Univ. (Japan)

SESSION 4 MAGNETO ACTIVE MATERIALS

- 9058 0H **Modeling of ferroelectric-ferromagnetic composites to improve magnetoelectric coupling and durability (Invited Paper)** [9058-17]
A. Ricoeur, A. Avakian, Z. Wang, Univ. Kassel (Germany)
- 9058 0I **Mechanosensitive droplet interface bilayer networks** [9058-18]
E. C. Freeman, M. K. Philen, Virginia Polytechnic Institute and State Univ. (United States); D. J. Leo, Univ. of Georgia (United States)
- 9058 0J **Characterization of optically actuated MRI-compatible active needles for medical interventions** [9058-58]
R. J. Black, S. Ryu, B. Moslehi, J. M. Costa, Intelligent Fiber Optic Systems Corp. (United States)

SESSION 5 PIEZOELECTRIC MATERIALS

- 9058 0K **Dynamic electromechanical behavior of barium titanate cantilevers under AC electric fields** [9058-20]
F. Narita, Y. Shindo, Tohoku Univ. (Japan)

- 9058 OM **Suppression method of overshoot on non/less-energy shape-retainment control utilizing hysteretic behavior of piezoelectric actuators** [9058-22]
T. Ikeda, T. Uchida, A. Senba, Nagoya Univ. (Japan); K. Ishimura, Japan Aerospace Exploration Agency (Japan)

SESSION 6 NANOCOMPOSITES APPLICATIONS

- 9058 OP **Test validation of environmental barrier coating (EBC) durability and damage tolerance modeling approach** [9058-26]
A. Abdul-Aziz, NASA Glenn Research Ctr. (United States); A. Najafi, ANSYS, Inc. (United States); F. Abdi, AlphaSTAR Corp. (United States); R. T. Bhatt, J. E. Grady, NASA Glenn Research Ctr. (United States)

SESSION 7 SMART COMPOSITES

- 9058 OX **Programmable variable stiffness 2D surface design** [9058-34]
S. Trabia, T. Hwang, W. Yim, Univ. of Nevada, Las Vegas (United States)

SESSION 8 PHOTORESPONSIVE MATERIALS

- 9058 OY **Thermodynamics and nonlinear mechanics of materials with photoresponsive microstructure (Invited Paper)** [9058-35]
W. S. Oates, J. Bin, Florida A&M Univ. (United States) and Florida State Univ. (United States)
- 9058 OZ **Photoactive and self-sensing P3HT-based thin films for strain and corrosion monitoring** [9058-36]
D. Ryu, K. J. Loh, Univ. of California, Davis (United States)

SESSION 9 SMA MATERIALS AND DESIGN

- 9058 10 **Thermal response of novel shape memory polymer-shape memory alloy hybrids** [9058-37]
J. Rossiter, Univ. of Bristol (United Kingdom); K. Takashima, Kyushu Institute of Technology (Japan); T. Mukai, RIKEN (Japan)
- 9058 14 **Load bearing and stiffness tailored NiTi implants produced by additive manufacturing: a simulation study** [9058-41]
R. Rahmanian, N. Shayesteh Moghaddam, C. Haberland, The Univ. of Toledo (United States); D. Dean, M. Miller, The Ohio State Univ. (United States); M. Elahinia, The Univ. of Toledo (United States)
- 9058 15 **Numerical predictions versus experimental findings on the power-harvesting output of a NiMnGa alloy** [9058-42]
I. Nelson, J. Dikes, H. Feigenbaum, C. Ciocanel, Northern Arizona Univ. (United States)

POSTER SESSION

- 9058 17 **A stress-induced phase transition model for semi-crystallize shape memory polymer** [9058-44]
X. Guo, B. Zhou, Harbin Engineering Univ. (China); L. Liu, Y. Liu, J. Leng, Harbin Institute of Technology (China)
- 9058 19 **One-step fabrication of multifunctional silica microbelt with the novel stacked structure by electrospinning technique** [9058-46]
Y. Yao, H. Lu, J. Leng, J. Li, Harbin Institute of Technology (China)
- 9058 1A **Preparation and properties of polyurethane/silicone materials for biomimetic gecko setae** [9058-47]
M. Yu, Z. Dai, Nanjing Univ. of Aeronautics and Astronautics (China); S. Yang, Lanzhou Institute of Chemical Physics (China)
- 9058 1B **High cycles fatigue damage of CFRP plates clamped by bolts for axial coupling joint with off-set angle during rotation** [9058-48]
K. Ooka, K. Okubo, T. Fujii, Doshisha Univ. (Japan); S. Umeda, M. Fujii, Tsubaki E&M Co. (Japan); T. Sugiyama, Nippon Steel & Sumikin Materials Co., Ltd. (Japan)
- 9058 1I **Multifunctional devices combining shape-memory alloy and piezoelectric materials** [9058-55]
H. Sato, National Institute of Advanced Industrial Science and Technology (Japan)
- 9058 1K **A multiscale-based approach for composite materials with embedded PZT filaments for energy harvesting** [9058-57]
A. E. El-Etriby, M. E. Abdel-Meguid, T. M. Hatem, Y. A. Bahei-El-Din, The British Univ. in Egypt (Egypt)

Author Index

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

Nakhiah C. Goulbourne, University of Michigan (United States)

Conference Co-chair

Hani E. Naguib, University of Toronto (Canada)

Conference Program Committee

Abhijit Bhattacharyya, University of Arkansas at Little Rock
(United States)
Gregory P. Carman, University of California, Los Angeles
(United States)
Pavel M. Chaplya, Sandia National Laboratories (United States)
Constantin Ciocanel, Northern Arizona University (United States)
Marcelo J. Dapino, The Ohio State University (United States)
Sergio Luis dos Santos e Lucato, Teledyne Scientific Company
(United States)
LeAnn E. Faidley, Wartburg College (United States)
Daniel J. Inman, University of Michigan (United States)
Marc Kamlah, Karlsruher Institut für Technologie (Germany)
Haluk E. Karaca, University of Kentucky (United States)
Kwang Jin Kim, University of Nevada, Las Vegas (United States)
Dimitris C. Lagoudas, Texas A&M University (United States)
Chad M. Landis, The University of Texas at Austin (United States)
Kam K. Leang, University of Nevada, Reno (United States)
Donald J. Leo, Virginia Polytechnic Institute and State University
(United States)
Jiangyu Li, University of Washington (United States)
Christopher S. Lynch, University of California, Los Angeles
(United States)

Karla M. Mossi, Virginia Commonwealth University (United States)
Robert C. O'Handley, Massachusetts Institute of Technology
 (United States)
Etienne Patoor, Université de Metz (France)
Ralph C. Smith, North Carolina State University (United States)
Jonghwan Suhr, University of Delaware (United States)
Vishnu Baba Sundaresan, Virginia Commonwealth University
 (United States)

Session Chairs

- 1 Modeling of SMA
Nakhiah C. Goulbourne, University of Michigan (United States)
Hani E. Naguib, University of Toronto (Canada)
- 2 Multifunctional Composites
Ali Abdul Aziz, NASA Glenn Research Center (United States)
- 3 Smart Gels and Polymers
Darren J. Hartl, Texas A&M University (United States)
- 4 Magneto Active Materials
William S. Oates, The Florida State University (United States)
Mehrdad N. Ghasemi-Nejhad, University of Hawaii (United States)
- 5 Piezoelectric Materials
Henry A. Sodano, University of Florida (United States)
Andreas Ricoeur, Universität Kassel (Germany)
- 6 Nanocomposites Applications
Zoubeida Ounaies, The Pennsylvania State University (United States)
Jonathan M. Rossiter, University of Bristol (United Kingdom)
- 7 Smart Composites
Kwang Jin Kim, University of Nevada, Las Vegas (United States)
- 8 Photoresponsive Materials
Ralph C. Smith, North Carolina State University (United States)
Arun R. Srinivasa, Texas A&M University (United States)
- 9 SMA Materials and Design
Mohammad H. Elahinia, The University of Toledo (United States)
Constantin Ciocanel, Northern Arizona University (United States)