Front Matter: Volume 7978
Behavior and Mechanics of Multifunctional Materials and Composites 2011

Zoubeida Ounaies
Stefan S. Seelecke
Editors

7-9 March 2011
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 7978
## Contents

### SESSION 1  MODELING OF FERROELECTRIC CERAMICS

<table>
<thead>
<tr>
<th>Paper</th>
<th>Title</th>
<th>Authors</th>
</tr>
</thead>
<tbody>
<tr>
<td>7978 02</td>
<td>3-D effects of polarization switching on interdigitated electroded ferroelectrics</td>
<td>D. M. Pisani, C. S. Lynch, Univ. of California, Los Angeles (United States)</td>
</tr>
<tr>
<td>7978 04</td>
<td>Discrete phase model of domain walls in ferroelectric crystals</td>
<td>W. Dong, D. Pisani, C. S. Lynch, Univ. of California, Los Angeles (United States)</td>
</tr>
<tr>
<td>7978 05</td>
<td>Constitutive model for rate dependent behavior of ferroelectric materials</td>
<td>T. Ikeda, Nagoya Univ. (Japan); K. Yoshida, Toyota Motor Corp. (Japan); T. Ueda, Nagoya Univ. (Japan)</td>
</tr>
</tbody>
</table>

### SESSION 2  CERAMIC-POLYMER PIEZOELECTRIC COMPOSITES

<table>
<thead>
<tr>
<th>Paper</th>
<th>Title</th>
<th>Authors</th>
</tr>
</thead>
<tbody>
<tr>
<td>7978 06</td>
<td>Statistical parameter estimation for macro fiber composite actuators using the homogenized energy model</td>
<td>Z. Hu, R. C. Smith, M. Stuebner, North Carolina State Univ. (United States); M. Hays, W. S. Oates, The Florida State Univ. (United States)</td>
</tr>
<tr>
<td>7978 07</td>
<td>Stress relaxation response of active fiber composites</td>
<td>H. Ben Altitallah, The Pennsylvania State Univ. (United States); A. Muliana, Texas A&amp;M Univ. (United States); Z. Ounaies, The Pennsylvania State Univ. (United States)</td>
</tr>
<tr>
<td>7978 08</td>
<td>Estimating mechanical properties of bi-continuous two-phase composites for optimised multi-functionality</td>
<td>Y. Xia, E. I. Saavedra Flores, Swansea Univ. (United Kingdom); H. X. Peng, Univ. of Bristol (United Kingdom); M. I. Friswell, Swansea Univ. (United Kingdom)</td>
</tr>
<tr>
<td>7978 09</td>
<td>Micromechanical analysis of constitutive properties of active piezoelectric structural fiber (PSF) composites</td>
<td>K. Ng, Q. Dai, Michigan Technological Univ. (United States)</td>
</tr>
<tr>
<td>7978 0A</td>
<td>Functionally modified bimorph PZT actuator for cm-scale flapping wing</td>
<td>J. C. Riddick, U.S. Army Research Lab. (United States); A. Hall, Motile Robotics Inc. (United States)</td>
</tr>
</tbody>
</table>

### SESSION 3  RESPONSIVE POLYMERS

<table>
<thead>
<tr>
<th>Paper</th>
<th>Title</th>
<th>Authors</th>
</tr>
</thead>
<tbody>
<tr>
<td>7978 0B</td>
<td>Dynamics of ion transport in a bio-derived ionic transistor</td>
<td>V. B. Sundaresan, H. Zhang, R. Northcutt, S. Salinas, Virginia Commonwealth Univ. (United States)</td>
</tr>
</tbody>
</table>
Nonlinear structural mechanics and dynamics of azobenzene polymer network film
[7978-24]
L. Cheng, Y. Torres, W. S. Oates, The Florida State Univ. (United States)

Finite element modeling of electromechanical behavior of a dielectric electroactive polymer actuator
[7978-25]
A. Deodhar, North Carolina State Univ. (United States) and Univ. of Saarland (Germany);
A. York, M. Hodgins, S. Seelecke, Univ. of Saarland (Germany)

A novel hp-FEM model for IPMC actuation
[7978-26]
D. Pugal, Univ. of Nevada, Reno (United States) and Univ. of Tartu (Estonia); K. J. Kim, Univ. of Nevada, Reno (United States); P. Solin, Univ. of Nevada, Reno (United States) and Institute of Thermomechanics (Czech Republic); A. Aabloo, Univ. of Tartu (Estonia)

Light induced stress rate effects in azobenzene liquid crystal polymer networks
[7978-27]
H. Wang, W. S. Oates, The Florida State Univ. (United States)

Opto-mechanical behavior of photochromic liquid crystal polymer film composites
[7978-29]
Y. Huo, Y. You, C. Xu, Y. Lin, Fudan Univ. (China)

Adaptive control design for hysteretic smart systems
[7978-32]
J. A. McMahan, R. C. Smith, North Carolina State Univ. (United States)

An extended model for electrostatic tractions at crack faces in piezoelectrics
[7978-33]
A. Ricoeur, R. Gellmann, Univ. of Kassel (Germany)

Fundamental investigations of carbon nanotubes working as actuators
[7978-36]
S. Geier, Deutsches Zentrum für Luft- und Raumfahrt e.V. (Germany); T. Schnoor, Technical Univ. Hamburg-Harburg (Germany); J. Riemenschneider, T. Mahnholz, P. Wierach, Deutsches Zentrum für Luft- und Raumfahrt e.V. (Germany); K. Schulte, Technical Univ. Hamburg-Harburg (Germany); M. Sinapius, Deutsches Zentrum für Luft- und Raumfahrt e.V. (Germany)

Strain dependent visco-elastic response of CNFs’ reinforced epoxy composites
[7978-38]
J. Varischetti, Univ. of Nevada, Reno (United States); J.-S. Jang, J. Suhr, Univ. of Delaware (United States)

Graphene and carbon nanofiber nanopaper for multifunction composite materials
[7978-39]
C. Wu, H. Lu, L. Liu, Y. Liu, J. Leng, Harbin Institute of Technology (China)
<table>
<thead>
<tr>
<th>Session</th>
<th>Title</th>
<th>Authors</th>
<th>Institution(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>7078 OS</td>
<td>Improved energy density of nanocomposites with aligned PZT nanowires</td>
<td>H. Tang, Y. Lin, H. A. Sodano, Univ. of Florida (United States)</td>
<td></td>
</tr>
<tr>
<td>7078 OT</td>
<td>Novel biodegradable composites and foams of polylactide and chitin</td>
<td>R. Rizvi, B. Cochrane, H. Naguib, Univ. of Toronto (Canada); P. C. Lee, The Dow Chemical Co. (United States)</td>
<td></td>
</tr>
<tr>
<td>7078 OU</td>
<td>Spherically shaped micron-size particle-reinforced PMMA and PC composites for improving energy absorption capability</td>
<td>H. Kim, Univ. of Delaware (United States); E.-C. Kang, Univ. of Nevada, Reno (United States); J.-S. Jang, J. Suhr, Univ. of Delaware (United States)</td>
<td></td>
</tr>
</tbody>
</table>

### SESSION 7 MULTIFUNCTIONAL COMPOSITES AND METAMATERIALS

<table>
<thead>
<tr>
<th>Session</th>
<th>Title</th>
<th>Authors</th>
<th>Institution(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>7078 OV</td>
<td>Enhanced thermal conductivity of novel multifunctional polyphenylene sulfide composites embedded with heat transfer networks of hybrid fillers</td>
<td>S. N. Leung, O. M. Khan, E. Chan, H. E. Naguib, F. Dawson, Univ. of Toronto (Canada); V. Adinkrah, L. Lakatos-Hayward, AEG Power Solutions, Inc. (Canada)</td>
<td></td>
</tr>
<tr>
<td>7078 OY</td>
<td>Semi-active optimization of 2D wave’s dispersion into mechanical systems by the mean of periodically distributed shunted piezoelectric patches: a new class of adaptive metamaterials</td>
<td>M. Collet, M. Ouisse, Univ. de Franche-Comté (France); M. Ichchou, Ecole Centrale de Lyon (France); M. Ruzzene, Georgia Institute of Technology (United States)</td>
<td></td>
</tr>
<tr>
<td>7078 OZ</td>
<td>Optimization of magnetoimpedance and stress-impedance effects in single-microwire polymer composites for stress monitoring</td>
<td>F. Qin, H. X. Peng, Univ. of Bristol (United Kingdom); V. V. Popov, Taurida National Univ. (Ukraine); M. H. Phan, Univ. of South Florida (United States)</td>
<td></td>
</tr>
<tr>
<td>7078 10</td>
<td>Damping characterization of viscoelastic composites using micromechanical approach</td>
<td>M. Bonakdar, G. D. Seidel, D. J. Inman, Virginia Polytechnic Institute and State Univ. (United States)</td>
<td></td>
</tr>
<tr>
<td>7078 11</td>
<td>Design of phononic band gaps in functionally graded piezocomposite materials by using topology optimization</td>
<td>S. L. Vatanabe, E. C. N. Silva, Escola Politécnica da Univ. de São Paulo (Brazil)</td>
<td></td>
</tr>
<tr>
<td>7078 12</td>
<td>Chiral braided and woven composites: design, fabrication, and electromagnetic characterization</td>
<td>S. Wheeland, F. Bayatpur, A. V. Amirkhizi, S. Nemat-Nasser, Univ. of California, San Diego (United States)</td>
<td></td>
</tr>
<tr>
<td>7078 13</td>
<td>Self-actuating and self-diagnosing plastically deforming piezo-composite flapping wing MAV</td>
<td>A. B. Harish, D. Harursampath, D. R. Mahapatra, Indian Institute of Science (India)</td>
<td></td>
</tr>
<tr>
<td>7078 14</td>
<td>The effect of electro-discharge machined sonotrode topology on interlaminar bonding in ultrasonic consolidation</td>
<td>H. C. Edmonds, R. A. Harris, Loughborough Univ. (United Kingdom)</td>
<td></td>
</tr>
</tbody>
</table>
SESSION 8  SMP S

7978 16  On a novel self-regulating shape memory polymer composite [7978-52]
F. Gao, Univ. of Michigan (United States); S. Son, Univ. of Michigan (United States) and
Virginia Polytechnic Institute and State Univ. (United States); K. Park, D. Biggs, C. Andrews,
Univ. of Michigan (United States); E. M. Mockensturm, The Pennsylvania State Univ. (United
States); N. C. Goulbourne, Univ. of Michigan (United States)

SESSION 9  MAGNETO-RESPONSIVE MATERIALS

7978 18  Giant electrical control of magnetic anisotropy in magnetoelectric heterostructures using
(011) PMN-PT single crystal [7978-54]
T. Wu, A. Bur, H. K. D. Kim, P. Zhao, G. P. Carman, Univ. of California, Los Angeles (United
States)

7978 19  Rate dependent finite deformation of magneto-active polymers [7978-55]
Y. Han, W. Hong, L. E. Faidley, Iowa State Univ. (United States)

7978 1A  Design and fabrication of a microscale magnetoelectric surgical tool [7978-56]
J. Clarke, V. B. Sundaresan, Virginia Commonwealth Univ. (United States)

7978 1B  Preliminary model of a 3D dynamically loaded galfenol-based stress sensor using rate
equations [7978-57]
P. Weetman, G. Akhras, Royal Military College of Canada (Canada)

SESSION 10  SMAs I

7978 1D  FE modeling of multiple SMA wire actuated adaptive structures [7978-05]
N. M. Lewis, S. Seelecke, North Carolina State Univ. (United States)

7978 1E  The influence of stress and temperature on the residual strain generated during
pseudoelastic cycling of NiTi SMA wires [7978-06]
P. K. Kumar, Texas A&M Univ. (United States); C. Caer, Ecole Nationale d'Ingénieurs de Brest
(France); G. Atkinson, Texas A&M Univ. (United States); E. Patoo, Arts et Metiers ParisTech
(France); D. C. Lagoudas, Texas A&M Univ. (United States)

7978 1H  A multi-block-spin approach for martensitic phase transformation based on statistical
physics [7978-09]
M. Fischlschweiger, Materials Ctr. Leoben Forschung GmbH (Austria) and MINES ParisTech,
CNRS (France); E. R. Oberaigner, T. Antretter, Montan Univ. Leoben (Austria); G. Cailletaud,
MINES ParisTech, CNRS (France)
<table>
<thead>
<tr>
<th>SESSION 11</th>
<th>SMAs II</th>
</tr>
</thead>
</table>
| 7978 1J    | A two-dimensional theory of coupled electro-magneto-mechanical plates as an application to load-bearing antenna structures [7978-83]  
S. Santapuri, S. E. Bechtel, The Ohio State Univ. (United States) |
| 7978 1K    | Experimental validation of different methods for controlling a flexible nozzle using embedded SMA wires as both positioning actuator and sensor [7978-11]  
S. J. Furst, S. Seelecke, Univ. of Saarland (Germany) |
| 7978 1L    | Virtual processing of hybrid SMA composites through martensitic transformation [7978-12]  
B. T. Lester, Y. Chemisky, Texas A&M Univ. (United States); A. Geltmacher, S. M. Qidwei, U.S. Naval Research Lab. (United States); D. C. Lagoudas, Texas A&M Univ. (United States) |

<table>
<thead>
<tr>
<th>SESSION 12</th>
<th>MSMAs</th>
</tr>
</thead>
</table>
| 7978 1N    | Model predictions of strain and magnetization responses under magneto-thermo-mechanical loading paths in magnetic shape memory alloys [7978-13]  
K. Haldar, D. C. Lagoudas, Texas A&M Univ. (United States) |
| 7978 1P    | Electromotive force generation using the dynamic response of Ni50Mn28.5Ga21.5 magnetic shape memory alloy [7978-16]  
N. Bruno, C. Ciocanel, H. Feigenbaum, Northern Arizona Univ. (United States) |

<table>
<thead>
<tr>
<th>POSTER SESSION</th>
</tr>
</thead>
</table>
| 7978 1T        | Electromechanical filed concentrations and polarization switching due to interdigitated electrodes in piezoelectric macro-fiber composites under tension [7978-61]  
F. Narita, Y. Shindo, K. Sato, T. Takeda, Tohoku Univ. (Japan) |
| 7978 1V        | Study on the graphene-based actuator [7978-63]  
L. Xu, I.-K. Oh, KAIST (Korea, Republic of) |
| 7978 1W        | Electrical and mechanical properties of multi-phase systems under external impacts [7978-64]  
S. V. Ovsyannikov, Univ. Bayreuth (Germany) and Institute of Metal Physics (Russian Federation); V. V. Shchennikov, I. A. Komarovskii, G. V. Vorontsov, I. V. Korobeynikov, Institute of Metal Physics (Russian Federation); V. V. Shchennikov, Jr., Institute of Engineering Science (Russian Federation) |
| 7978 1Y        | Investigation on mechanical behavior of filament-wound CFRP tubes [7978-66]  
L. Zhang, China Earthquake Administration (China) and Northeast Forestry Univ. (China); H. Li, Harbin Institute of Technology (China) |
| 7978 1Z        | Buckling control of morphing composite airfoil structure using multi-stable laminate by piezoelectric sensors/actuators [7978-67]  
S. Zareie, A. Zabihollah, A. Azizi, Sharif Univ. of Technology (Iran, Islamic Republic of) |
| 7978 20        | Electromagnetic radiation of polaritons in piezoelectric superlattices [7978-68]  
Y.-F. Chou, C.-H. Shih, National Taiwan Univ. (Taiwan) |
<table>
<thead>
<tr>
<th>7978 21</th>
<th>Phase-field simulation and design of a ferroelectric nano-generator [7978-70]</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>M. Krauß, I. Münch, Karlsruher Institut für Technologie (Germany); C. M. Landis, Univ. of Texas at Austin (United States); W. Wagner, Karlsruher Institut für Technologie (Germany)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>7978 23</th>
<th>Fracture toughness characterization of nanoreinforced carbon-fiber composite materials for damage mitigation [7978-73]</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>J. A. VanderVennet, T. Duenas, NextGen Aeronautics, Inc. (United States); Y. Dzenis, C. T. Peterson, Precision Nanotechnologies LLC (United States) and Univ. of Nebraska-Lincoln (United States); C. E. Bakis, The Pennsylvania State Univ. (United States); D. Carter, J. K. Roberts, U.S. Army Research, Development and Engineering Command (United States)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>7978 24</th>
<th>A micropolar continuum model for large deformation caused by magnetic or electric fields [7978-74]</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>I. Münch, Karlsruhe Institute of Technology (Germany); P. Neff, Univ. of Duisburg-Essen (Germany); W. Wagner, Karlsruhe Institute of Technology (Germany)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>7978 25</th>
<th>Experimental investigation of road snow-melting based on CNFP self-heating concrete [7978-75]</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Q. Zhang, H. Li, Harbin Institute of Technology (China)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>7978 26</th>
<th>Equivalent properties of 1-3 piezocomposites made of PMN-PT single crystals for underwater sonar transducers [7978-77]</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>J. Kim, Y. Roh, Kyungpook National Univ. (Korea, Republic of)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>7978 28</th>
<th>Overall dynamic constitutive relations for layered elastic composites [7978-79]</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>A. Srivastava, S. Nemat-Nasser, Univ. of California, San Diego (United States)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>7978 2A</th>
<th>Magnetic performance of Fe3O4/epoxy nanocomposites [7978-81]</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>J. Li, J. Yang, Y. Liu, J. Leng, Harbin Institute of Technology (China)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>7978 2B</th>
<th>Fabrication of TiNi shape memory alloy thin films by current activated tip-based sintering (CATS) [7978-82]</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>K. S. Moon, M. Patel, K. Morsi, S. K. Kassegne, San Diego State Univ. (United States)</td>
</tr>
</tbody>
</table>

Author Index
Conference Committee

Symposium Chairs

Donald J. Leo, Virginia Polytechnic Institute and State University (United States)
Kara J. Peters, North Carolina State University (United States)

Symposium Cochairs

Norbert G. Meyendorf, Fraunhofer-Institut für Zerstörungsfreie Prüfverfahren (Germany) and University of Dayton (United States)
Norman M. Wereley, University of Maryland, College Park (United States)

Conference Chair

Zoubeida Ounaies, The Pennsylvania State University (United States)

Conference Chair

Stefan S. Seelecke, Universität des Saarlandes (Germany) and North Carolina State University (United States)

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 L dos Santos e Lucato, Teledyne Scientific Co. (United States)
Christopher P. Henry, HRL Laboratories, LLC (United States)
Daniel J. Inman, Virginia Polytechnic Institute and State University (United States)
Marc Kamleh, Forschungszentrum Karlsruhe GmbH (Germany)
Haluk E. Karaca, University of Kentucky (United States)
Ibrahim Karaman, Texas A&M University (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 Paul Verlaine Metz (France)
Ralph C. Smith, North Carolina State University (United States)
Jonghwan Suhr, University of Nevada, Reno (United States)

Session Chairs

1. Modeling of Ferroelectric Ceramics
   Christopher S. Lynch, University of California, Los Angeles (United States)
   William S. Oates, The Florida State University (United States)

2. Ceramic-Polymer Piezoelectric Composites
   Henry A. Sodano, Arizona State University (United States)
   Ralph C. Smith, North Carolina State University (United States)

3. Responsive Polymers
   Ralph C. Smith, North Carolina State University (United States)
   Zhengzheng Hu, North Carolina State University (United States)

4. Modeling of Piezoelectric Ceramics
   Marc Kamlah, Karlsruher Institut für Technologie (Germany)
   Kwang J. Kim, University of Nevada, Reno (United States)

5. Carbon Nanotube-based Multifunctional Materials
   Jonghwan Suhr, University of Nevada, Reno (United States)
   Stefan S. Seelecke, Universität des Saarlandes (Germany) and North Carolina State University (United States)

6. Nanocomposites
   Hani E. Naguib, University of Toronto (Canada)
   Zoubeida Ounaies, The Pennsylvania State University (United States)

7. Multifunctional Composites and Metamaterials
   Marcelo J. Dapino, The Ohio State University (United States)
   Vishnu Baba Sundaresan, Virginia Commonwealth University (United States)

8. SMPs
   Barbara J. Akle, Lebanese American University (Lebanon)
   Thomas Wallmersperger, Technische Universität Dresden (Germany)
9 Magneto-responsive Materials
LeAnn E. Faidley, Iowa State University (United States)
Vishnu Baba Sundaresan, Virginia Commonwealth University (United States)

10 SMAs I
Darren J. Hartl, Texas A&M University (United States)
Manuel Collet, Université de Franche-Comté (France)

11 SMAs II
Karla M. Mossi, Virginia Commonwealth University (United States)
Stefan S. Seelecke, Universität des Saarlandes (Germany) and North Carolina State University (United States)

12 MSMAs
Constantin Ciocanel, Northern Arizona University (United States)
Zoubeida Ounaies, The Pennsylvania State University (United States)