

PROCEEDINGS OF SPIE

***Electroactive Polymer Actuators,
Sensors, and Devices
(EAPAD) 2025***

**Stefan S. Seelecke
Anne L. Skov
Kentaro Takagi
John D. Madden**
Editors

**17–21 March 2025
Vancouver, B.C., Canada**

*Sponsored and Published by
SPIE*

Volume 13431

Proceedings of SPIE 0277-786X, V. 13431

SPIE is an international society advancing an interdisciplinary approach to the science and application of light.

The papers in this volume were part of the technical conference cited on the cover and title page. Papers were selected and subject to review by the editors and conference program committee. Some conference presentations may not be available for publication. Additional papers and presentation recordings may be available online in the SPIE Digital Library at SPIDigitalLibrary.org.

The papers reflect the work and thoughts of the authors and are published herein as submitted. The publisher is not responsible for the validity of the information or for any outcomes resulting from reliance thereon.

Please use the following format to cite material from these proceedings:

Author(s), "Title of Paper," in *Electroactive Polymer Actuators, Sensors, and Devices (EAPAD) 2025*, edited by Stefan S. Seelecke, Anne L. Skov, Kentaro Takagi, John D. Madden, Proc. of SPIE 13431, Seven-digit Article CID Number (DD/MM/YYYY); (DOI URL).

ISSN: 0277-786X

ISSN: 1996-756X (electronic)

ISBN: 9781510686489

ISBN: 9781510686496 (electronic)

Published by

SPIE

P.O. Box 10, Bellingham, Washington 98227-0010 USA

Telephone +1 360 676 3290 (Pacific Time)

SPIE.org

Copyright © 2025 Society of Photo-Optical Instrumentation Engineers (SPIE).

Copying of material in this book for internal or personal use, or for the internal or personal use of specific clients, beyond the fair use provisions granted by the U.S. Copyright Law is authorized by SPIE subject to payment of fees. To obtain permission to use and share articles in this volume, visit Copyright Clearance Center at copyright.com. Other copying for republication, resale, advertising or promotion, or any form of systematic or multiple reproduction of any material in this book is prohibited except with permission in writing from the publisher.

Printed in the United States of America by Curran Associates, Inc., under license from SPIE.

Publication of record for individual papers is online in the SPIE Digital Library.

**SPIE. DIGITAL
LIBRARY**

SPIDigitalLibrary.org

Paper Numbering: A unique citation identifier (CID) number is assigned to each article in the Proceedings of SPIE at the time of publication. Utilization of CIDs allows articles to be fully citable as soon as they are published online, and connects the same identifier to all online and print versions of the publication. SPIE uses a seven-digit CID article numbering system structured as follows:

- The first five digits correspond to the SPIE volume number.
- The last two digits indicate publication order within the volume using a Base 36 numbering system employing both numerals and letters. These two-number sets start with 00, 01, 02, 03, 04, 05, 06, 07, 08, 09, 0A, 0B ... 0Z, followed by 10-1Z, 20-2Z, etc. The CID Number appears on each page of the manuscript.

Contents

vii *Conference Committee*

TWIST-BASED EAPS

13431 02 **Work out: measuring the energy output of artificial muscle** [13431-2]

SOFT ROBOTICS: JOINT SESSION WITH 13430 AND 13431

13431 03 **Active soft materials paving the way for deep biomimetic robotics (Keynote Paper)**
[13431-5]

13431 04 **A tensegrity-based locomoting soft robot actuated by rolled dielectric elastomer transducers** [13431-6]

EAP-IN-ACTION DEMONSTRATION SESSION

13431 05 **DEMO: Dielectric elastomer actuators (DEAs) for the restoration of facial movements**
[13431-201]

ADVANCED SYSTEMS AND APPLICATIONS I

13431 07 **An innovative dynamic hybrid metamaterial structure created for an ultra-light, highly precise, and self-correcting live mirror** [13431-8]

13431 08 **Ferroelectric polymers exhibiting giant cross energy coupling and self-actuated electrocaloric heat pump (Invited Paper)** [13431-9]

HYDRAULIC EAPS

13431 09 **High performance HASEL actuators as self-healing trigger devices for lithium-ion batteries**
[13431-11]

13431 0A **Electroadhesive electrohydraulic soft actuators** [13431-12]

13431 0B **HASEL actuators for underwater robots** [13431-13]

SOFT ROBOTICS

- 13431 0C **Autonomous soft robotic with distributed DE-electronic networks** [13431-16]
- 13431 0D **Novel soft finger-like robots with multilayer DEAs for minimal energy consumption**
[13431-17]
- 13431 0E **Sensitive and robust tactile fingertips for robotic grippers and humanoid hands** [13431-18]
- 13431 0F **Sensing like a fish: robust soft sensors for fish-like robots** [13431-68]

HAPTICS

- 13431 0G **Integrated textile-biased dielectric elastomer feedback actuator** [13431-21]

ADVANCED SYSTEMS AND APPLICATIONS II

- 13431 0H **Hybrid smart actuator combining electroactive polymers with superelastic TiNiCuCo**
[13431-25]
- 13431 0I **The S3 wave energy converter story** [13431-78]

NOVEL EAP FABRICATION METHODS

- 13431 0J **Enhancing dielectric properties of PDMS composites through particle alignment via the dielectrophoretic method** [13431-65]
- 13431 0K **Optimizing 3D printing parameters for enhanced electroactive PVDF formation** [13431-31]
- 13431 0L **Enhancing piezoelectric and optical properties of PVDF-TrFE films: the role of annealing and cooling rates** [13431-59]

EAP FIBER TECHNOLOGY

- 13431 0M **Advancing textile thread transducers for airflow measurement and characterization**
[13431-34]
- 13431 0N **Contractile dielectric elastomer actuators with embedded active and passive structured fibres** [13431-36]

EXPERIMENTAL METHODS

- 13431 OO **Detection of inhomogeneities in dielectric elastomer transducers using thermal imaging** [13431-37]
- 13431 OP **ADEPT: automated dielectric elastomer actuator performance-tester** [13431-40]

IONIC EAPS

- 13431 OQ **Optimizing actuation in ionic actuators with ionic liquids: the role of ionic liquid ions** [13431-42]
- 13431 OR **Multi-stimulus-responsive soft actuators: integrating bio-inspired designs and intelligent material systems** [13431-45]

POSTER SESSION

- 13431 OS **Development and validation of a dielectric-elastomer-based artificial urinary sphincter** [13431-46]
- 13431 OT **Fully printable plasticized fluorinated terpolymers for mirror active morphing control** [13431-47]
- 13431 OU **Soft generators for roadway energy harvesting: a preliminary study on design and fabrication of stacked integrated dielectric elastomer architectures using liquid silicone rubber composites** [13431-48]
- 13431 OV **Maximizing power generation of bi-stable electrostatic energy harvesters in river flow scenarios** [13431-49]
- 13431 OW **Model-based investigation of distributed sensing in dielectric elastomer membranes** [13431-50]
- 13431 OX **Multi-layer dielectric elastomers managing swelling of battery systems** [13431-53]
- 13431 OY **Force measurements of planar dielectric elastomer actuators** [13431-55]
- 13431 OZ **Development of a dual-layer structured piezoelectric film for haptic applications** [13431-58]
- 13431 10 **Influence of solvent on the piezoresistive properties of carbon-particle-filled elastomers** [13431-60]
- 13431 11 **Robust, low-cost, and stretchable matrix tactile sensor array with anti-ghosting capabilities** [13431-61]
- 13431 12 **Investigation of local strains in circular dielectric elastomer actuators** [13431-62]

- 13431 13 **High-voltage switches based on flexible dielectric elastomers** [13431-63]
- 13431 14 **Multi-dimensional negative-stiffness thermoplastic bias mechanisms for high-stroke dielectric elastomer actuator arrays** [13431-64]
- 13431 15 **Dielectric elastomer switch with the potential as bricks of cooperative multi-actuator system** [13431-66]
- 13431 16 **On the first-order numerical approximation of the exact transfer function of a multi-physics model of IPMC sensors** [13431-70]
- 13431 17 **Towards 3D-printed fully stretchable soft sensors for stress, shear, and proximity** [13431-73]
- 13431 18 **Smart roller: normal and three-axis stress measurement sensor array for automated fiber placement** [13431-75]

DIGITAL POSTER SESSION

- 13431 19 **Tubular actuator using dielectric elastomers and conductive fabric for orthotic applications** [13431-57]