

SYMPOSIUM SM4

A Soft Future—From Electronic Skin to Robotics
and Energy Harvesting
April 18 - April 21, 2017

Symposium Organizers

Michael Dickey, North Carolina State University
Martin Kaltenbrunner, Johannes Kepler University
Christoph Keplinger, University of Colorado Boulder
Rebecca Kramer, Purdue University

Symposium Support
Heraeus Holding GmbH

Proceedings Statement

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* Invited Paper

SESSION SM4.1/SM1.1/SM3.1: Joint Session I
Session Chairs: Mohammad Reza Abidian, Martin Kaltenbrunner
and Jonathan Rivnay
Tuesday Morning, April 18, 2017
PCC North, 100 Level, Room 121 AB

10:30 AM *SM4.1.01/SM1.1.01/SM3.1.01
Nano-Bioelectronics: From Biological Sensor Chips to Cyborg Tissues and Seamless Brain-Electronics Implants [Jae-Hyun Lee](#); Harvard University, United States.

11:00 AM *SM4.1.02/SM1.1.02/SM3.1.02
Soft Wearable Robots Improve Walking Function and Economy after Stroke and Grasping Function after Spinal Cord Injury [Conor Walsh](#); Harvard School of Engineering, United States.

SESSION SM4.2/SM1.2/SM3.2: Joint Session II: Bioelectronics
Session Chairs: Mohammad Reza Abidian, Martin Kaltenbrunner
and Jonathan Rivnay
Tuesday Afternoon, April 18, 2017
PCC North, 100 Level, Room 121 AB

1:30 PM *SM4.2.01/SM1.2.01/SM3.2.01
Skin-Inspired Materials, Devices and Applications [Zhenan Bao](#); Stanford University, United States.

2:00 PM *SM4.2.02/SM1.2.02/SM3.2.02
Biocompatible Gel Electrodes and Ultraflexible Organic Devices for Implantable Electronics [Takao Someya](#); University of Tokyo, Japan.

2:30 PM *SM4.2.03/SM1.2.03/SM3.2.03
Interfacing with the Brain Using Organic Electronics [George G. Malliaras](#); ENSM Saint-Etienne, France.

3:00 PM BREAK

3:30 PM *SM4.2.04/SM1.2.04/SM3.2.04
Materials and Devices Designs for Flexible, Active Electronic Interfaces to the Brain and the Heart [John A. Rogers](#); Northwestern University, United States.

4:00 PM *SM4.2.05/SM1.2.05/SM3.2.05

Conformal, Microfabricated Electrode Array for Optimization of Spectral Content in the Auditory Brainstem Implant (ABI) [Stephanie P. Lacour](#); Ecole Polytechnique Federale de Lausanne, Switzerland, Switzerland.

4:30 PM *SM4.2.06/SM1.2.06/SM3.2.06

Interfacing Neurons with Electronic Devices [Andreas Offenhaeusser](#); Forschungszentrum Juelich, Germany.

SESSION SM4.3: Soft and Flexible Electronics
Session Chairs: Martin Kaltenbrunner and Matthew White
Wednesday Morning, April 19, 2017
PCC North, 100 Level, Room 121 B

8:00 AM SM4.3.01

Inkjet-Printed Electrodes Fabricated on Various Substrates for Cutaneous Electrophysiological Applications [Timothee Roberts](#)^{1,2}; ¹Institut des Sciences du Mouvement, France; ²Microvitae Technologies, France.

8:15 AM SM4.3.02

Wearable Paper-Based Sensors for Green Electronics [Xinqin Liao](#); University of Science and Technology Beijing, China.

8:30 AM *SM4.3.03

Concealed Electronics and Photonics [Siegfried Bauer](#); Johannes Kepler Univ-Linz, Austria.

9:00 AM SM4.3.04

A Soft Prosthetic Hand—Synthetic Remapping of Softness and Roughness Enabled by Stretchable Optical Sensors and Displays [Shuo Li](#); Cornell University, United States.

9:15 AM SM4.3.05

Epidermal Mechano-Acoustic Sensing Electronics for Cardiovascular Diagnostics and Human-Machine Interfaces [YuHao Liu](#); University of Illinois at Urbana-Champaign, United States.

9:30 AM *SM4.3.06

Soft Gel Electrodes and Organic Amplification Circuits for Bio-Signal Monitoring Systems [Tsuyoshi Sekitani](#); Osaka University, Japan.

10:00 AM BREAK

10:30 AM *SM4.3.07

Flexible and Printed Organic TFT Devices and their Potential Applications [Shizuo Tokito](#); Yamagata University, Japan.

11:00 AM SM4.3.08

All-Solution-Processed Stretchable Transistor Arrays Based on Polymer Semiconductor and Dielectric [Sihong Wang](#); Stanford University, United States.

11:15 AM SM4.3.09

Towards Non-Invasive Biochemical Monitoring—Utilizing Hydrogels and Paper Microfluidics to Create a Wearable Sweat Sensing Platform [Timothy W. Shay](#); North Carolina State University, United States.

11:30 AM *SM4.3.10

Tailoring Organic Electronic Materials for Bioelectronics—A Case for Biosensors [Sahika Inal](#)^{1,2}; ¹KAUST, Saudi Arabia; ²CMP-EMSE, France.

SESSION SM4.4: Soft Power Generation and Storage
Session Chairs: Sahika Inal and Tsuyoshi Sekitani
Wednesday Afternoon, April 19, 2017
PCC North, 100 Level, Room 121 B

1:30 PM *SM4.4.01

Ultrathin Optoelectronic Devices—Light-Weight and Extreme Flexibility [Matthew S. White](#)^{1,2}; ¹University of Vermont, United States; ²University of Vermont, United States.

2:00 PM SM4.4.02

High Efficiency and Stable Polymer Solar Cells on Ultra-Flexible Substrate Kenjiro Fukuda^{1,2}; ¹RIKEN, Japan; ²JST PRESTO, Japan.

2:15 PM SM4.4.03

Subcutaneous Flexible Solar Cells for Supplying Electrical Power to Medical Implants Kwangsun Song; Gwangju Institute of Science and Technology (GIST), Korea (the Republic of).

2:30 PM BREAK

3:30 PM SM4.4.04

Electronic Proprioception Denys Makarov; Helmholtz-Zentrum Dresden-Rossendorf e.V., Germany.

3:45 PM SM4.4.05

Compliant On-Skin Compass for Artificial Magnetoception Gilbert Santiago Canon Bermudez; Helmholtz-Zentrum Dresden Rossendorf, Germany.

4:00 PM SM4.4.06

Self-Healing Polymers for Electronic Skin, Energy Storage and Actuators Chao Wang; University of California, Riverside, United States.

4:15 PM SM4.4.07

High Power, Tough Battery with Integrated Stretchable Circuit Florian Hartmann; Johannes Kepler University Linz, Austria.

4:30 PM SM4.4.08

Flexible and Stretchable Batteries with Concept of Geometric Design In-Suk Choi; Korea Institute of Science and Technology (KIST), Korea (the Republic of).

4:45 PM SM4.4.09

Highly Stretchable and Self-Powered Conformal Electronic Skin Ying-Chih Lai^{1,2}; ¹National Chung Hsing University, Taiwan; ²Georgia Institute of Technology, United States.

SESSION SM4.5: Poster Session I

Session Chairs: Michael Dickey, Martin Kaltenbrunner, Christoph Keplinger and Rebecca Kramer

Wednesday Afternoon, April 19, 2017

8:00 PM - 10:00 PM

Sheraton, Third Level, Phoenix Ballroom

SM4.5.01

Skin-Inspired Haptic Memory Arrays with Electrically Reconfigurable Architecture Geng Chen; Nanyang Technological University, Singapore.

SM4.5.02

All-Printed, Stretchable Zn-Ag₂O Rechargeable Battery via Hyperelastic Binder for Self-Powering Wearable Electronics Rajan Kumar; University of California, San Diego, United States.

SM4.5.03

Skin-Like, Transparent and Flexible Tactile Sensor Based on Graphene Films for Human-Machine Interfaces Minxuan Xu; University of Science and Technology Beijing, China.

SM4.5.04

Wearable Strain Sensor Based on Carbonized Silk Fabric for Full-Range Human Motion Detection Chunya Wang; Tsinghua University, China.

SM4.5.05

Highly Sensitive, Transparent and Durable Pressure Sensors Based on Sea-Urchin Shaped Metal Nanoparticles Donghwa Lee; Daegu Gyeongbuk Institute of Science and Technology (DGIST), Korea (the Republic of).

SM4.5.06

Ultrasensitive and Transparent Electronic Skin Based on Carbonized Silk Nanofibers Qi Wang; Tsinghua University, China.

SM4.5.07

Skin-Mountable Multichannel Surface Electromyography Sensor for Controlling Home Electronics Namyun Kim; Gwangju Institute of Science and Technology, Korea (the Republic of).

SM4.5.08

A Core-Shell Structured Mechanically Robust and Electrically Conductive Solid-Phase Via for Stretchable Electronics Eunho Oh^{1,2}; ¹Seoul National University, Korea (the Republic of); ²Seoul National University, Korea (the Republic of).

SM4.5.09

Stretchable and Multimodal all Graphene Electronic Skin Qijun Sun; Beijing Institute of Nanoenergy and Nanosystems, Chinese Academy of Sciences, China.

SM4.5.10

Thin Carbon Nanotubes/Nickel Sulfide Composite as Binder-Free and Flexible High Performance Lithium-Ion Batteries Anode Hao Liu; China University of Geoscience-Beijing, China.

SM4.5.11

Wrinkled Nitrile Rubber Films for Stretchable Ultra-Sensitive Respiration Sensors Yaodong Guan; Huazhong University of Science and Technology, China.

SM4.5.12

Capillary Force Induced Cold Welding in Silver-Nanowire-Based Flexible Transparent Electrodes Yuan Liu; University of Houston, United States.

SM4.5.13

Viscoelastic Effects on Piezoelectric Performance of Soft Piezoelectric Nanocomposites Jing Li^{1,2,3}; ¹Johns Hopkins University, United States; ²Johns Hopkins University, United States; ³Wuhan University of Technology, China.

SM4.5.14

Soft Electrical Conductor Based on PEDOT:PSS-Metal Nanowire Hybrid Nanocomposites/Acrylamide Organogels Seung-Min Lim; Seoul National University, Korea (the Republic of).

SM4.5.15

Highly Stretchable Polymer Semiconductor Films through Nanoconfinement Effect Sihong Wang; Stanford University, United States.

SM4.5.16

Mechanical Metamaterial Based Highly Sensitive Stretchable Strain Sensors Ying Jiang; Nanyang Technological University, Singapore.

SM4.5.17

Stretchable Silver-Polymer Composite Based Interdigitated Sensor for Capacitive Strain Sensing Jignesh Vanjaria; Arizona State University, United States.

SM4.5.18

A Novel Fiber-Based Stretchy Sensor Qiao Li; Donghua University, China.

SM4.5.19

Flexible Vertical GaAs Solar Cells by Using Interlayer Adhesiveless Transfer-Printing Juho Kim; Gwangju Institute of Science and Technology, Korea (the Republic of).

SM4.5.20

Adhesiveless Transfer Printing Assisted by Controllable Bending Radius of a Flat Elastomeric Stamp Sungbum Cho; Gwangju Institute of Science and Technology, Korea (the Republic of).

SESSION SM4.6: Soft Robotics—Manufacturing, Design, Materials and Applications

Session Chairs: Christoph Keplinger and Rebecca Kramer

Thursday Morning, April 20, 2017

PCC North, 100 Level, Room 121 B

8:00 AM SM4.6.01

Autonomous Locomotion of Polymer Films Coupled to Stimuli Gradients Benjamin Tremblé^{1,2}; ¹UES, United States; ²Air Force Research Laboratory, United States.

8:15 AM SM4.6.02

A 3D Fabrication Method for Soft Robots and Organ Phantoms Peer Fischer; Max Planck Institute for Intelligent Systems, Germany.

8:30 AM *SM4.6.03

Elastomeric Robots via Additive Manufacturing: Actuation, Sensing and Visual Interfaces [Robert Shepherd](#); Cornell University, United States.

9:00 AM SM4.6.04

Stereolithography 3D Printing of Highly Extensible Silicones for Soft Robotics [Thomas J. Wallin](#); Cornell University, United States.

9:15 AM SM4.6.05

3D Printed Soft Materials for Sensors and Actuators across Multiple Length Scales [Michal Soreni-Harari](#); University of Maryland, United States.

9:30 AM SM4.6.06

A New Class of Soft Microrobotic Components Assembled from Magnetically Interacting Metallo-Dielectric Microcubes [Koohee Han](#)^{1,2}; ¹North Carolina State University, United States; ²Research Triangle Materials Research Science and Engineering Center, United States.

9:45 AM SM4.6.07

Printable Robots—Self-Assembled Function during Inkjet Printing [Rebecca Kramer](#); Purdue University, United States.

10:00 AM BREAK

10:30 AM *SM4.6.08

Micro-Patterned Materials to Enable In Vivo Robotic Capsule Endoscope Locomotion [Mark Rentschler](#); University of Colorado, United States.

11:00 AM SM4.6.09

Compliant, Buckled-Foam Pneumatic Actuators and Application in a Patient-Specific Cardiac Assist Device [Benjamin C. Mac Murray](#); Cornell University, United States.

11:15 AM SM4.6.10

Multifunctional Soft-Robotic Skin for Medical Applications [Deepak Ganta](#); Texas A&M International University, United States.

11:30 AM *SM4.6.11

Towards a Continuous Sensory Experience and Autonomic Nervous System for Soft Robots [Iain A. Anderson](#)^{1,3,2}; ¹University of Auckland, New Zealand; ²Stretchsense Ltd., New Zealand; ³University of Auckland, New Zealand.

SESSION SM4.7: Soft Robotics—Actuators, Sensors, Materials and Mechanics

Session Chairs: Iain Anderson and Matt Pharr
Thursday Afternoon, April 20, 2017
PCC North, 100 Level, Room 121 B

1:30 PM *SM4.7.01

Hydrogel Robots—High-Speed, High-Force and Opto-Sonically Camouflaged [Xuanhe Zhao](#); Massachusetts Institute of Technology, United States.

2:00 PM SM4.7.02

4D Printing Spatiotemporal Material Gradients in Ionic Hydrogel Soft Actuators [Brittany M. Rauzan](#); University of Illinois at Urbana-Champaign, United States.

2:15 PM SM4.7.03

Stimuli-Induced Bi-Directional Hydrogel Unimorph Actuators [Shanliangzi Liu](#); Purdue University, United States.

2:30 PM *SM4.7.04

Embracing Instabilities to Achieve Function in Soft Structures [Katia Bertoldi](#); Harvard University, United States.

3:00 PM BREAK

3:30 PM *SM4.7.05

Dielectric Elastomers Actuators for Soft High-Force Grippers [Herbert R. Shea](#); EPFL, Switzerland.

4:00 PM SM4.7.06

High Performance, Electrically Powered, Soft Actuators that Self-Heal [Christoph Keplinger](#); University of Colorado at Boulder, United States.

4:15 PM SM4.7.07

Rapidly Actuated Shape Changing Surfaces Using Circumferentially Constrained Elastomeric Membranes [James H. Pikul](#)^{2,1}; ¹Cornell University, United States; ²Cornell University, United States.

4:30 PM SM4.7.08

Actuation of Elastomeric Surfaces for the Micromanipulation and Assembly of Solid Particles and Liquid Pre-Polymer Droplets [Stephen A. Morin](#); University of Nebraska Lincoln, United States.

4:45 PM SM4.7.09

Soft Multi-Modal Sensor—Bend, Stretch, Pressure, Touch and Proximity Using a Gel Electrode Array [Mirza Sarwar](#); University of British Columbia, Canada.

SESSION SM4.8: Poster Session II

Session Chairs: Michael Dickey, Martin Kaltenbrunner, Christoph Keplinger and Rebecca Kramer

Thursday Afternoon, April 20, 2017

8:00 PM - 10:00 PM

Sheraton, Third Level, Phoenix Ballroom

SM4.8.01

Soft Robotic Hand with Fiber Reinforced Actuators for Hand Rehabilitation [Deepak Ganta](#); Texas A&M University, United States.

SM4.8.02

Fabrication and Characterization of BaTiO₃/PVDF Nanocomposites Using FDM 3D Printing Technology [Hoejin Kim](#); University of Texas at El Paso, United States.

SM4.8.03

Reversible Actuation of Soft Liquid Metal Plugs in Microfluidic Systems Using Low Voltages [Ishan D. Josphipura](#); North Carolina State University, United States.

SM4.8.04

Purifying Nanomaterials Using AC Dielectrophoresis for Flexible Electronic and Energy Harvesting Applications [Roshan J. Plamthottam](#)^{2,1}; ¹Johns Hopkins University, United States; ²NanoDirect LLC, United States.

SM4.8.05

Soft Microactuator for Minimally Invasive Surgery [Jun Kamcoaka](#)^{1,2}; ¹Texas A&M University, United States; ²Jikei Medical School of Tokyo, Japan.

SM4.8.06

Interface Contact Mechanics for Highly Functional Flexible/Stretchable Sensors [Yan Yu](#); Huazhong University of Science and Technology, China.

SM4.8.07

Mechanically Tunable Elastomeric Hydrogels Made from Melt-Fabricated Photoreactive Block Copolymer Micelles [Nabila Huq](#); Colorado State University, United States.

SM4.8.08

Omnidirectional Soft Elasticity in Homeotropically Aligned Liquid Crystal Elastomers [Anesia D. Auguste](#); Air Force Research Laboratory, United States.

SM4.8.09

Geometric Design of Mechanically Tunable Soft Composite Materials [Young-Joo Lee](#); Seoul National University, Korea (the Republic of).

SM4.8.10

Monodisperse Core-Shell Microcapsules for Acid-Responsive Release of Hydrophobic Agents [Mostafa Yourdkhani](#); University of Illinois at Urbana-Champaign, United States.

SM4.8.11

3D Microstructured Flexible Molds via Direct Laser Lithography for the Functional Patterning of Soft Materials [Irene Bernardeschi](#); Istituto Italiano di Tecnologia, Italy.

SESSION SM4.9: Soft Systems and Liquid-Metal Embedded Soft Structures
Session Chairs: Siegfried Bauer and Michael Dickey
Friday Morning, April 21, 2017
PCC North, 100 Level, Room 121 B

8:00 AM SM4.9.01

Smart Garments for Joint Position Analysis [Massimo Totaro](#); Istituto Italiano di Tecnologia, Italy.

8:15 AM SM4.9.02

Design, Mechanics and Fabrication of 3D Helix Coil Interconnection for Extremely Stretchable Biomedical Devices [Kyung In Jang](#); DGIST, Korea (the Republic of).

8:30 AM *SM4.9.03

R2R-Nanoimprint Lithography on the Long Run for Fabrication of Hierarchical Microfluidic Structures on Large and Flexible Plastic Films [Barbara Stadlober](#); Joanneum Research, Austria.

9:00 AM SM4.9.04

Camouflage Materials Inspired by Cephalopods [Erica Leung](#); University of California, Irvine, United States.

9:15 AM SM4.9.05

A Flexible Sensor Analog to Human Skin Via Air-Configured Motile Electronic Whiskers [Jonathan Reeder](#); University of Texas at Dallas, United States.

9:30 AM *SM4.9.06

Fabrication of Fixed-Shape Soft Smart Objects by Thermoplastic Forming of Flat Stretchable Circuits [Jan Vanfleteren](#); imec Ghent University, Belgium.

10:00 AM BREAK**10:30 AM *SM4.9.07**

Liquid-Metal Embedded Elastomers—Microfluidics, Colloids and Microelectronics Interfacing [Carmel Majidi](#); Carnegie Mellon University, United States.

11:00 AM SM4.9.08

3D Printing of Flexible and Stretchable Electronic Devices via Direct-Writing of Liquid Metals [Dishit P. Parekh](#); North Carolina State University, United States.

11:15 AM SM4.9.09

Liquid Metal Switches for Environmentally Responsive Electronics [R. Adam Bilodeau](#); Purdue University, United States.

11:30 AM SM4.9.10

Self Actuation of Liquid Metals in Ionic Imbalance of Aqueous Electrolytes [Ali Zavabeti](#); RMIT University, Australia.

11:45 AM SM4.9.11

Facile Patterning Methods for Liquid Metal Soft Electronics [Yiliang Lin](#); North Carolina State University, United States.

SESSION SM4.10: Soft Structures and Emerging Applications
Session Chairs: Martin Kaltenbrunner and Carmel Majidi
Friday Afternoon, April 21, 2017
PCC North, 100 Level, Room 121 B

1:30 PM SM4.10.01

Soft Elastomers with Ionic Liquid-Filled Cavities as Strain Isolating Substrates for Wearable Electronics [Matt Pharr](#); Texas A&M University, United States.

1:45 PM SM4.10.02

Strain-Dependent and Hysteretic Resistance of Stretchable Carbon Nanotube Electrodes under Cyclic Loadings [Lihua Jin](#); University of California, Los Angeles, United States.

2:00 PM SM4.10.03

Highly-Stretchable 3D-Architected Mechanical Metamaterials [Qiming Wang](#); University Southern California, United States.

2:15 PM SM4.10.04

Fabric Sensory Sleeves for State Estimation of Soft Structures [Michelle C. Yuen](#); Purdue University, United States.

2:30 PM *SM4.10.05

Molecularly Stretchable Electronics for Energy and Healthcare [Darren J. Lipomi](#); University of California, San Diego, United States.

3:00 PM BREAK**3:30 PM SM4.10.06**

Superporous Intelligent Hydrogels for Environmentally Adaptive Building Skins [Shane I. Smith](#); University of Arizona, United States.

3:45 PM SM4.10.07

Fully-Printed, Double-Side Integrated High-Speed Stretchable Digital Logic Circuits for Self-Computable Electronic Skin [Junghwan Byun](#)^{1,2}; ¹Seoul National University, Korea (the Republic of); ²Inter-University Semiconductor Research Center, Korea (the Republic of).

4:00 PM SM4.10.08

Metamorphic Stretchable Electronics [Shantonu Biswas](#); Technical University Ilmenau, Germany.

4:15 PM SM4.10.09

Heat and pH Activated Fibrillar Adhesives [Kathleen P. Farrell](#); Arizona State University, United States.

4:30 PM SM4.10.10

Highly Stretchable, Twisted, Conductive Tubules for Robotics, Electronics and Healthcare Applications [Thanh Nho Do](#); California NanoSystems Institute, United States.

4:45 PM SM4.10.11

Soft Electronics with Hard Performance: Morphology and Geometry Engineering of In-Plane Crystalline Silicon Nanowires for Highly Stretchable Electronics [Linwei Yu](#)^{1,2}; ¹Nanjing University, China; ²LPICM, Ecole Polytechnique, France.