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 Timothée Roberts; Institut des Sciences du Mouvement, France; Microvitae 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 Lu; 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 KAUST, Saudi Arabia; 2 CMP-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

4:00 PM *SM4.4.01
Ultrathin Optoelectronic Devices—Light-Weight and Extreme Flexibility Matthew S. White; 1 University of Vermont, United States; 2 University 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 RIKEN, Japan; 3 JST PRESTO, Japan.

2:15 PM SM4.4.03 Subcutaneous Flexible Solar Cells for Supplying Electrical Power to Medical Implants Kwansung Song; Gwangju Institute of Science and Technology (GIST), Korea (the Republic of).

2:30 PM BREAK

3:00 PM SM4.4.04 Electronic Proprioception Denys Makarov; Helmholtz-Zentrum Dresden-Rossendorf e.V., Germany.

3:15 PM SM4.4.05 Compliant On-Skin Compass for Artificial Magnetoreception Gilbert Santiago Canon Bermudez; Helmholtz-Zentrum Dresden Rossendorf, Germany.

3:45 PM SM4.4.06 Self-Healing Polymers for Electronic Skin, Energy Storage and Actuators Chao Wang; University of California, Riverside, United States.

4:00 PM SM4.4.07 High Power, Tough Battery with Integrated Stretchable Circuit Florian Hartmann; Johannes Kepler University Linz, Austria.

4:15 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 Lai1, 2; National Chung Hsing University, Taiwan; 3 Georgia 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-Ag, O 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 Funho Oh1, 2; Seoul National University, Korea (the Republic of); 3 Seoul National University, Korea (the Republic of).

SM4.5.09 Stretchable and Multimodal all Graphene Electronic Skin Qian 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 Yuadong 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 Li1, 2, 3; Johns Hopkins University, United States; 4 Johns Hopkins University, United States; 5 Wuhan 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).

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

Session Chairs: Christoph Keplinger and Rebecca Kramer

Thursday Morning, April 20, 2017

8:00 AM - 10:00 AM
PCC North, 100 Level, Room 121 B

SM4.6.01 Autonomous Locomotion of Polymer Films Coupled to Stimuli Gradients Benjamin Trembl; 1, 2 UES, United States; 3 Air Force Research Laboratory, United States.

SM4.6.02 A 3D Fabrication Method for Soft Robots and Organ Phantoms Peer Fischer; Max Planck Institute for Intelligent Systems, Germany.
Shea Dielectric Elastomers Actuators for Soft High-Force Grippers

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 Microwebes Koohe HAN; 1, 2; North Carolina State University, United States; 3Research 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, 2, 3; University of Auckland, New Zealand; 4Stretchsense Ltd., New Zealand; 5University 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 Xunhu 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 Shanlizgi LIAO; Purdue University, United States.

2:30 PM SM4.7.04
Embracing Instabilities to Achieve Function in Soft Structures Katie 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. Pikal; 1, 2; Cornell University, United States; 3Cornell 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 Hoesin 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. Joshipura; North Carolina State University, United States.

SM4.8.04
Purifying Nanomaterials Using AC Dielectrophoresis for Flexible Electronic and Energy Harvesting Applications Roshan J. Plamhottam; 1, 2; Johns Hopkins University, United States; 3NanoDirect LLC, United States.

SM4.8.05
Soft Microactuator for Minimally Invasive Surgery Jun Kameoka; 1, 2; Texas A&M University, United States; 3Jikei 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 Aneis D. Auguste; Air Force Research Laboratory, United States.

SM4.8.09
Geometric Design of Mechanically Tunable Soft Composite Materials Youn-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 Kahlenbrunner 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; 2; Seoul National University, Korea (the Republic of); 3Inter-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; 2Nanjing University, China; 3LPICM, Ecole Polytechnique, France.