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Yoseph Bar-Cohen
Federico Carpi
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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