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Yoseph Bar-Cohen
Federico Carpi
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Contents

Part One

xiii	<i>Conference Committee</i>
xviii	<i>Introduction</i>

EAP AS EMERGING ACTUATORS

7976 02	Walking with springs (Keynote Paper) [7976-01] T. G. Sugar, Arizona State Univ. (United States); K. W. Hollander, SpringActive, Inc. (United States); J. K. Hitt, United States Military Academy (United States)
7976 03	Dielectric elastomers: from the beginning of modern science to applications in actuators and energy harvesters (Invited Paper) [7976-02] R. Baumgartner, C. Keplinger, R. Kaltseis, R. Schwödiauer, S. Bauer, Johannes Kepler Univ. Linz (Austria)
7976 04	Directions for development of the field of electroactive polymer (EAP) [7976-03] Y. Bar-Cohen, Jet Propulsion Lab. (United States)

ENERGY HARVESTING SPECIAL SESSION: PART I

7976 05	From boots to buoys: promises and challenges of dielectric elastomer energy harvesting (Invited Paper) [7976-04] R. D. Kornbluh, R. Pelrine, H. Prahlad, A. Wong-Foy, B. McCoy, S. Kim, J. Eckerle, T. Low, SRI International (United States)
7976 06	Acrylic interpenetrating polymer network dielectric elastomers for energy harvesting [7976-05] P. Brochu, X. Niu, Q. Pei, Univ. of California, Los Angeles (United States)
7976 07	Characterization of the effect of energy harvesting on the dynamic response of dielectric elastomers [7976-06] H. L. Lai, C.-A. Tan, Y. Xu, Wayne State Univ. (United States)
7976 08	Energy harvesting from flutter instabilities of heavy flags in water through ionic polymer metal composites [7976-07] A. Giacomello, M. Porfiri, Polytechnic Institute of New York Univ. (United States)

ENERGY HARVESTING SPECIAL SESSION: PART II

7976 0B	Realizing the potential of dielectric elastomer generators [7976-10] T. McKay, B. O'Brien, The Univ. of Auckland (New Zealand); E. Calius, Industrial Research Ltd. (New Zealand); I. Anderson, The Univ. of Auckland (New Zealand)
---------	---

- 7976 0C **Circuit design considerations for regulating energy generated by dielectric elastomer generators** [7976-11]
H. C. Lo, T. McKay, B. M. O'Brien, The Univ. of Auckland (New Zealand); E. Calius, Industrial Research Ltd. (New Zealand); I. Anderson, The Univ. of Auckland (New Zealand)
- 7976 0D **Battery modeling for energy harvesting system** [7976-12]
R. Tiwari, N. Buch, E. Garcia, Cornell Univ. (United States)

EUROPEAN SCIENTIFIC NETWORK FOR ARTIFICIAL MUSCLE (ESNAM) SPECIAL SESSION: ENERGY HARVESTING

- 7976 0G **Dielectric elastomer materials for actuators and energy harvesting** [7976-15]
D. M. Opris, M. Molberg, F. Nüesch, C. Löwe, C. Walder, B. Fischer, EMPA (Switzerland)
- 7976 0H **Evaluation and optimization of energy harvesting cycles using dielectric elastomers** [7976-16]
C. Graf, J. Maas, Hochschule Ostwestfalen-Lippe Univ. of Applied Sciences (Germany)
- 7976 0I **Scalable design of DEAP for energy harvesting utilizing PolyPower** [7976-17]
M. Benslimane, M. J. Tryson, J. Oubak, H.-E. Kil, Danfoss PolyPower A/S (Denmark)

ESNAM SPECIAL SESSION: MATERIALS AND DEVICES I

- 7976 0J **Molecular level materials design for improvements of actuation properties of dielectric elastomer actuators (Invited Paper)** [7976-18]
G. Kofod, H. Stoyanov, M. Kollosche, S. Risse, H. Ragusch, D. N. McCarthy, R. Waché, D. Rychkov, M. Dansachmüller, Univ. of Potsdam (Germany)
- 7976 0K **Conducting IPN actuators for biomimetic vision system (Invited Paper)** [7976-19]
N. Festin, Univ. de Cergy-Pontoise (France) and Brain Vision Systems (France); C. Plesse, C. Chevrot, D. Teyssié, Univ. de Cergy-Pontoise (France); P. Pirim, Brain Vision Systems (France); F. Vidal, Univ. de Cergy-Pontoise (France)
- 7976 0L **Electro-mechanical modeling of dielectric elastomer transducers with micro-structured electrodes** [7976-20]
A. Schmidt, ETH (Switzerland) and EMPA (Switzerland); A. Bergamini, C. Jordi, G. Kovacs, EMPA (Switzerland); E. Mazza, ETH (Switzerland) and EMPA (Switzerland)
- 7976 0M **Electroactive semi-interpenetrating polymer networks architecture with tunable IR reflectivity** [7976-21]
C. Chevrot, D. Teyssié, P. Verge, L. Goujon, Univ. de Cergy-Pontoise (France); F. Tran-Van, Univ. F. Rabelais (France); F. Vidal, P. H. Aubert, S. Peralta, Univ. de Cergy-Pontoise (France); L. Sauques, Délégation Générale de l'Armement (France)
- 7976 0N **DEA material enhancement with dipole grafted PDMS networks** [7976-22]
S. Risse, Univ. of Potsdam (Germany); B. Kussmaul, H. Krüger, Fraunhofer IAP (Germany); R. Waché, G. Kofod, Univ. of Potsdam (Germany)

- 7976 0O **Carbon aerogel based electrode material for EAP actuators** [7976-23]
F. Kaasik, J. Torop, Univ. of Tartu (Estonia); A.-L. Peikolainen, M. Koel, Tallinn Univ. of Technology (Estonia); A. Aabloo, Univ. of Tartu (Estonia)
- 7976 0P **Lifetime of dielectric elastomer stack actuators** [7976-24]
P. Lotz, Technische Univ. Darmstadt (Germany); M. Matysek, Philips Research Europe (Germany); H. F. Schlaak, Technische Univ. Darmstadt (Germany)
- 7976 0Q **Self-sensing properties of carbon-polymer composite (CPC) actuators** [7976-25]
K. Kruusamäe, A. Punning, A. Aabloo, Univ. of Tartu (Estonia)

ESNAM SPECIAL SESSION: MATERIALS AND DEVICES II

- 7976 0R **Miniaturized EAPs with compliant electrodes fabricated by ion implantation (Invited Paper)** [7976-26]
H. Shea, Ecole Polytechnique Fédérale de Lausanne (Switzerland)
- 7976 0S **Parameter dependence of an electro-mechanical breakdown model for insulating elastomeric films** [7976-27]
M. Kollosche, H. Stoyanov, S. Best, H. Ragusch, G. Kofod, Univ. of Potsdam (Germany)

FIELD ACTIVATED EAP

- 7976 0T **Transparent active skin** [7976-77]
H.-Y. Kwon, K. J. An, J. Kang, V. H. Phuc, N. C. Toan, B. C. Kim, J. A. Chung, B. H. Hong, J. Choi, H. Moon, J. Koo, J. Nam, H. R. Choi, Sungkyunkwan Univ. (Korea, Republic of)
- 7976 0U **Multilayer dielectric elastomer actuators with ion implanted electrodes** [7976-29]
A. Punning, S. Akbari, M. Niklaus, H. Shea, Ecole Polytechnique Fédérale de Lausanne (Switzerland)
- 7976 0V **Multi-walled carbon nanotubes (MWCNT) as compliant electrodes for dielectric elastomer actuators** [7976-30]
S.-L. Chua, X.-H. Neo, G.-K. Lau, Nanyang Technological Univ. (Singapore)

ESNAM SPECIAL SESSION: MATERIALS AND DEVICES III

- 7976 0X **Dielectric elastomer actuators with granular coupling** [7976-32]
F. Carpi, Univ. of Pisa (Italy) and Technology & Life Institute (Italy); G. Frediani, M. Nanni, Univ. of Pisa (Italy); D. De Rossi, Univ. of Pisa (Italy) and Technology & Life Institute (Italy)

IONIC EAP

- 7976 0Z **Altering the structure of polypyrrole and the influence on electrodynamic performance** [7976-34]
D. Melling, S. Wilson, Cranfield Univ. (United Kingdom); M. Berggren, E. W. H. Jager, Linköping Univ. (Sweden)

HAPTIC AND BRAILLE DISPLAYS I

- 7976 10 **Refreshable tactile displays based on bistable electroactive polymer** [7976-35]
X. Niu, P. Brochu, B. Salazar, Q. Pei, Univ. of California, Los Angeles (United States)
- 7976 11 **PVDF core-free actuator for Braille displays: design, fabrication process, and testing**
[7976-36]
T. Levard, P. J. Diglio, S.-G. Lu, C. D. Rahn, Q. M. Zhang, The Pennsylvania State Univ. (United States)
- 7976 12 **Combined driving and sensing circuitry for dielectric elastomer actuators in mobile applications** [7976-37]
M. Matysek, Philips Research Europe (Netherlands); H. Haus, H. Moessinger, Technische Univ. Darmstadt (Germany); D. Brokken, Philips Research Europe (Netherlands); P. Lotz, H. F. Schlaak, Technische Univ. Darmstadt (Germany)

IONIC EAP (CONTINUED)

- 7976 13 **Effects of TEOS content on the mechanical property of ionic polymer metal composite**
[7976-38]
Q. He, M. Yu, D. Guo, Z. Dai, Nanjing Univ. of Aeronautics and Astronautics (China)
- 7976 14 **Frequency response of IPMC actuator with palladium electrode** [7976-39]
T. Kobayashi, M. Omiya, Keio Univ. (Japan)
- 7976 15 **Millimeter thick ionic polymer membrane-based IPMCs with bimetallic Pd-Pt electrodes**
[7976-40]
V. Palmre, S. J. Kim, K. Kim, Univ. of Nevada, Reno (United States)

HAPTIC AND BRAILLE DISPLAYS II

- 7976 16 **Opportunities for micro-steerable catheters and tactile feedback technology with high performance electrostrictive EAPs** [7976-41]
S. Liu, B. C. Zellers, D. Anderson, Strategic Polymer Sciences, Inc. (United States)
- 7976 17 **Haptic device development based on electro static force of cellulose electro active paper**
[7976-42]
G. Yun, Inha Univ. (Korea, Republic of); S.-Y. Kim, Korea Univ. of Technology and Education (Korea, Republic of); S.-D. Jang, D.-G. Kim, J. Kim, Inha Univ. (Korea, Republic of)
- 7976 18 **Opportunities of hydrostatically coupled dielectric elastomer actuators for haptic interfaces**
[7976-43]
F. Carpi, Univ. of Pisa (Italy) and Technology & Life Institute (Italy); G. Frediani, Univ. of Pisa (Italy); D. De Rossi, Univ. of Pisa (Italy) and Technology & Life Institute (Italy)

IONIC EAP (CONTINUED)

- 7976 19 **Multi-component single-substrate conducting polymer actuation systems and fabrication techniques** [7976-44]
E. Paster, B. P. Ruddy, P. V. Pillai, I. W. Hunter, Massachusetts Institute of Technology (United States)
- 7976 1C **Electrostatic and thermal segmentation of multi-segment IPMC sensor-actuators** [7976-47]
J. Rossiter, Univ. of Bristol (United Kingdom); T. Mukai, RIKEN (Japan)

ESNAM SPECIAL SESSION: APPLICATIONS AND CONTROLS

- 7976 1F **Accurate free-form surface actuation using a non-pre-stretched silicone dielectric polymer actuator** [7976-50]
F. M. H. Crompvoets, D. Brokken, H. de Koning, W. M. Martam, Philips Research (Netherlands)
- 7976 1G **Comparison of dielectric materials for the activation of a macro-scale hinge configuration** [7976-51]
C. Jordi, A. Schmidt, EMPA (Switzerland) and ETH (Switzerland); G. Kovacs, EMPA (Switzerland); P. Ermanni, ETH (Switzerland)
- 7976 1H **Control concepts for dielectric elastomer actuators** [7976-52]
J. Maas, C. Graf, L. Eitzen, Ostwestfalen-Lippe Univ. of Applied Sciences (Germany)
- 7976 1I **Dielectric elastomers for active vibration control applications** [7976-53]
S. Herold, W. Kaal, T. Melz, Fraunhofer Institute for Structural Durability and System Reliability (Germany)
- 7976 1J **Physical model-based internal model control of a DE actuator** [7976-54]
R. Sarban, Danfoss PolyPower A/S (Denmark) and Univ. of Southern Denmark (Denmark); R. W. Jones, Univ. of Southern Denmark (Denmark)
- 7976 1K **Dielectric elastomer stack actuators for integrated gas valves** [7976-106]
K. Flittner, M. Schlosser, H. F. Schlaak, Technische Univ. Darmstadt (Germany)
- 7976 1L **Polypyrrol/chitosan hydrogel hybrid microfiber as sensing artificial muscle** [7976-56]
Y. A. Ismail, Univ. of Nizwa (Oman); J. G. Martínez, Univ. Politécnic de Cartagena (Spain); A. S. Al Harrasi, Univ. of Nizwa (Oman); S. J. Kim, Hanyang Univ. (Korea, Republic of); T. F. Fernández Otero, Univ. Politécnic de Cartagena (Spain)

Part Two

MODELING AND ANALYSIS OF EAP

- 7976 1N **Constitutive relation and electromechanical stability of compressible dielectric elastomer** [7976-58]
L. Liu, Harbin Institute of Technology (China); X. Liang, Institute of Process Engineering (China); K. Yang, C. Wu, Z. Liu, S. Sun, Y. Liu, J. Leng, Harbin Institute of Technology (China)

- 7976 1O **Chemo-electro-mechanical modeling of pH-sensitive hydrogels** [7976-59]
T. Wallmersperger, Technische Univ. Dresden (Germany); K. Keller, B. Kröplin, Univ. Stuttgart (Germany); M. Günther, G. Gerlach, Technische Univ. Dresden (Germany)
- 7976 1P **Charge modeling of ionic polymer-metal composites for dynamic curvature sensing** [7976-60]
Y. Bahramzadeh, M. Shahinpoor, Univ. of Maine (United States)
- 7976 1Q **A validated finite element model of a soft artificial muscle motor** [7976-61]
T. C. H. Tse, B. O'Brien, T. McKay, Auckland Bioengineering Institute (New Zealand); I. A. Anderson, Auckland Bioengineering Institute (New Zealand) and The Univ. of Auckland (New Zealand)
- 7976 1R **A viscoelastic model for dielectric elastomers based on a continuum mechanical formulation and its finite element implementation** [7976-62]
A. Bueschel, Karlsruhe Institute of Technology (Germany); S. Klinkel, Technische Univ. Kaiserslautern (Germany); W. Wagner, Karlsruhe Institute of Technology (Germany)
- 7976 1S **Modeling and designing IPMCs for twisting motion: electromechanical and mechano-electrical transduction** [7976-63]
D. Pugal, K. J. Kim, K. K. Leang, V. Palmre, Univ. of Nevada, Reno (United States)

APPLICATIONS OF EAP I: FIELD ACTIVATED

- 7976 1T **Flexidrive: a soft artificial muscle motor (Invited Paper)** [7976-64]
I. A. Anderson, Auckland Bioengineering Institute (New Zealand) and The Univ. of Auckland (New Zealand); T. C. H. Tse, T. Inamura, B. O'Brien, T. McKay, T. Gisby, Auckland Bioengineering Institute (New Zealand)
- 7976 1U **In-plane DEAP stack actuators for optical MEMS applications** [7976-65]
J. Brunne, S. Kazan, U. Wallrabe, Univ. of Freiburg (Germany)

NON-EAP ACTUATORS I

- 7976 1V **Determination of the sinking and terminating points of action unit on humanoid skull through GFEAD** [7976-66]
Y. Tadesse, S. Priya, Virginia Polytechnic Institute and State Univ. (United States)

APPLICATIONS OF EAP I: FIELD ACTIVATED (CONTINUED)

- 7976 1Y **Relaxor fluorinated polymers: novel applications and recent developments** [7976-69]
F. Bauer, D. Dos Santos, Piézotech S.A.S. (France); Q. Zhang, The Pennsylvania State Univ. (United States)
- 7976 1Z **Antagonistic dielectric elastomer actuator for biologically-inspired robotics** [7976-70]
A. T. Conn, J. Rossiter, Univ. of Bristol (United Kingdom) and Bristol Robotics Lab. (United Kingdom)

- 7976 20 **Closed loop control of dielectric elastomer actuators** [7976-71]
T. A. Gisby, B. M. O'Brien, Auckland Bioengineering Institute (New Zealand); S. Q. Xie, The Univ. of Auckland (New Zealand); E. P. Calius, Industrial Research Ltd. (New Zealand); I. A. Anderson, Auckland Bioengineering Institute (New Zealand) and The Univ. of Auckland (New Zealand)
- 7976 21 **Dielectric elastomer memory** [7976-72]
B. M. O'Brien, T. G. McKay, S. Q. Xie, The Univ. of Auckland (New Zealand); E. P. Calius, Industrial Research Ltd. (New Zealand); I. A. Anderson, The Univ. of Auckland (New Zealand)
- 7976 22 **Modelling approaches for a novel balloon-shape actuator made of electroactive polymers** [7976-73]
M. Soleimani, J. Aristizabal, C. Menon, Simon Fraser Univ. (Canada)

APPLICATIONS OF EAP II: IONIC EAP

- 7976 23 **A bionic eye actuated by ionic polymer-metal composite (IPMC) artificial muscle** [7976-74]
M. Yu, Y. Li, Q. He, L. Song, Z. Dai, Nanjing Univ. of Aeronautics and Astronautics (China)
- 7976 24 **Design and development of bio-inspired underwater jellyfish like robot using ionic polymer metal composite (IPMC) actuators** [7976-75]
B. Akle, Lebanese American Univ. (Lebanon); J. Najem, D. Leo, Virginia Polytechnic Institute and State Univ. (United States); J. Blottman, Naval Undersea Warfare Ctr. (United States)
- 7976 25 **Multilayered polypyrrole-gold-polyvinylidene fluoride composite actuators** [7976-76]
C. F. Smith, S. C. Yang, T. E. Long, S. Priya, Virginia Polytechnic Institute and State Univ. (United States)
- 7976 26 **Cell-inspired electroactive polymer materials incorporating biomolecular materials** [7976-78]
S. A. Sarles, D. J. Leo, Virginia Polytechnic Institute and State Univ. (United States)
- 7976 27 **Localization of source with unknown amplitude using IPMC sensor arrays** [7976-88]
A. T. Abdulsadda, F. Zhang, X. Tan, Michigan State Univ. (United States)

APPLICATIONS OF EAP I: FIELD ACTIVATED (CONTINUED)

- 7976 28 **A dual axis shear force film sensor for robotic tactile applications** [7976-79]
B. Kim, S. Shin, J. Chung, Y. Lee, J.-D. Nam, H. Moon, H. R. Choi, J. C. Koo, Sungkyunkwan Univ. (Korea, Republic of)
- 7976 29 **Dielectric elastomer pump for artificial organisms** [7976-80]
A. E. Bowers, Univ. of Bristol (United Kingdom) and Bristol Robotics Lab. (United Kingdom); J. M. Rossiter, Univ. of Bristol (United Kingdom); P. J. Walters, Univ. of the West of England (United Kingdom); I. A. Ieropoulos, Bristol Robotics Lab. (United Kingdom)
- 7976 2A **Interconnection concepts for rigid micro-electrodes of a dielectric elastomer bending tube actuator** [7976-81]
F. Wehrheim, Richard Wolf GmbH (Germany); H. F. Schlaak, Technische Univ. Darmstadt (Germany)

- 7976 2B **Considerations for contractile electroactive materials and actuators** [7976-82]
L. Rasmussen, D. Schramm, P. Rasmussen, K. Mullally, Ras Labs, LLC (United States);
L. D. Meixler, D. Pearlman, A. Kirk, Princeton Plasma Physics Lab. (United States)
- 7976 2C **Design of a MRI-compatible dielectric elastomer powered jet valve** [7976-83]
S. Proulx, P. Chouinard, J.-P. Lucking Bigue, G. Miron, J.-S. Plante, Univ. de Sherbrooke
(Canada)

APPLICATIONS OF EAP II: IONIC EAP (CONTINUED)

- 7976 2D **Biochemical microsensors on the basis of metabolically sensitive hydrogels** [7976-84]
M. Günther, G. Gerlach, T. Wallmersperger, Technische Univ. Dresden (Germany);
F. Solzbacher, J. J. Magda, G. Lin, P. Tathireddy, M. P. Orthner, The Univ. of Utah (United
States)
- 7976 2E **Linear and bending actuation of bucky gel** [7976-85]
M. Biso, A. Ansaldo, Italian Institute of Technology (Italy); V. Vintera, Univ. di Genova (Italy);
D. Ricci, Italian Institute of Technology (Italy)
- 7976 2G **An automatic tuning method of the largest amplitude vibration of Au-nafion IPMC** [7976-87]
A. Itoh, Y. Mori, Tokyo Denki Univ. (Japan)

POSTER SESSION

- 7976 2H **Inkjet printing of electroactive polymer actuators on polymer substrates** [7976-89]
O. Pabst, Friedrich-Schiller-Univ. Jena (Germany) and Fraunhofer Institute for Applied Optics
and Precision Engineering (Germany); J. Perelaer, Friedrich-Schiller-Univ. Jena (Germany);
E. Beckert, Fraunhofer Institute for Applied Optics and Precision Engineering (Germany);
U. S. Schubert, Friedrich-Schiller-Univ. Jena (Germany); R. Eberhardt, Fraunhofer Institute for
Applied Optics and Precision Engineering (Germany); A. Tünnermann,
Friedrich-Schiller-Univ. Jena (Germany) and Fraunhofer Institute for Applied Optics and
Precision Engineering (Germany)
- 7976 2I **Electroactive polymer devices for active vibration damping** [7976-90]
C. Graf, J. Maas, Hochschule Ostwestfalen-Lippe Univ. of Applied Sciences (Germany)
- 7976 2J **Dielectric elastomer actuators with enhanced permittivity and strain** [7976-91]
H. Böse, D. Uhl, Fraunhofer-Institut für Silicatforschung (Germany); K. Flittner, H. Schlaak,
Technische Univ. Darmstadt (Germany)
- 7976 2L **PWM drive of IPMC actuators with the consideration of the capacitive impedance** [7976-93]
K. Takagi, Nagoya Univ. (Japan) and RIKEN (Japan); N. Yamaguchi, Nagoya Univ. (Japan);
K. Asaka, AIST (Japan)
- 7976 2M **Active suspension with multilayer dielectric elastomer actuator** [7976-94]
R. Karsten, P. Lotz, H. F. Schlaak, Technische Univ. Darmstadt (Germany)

- 7976 2N **Low voltage driven dielectric electro active polymer actuator with integrated piezoelectric transformer based driver** [7976-95]
T. Andersen, M. S. Rødgaard, O. C. Thomsen, M. A. E. Andersen, Technical Univ. of Denmark (Denmark)
- 7976 2O **Ion distribution in ionic electroactive polymer actuators** [7976-96]
Y. Liu, C. Lu, The Pennsylvania State Univ. (United States); S. Twigg, Villanova Univ. (United States); J. Lin, G. Hatipoglu, The Pennsylvania State Univ. (United States); S. Liu, Strategic Polymer Sciences, Inc. (United States); N. Winograd, Q. M. Zhang, The Pennsylvania State Univ. (United States)
- 7976 2Q **Electromechanical fatigue in IPMC under dynamic energy harvesting conditions** [7976-98]
A. Krishnaswamy, D. Roy Mahapatra, Indian Institute of Science (India)
- 7976 2R **DEA based neonatal lung simulator** [7976-99]
S. Schlatter, E. Haemmerle, R. Chang, B. M. O'Brien, T. Gisby, I. Anderson, The Univ. of Auckland (New Zealand)
- 7976 2S **Open-loop control of IPMC actuators under varying temperatures** [7976-100]
R. Dong, X. Tan, Michigan State Univ. (United States)
- 7976 2T **Influence of fabrication process steps on Pd-IPMC electrode morphologies and mechano-electrical properties** [7976-101]
Z. Zhu, H. Chen, L. Chang, B. Li, Y. Wang, Xi'an Jiaotong Univ. (China)
- 7976 2V **New elastomeric silicone based networks applicable as electroactive systems** [7976-104]
A. G. Bejenariu, M. Boll, M. R. Lotz, C. Vraa, A. L. Skov, Technical Univ. of Denmark (Denmark)
- 7976 2W **Induced interaction of NH_4NO_3 with poly(p-phenylene vinylene) by mean of zeolite Y** [7976-107]
J. Kamonsawas, A. Sirivat, Chulalongkorn Univ. (Thailand); P. Hormnirun, Kasetsart Univ. (Thailand); W. Prissanaroon, KNITB (Thailand)
- 7976 2Z **Biomimetic small scale variable focal length lens unit using synthetic elastomer actuators** [7976-110]
B. Kim, J. Chung, Y. Lee, J.-D. Nam, H. Moon, H. R. Choi, J. C. Koo, Sungkyunkwan Univ. (Korea, Republic of)
- 7976 36 **High actuation strain in silicone dielectric elastomer actuators with silver electrodes** [7976-118]
S. H. Low, G. K. Lau, Nanyang Technological Univ. (Singapore)
- 7976 37 **Ionic polymer-metal composite enabled robotic manta ray** [7976-119]
Z. Chen, T. I. Um, H. Bart-Smith, Univ. of Virginia (United States)
- 7976 39 **Experimental analysis of biasing elements for dielectric electro-active polymers** [7976-122]
M. Hodgins, S. Seelecke, Univ. of Saarland (Germany)
- 7976 3A **Dynamic window daylighting systems: electropolymeric technology for solar responsive building envelopes** [7976-123]
E. A. Kriemeyer, S. I. Smith, A. H. Dyson, Rensselaer Polytechnic Institute (United States)

7976 3B **Dielectric and insulating properties of an acrylic DEA material at high near-DC electric fields**

[7976-124]

L. Di Lillo, ETH Zurich (Switzerland); A. Schmidt, ETH Zurich (Switzerland) and EMPA (Switzerland); A. Bergamini, EMPA (Switzerland); P. Ermanni, ETH Zurich (Switzerland); E. Mazza, ETH Zurich (Switzerland) and EMPA (Switzerland)

Author Index

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Qiming M. Zhang, The Pennsylvania State University (United States)

Session Chairs

- 1 EAP as Emerging Actuators
Yoseph Bar-Cohen, Jet Propulsion Laboratory (United States)
Federico Carpi, Università di Pisa (Italy)
- 2 Energy Harvesting Special Session: Part I
Siegfried G. Bauer, Johannes Kepler Universität Linz (Austria)
Roy D. Kornbluh, SRI International (United States)
- 3 EAP-in-Action Demonstration Session
Yoseph Bar-Cohen, Jet Propulsion Laboratory (United States)
- 4 Energy Harvesting Special Session: Part II
Zhigang Suo, Harvard University (United States)
Jonathan M. Rossiter, University of Bristol (United Kingdom)
- 5 European Scientific Network for Artificial Muscle (ESNAM) Special Session: Energy Harvesting
Hans-Erik Kiil, Danfoss PolyPower A/S (Denmark)
Frederic Vidal, Université de Cergy-Pontoise (France)
- 6 ESNAM Special Session: Materials and Devices I
Peter Lotz, Technische Universität Darmstadt (Germany)
Guggi Kofod, Universität Potsdam (Germany)
Karl Kruusamäe, University of Tartu (Estonia)

- 7a ESNAM Special Session: Materials and Devices II
Herbert R. Shea, Ecole Polytechnique Fédérale de Lausanne (Switzerland)
Qibing Pei, University of California, Los Angeles (United States)
- 7b Field Activated EAP
Roy D. Kornbluh, SRI International (United States)
Jinsong Leng, Harbin Institute of Technology (China)
- 8a ESNAM Special Session: Materials and Devices III
Edwin W. H. Jager, Linköping University (Sweden)
Tissaphern Mirfakhrai, Stanford University (United States)
- 8b Ionic EAP
Keiichi Kaneto, Kyushu Institute of Technology (Japan)
Kwang J. Kim, University of Nevada, Reno (United States)
- 9a Haptic and Braille Displays I
Qiming M. Zhang, The Pennsylvania State University (United States)
Tushar K. Ghosh, North Carolina State University (United States)
- 9b Ionic EAP (continued)
Keiichi Kaneto, Kyushu Institute of Technology (Japan)
Kwang J. Kim, University of Nevada, Reno (United States)
- 10a Haptic and Braille Displays II
Helmut F. Schlaak, Technische Universität Darmstadt (Germany)
Marc Matysek, Philips Research Nederland B.V. (Netherlands)
- 10b Ionic EAP (continued)
Keiichi Kaneto, Kyushu Institute of Technology (Japan)
Kwang J. Kim, University of Nevada, Reno (United States)
- 11a ESNAM Special Session: Applications and Controls
Iain A. Anderson, The University of Auckland (New Zealand)
Juergen Maas, Ostwestfalen-Lippe Universität of Applied Sciences (Germany)
- 11b Modeling and Analysis of EAP
Jonathan M. Rossiter, University of Bristol (United Kingdom)
Barbar J. Akle, Lebanese American University (Lebanon)
- 12a Applications of EAP I: Field Activated
Emilio P. Calius, Industrial Research Ltd. (New Zealand)
Tissaphern Mirfakhrai, Stanford University (United States)

- 12b Non-EAP Actuators I
Ravi Shankar, Intel Corporation (United States)
Andrew T. Conn, University of Bristol (United Kingdom)
- 13a Applications of EAP I: Field Activated (continued)
Emilio P. Calius, Industrial Research Ltd. (New Zealand)
Tissaphern Mirfakhrai, Stanford University (United States)
- 13b Applications of EAP II: Ionic EAP
Thomas Wallmersperger, Technische Universität Dresden (Germany)
Hani E. Naguib, University of Toronto (Canada)
- 14a Applications of EAP I: Field Activated (continued)
Emilio P. Calius, Industrial Research Ltd. (New Zealand)
Tissaphern Mirfakhrai, Stanford University (United States)
- 14b Applications of EAP II: Ionic EAP (continued)
Thomas Wallmersperger, Technische Universität Dresden (Germany)
Hani E. Naguib, University of Toronto (Canada)

Introduction

The SPIE Electroactive Polymers Actuators and Devices (EAPAD) conference is the leading international forum for presenting the latest progress and holding discussions among the attendees regarding the capabilities, challenges, and potential future directions. The conference this year was co-chaired by Federico Carpi, University of Pisa, Italy and included 124 presentations, which is the largest number of EAP related papers that have ever been submitted. EAP materials are increasingly attracting researchers from many fields for their large displacement and functional similarity to biological muscles.

The conference was well attended by internationally leading experts in the field including members of academia, industry, and government agencies from the USA and overseas. The keynote speaker was Thomas Sugar, Arizona State University, and the title of his presentation was "Walking with Springs". In his presentation he gave a review of his work related to the development of compliant wearable robots using tunable springs as well as robotic orthoses and prostheses for rehabilitation and mobility. He described spring ankle with regenerative kinetics and a powered ankle foot orthosis for stroke rehabilitation.

Turning EAP into actuators-of-choice requires solidifying the technical foundations and identifying niche applications taking advantage of their unique capabilities to provide edge for critical needs. Significant progress was reported in each of the topics of the EAP infrastructure with focus on such areas as energy harvesting, biomimetics, haptics, braille displays, and miniaturization. The papers addressed issues that can forge the transition to practical use, including improved materials, better understanding of the principles responsible for the electromechanical behavior, analytical modeling, processing and characterization methods as well as considerations and demonstrations of various applications. Two special sessions were dedicated this year to the topic of energy harvesting. Moreover, the conference included four special sessions grouping contributions from members of the European Scientific Network for Artificial Muscle (ESNAM). One of these sessions was also dedicated to energy harvesting. Other topics that were covered in this conference included:

- Electroactive polymers (EAP) and non-electro active-polymer (NEAP) materials
- Theoretical models, analysis and simulation of EAP
- Methods of testing and characterization of EAP
- EAP as artificial muscles, actuators and sensors
- Design, control, intelligence, and kinematic issues related to robotic and biomimetic operation of EAP
- Under consideration and in progress applications of EAP

The efforts described in the presented papers are showing significant improvements in understanding of the electromechanical principles and better methods of dealing with the challenges to the materials applications. Researchers are continuing to develop analytical tools and theoretical models to describe the electro-chemical and -mechanical processes, non-linear behavior as well as methodologies of design and control of the activated materials. EAP with improved response were described including dielectric elastomer, IPMC, conductive polymers, gel EAP, carbon nanotubes, and other types. Specifically, there seems to be a significant trend towards using dielectric elastomers as practical EAP actuators.

This year, the EAP-in-Action session was held on Monday, March 7, 2011 and included seven demonstrations from Benjamin Thomsen, Danfoss PolyPower A/S (Denmark); P. Lotz, Technische Univ. Darmstadt (Germany); M. Matysek, Philips Research Nederland B.V. (Netherlands); H. Haus, Technische Univ. Darmstadt (Germany); H. Moessinger, D. Brokken, Philips Research Nederland B.V. (Netherlands); H. F. Schlaak, Technische Univ. Darmstadt (Germany); Federico Carpi, Univ. of Pisa, Research Centre "E. Piaggio" (Italy); Iain Anderson, Emilio Calius, Todd Gisby, Andrew Lo, Thomas McKay, Ben O'Brien, Tony Tse, The Biomimetics Lab of the Auckland Bioengineering Institute (New Zealand); Marcus Rosenthal, Artificial Muscle, Inc. (United States); Qibing Pei, Univ. of California, Los Angeles (United States); and Lenore Rasmussen, Ras Labs. LLC (United States).

To provide the attendees with opportunity to learn about EAP, an introductory course was given on Sunday, March 6, 2011 as part of the EAPAD conference. The course was entitled "Electroactive Polymer Actuators and Devices," and the lead instructor was the conference chair, Yoseph Bar-Cohen, who presented an overview and covered applications that are currently developed and ones that are being considered. The subject of Ionic EAP was covered by John D. W. Madden, the Univ. of British Columbia, Canada, while the topic of Electronic EAP was covered by Qibing Pei from the University of California at Los Angeles (UCLA).

In closing, we would like to extend a special thanks to all the conference attendees, session chairs, the EAP-in-Action demo presenters, the members of the EAPAD program organization committee. In addition, special thanks are extended to the SPIE staff that helped making this conference a great success.

**Yoseph Bar-Cohen
Federico Carpi**