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Yoseph Bar-Cohen
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Introduction

The large displacement that can be produced by EAP materials and their functional similarity to biological muscles are increasingly attracting the interest of researchers from many fields. Turning these materials into actuators-of-choice continues to require solidifying the technical foundations. Also, it is essential to identify niche applications for EAP materials where their unique capabilities would provide an edge for critical needs. SPIE's Electroactive Polymers Actuators and Devices (EAPAD) conference serves as the leading international forum for presenting the latest progress and discussions among the attendees regarding the capabilities, challenges, and potential future directions.

The keynote speaker was Adam P. Summers, University of California, Irvine, and the title of his presentation was "High-performance with a 'soft' skeleton: the shark cartilage composite." This presentation gave the attendees details about the fascinating capability of sharks to swim at high speed and maneuverability using controlled body pressure. The presentation provided the audience ideas for making future robotic fish using EAP. This paper tied well with the EAP-in-Action Session where the EMPA's blimp was demonstrated with enhanced capability to be steered by Dielectric Elastomer EAP strips on its four fins. This blimp is being developed at EMPA, Switzerland, toward propelling it in the air by a wagging tail and a body that bends like a fish. The EAP-in-Action Session was held on Monday 10 March, and it included 8 demonstrations by organizations from Australia, China, Italy, New Zealand, Switzerland, and the USA. The presenters included Artificial Muscle, Inc.; Auckland Biomimetics Laboratory Bioengineering Institute, and Industrial Research Ltd. (New Zealand); Hyper Drive Corporation (Japan) and SRI International; Materials Science & Technology, EMPA, (Switzerland); Harbin Institute of Technology (China); Optotune, Zürich (Switzerland); Research Centre "E. Piaggio", University of Pisa (Italy); and University of Wollongong (Australia).

The conference program this year included 85 presentations and was well attended by leading world experts in the field including members of academia, industry, and government agencies from the USA and overseas. Significant progress was reported in each of the topics of the EAP infrastructure. The papers focused on 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. A special session dedicated to the issue of energy harvesting covered the use of EAP materials and solar energy, and vibration conversion.

Papers in this conference covered the following topics:

- 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, nonlinear behavior, as well as methodologies of design and control of the activated materials. EAP with improved response were described including electrostrictive, IPMC, dielectric, carbon nanotubes, conductive polymers, and other types. Also, the IPMC challenge of the need to maintain wetness was addressed using non-water-based electrolyte and efforts were made to deal with the high voltage requirement to drive the field activable (i.e., electronic) group.

To provide the attendees with opportunity to learn about EAP, an introductory course was given on Sunday 9 March 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 Kwang Kim from the University of Nevada-Reno. Further, the topic of electronic EAP was covered by Qibing Pei from the University of California at Los Angeles. This course was intended for engineers, scientists and managers who need to understand the basic concepts of EAP, or are interested in learning, applying or engineering mechanisms or devices using EAP materials. Also, it was intended for those who are considering research and development in EAP materials and their present and/or future applications. For those who are seeking to self-learn about EAP, comprehensive coverage of the topic is given in the book *Electroactive Polymer (EAP) Actuators as Artificial Muscles—Reality, Potential, and Challenges* (SPIE Press, 2nd ed., http://ndeaa.jpl.nasa.gov/nasa-nde/yosi/yosi-books.htm, as well as the WW-EAP webhub: (http://eap.jpl.nasa.gov) with links to the leading research and development labs worldwide, and the WW-EAP Newsletter.

In closing, I 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 and my cochair, Emilio P. Calius, Industrial

Research Ltd., New Zealand. In addition, special thanks are extended to the SPIE staff that helped making this conference a great success.

Yoseph Bar-Cohen