

# WorldWide ElectroActive Polymers



# EAP

## (Artificial Muscles) Newsletter

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WW-EAP Newsletter  
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### FROM THE EDITOR

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This Newsletter issue reports the latest progress in the fields of Electroactive Polymers (EAP) and Biomimetics.

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### ABOUT THE EXPERTS

#### Visitor to the NDEAA Lab at JPL

On December 1, 2017, Ji Su, NASA Langley Research Center (LaRC), visited at the Nondestructive Evaluation and Advanced Actuators (NDEAA) lab of Jet Propulsion Laboratory (JPL). Ji Su is the EAP pioneer who developed the Electro-Strictive Graft-Elastomer. The objective of his visit has been to discuss the current state of the art of the field of EAP and potential niche applications that may help propel the field toward development of commercial products.



**Figure 1:** Ji Su, NASA LaRC (left), and Yoseph Bar-Cohen, JPL, during the visit of Ji Su to the NDEAA Lab, JPL.

At the upcoming 20<sup>th</sup> SPIE EAPAD Conference that will be held on March 5-8, 2018 at Denver, CO, Ji Su is going to give an invited paper reviewing the development of the graft-Elastomers over the last 20 years.

## GENERAL NEWS

The WW-EAP Webhub <http://eap.jpl.nasa.gov> is periodically being updated with information regarding the EAP activity worldwide. This Webhub is a link of the JPL's NDEAA Webhub of the Advanced Technologies Group having the address: <http://ndea.jpl.nasa.gov>

## EAP Commercialization

### StretchSense brings EAP to the people

Iain Anderson [i.anderson@auckland.ac.nz](mailto:i.anderson@auckland.ac.nz)

StretchSense Ltd. has developed a new product that will take the hassle out of the fitting of clothes. This product is called the Zozosuit and information can be found at <https://www.stretchsense.com/article-resources/press/slip-into-the-zozosuit-to-take-the-headache-out-of-online-shopping/>. This stretchy suit conforms to your body shape and contains 150 EAP stretch sensors that communicate with customized electronics. Put it on and it will capture your measurements for confident on-line clothes shopping. The suit is being manufactured for StretchSense's customer Start Today, a Japanese online fashion retailer, and owner of the ZozoTown shopping portal.

StretchSense Ltd. is a spin-out from the Auckland Bioengineering Institute's Biomimetics Lab ([www.biomimeticslab.com](http://www.biomimeticslab.com)). It was founded about 5 years ago by Ben O'Brien (CEO), Todd Gisby (CTO) and Iain Anderson (Chief Scientist).

## Standard for EAP

A paper about a standard for EAP materials is posted on the internet and can be read at <http://dx.doi.org/10.1088/0964-1726/24/10/105025>

## JOB OPPORTUNITIES

### Faculty openings at Northwestern University, USA

Openings at the assistant, associate, or full professor levels are available at the Dept. Mechanical Engineering of Northwestern University

Horacio D. Espinosa, [espinosa@northwestern.edu](mailto:espinosa@northwestern.edu)

### Positions Summary

The Mechanical Engineering Department at Northwestern University invites applications for multiple tenure-track faculty positions at the Assistant, Associate, or Full Professor levels.

### Positions Details

Candidates are expected to build world-class research program, to contribute to the interdisciplinary collaborative research culture at Northwestern, and to demonstrate a commitment to teaching in the undergraduate and graduate programs in the McCormick School of Engineering.

Outstanding applicants will be considered in all research areas related to mechanical engineering. Areas of particular interest include materials design, mechanics of materials, robotics, and advanced manufacturing, including bio-manufacturing and additive manufacturing, nano/micro-manufacturing - with connections to fields such as healthcare, machine learning, data analytics, cyber-physical systems, and water and energy.

To ensure full consideration, applications should be received by December 31, 2017. Applications will be accepted until the positions are filled. Application materials should be submitted to the Search Committee Chair, exclusively via the link:

<https://facultyrecruiting.northwestern.edu/apply/MzE=>

Candidates should upload a cover letter, curriculum vitae, statement of research, statement of teaching, and the names and contact information for three to five references. Information about the Mech. Eng. Dept. at Northwestern University is available at <http://www.mech.northwestern.edu>

### Equal Employment Opportunity

Northwestern University is an Affirmative Action/Equal Opportunity employer. Women and minorities are encouraged to apply. Hiring is contingent upon eligibility to work in the United States. It is the policy of Northwestern University not to discriminate against any individual based on race, color, religion, national origin, sex, sexual orientation, marital status, age, disability, citizenship, veteran status or other protected group status.

### **Postdoc opening at Linköping University, Sweden**

#### **Postdoc scholarship position in Textile Actuators for Wearables**

Edwin Jager, [edwin.jager@liu.se](mailto:edwin.jager@liu.se)

Linköping University, Sweden, Department of Physics, Chemistry and Biology (IFM) has a postdoc scholarship position in Textile Actuators for Wearables. The selected postdoc will fabricate, optimize and characterize soft artificial muscles based on electroactive polymers and textiles. The textile actuators may be based on single yarns or fabrics. He/She will also integrate the textile actuators in various textile constructions and electroactive wearables. The work will be carried out at Division of Sensor and Actuator Systems (<https://liu.se/en/research/sensor-and-actuator-systems>) in the unit of Edwin Jager and in close collaboration with the Swedish School of Textiles at University of Borås (<http://www.hb.se/en/The-Swedish-School-of-Textiles>). The Postdoc will essentially carry out research. The position may also involve teaching, but during no more than a fifth of work time.

The position requires a doctorate within an applicable background such as mechanical engineering, (organic) chemistry, materials science, or applied physics. Experience in smart textiles, wearables, soft actuators, electroactive polymers, or linear actuators is preferred.

Linköping University will continue to develop as an attractive and creative place of work, characterized by equal terms and actively works for

equality and diversity. Complete description of the position opportunity and information about how to apply can be found at:

[https://people.ifm.liu.se/edwja/advertisement\\_post-doc1.pdf](https://people.ifm.liu.se/edwja/advertisement_post-doc1.pdf) Contact: Edwin Jager, [edwin.jager@liu.se](mailto:edwin.jager@liu.se)

### **Awards, EAP Societies and Committees**

#### **Call for award nominations of biomimetics innovation**

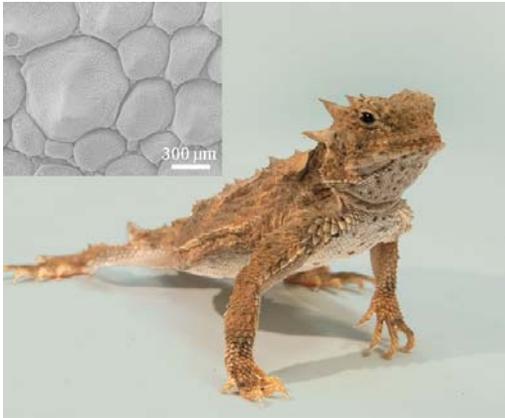
Ljuba Woppowa [woppowa@vdi.de](mailto:woppowa@vdi.de)

The call for the International Bionic Award 2018 has been issued by the German Association of Engineers (VDI) and the Schauenburg Foundation. Applications and nominations in the form of a paper written in English are due by 28 February 2018.

Every other year, this call is issued and it is a reward for outstanding scientific achievement of product development in the field of biomimetics. Among other objectives, it seeks to support young scientists worldwide. The awardee(s) receives 10,000 EUR.

The International Bionic Award honors an excellent work, and example of a biomimetic/bionic product that can be submitted for award includes bachelor thesis or dissertation that has been completed within the last two years before the submission deadline. Both individuals and teams can participate. An international committee of top-ranking scientists in biomimetics selects the International Bionic Award Winner(s).

The winners of the International Bionic Award 2016 are Philipp Comanns, RWTH Aachen, Germany, Kai Winands and Mario Pothen, Fraunhofer-Institute for Production Technology IPT Aachen, Germany, as well as Gerda Buchberger, Johannes Kepler University Linz, Austria for their excellent scientific work. Their product has been inspired by the Texas horned lizard's skin, innovative capillary surface structures. It enabled (uni)directional liquid transport for applications ranging from lubrication to lab-on-a-chip (**Figure 2**).



**Figure 2:** Winner of the 2016 award: Inspired by the Texas horned lizard's skin, innovative capillary surface structures enable (uni)directional liquid transport for applications ranging from lubrication to lab-on-a-chip (Image: RWTH Aachen University, Germany, JKU Linz/Austria; and Fraunhofer IPT, Germany)

Biomimetics is an interdisciplinary field of natural and engineering sciences. It belongs to the most important future technologies. Developments in biomimetics implement innovative and novel solutions for technical problems inspired by nature.

In 2008, the Bionic Award was launched by the Schauenburg Foundation and the VDI, and was established to encourage start-ups and to open new avenues for young scientists in developing innovative biomimetic products. This award has been proved to be impressive by the success of the past years awardees.

Further information about the award and the requirements for participation can be found at [www.vdi.de/bionic2018](http://www.vdi.de/bionic2018) or obtained from the VDI Society Technologies of Life Sciences (VDI-TLS), POB 10 11 39, 40002 Düsseldorf/Germany, e-mail: [bionik@vdi.de](mailto:bionik@vdi.de).

The contact person at VDI is: Ljuba Woppowa, VDI Society Technologies of Life Sciences, Telephone: +49 211 6214-266, Fax: +49 211 6214-97266; and e-mail: [bionik@vdi.de](mailto:bionik@vdi.de)

About VDI: The VDI Association of German Engineers has been in operation for over 150 years and has over 155,000 members. It is the largest engineering association in Germany and

the third largest standards organization. VDI collaborates its activity with the German business community and scientific organizations.

About the Schauenburg Foundation: The international Bionic Award has been endowed by the Schauenburg-Foundation since 2008. The Schauenburg-Foundation was established in 1986 by Hans-Georg Schauenburg, who was the founder of the Schauenburg Group and has been in business in the Rhein-Ruhr area for over 60 years. The focus of the Schauenburg-Foundation, which is administered by the independent Stifterverband (Stifterverband is the business community's innovation agency for the German science system), reflects the close connection of the International Schauenburg Group to its roots and with scientific and technical innovation. The foundation mainly endorses academic projects in the area of engineering, economics and social sciences, as well as supporting young people in their vocational training.

## The International EuroEAP Society

**Annual Meeting and benefits of being a member**  
*Anne Ladegaard Skov, DTU, Denmark, [al@kt.dtu.dk](mailto:al@kt.dtu.dk); Edwin Jager, Linköping University, Sweden; and Gabor Kovacs, Empa, Switzerland*

The EuroEAP – European Society for Electro-mechanically Active Polymer Transducers & Artificial Muscles' ([www.euroeap.eu](http://www.euroeap.eu)) is a non-profit international association. Its main objective is to contribute to and promote the scientific and technological advancement and the diffusion of transducers and Artificial Muscles using Electromechanically Active Polymers (EAP).

The Society operates at international level and it welcomes members from any country worldwide. If you are interested in learning more about the Society, please visit the website [www.euroeap.eu](http://www.euroeap.eu) and subscribe to become a Member of this EAP field association and take advantage of the benefits of being a Member including:

- Being part of the largest international scientific and industrial Association in the EAP field;
- Facilitated networking with experts and professionals in the EAP field, and easy access to the most recent developments;

- Reduction on the registration fees for the annual EuroEAP Conference;
- Discount on the purchase of the EuroEAP Conference proceedings;
- Possibility to apply to annual calls for short term scientific missions grants offered by the Society to foster or strengthen collaborations with any institution in any country of any continent;
- Possibility to participate in the annual Society Challenge;
- Possibility to disseminate your work via the broad EuroEAP emailing list;
- Possibility to participate in working groups on topics of scientific, technological and industrial relevance in the EAP field;
- Being a member of the General Assembly of the EuroEAP Society, with voting rights and eligibility to its Committees.

The next Annual Meeting of the Society will be held at the same place hosting the next EuroEAP conference: [www.euroeap.eu/conference](http://www.euroeap.eu/conference). The Meeting will take place in the afternoon of the day before.

## **EuroEAP 2020: Call for candidatures**

### **The EuroEAP Conference Committee**

European groups active in the EAP field are warmly invited to submit candidacy for the organisation of EuroEAP 2020 – the 10th International Conference on Electromechanically Active Polymer (EAP) transducers & artificial muscles. The event will be held during the first half of June 2020, at a nice location that is well connected to an international airport. The location of previous EuroEAP conferences are listed at [www.euroeap.eu/conference](http://www.euroeap.eu/conference). Candidate for becoming Chairpersons are kindly requested to contact by email the President and Vice-President of the EuroEAP Conference Committee, Anne Ladegaard Skov ([al@kt.dtu.dk](mailto:al@kt.dtu.dk)) and Edwin Jager ([edwin.jager@liu.se](mailto:edwin.jager@liu.se)).

## **UPCOMING CONFERENCES**

### **2018 SPIE EAPAD Conference**

The 2018 SPIE's EAPAD conference is going to be held at Denver, Colorado, from March 4 thru 8, 2018. This conference, which is part of the Smart Structures Symp., is going to be the 20<sup>th</sup> annual one and is going to be chaired by Yoseph Bar-Cohen, JPL, and Co-chaired by Iain A. Anderson, The

Univ. of Auckland (New Zealand). The Conference Program Committee consists of representatives from 32 countries. The call for papers is posted at: <http://www.spie.org/eap>

The papers will focus on issues that help transitioning EAP to practical use thru better understanding the principles responsible for the electro-mechanical behavior, analytical modeling, improved materials and their processing methods, characterization of the properties and performance as well as various applications.

In the 2018 EAPAD Conf., a Special Session is going to be “Celebrating the EAP Advances in The Last 20 Years” and will have presentation by pioneers of the field. The speakers are going to give an overview of the progress in each of the key EAP materials.

The Keynote speaker is going to be Brian Trease (**Figure 3**), Mechanical, Industrial, & Manufacturing Engineering, The University of Toledo. His paper title is “Origami-inspired Engineering, from Minimally Invasive Surgery to Exoplanet Exploration”. His bio is as follows: After graduating from the University of Michigan, Brian Trease spent eight years working at NASA JPL in Pasadena, CA. His specialties include mechanism design, optimization, flexible systems, and deployable structures. At NASA, Dr. Trease was a research technologist in compliant mechanisms, printable spacecraft, rover mobility, and solar sail development. His current research interests at the University of Toledo include origami-inspired design, biomimicry, swarm robotics, and autonomous robotics for environmental remediation.

The abstract of Brian Trease's presentation is as follows: The engineering world has exploded with recent interest in the craft of origami. Most often, this traditional art form has been associated with Japan and it has become fertile ground for inspiration of devices with applications ranging from medicine to aerospace. What is it about origami that makes it attractive, and why is the origami revolution occurring now? This talk will present an overview of the prominent figures and applications that are currently driving innovation in

the field. Engineers and artists alike have come together to develop new techniques that take the practice from paper curiosities to practical engineered devices and systems. Foldable tools are now entering the human body during minimally invasive surgery, and foldable optical structures are being designed for the next generation of space-based telescopes. Mathematicians, material scientists, roboticists, architects, and mechanical designers are all investigating classical origami patterns and inventing new ones, benefiting from the insights and craftsmanship of partnering artist. The resulting software tools are accessible by engineers, tinkerers, and artists alike, some of who then leverage laminated manufacturing techniques to fabricate fully-operational systems with embedded electrical components and smart material actuation. While engineering is often influenced by external disciplines, such as biology or aesthetics, the melding of engineering and origami has been uniquely synergistic. The interaction of scientists and artists has mutually benefited both sides: beyond the novel advancements in engineering, the artists themselves are taking back the numerical tools and material innovations, using them to produce revolutionary pieces of balanced complexity and elegance.



**Figure 3:** Brian Trease, the Keynote Speaker at the 2018 EAPAD.

For the record of the EAPAD conferences archive, the following is the list of the Co-chairs

since the first one that was held in 1999 at Newport Beach, CA.

Year	Co-chair	Country
1999	Mohsen Shahinpoor, U. of New Mexico	USA
2000	Steve Wax, DARPA	USA
2001	Danilo De Rossi, Univ. degli Studi di Pisa	Italy
2002	Yoshihito Osada, Hokkaido University	Japan
2003	Geoff Spinks, University of Wollongong	Australia
2004	Peter Sommer-Larsen, Risoe National Lab.	Denmark
2005	John D. Madden, U. of British Columbia	Canada
2006	Jae-Do Nam, Sung Kyun Kwan University	S. Korea
2007	Gabor Kovacs, EMPA	Switzerland
2008	Emillio P. Calius, Industrial Res. Limited	New Zealand
2009	Thomas Wallmersperger, Univ. Stuttgart	Germany
2010	Jinsong Leng, Harbin Institute of Tech.	China
2011	Federico Carpi, Univ. of Pisa	Italy
2012	Keiichi Kaneto, Kyushu Inst. of Tech.	Japan
2013	Siegfried Bauer, Johannes Kepler U.	Austria
2014	Barbar J. Akle, Lebanese American Univ.	Lebanon
2015	Gal deBotton, Ben-Gurion U. of the Negev	Israel
2016	Frédéric Vidal, U. de Cergy-Pontoise	France
2017	Jonathan Rossiter, University of Bristol	England
2018	Iain A. Anderson, The Univ. of Auckland	New Zealand

### EuroEAP 2018 – the 8th international Conf. on EAPs

The rapid expansion of the EAP technologies has stimulated in Europe the creation of the annual, international EuroEAP conference series, organized by the EuroEAP Society. The conference is a multidisciplinary event with international breath. It is always held in Europe at charming and easy-to-reach locations, and it gathers participants and experts from all over the world.

The EuroEAP conference has a unique format, which is conceived to facilitate interaction among participants and includes:

- ‘EAPlenaries’: plenary talks;
- ‘EAPodiums’: invited lectures;
- ‘EAPromises’: invited lectures given by young emerging researchers;
- ‘EAPills’: very short oral presentations given by all the non-invited contributors;
- ‘EAPosters’: poster presentations (associated with the ‘EAPills’) given by all the non-invited contributors;

- ‘EAPrototypes’: exhibitions of prototypes (optional and free-of-charge for all attendees);
- ‘EAProducts’: exhibitions of products (optional and free-of-charge for all attendees).

The entire event is condensed into two days, consisting of consecutive single-track sessions that include oral and poster sessions. During the oral sessions, all the contributors (invited and not) present the significance of their work, in front of all the participants.

For non-invited participants, the oral presentation is very short (EAPill) and it is aimed at anticipating in no more than 2 minutes key aspects of the work, which then has to be presented more extensively in a poster (EAPoster) during a subsequent dedicated poster session.

EAPills and EAPosters have to be prepared according to a special template that is described in the section ‘Templates’.

The invited oral presentations are given by world-leading scientists, young emerging researchers, as well as representatives of industry.

The oral sessions are intertwined by long poster sessions that facilitate discussions among participants in a friendly atmosphere.

Prototypes and products can be shown during the whole event (EAPrototypes and EAProducts) by any attendee, at no cost.

Discussions and networking continue also during the organized lunch on each day and the social dinner on the first day, whose costs are entirely included within the registration fees that are maintained competitively low by the non-for-profit approach taken in organizing this unique event.

The next EuroEAP will held in Lyon, France, on 5-6 June 2018 and it will be chaired by Claire Jean-Mistral (INSA Lyon, France). Detailed information about the Conference will be made available at [www.euroeap.eu/conference](http://www.euroeap.eu/conference).

## ADVANCES IN EAP

### Aerospace Engineering-Propulsion PDTurboDEA: Operation, Mechanism and Performance of DEA Compressor

Babak Aryana [Babak.Aryana@Gmail.com](mailto:Babak.Aryana@Gmail.com)/MEMS  
Independent Researcher/Inventor

Various sections of a DEA compressor have been improved since more than a decade ago. Current concept that is being considered for the design follows the same principles of the first concept [1], but its actuator is completely different. Basic principle of DEA compressor operation resembles inflating a bike tire. It is constructed of a series of thin tubes that are pumping air into a constant volume vessel up to a desired pressure ratio. As soon as vessel inlet pressure reaches desirable value, the pressurized air is delivered. The mechanism that has been implemented is shown in **Figure 4**. The most prominent specification of this actuator is to create the widest diameter for a tube in a certain circular area **Figure 5**.

In fact, special configuration of DEA compressor allows creating engines with exceptional performances. For this purpose, TurboDEA [2] and PDTurboDEA were introduced in previous issues of this Newsletter. These engine concepts are designed based on particular characteristic of DEA compressor in which the operation of the compressor can dynamically be adapted to the best performance Combination of tube working frequency, vessel depletion frequency and vessel volume creates a broad area to regulate compressor performance regarding working condition and environmental elements. Additionally, the produced pump is inherently feasible to configure to make it meet engine requirements and usage. **Figure 6** illustrates performance sizing of a DEA compressor designed for a PDTurboDEA that is being worked on in this ongoing research project.

### References

- [1] B. Aryana, "Implementing DEA to Create a Novel Type of Compressor," Materials Science and Engineering C, vol. 30, pp. 42-49, 2010.
- [2] B. Aryana, "New version of DEA compressor for a Novel Hybrid Gas Turbine Cycle: TurboDEA," Energy, vol. 111, pp. 676-690, 2016.

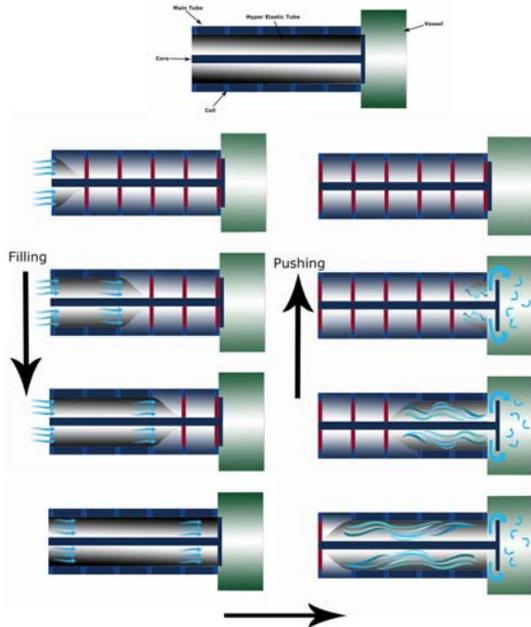


Figure 4: Schematic illustration of a Tube Mechanism

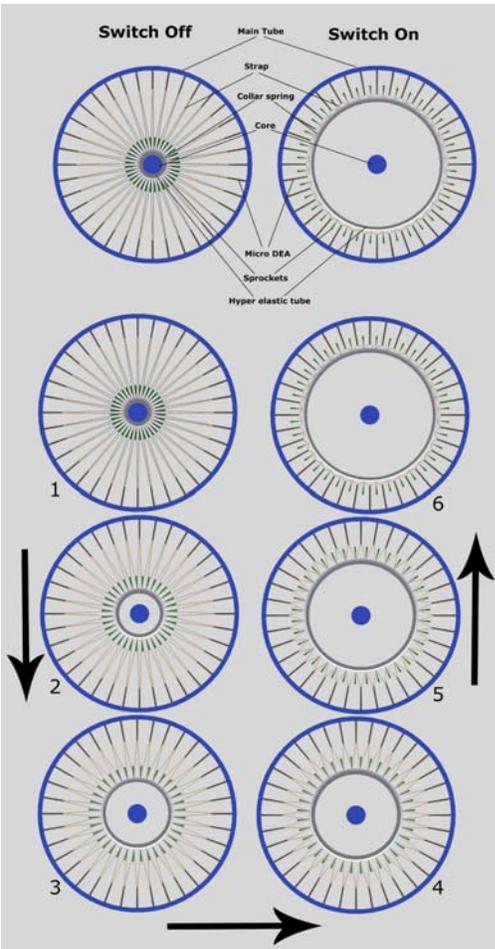


Figure 5: Mechanism of a Cell Actuator

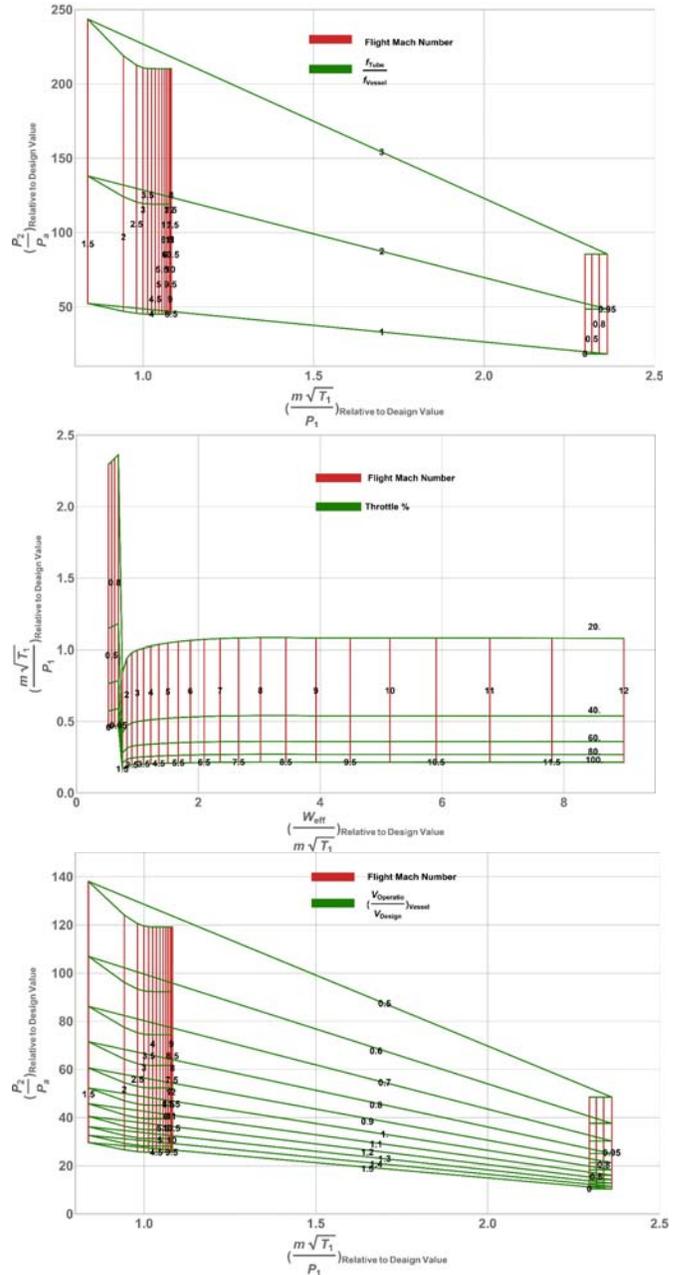


Figure 6: Performance of a DEA Compressor Designed for a PDTurboDEA Operating in a Wide Range of Flight Mach Numbers.

**Embry Riddle Aeronautical University, Florida, USA**

**On the performance of helical dielectric elastomer actuator with additive manufacturing**  
 JangHo Park [JANGHO.PARK@erau.edu](mailto:JANGHO.PARK@erau.edu), DaeWon Kim and Eduardo Divo Park

Manufacturing dielectric elastomer actuator (DEA) with additive manufacturing enables DEAs with complex geometric configurations to be manufactured. This study investigates analytical approaches to optimize the performance of helical dielectric elastomer actuator (HDEA) based on additive manufacturing. The performance of the HDEA is evaluated by varying multiple geometric parameters. Due to the manufacturing process, appropriate materials that display proper dielectric and mechanical properties are also important. Optimizing the geometric parameters along with appropriate materials selection, the overall actuator performance can be improved. In addition, the most optimal material properties based on Yeoh function can be found for future manufacturing purpose. Other factors such as manufacturing considerations, technical drawbacks, and fabrication techniques are also discussed.

### Universität Basel, Switzerland

#### Enhancing the capabilities of artificial muscle implants using low-voltage dielectric elastomer sensors

Bert Müller [bert.mueller@unibas.ch](mailto:bert.mueller@unibas.ch)

BRIDGE Proof-of-Concept is a recent Swiss initiative jointly organized by the Swiss National Science Foundation and the Commission for Technology and Innovation. It supports young researchers to apply their ideas from multidisciplinary areas for commercialization. Tino Töpfer from the Biomaterials Science Center at the University of Basel obtained financial support in the [second round](#) that began in September 2017.

The focus of this project is on the use of dielectric elastomer sensors based on nanometer-thin silicone elastomer layers fabricated by means of molecular beam deposition (**Figure 7**) [1]. Both the deposition and the subsequent polymerization using ultra-violet light are on-line monitored by spectroscopic ellipsometry with the aim to control the deposition rate and the surface roughness [2]. The same technique also enables the control of the gold deposition for the compliant electrodes [3]. Within the first three months of the project, the

researchers from Basel realized capacitive sensors on flexible substrates that reach a sensitivity of  $4 \text{ kPa}^{-1}$  for pressures between 0.01 and 10 kPa, which corresponds to loads between 0.01 and 10  $\text{g/mm}^2$ . This sensitivity is about an order of magnitude improved with respect to literature values [4, 5] and qualifies for resolving pressure changes at urethra. Thus, the team envisions integrating this sensor into an artificial muscle implant that is under development at Wayne State University in Detroit, MI. The leading scientist, Nivedita Dhar, is a medical expert seeking reliable force feedback for a significantly improved implant to treat urinary incontinence.

Bert Müller, Bekim Osmani and Tino Töpfer plan to present the prototype sensor at the EAP-in-Action Session in Denver in March 2018. Together with the Swiss polymer team of Dorina Opris at Empa, the elastomer's permittivity will be further improved in order to realize multi-layer dielectric elastomer transducers, generating pressures to mimic the natural sphincter muscle at battery voltages.

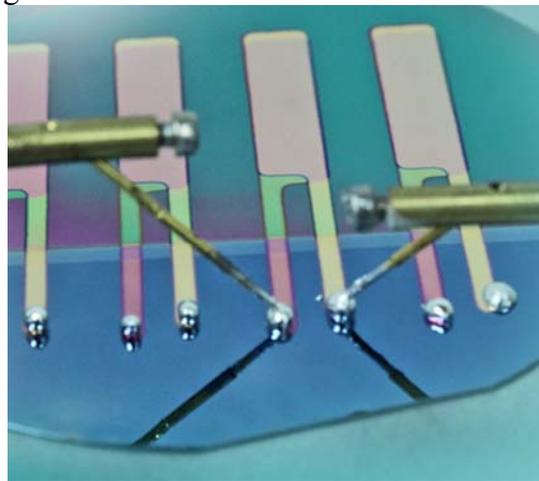


Figure 7: Nanometer-thin dielectric elastomer layers (green) are fabricated by molecular beam deposition on a 2-inch Si-wafer (blue). The embedding Au-electrodes (goldish) are contacted via liquid metal drops.

#### References

1. T. Töpfer, F. M. Weiss, B. Osmani, C. Bippes, V. Leung & B. Müller. Sensors and Actuators A: Physical 233, 32-41, (2015).

2. T. Töpfer, S. Lörcher, H. Deyhle, B. Osmani, V. Leung & B. Müller. *Advanced Electronic Materials* **3**, 8, 1700073, (2017).
3. B. Osmani, T. Töpfer, H. Deyhle, T. Pohl & B. Müller. *Advanced Materials Technologies* **2**, 10, 1700105, (2017).
4. S. C. B. Mannsfeld, B. C. K. Tee, R. M. Stoltenberg, C. V. H. H. Chen, S. Barman, B. V. O. Muir, A. N. Sokolov, C. Reese & Z. Bao. *Nature Materials* **9**, 859, (2010).
5. Y. Joo, J. Yoon, J. Ha, T. Kim, S. Lee, B. Lee, C. Pang & Y. Hong. *Advanced Electronic Materials* **3**, 4, 1600455-n/a, (2017).

## FUTURE CONFERENCES

Date	Conference/Symposium
March 4 - 8, 2018	The 2018 SPIE's EAPAD Conf. is going to be held at Denver, Colorado, from March 4 thru 8, 2018. This conference will be the 20 <sup>th</sup> annual one and is going to be chaired by Y. Bar-Cohen, JPL, and Co-chaired by I. A. Anderson, The Univ. of Auckland (New Zealand). The conference program is posted at: <a href="http://www.spie.org/eap">http://www.spie.org/eap</a>
March 6-8, 2018	4th Annual World Congress of Smart Materials-2018 (WCSM-2018) Venue: Osaka, Japan, <a href="https://www.compositespress.com/event/4th-annual-world-congress-smart-materials-2018/">https://www.compositespress.com/event/4th-annual-world-congress-smart-materials-2018/</a> Ms. Snowy Liang, Coordinator of WCSM-2018, <a href="mailto:snowy@wcm-con.com">snowy@wcm-con.com</a>
April 11 – 12, 2018	Smart Systems Integration, International Conference and Exhibition on Integration Issues of Miniaturized Systems - MEMS, NEMS, ICs and Electronic Components. Further information can be found at <a href="https://www.mesago.de/en/SSI/The_conference/Program/index.htm">https://www.mesago.de/en/SSI/The_conference/Program/index.htm</a>
April 24-28, 2018	RoboSoft2018, which is the First IEEE-RAS International Conf. on Soft Robotics, is going to be held

	on April 24-28, 2018 at Livorno, Italy. Further information can be found at <a href="http://www.robosoft2018.org/">http://www.robosoft2018.org/</a>
May 20 - 24, 2018	BIONATURE 2018, which is the 9th International Conf. on Bioenvironment, Biodiversity and Renewable Energies, is going to be held on May 20 - 24, 2018 at Nice, France. Further information about this Conf., which is under the InfoSys 2018 umbrella, can be found at <a href="http://www.iaria.org/conferences2018/BIONATURE18.html">http://www.iaria.org/conferences2018/BIONATURE18.html</a>
June 5-6, 2018	The EuroEAP 2018, which is the 8th international Conf. on EAPs, will take place in Lyon, France, on 5-6 June 2018 and it is chaired by Claire Jean-Mistral (INSA Lyon, France). Detailed information is available at <a href="http://www.euroeap.eu/conference">www.euroeap.eu/conference</a>
June 25-27, 2018	Actuators18 - The International Conf. and Exhibition on New Actuators and Drive Systems is going to be held June 25-27, 2018 in Bremen, Germany. Further information can be obtained at <a href="http://www.actuators.de">www.actuators.de</a> or by contacting <a href="mailto:actuators@messe-bremen.de">actuators@messe-bremen.de</a>

## EAP ARCHIVES

Information archives and links to various websites worldwide are available on the following (the web addresses below need to be used with no blanks):

**Webhub:** <http://eap.jpl.nasa.gov>

**Newsletter:** <http://ndea.jpl.nasa.gov/nasa-nde/lommas/eap/WW-EAP-Newsletter.html>

**Recipes:** <http://ndea.jpl.nasa.gov/nasa-nde/lommas/eap/EAP-recipe.htm>

**EAP Companies:** <http://ndea.jpl.nasa.gov/nasa-nde/lommas/eap/EAP-material-n-products.htm>

**Armrestling Challenge:**

<http://ndea.jpl.nasa.gov/nasa-nde/lommas/eap/EAP-armrestling.htm>

## Books and Proceedings:

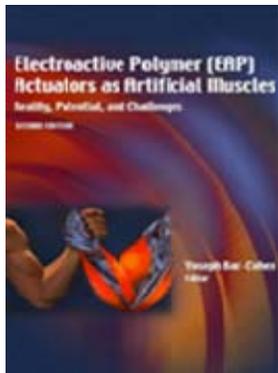
<http://ndea.jpl.nasa.gov/nasa-nde/yosi/yosi-books.htm>

### 2<sup>nd</sup> Edition of the book on EAP

Y. Bar-Cohen (Editor)

In March 2004, the 2<sup>nd</sup> edition of the “Electroactive Polymer (EAP) Actuators as Artificial Muscles - Reality, Potential and Challenges” was published.

This book includes description of the available materials, analytical models, processing techniques, and characterization methods. This book is intent to provide a reference about the subject, tutorial resource, list the challenges and define a vision for the future direction of this field. Observing the progress that was reported in this field is quite heartwarming, where major milestones are continually being reported.

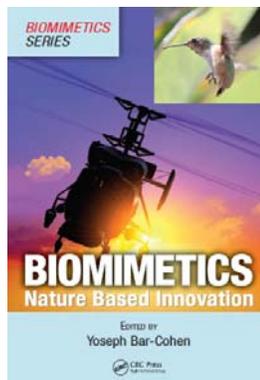


## Biomimetics books series

### Biomimetics – Nature Inspired Innovation

Yoseph Bar-Cohen (Editor)

This book contains 20 chapters covering various aspects of the field of biomimetics including Nature as a source for inspiration of innovation; Artificial Senses & Organs; Bio-mimicry at the Cell-Materials Interface; Multiscale modeling of plant cell wall architecture and tissue mechanics for biomimetic applications; Biomimetic composites; EAP actuators as artificial muscles; Refreshable Braille Displays Actuated by EAP; Biological Optics; Biomimicry of the Ultimate Optical Device: Biologically Inspired Design: a tool for interdisciplinary education Enhancing Innovation Through Biologically-Inspired Design; Self-



reproducing machines and manufacturing processes; Biomimetic products; Biomimetics for medical implants; Application of biomimetics in the design of medical devices; Affective Robotics: Human Motion and Behavioral Inspiration for Safe Cooperation between Humans and Humanoid Assistive Robots; Humanlike robots - capabilities, potentials and challenges; Biomimetic swimmer inspired by the manta ray; Biomimetics and flying technology; The Biomimetic Process in Artistic Creation; and Biomimetics - Reality, Challenges, and Outlook. Further information is available at:

<http://www.crcpress.com/product/isbn/9781439834763>

### Architecture Follows Nature - Biomimetic Principles for Innovative Design

Authored by Ilaria Mazzoleni [www.imstudio.us](http://www.imstudio.us) [info@imstudio.us](mailto:info@imstudio.us) in collaboration with Shauna

Price <http://www.crcpress.com/product/isbn/9781466506077>

The book entitled “Architecture Follows Nature - Biomimetic Principles for Innovative Design” has been published by CRC Press as part of the book series on Biomimetics for which Y. Bar-Cohen is the editor. The homepage of this book series is: [http://www.crcpress.com/browse/series/?series\\_id=2719](http://www.crcpress.com/browse/series/?series_id=2719)

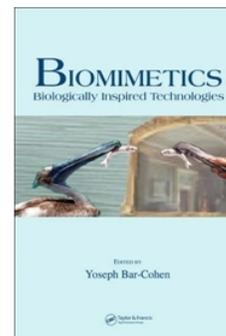


### Biomimetics - Biologically Inspired Technologies

Y. Bar-Cohen (Editor)

<http://ndea.jpl.nasa.gov/nasa-nde/yosi/yosi-books.htm>

This book about Biomimetics review technologies that were inspired by nature and outlook



for potential development in biomimetics in the future. This book is intended as a reference comprehensive document, tutorial resource, and set challenges and vision for the future direction of this field. Leading experts (co)authored the 20 chapters of this book and the outline can be seen on <http://ndea.jpl.nasa.gov/ndea-pub/Biomimetics/Biologically-Inspired-Technology.pdf>

### **Ocean Innovation: Biomimetics Beneath the Waves**

Authored by Iain A. Anderson  
[i.anderson@auckland.ac.nz](mailto:i.anderson@auckland.ac.nz), Julian Vincent, and John Montgomery  
<https://www.crcpress.com/Ocean-Innovation-Biomimetics-Beneath-the-Waves/Anderson-Vincent-Montgomery/p/book/9781439837627>

Generally, biomimetics is the idea of creating new technologies abstracted from what we find in biology. The book “Ocean Innovation: Biomimetics Beneath the Waves” seeks that technological inspiration from the rich biodiversity of marine organisms. Bringing both a biological and engineering perspective to the biomimetic potential of oceanic organisms, this richly illustrated book investigates questions such as:



- How can we mimic the sensory systems of sea creatures like sharks, sea turtles, and lobsters to improve our ability to navigate underwater?
- What can we do to afford humans the opportunity to go unnoticed by marine life?
- How can we diffuse oxygen from water to enable deep diving without the risk of decompression sickness?

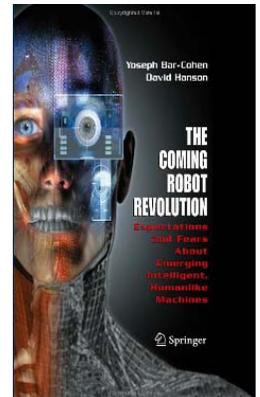
Each chapter explores an area where we, as divers and technologists, can benefit from understanding how animals survive in the sea, presenting case studies that demonstrate how natural solutions can be applied to humankind’s engineering challenges.

### **Books about robotics**

#### **The Coming Robot Revolution - Expectations and Fears about Emerging Intelligent, Humanlike Machines**

Yoseph, Bar-Cohen and David Hanson (with futuristic illustrations by Adi Marom), Springer, ISBN: 978-0-387-85348-2, (2009)

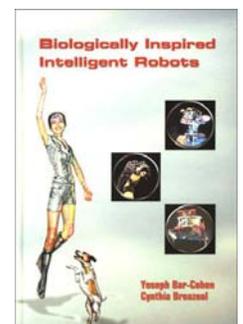
This book covers the emerging humanlike robots. Generally, in the last few years, there have been enormous advances in robot technology to which EAP can help greatly in making operate more lifelike. Increasingly, humanlike robots are developed for a wide variety of applications. These “smart” lifelike robots are designed to help with household chores, as office workers, to perform tasks in dangerous environments, and to assist in schools and hospitals. In other words, humanlike robots are coming and they may fundamentally change the way we live, even the way we view ourselves.



#### **Biologically Inspired Intelligent Robots**

Y. Bar-Cohen and C. Breazeal (Editors)

The book that is entitled “Biologically-Inspired Intelligent Robots,” covering the topic of biomimetic robots, was published by SPIE Press in May 2003. There is already extensive heritage of making robots and toys that look and operate similar to human, animals and insects. The emergence of artificial muscles is expected to make such a possibility a closer engineering reality. The topics that are involved with the development of such biomimetic robots are multidisciplinary and they are covered in this book. These topics include materials, actuators, sensors, structures, control, functionality, intelligence and autonomy.



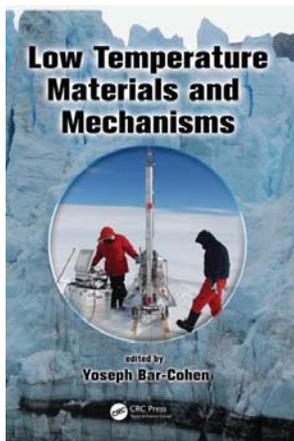
## Other books

### Low Temperature Materials and Mechanisms

Yoseph Bar-Cohen (Editor)

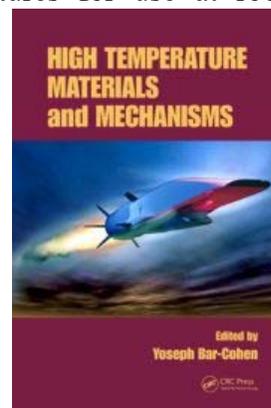
<https://www.crcpress.com/Low-Temperature-Materials-and-Mechanisms/Bar-Cohen/p/book/9781498700382>

Published in 2016, this book addresses the growing interest in low temperature technologies. Since the subject of low temperature materials and mechanisms is multidisciplinary, the chapters reflect the broadest possible perspective of the field. Leading experts in the specific subject area address the various related science and engineering chemistry, material science, electrical engineering, mechanical engineering, metallurgy, and physics.



processed at high temperatures for use at room temperature.

Reflecting the multidisciplinary nature of the subject of high-temperature materials and mechanisms, the chapters bring as broad perspective to the field as possible. The chapters were authored by leading experts in the specific subjects that the book covers. It addresses the various related science and engineering disciplines, including chemistry, material science, electrical and mechanical engineering, metallurgy, and physics.



# Happy New Year

### High Temperature Materials and Mechanisms

Yoseph Bar-Cohen (Editor)

<http://www.crcpress.com/product/isbn/9781466566453>

This book is addressing the growing interest in high-temperature technologies. This book covers technology related to energy, space, aerospace, electronics, metallurgy, and other areas. While some applications involve the use of materials at high temperatures, others require materials

## WorldWide Electroactive Polymers (EAP) Newsletter

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