Front Matter: Volume 8107
Nano-Opto-Mechanical Systems (NOMS)

Jaume Esteve
Eugene M. Terentjev
Eva M. Campo
Editors

21 August 2011
San Diego, California, United States

Sponsored and Published by
SPIE
Contents

vii  Conference Committee
ix  Introduction

SESSION 1  FUNDAMENTALS OF PHOTOACTUATION: THEORY AND PRACTICE

8107 02  Light-induced disorder in liquid-crystalline elastomers for actuation (Invited Paper) [8107-01]  
A. Sánchez-Ferrer, ETH Zürich (Switzerland)

8107 04  Opto-mechanical parameters of liquid crystals elastomers with carbon nanotubes [8107-03]  
N. Torras, K. Zinoviev, C. J. Camargo, H. Campanella, J. Esteve, Ctr. Nacional de Microelectrónica (Spain) and Instituto de Microelectrónica de Barcelona (Spain) and Consejo Superior de Investigaciones Científicas (Spain); E. M. Campo, Univ. of Pennsylvania (United States); J. E. Marshall, E. M. Terentjev, Univ. of Cambridge (United Kingdom)

8107 05  Light-responsive actuation materials based on the photodeformable liquid crystal polymers (Invited Paper) [8107-04]  
J. Zhao, F. Cheng, Y. Yu, Fudan Univ. (China)

8107 07  Photoactuators on the base of polymeric elastomers and multiwall carbon nanotubes [8107-06]  
K. Czaniková, I. Krupa, M. Ilčíková, J. Mosnáček, P. Kasák, M. Mičušík, Polymer Institute (Slovakia); D. Chorvát, Jr., International Laser Ctr. (Slovakia); M. Omastová, Polymer Institute (Slovakia)

SESSION 2  MICROSYSTEM TECHNOLOGIES FOR NOMS

8107 08  Carbon based micro- and nano-opto-mechanical systems (C-MOMS/NOMS) [8107-07]  
B. Panchapakesan, P. Xu, J. Loomis, Univ. of Louisville (United States)

8107 09  Microstamped opto-mechanical actuator for tactile displays [8107-08]  
C. J. Camargo, N. Torras, H. Campanella, Ctr. Nacional de Microelectrónica (Spain) and Instituto de Microelectrónica de Barcelona (Spain) and Consejo Superior de Investigaciones Científicas (Spain); J. E. Marshall, Univ. of Cambridge (United Kingdom); K. Zinoviev, Ctr. Nacional de Microelectrónica (Spain) and Instituto de Microelectrónica de Barcelona (Spain) and Consejo Superior de Investigaciones Científicas (Spain); E. M. Campo, Univ. of Pennsylvania (United States); E. M. Terentjev, Univ. of Cambridge (United Kingdom); J. Esteve, Ctr. Nacional de Microelectrónica (Spain) and Instituto de Microelectrónica de Barcelona (Spain) and Consejo Superior de Investigaciones Científicas (Spain)
Opto-thermal actuation in double layer polymer microcantilevers [8107-09]
C. Martin-Olmos, L. G. Villanueva, A. Llobera, Ctr. Nacional de Microelectrónica (Spain) and Instituto de Microelectrónica de Barcelona (Spain) and Consejo Superior de Investigaciones Científicas (Spain); A. Voigt, G. Gruetzner, Microresist Technology Gmbh (Germany); G. Abadal, Univ. Autònoma de Barcelona (Spain); F. Perez-Murano, Ctr. Nacional de Microelectrónica (Spain) and Instituto de Microelectrónica de Barcelona (Spain) and Consejo Superior de Investigaciones Científicas (Spain)

Materials science: the key to revolutionary breakthroughs in micro-fluidic devices [8107-11]
M. Czugala, B. Ziolkowski, R. Byrne, D. Diamond, F. Benito-Lopez, Dublin City Univ. (Ireland)

Synthesis and characterization of poly lactic acid and multiwall carbon nano-tubes mixtures [8107-14]
S. Kumar LG, R. del A. Cardona, Univ. of Pennsylvania (United States); M. Berriós-Soto, Univ. de Puerto Rico Mayagüez (United States); J. J. Santiago-Avilés, Univ. of Pennsylvania (United States)

The continuing quest for the 'Holy Braille' of tactile displays [8107-15]
N. H. Runyan, D. B. Blazie, National Braille Press, Inc. (United States)

Nano opto-mechanical systems (NOMS) as a proposal for tactile displays [8107-16]
E. M. Campo, Univ. of Pennsylvania (United States); J. Roig, Univ. Autònoma de Barcelona (Spain); B. Roeder, Univ. Hamburg (Germany); D. Wenn, iXscient Ltd. (United Kingdom); B. Mamojka, Slovak Blind and Partially Sighted Union (Slovakia); M. Omastova, Polymer Institute (Slovakia); E. M. Terentjev, Univ. of Cambridge (United Kingdom); J. Esteve, Ctr. Nacional de Microelectrónica (Spain) and Instituto de Microelectrónica de Barcelona (Spain) and Consejo Superior de Investigaciones Científicas (Spain)

A nonlinear model an actuator [8107-17]
P. V. Negrón-Marrero, Univ. de Puerto Rico en Humacao (United States); E. Campo, Univ. of Pennsylvania (United States)

Mechanical modeling of thermally actuated LCE-CNT composite [8107-18]
C. J. Camargo, H. Campanella, K. Zinoviev, N. Torras, Ctr. Nacional de Microelectrónica (Spain) and Instituto de Microelectrónica de Barcelona (Spain) and Consejo Superior de Investigaciones Científicas (Spain); E. M. Campo, Univ. of Pennsylvania (United States); J. E. Marshall, E. M. Terentjev, Univ. of Cambridge (United Kingdom); J. Esteve, Ctr. Nacional de Microelectrónica (Spain) and Instituto de Microelectrónica de Barcelona (Spain) and Consejo Superior de Investigaciones Científicas (Spain)
SESSION 5 EDUCATION AND NON-GRADUATE RESEARCH

8107 OK Education and dissemination strategies of photoactuation as a novel phenomenon
[8107-19]
E. M. Campo, Univ. of Pennsylvania (United States); D. Wenn, iXscient Ltd. (United Kingdom);
I. Ramos, Univ. de Puerto Rico en Humacao (United States); J. Esteve, Ctr. Nacional de
Microelectrónica (Spain) and Instituto de Microelectrónica de Barcelona (Spain) and
Consejo Superior de Investigaciones Científicas (Spain); B. Mamojka, Slovak Blind and
Partially Sighted Union (Slovakia); E. M. Terentjev, Univ. of Cambridge (United Kingdom)

8107 OL CNT dispersion and precursor synthesis for electrospinning of polymer-CNT composites
[8107-20]
S. M. Rosa, J. P. Crespo, A. Meléndez, Univ. de Puerto Rico en Humacao (United States);
J. J. Santiago-Avilés, Univ. of Pennsylvania (United States); I. Ramos, Univ. de Puerto Rico en
Humacao (United States); E. M. Campo, Univ. of Pennsylvania (United States)

8107 OM Electrospun polymer-CNT actuators [8107-21]
J. P. Crespo, S. Rosa, A. Meléndez, Univ. de Puerto Rico en Humacao (United States);
J. J. Santiago-Avilés, Univ. of Pennsylvania (United States); I. Ramos, Univ. de Puerto Rico en
Humacao (United States); E. M. Campo, Univ. of Pennsylvania (United States)

Author Index
Conference Committee

Symposium Chairs

David L. Andrews, University of East Anglia Norwich (United Kingdom)
James G. Grote, Air Force Research Laboratory (United States)

Conference Chairs

Jaume Esteve, Centro Nacional de Microelectrónica (Spain)
Eugene M. Terentjev, University of Cambridge (United Kingdom)
Eva M. Campo, University of Pennsylvania (United States)

Program Committee

Yoseph Bar-Cohen, Jet Propulsion Laboratory (United States)
Federico Carpi, Università di Pisa (Italy)
Nibir K. Dhar, Defense Advanced Research Projects Agency (United States)
Toribio Fernández Otero, Universidad Politécnica de Cartagena (Spain)
Paolo Gaudenzi, Università degli Studi di Roma La Sapienza (Italy)
Tomiki Ikeda, Tokyo Institute of Technology (Japan)
Pablo V. Negron-Marrero, Universidad de Puerto Rico en Humacao (United States)
Mária Omastová, Polymer Institute (Slovakia)
Balaji Panchapakesan, University of Louisville (United States)
Idalia Ramos, Universidad de Puerto Rico en Humacao (United States)
Johannes Riemschneider, Deutsches Zentrum für Luft- und Raumfahrt e.V. (Germany)
Jorge J. Santiago-Aviles, University of Pennsylvania (United States)
Gilbert Sloan, Consultant (United States)
Nelson Tabirian, BEAM Engineering for Advanced Measurements Company (United States)
Richard A. Vaia, Air Force Research Laboratory (United States)
Mark Warner, University of Cambridge (United Kingdom)

Session Chairs

1 Fundamentals of Photoactuation: Theory and Practice
Jaume Esteve, Centro Nacional de Microelectrónica (Spain)
Eva Campo, University of Pennsylvania (United States)
2 Microsystem Technologies for NOMS
Balaji Panchapakesan, University of Louisville (United States)
Jorge J. Santiago-Aviles, University of Pennsylvania (United States)

3 Applications
Idalia Ramos, Universidad de Puerto Rico en Humacao (United States)
Jaume Esteve, Centro Nacional de Microelectronica (Spain)

4 Simulations
Eva Campo, University of Pennsylvania (United States)

5 Education and Non-Graduate Research
Pablo V. Negron-Marrero, Universidad de Puerto Rico en Humacao (United States)
Jorge J. Santiago-Aviles, University of Pennsylvania (United States)
Introduction

The first scientific meeting on the topic Nano-Opto-Mechanical-Systems (NOMS) took place in San Diego on September 21st 2011, kindly hosted by SPIE NanoScience+Engineering. This is the first forum gathering scholars to purposefully discuss photoactuation in the realm of smart materials, and has assembled participants from Asia, Europe and the United States.

The SPIE NOMS 2011 edition was honored to host invited speakers Antonio Sanchez-Ferrer (ETH Zürich) and Yanlei Yu (Fudan University). Sanchez-Ferrer overviewed chemical processes conducive to photoactuation of liquid-crystal elastomers and Yu reviewed photoisomerization of cross-linked liquid-crystal polymers, providing abundant examples of photoactuators. Demonstrations were staged by Deane B. Blazie and Noel H. Runyan (National Braille Press) and by Balaji Pachapackesan (University of Louisville), who provided a comprehensive review of efforts to incorporate photoactuators into common microtechnologies manufacturing practices.

Additional covered topics included thermo mechanical modeling and microstamping of photoactuators for microtechnologies (Camargo), optical properties (Torras and Zinoviev), all-optical shape memory in azo-LCN materials (Lee), liquid crystalline polymeric nanoparticles immobilized on solid substrates (Tsoi), photoactuation elasticity models (Negron-Marrero), in situ TEM characterization (McGilvray), photo-active double-layer polymer cantilevers (Martin-Olmos), synthesis and characterization of poly lactic acid and multiwall carbon nano-tubes (Kumar and Berrios), and novel photoactuators in polymeric elastomers and carbon nanotubes (Krupa and Omastova). An overview of the impact of photoactuation in the Nano-Bio-Info-Cogni (NBIC) quartet was provided by Campo, as well as a description of societal impacts by way of education to the general public; critical to influence consumer behavior. Education was emphasized at the NOMS session by including undergraduate research presentations, where Electrospinning was suggested as a possible manufacturing method of photoactuators (Rosa and Crespo).

Scientific discussion was prompted by the reviewed topics with a distinctive multidisciplinary tone. Indeed, participants assembled experts in materials, microtechnology, chemistry, and applications. We are delighted with the success of this first edition of SPIE NOMS; we are in the planning stages of the second edition. In closing, the NOMS community is indebted to the SPIE staff and symposium chairs for kindly hosting this meeting. In particular, we are especially grateful to Professor Maria Yzuel, SPIE 2009 President, whose combined leadership, mentorship, and vision has been crucial to make this event possible. We would...
also like to thank all conference participants and session chairs, as well as the funding bodies that have facilitated this gathering.

Eva M. Campo
Jaume Esteve
Eugene M. Terentjev