Symposium CH01: Advanced Characterization Techniques for Electrochemistry—Accelerating Research and Development of Energy Materials

This symposium covers recent progress in the multiscale advanced characterization of energy materials to understand the foundations of the physico-chemical phenomena that determine performances as a way to design more efficient and durable materials. The first part focuses on investigations of the physical/chemical processes and materials behaviour in reversible batteries, electrolysis, fuel cells, etc. Techniques of interest for multiscale in situ studies are TEM, XAFS, XRD, XPS, X-ray tomography and SIMS, to name a few. The second part focuses on electrochemical reactions under extreme environments such as high/low temperatures and pressure, large temperature fluctuations, irradiation, etc. The contributions address basic scientific issues, discover of new phenomena, limiting factors in the practical application of emerging energy materials. Examples of the translation of fundamental knowledge from the advanced characterization techniques on materials/device development are welcomed, together with complementary computational studies. This symposium aims to cover the state-of-the-art of our understanding of energy materials chemistry, identify synergy between different techniques and applications and is an opportunity to discuss generalised concepts from a fundamental perspective.

Topics will include:

- Advanced characterization techniques, in situ/operando techniques: development and application
- Electrochemistry and interface evolution, CO_2 reduction and H_2 production
- Electro-chemo-mechanics/ Electrochemistry under extreme environment
- Lithium-based anode/ Stable cathode materials for high-energy-density batteries
- All-solid-state battery system/ Electrode reactions and degradation

A **tutorial** complementing this symposium is tentatively planned. Further information will be included in the MRS Program that will be available online in January.

Invited speakers include:

Daan Alsem	Hummingbird Scientific, USA
Aimy Bazylak	University of Toronto, Canada
Gloria Berlier	Torino University, USA
Clotilde Cucinotta	Imperial College London, United Kingdom
Sofia Diaz-Moreno	Diamond Light Source, United Kingdom
Madeline Dukes	Protochips, USA
Nikita Dutta	National Renewable Energy Laboratory, USA
Kae Fink	National Renewable Energy Laboratory, USA
Avetik Harutyunyan	Honda Research Institute, USA
Heung Lee	Samsung, Republic of Korea
Zhao Liu	Thermo Fisher Scientific, USA
Amy Marschilok	Stony Brook University, The State University of New York, USA
Titus Masese	National Institute of Advanced Industrial Science and Technology, Japan
Alvaro Masias	Ford Motor Company, USA
He Qian	National University of Singapore, Singapore
Shizhang Qiao	The University of Adelaide, Australia
Manfred Erwin Schuster	Johnson Matthey, United Kingdom
Nikhilendra Singh	Toyota Research Institute, USA
Ifan Stephens	Imperial College London, United Kingdom
Verena Streibel	Technische Universität München, Germany
Chongmin Wang	Pacific Northwest National Laboratory, USA
Feng Wang	Brookhaven National Laboratory, USA
Johanna Weker	Stanford University, USA
Kazuo Yamamoto	Japan Fine Ceramics Center, Japan
Yunlong Zhao	University of Surrey, United Kingdom

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Symposium CH02: Advances in Cryogenic Transmission Electron Microscopy and Spectroscopy for Quantum and Energy Materials

Cryogenic transmission electron microscopy (TEM) has revolutionised our understanding of biological materials at the atomic scale. Despite the research breakthroughs in biology, utilising cryogenic conditions for TEM research of heterogeneous materials is still in its infancy. The main advantages of cryogenic TEM for energy materials lie in two aspects. First, it reduces damage from electron irradiation for beam sensitive materials, such as superionics, soft matter, and materials involving liquid phases. Second, temperature control of TEM holders well below room temperature allows for researchers to explore in-situ how complex exotic phenomena occur that only exist at cryogenic temperatures in quantum materials. New theoretical and data analysis techniques including artificial intelligence/machine learning approaches are critical for cryogenic TEM to overcome low signal/noise and instrumentation stability constraints that can be common to cryo-EM experiments. This symposium focuses on recent advances and emerging developments in the area of cryogenic TEM, including cryo-FIB based sample preparation and vitrification, which are expected to open a new platform to probe phenomena in quantum and energy materials that have not been accessible before.

Topics will include:

- Applications of cryogenic S/TEM and EELS for quantum and energy materials
- Applications of cryogenic S/TEM for beam sensitive materials
- Cryogenic sample preparation techniques including vitrification and cryogenic focused ion beam
- Advancements in cryogenic TEM holders, such as temperature control and extreme low liquid helium temperatures
- Advancements in cryogenic in-situ holders (eg. additional applied stimulus such as bias, magnetic field or strain)
- Combination with advanced TEM techniques (phase related, spectroscopy, 4D-STEM)
- Synergies with theoretical methods and data science
- Advanced data acquisition and analysis methods (including AI/ML) for cryogenic microscopy
- TEM techniques to explore interplay of quantum phenomena such as charge, spin, orbital, lattice correlations
- Phase transitions and dynamic process at cryogenic temperatures

A **tutorial** complementing this symposium is tentatively planned. Further information will be included in the MRS Program that will be available online in January.

Invited speakers include:

Patricia Abellan	Institut des Matériaux Jean Rouxel, France	**Yuzhang Li**	University of California, Los Angeles, USA
Ismail El Baggari	Harvard University, USA	**Ana Pakzad**	Ametek, USA
Ayman El-Zoka	Max-Planck-Institut für Eisenforschung GmbH, Germany	**Xiaoqing Pan**	University of California, Irvine, USA
Meng Gu	Southern University of Science and Technology, China	**Charudatta Phatak**	Argonne National Laboratory, USA
Jordan Hachtel	Oak Ridge National Laboratory, USA	**Alex Porter**	Imperial College London, United Kingdom
Juan Carlos Idrobo	University of Washington, USA	**Robert Streubel**	University of Nebraska–Lincoln, USA
Shuhei Ikezawa	Mel-Build Inc., Japan	**Denys Sutter**	CondenZero GmbH, Switzerland
Xi Jiang	Lawrence Berkeley National Laboratory, USA	**Luiz Tizei**	Université Paris-Saclay, France
Katherine Jungjohann	National Renewable Energy Laboratory, USA	**Chongmin Wang**	Pacific Northwest National Laboratory, USA
James LeBeau	Massachusetts Institute of Technology, USA	**Yimei Zhu**	Brookhaven National Laboratory, USA

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Symposium CH03: Neutron Scattering-Enabled Energy Materials Design

Neutron scattering provides insight into the structure and dynamics driving material properties through a wide range of different techniques. It is a non-destructive and highly penetrating probe, which can be combined with complex sample environment enabling in situ and in operando measurements. This symposium will explore how different neutron scattering techniques can be used to explore energy materials, with the aim of understanding the structures and processes to accelerate materials development. Neutron scattering is used to understand the structure and properties of all forms of condensed matter, and is exceptionally-well suited to studying how the transport and binding of energy and charge-carrying species relate to their dynamics and the material's crystal structure. H_2, H^+, and Li^+ are key to a range of leading energy technologies, and are excellent neutron scatterers, making neutron-based analysis ideal for in situ and in operando studies of hydrogen storage, fuel-cell, catalytic, and battery materials. Similar research into the functionality of solar-cell, thermoelectric, caloric, nuclear, and CO_2 capture/storage materials rely on other unique aspects of neutron scattering and can be used to showcase how their structure and dynamics provide an understanding of the material stability and the binding and mobility of species of interest. This symposium, focussing on advances and developments in neutron scattering for the characterization of energy materials, will be of interest to new and expert users alike. Attendees with little or no experience of neutron scattering who are working on energy materials will discover how powerful neutron scattering is as a characterization method, while those with more experience will find this an invaluable networking opportunity, fostering interactions and advancing knowledge in the field.

Topics will include:

- Battery materials, fuel cells and capacitors
- Gas storage/separation
- Catalysis
- Thermoelectrics
- Baro/magneto/elasto-calorics
- Solar cells
- Nuclear industry

Invited speakers include:

Aritra Banerjee	University of Calcutta, India
Craig Brown	National Institute of Standards and Technology, USA
Karena Chapman	Stony Brook University, The State University of New York, USA
Serena Cussen	The University of Sheffield, United Kingdom
Olivier Delaire	Duke University, USA
Ivana Evans	Durham University, United Kingdom
Karen Friese	Forschungszentrum Jülich GmbH, Germany
Masahi Harada	Toyota Central R&D Labs., Inc., Japan
Maths Karlsson	Chalmers University of Technology, Sweden
Bing Li	Institute of Metals Research, Chinese Academy of Sciences, China
Xiangfeng Liu	The University of the Chinese Academy of SciencesSciences, China
Martin Mansson	KTH Royal Institute of Technology, Sweden
Mahmoud Mostafavi	University of Bristol, United Kingdom
Xavier Moya	University of Cambridge, United Kingdom
Alex O'Malley	University of Bath, United Kingdom
Katharine Page	University of Tennessee, USA
Andrea Piovano	Institut Laue-Langevin, France
Yang Ren	City University of Hong Kong, China
Danas Ridikas	International Atomic Energy Authority, Austria
Efrain Rodriguez	University of Maryland, USA
Paul Shearing	University College London, United Kingdom
Nicholas Weadock	University of Colorado Boulder, USA
Claire White	Princeton University, USA
Sihai Yang	The University of Manchester, United Kingdom

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Symposium EL01: Phase-Change Materials for Emerging Applications in Reconfigurable Devices, Memory and Computing

Phase-change materials (PCMs), such as chalcogenides alloys (GeTe, $Ge_2Sb_2Te_5$, AgInSbTe, GeSbSe, etc.), and VO_2, have recently emerged as a promising platform to control both nanoscale electronic and photonic devices on-chip due to their fast, dramatic, and reversible change in electrical and optical properties. Since their initial demonstration, significant technical progress in the field of both electrical and optical PCMs has been achieved in terms of finding new alloys with superior switching speeds, optical transparency, opto-electronic control, and large-scale electronic and photonic integration. These advances have led to exciting applications ranging from reconfigurable RF and photonic switches, ovonic threshold selectors, tunable optical metasurfaces, and highly efficient in-memory computing.

With the growing academic and industrial interest in these unique materials, it is crucial to understand both the advantages and challenges of PCMs to inform future research in this field. Further work is needed at the materials, device, and systems levels to address current challenges such as integrating emerging PCMs into the foundry process flow, optimizing multilevel reliability for in-memory computing applications, and improving large area switching endurance for both RF and photonic devices. Presenters and invited speakers will represent a broad range of disciplines from chemistry, physics, engineering, and materials science to encourage fertile cross-cutting discussions.

Topics will include:

- Application of phase change materials to PCRAM devices and optical storage
- Phase-change materials in reconfigurable photonic memories, logic and displays applications
- Neuromorphic and in-memory computing with phase change memory devices
- Integration of phase-change materials into hybrid nanostructures
- Concepts and enabling technologies for 3D memory, OTS devices, RF Switches
- Processing and reliability issues in device fabrication and integration
- Theory and computer simulations of structural, electronic, and optical processes in phase change materials
- Physical properties of chalcogenide phase change materials

Joint sessions are being considered with **EL06 - Adaptive Nanophotonics—Tunable, Reprogrammable and Integrated Nanophotonics**.
Also, a **tutorial** complementing this symposium is tentatively planned. Further information will be included in the MRS Program that will be available online in January.

Invited speakers include:

Marco Bernasconi	Università degli Studi di Milano-Bicocca, Italy
Harish Bhaskaran	University of Oxford, United Kingdom
Massimo Borghi	STMicroelectronics, Italy
Valeria Bragaglia	IBM Research-Zurich, Switzerland
Huai-Yu (Michelle) Cheng	Macronix International Co., LTD, USA
Zengguang Cheng	Fudan University, China
Bart Kooi	University of Groningen, Netherlands
Andriy Lotnyk	Leibniz Institute of Surface Engineering, Germany
Anbarasu Manivannan	Indian Institute of Technology Madras, India
Stephan Menzel	Forschungszentrum Jülich GmbH, Germany

Pierre Noe	Commissariat à l'énergie atomique et aux énergies alternatives, France
Wolfram Pernice	Universität Münster, Germany
Timothy Philips	IBM Research-Albany, USA
Eric Pop	Stanford University, USA
Mina Rais-Zadeh	University of Michigan, USA
Innocenzo Tortorelli	Micron, Italy
Sharon Weiss	Vanderbilt University, USA
Nathan Youngblood	University of Pittsburgh, USA
Wei Zhang	Xi'an Jiaotong University, China

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Symposium EL02: Material Innovation Toward Stable Halide Perovskite Electronics

Metal-halide perovskite materials are recent champions for clean energy generation and power conversion applications. Over the past decade, perovskite photovoltaics and light emitting diodes have delivered unprecedented efficiencies by virtue of the rapid development in the field. Despite these impressive progresses, one of the key remaining road blocks preventing the practical application of perovskite devices is their poor environmental stability and proneness to degradation under device operational conditions. Without addressing the stability issues, perovskite-based optoelectronic devices will remain to be laboratory scale demonstrations.

This symposium aims to bring together cutting-edge ideas that would facilitate material innovation for stable perovskite photovoltaics, light emitting diodes and detectors. Recent developments for stable performances in this area include, but are not limited to, novel perovskite nano-structures such as quantum dots, nanowires and nanosheets, hetero-structures formed by perovskites and passivation organic layers or frameworks, and ligand-mediated wavefunction engineering. These advances in material discovery and structural engineering have led to significant progresses in device stability that ranges from environmental stability, electrical field stability and stability under constant irradiation.

In addition to material growth, this symposium will also cover topics on mechanistic understanding of material and device stability through advanced characterization tools, such as operando high resolution spectroscopy and in-situ characterization techniques.

Topics will include:

- Innovative perovskite nano-structures and heterostructures for improved environmental stability
- Innovations in device layouts, electrodes, interface layers to extend the devices' operational stability
- Water stable perovskite structures, hetero-structures for water splitting, CO_2 reduction
- Novel extreme characterization techniques, such as ultra-fast, ultra-resolution optical spectroscopy, X-ray spectroscopy, and electron
- *In situ*, *operando* characterization methods for mechanistic understanding of the materials' structural assembly and stability
- Theoretical modeling for understanding the degradation chemistry and defect induced degradation
- Data science, machine learning tool for discovering stable perovskite structures

Joint sessions are being considered with **EL04 - Metal Halide Perovskites for Applications Beyond Solar**.

Invited speakers include:

Christoph Brabec	Friedrich-Alexander-Universität Erlangen-Nürnberg, Germany
Annalisa Bruno	Nanyang Technological University, Singapore
Caterina Ducati	University of Cambridge, United Kingdom
Alessio Filipetti	Università degli Studi di Cagliari, Italy
Mercouri Kanatzidis	Northwestern University, USA
Aron Lindenberg	Stanford University, USA
Rebecca Milot	University of Warwick, United Kingdom
Laura Miranda Perez	Oxford PV, United Kingdom
Peter Müller-Buschbaum	Technische Universität München, Germany
Nakita Noel	University of Oxford, United Kingdom
Lakshmi Polavarapu	Universidade de Vigo, Spain
Giuseppe Portale	University of Groningen, Netherlands
Loredana Protesescu	University of Groningen, Netherlands
Laura Schelhas	National Renewable Energy Laboratory, USA
Hayase Shuzi	The University of Electro-Communications, Japan
Sam Stranks	University of Cambridge, United Kingdom
Shijing Sun	Toyota Research Institute, USA
Sergei Tretiak	Los Alamos National Laboratory, USA
Hsinhan Tsai	University of California, Berkeley, USA
Leeyih Wang	National Taiwan University, Taiwan
Lydia Wong	Nanyang Technological University, Singapore
Yang Yang	Zhejiang University, China
Alvin Zhou	Hong Kong Baptist University, Hong Kong

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Symposium EL03: Frontiers in Electrochromic Materials and Devices

Electrochromic devices (ECDs) that reversibly modulate optical transmittance or reflectance under applied potentials are key components for a variety of energy-saving and color-tuning applications, especially when integrated into “smart windows” that switch between a colored (dark) state and a colorless (bleached) state to increase the energy efficiency of automobile and buildings and bring visual comfort to people. Electrochromic materials and devices are also expected to play a key role in the future meta world as a critical component for VR/AR. Further, electrochromic displays feature low power consumption and transmissive/reflective mode, which is complementary to emissive displays and presents unique application scenarios. To fulfill the potentials of ECDs, advances in materials design, processing, device structures, mechanistic understanding of ion and electron transport, and the failure mode are essential. This symposium intends to bring together active researchers and business leaders in this field and discuss the advancements in technical developments, challenges in scalable manufacturing, and business opportunities in the real world.

This symposium welcomes a collection of abstracts that cover all aspects of electrochromic technology development from materials design, patterning, coating, device fabrication, and scalable manufacturing.

Topics will include:

- Small molecule-based electrochromic materials and devices
- Polymer-based electrochromic materials and devices
- Metal-oxide based electrochromic materials and devices
- Plasmonic electrochromics
- Reversible metal deposition
- Mixed organic conductors
- Ion and electron transport
- Optical and electronic modeling of electrochromic thin films
- Electrochromic dynamic display
- Emerging electrochromic functions and devices
- Scalable manufacturing of thin-film electrochromics
- Technical challenges in scaling up

A **tutorial** complementing this symposium is tentatively planned. Further information will be included in the MRS Program that will be available online in January.

Invited speakers include:

Chris Barile	University of Nevada, Reno, USA
Andreas Dahlin	Chalmers University of Technology, Sweden
Jiazhi He	Ambilight Inc, China
Masayoshi Higuchi	National Institute for Materials Science, Japan
Eunkyoung Kim	Yonsei University, Republic of Korea
Caroline Lee	Hanyang University, Republic of Korea
Pooi See Lee	Nanyang Technological University, Singapore
Mike McGehee	University of Colorado Boulder, USA
Delia Milliron	The University of Texas at Austin, USA
John Reynolds	Georgia Institute of Technology, USA
Marco Schott	Fraunhofer Institute for Silicate Research, Germany
Gregory Sotzing	University of Connecticut, USA
Miko van der Boom	Weizmann Institute of Science, Israel
Chunye Xu	University of Science and Technology of China, China
Yumo Zhang	Jilin University, China
Zhigang Zhao	Suzhou Institute of Nanotechnology and Nano-Bionics, Chinese Academy of Sciences, China

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Symposium EL04: Metal Halide Perovskites for Applications Beyond Solar

Metal halide perovskites are by now well-established materials for optoelectronics, with power conversion efficiencies of single cell devices exceeding 25% rivaling established solar cell technologies. Halide perovskite materials exhibit exceptional properties related to their electronic and excited state structure, but also their unusual structural dynamics which have yet to be investigated in depth from experimental and theoretical perspectives A large fraction of the literature focuses on properties relevant for optoelectronic applications, while we envision a much wider scope for these materials, e.g in spintronic and electro-chemical applications. The purpose of this symposium is now to provide a platform for theorists and experimentalists working on novel materials and applications based on halide perovskites, e.g spintronics, electro-chemical charge storage, or quantum applications. We believe that interactions and exchange of ideas between theoreticians and experimentalist will now be needed and fruitful for the discovery of future directions for this technologically relevant class of materials, beyond the focus on optoelectronics. We have further observed a widening gap between experimental and theoretical efforts in the literature on halide perovskites. We will, thus, offer a workshop targeted at graduate students and emerging leaders, to discuss how state-of-the art approaches in data sharing and theory can be effectively combined with experiments, for future sustainable material discovery.

Topics will include:

- Theoretical and experimental understanding of defects
- Computation-driven discovery of perovskite phenomena
- Spintronic materials and applications
- Excitonics in lower-dimensional perovskites
- Quantum Effects and Information Storage
- Machine learning based accelerated characterization of perovskite materials
- Structure-property relations of lower-dimensional perovskites
- Emerging properties of perovskite-derived materials
- Fundamentals of halide migration and control
- Fundamentals and applications of (photo-)electrochemical energy storage
- Transient charge and ionic movement under operating conditions
- Phenomena at surfaces and interfaces
- Epitaxial halide perovskites

Joint sessions are being considered with **EL02 - Material Innovation Toward Stable Halide Perovskite Electronics**.
Also, a **tutorial** complementing this symposium is tentatively planned. Further information will be included in the MRS Program that will be available online in January.

Invited speakers include:

David Cahen	Weizmann Institute of Science, Israel
Juan-Pablo Correa Baena	Georgia Institute of Technology, USA
Emanuelle Deleporte	Université Paris-Saclay, France
Bruno Ehrler	AMOLF, Netherlands
Marina Filip	Oxford University, United Kingdom
Hyun Myung Jang	Pohang University of Science and Technology, Republic of Korea
Yoshihiko Kanemitsu	Kyoto University, Japan
Hemamala Karunadasa	Stanford University, USA
Claudine Katan	Université de Rennes 1, France
Mingzhen Liu	University of Electronic Science and Technology of China, China
Monica Morales-Masis	Twente University, Netherlands
Jeff Neaton	University of California, Berkeley, USA
David Scanlon	London's Globa University, United Kingdom
Tze Chien Sum	Nanyang Technological University, Singapore
Liang Tan	Lawrence Berkeley National Laboratory, USA
Chris van de Walle	University of California, Santa Barbara, USA
Julia Wiktor	Chalmers University of Technology, Sweden
Omer Yaffe	Weizmann Institute of Science, Israel

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Symposium EL05: Molecular and Colloidal Plasmonics—From Synthesis to Application

This symposium aims to bring together a diverse community of researchers who are advancing the field of plasmonics through synthesis, nanofabrication, and application where the greater goal is to provide an understanding of the opportunities and challenges that lie ahead. Topics closely related to synthesis will include chiral plasmonic nanostructures, colloidal plasmonic nanocomposites, hybrid nanostructures, advances in colloidal synthesis, sinter-resistant catalysts, and unconventional plasmonic materials. Advances in nanofabrication pertaining to patterned and self-assembled surfaces, the formation of well-defined and tunable nanogaps, and durable plasmonics will be highlighted. Applications of specific interest include chemical, biological, and optical sensors, plasmonic photocatalysis, plasmonic solar cells, and plasmonics in environmental remediation.

Topics will include:

- Advances in the colloidal synthesis of plasmonic nanoparticles, 2D and 3D nanoparticle assembly, and patterning
- Artificial plasmonic molecules: plasmonic coupling, quantum and chirality effects, Fano resonance
- Colloidal plasmonic nanocomposites and nanoparticle-semiconductor hybrid nanomaterials
- Plasmonic heating of nanostructures: thermoplasmonics and nanothermometry
- Surface Enhanced Raman Spectroscopy (SERS) and Tip-Enhanced Raman Excitation Spectroscopy (TERES)
- Ultrafast transient absorption spectroscopy, single particle spectroscopy, and super-resolution imaging
- Plasmonic photocatalysts: synthesis, performance, and artificial photosynthesis
- Plasmonic nanoparticles for drug delivery, pharmaceutical applications, and photothermal therapy
- Stabilization of plasmonic nanoparticles: durable plasmonics and sinter-resistant plasmonic catalysts

Invited speakers include:

Jost Adam	University of Southern Denmark, Denmark
Jingyi Chen	University of Arkansas, USA
Jennifer Dionne	Stanford University, USA
Michael Engel	Friedrich-Alexander-Universität Erlangen-Nürnberg, Germany
Laura Fabris	Rutgers University, USA
Hongyou Fan	Sandia National Laboratories, USA
Alexander Govorov	Ohio University, USA
Amanda Haes	University of Iowa, USA
Christy Haynes	University of Minnesota, USA
Prashant Jain	University of Illinois at Urbana-Champaign, USA
Nicholas Kotov	University of Michigan, USA
Christy Landes	Rice University, USA
Howard Lee	University of California, Irvine, USA
Dongling Ma	Université du Québec, Canada
Jill Millstone	University of Pittsburgh, USA

Ki Tae Nam	Seoul National University, Republic of Korea
Zhihong Nie	Fudan University, China
Teri Odom	Northwestern University, USA
Michelle Personick	Wesleyan University, USA
Dong Qin	Georgia Institute of Technology, USA
Andreas Seifer	CIC nanoGUNE, Spain
Jennifer Shumaker-Parry	The University of Utah, USA
Hui Wang	University of South Carolina, USA
Nianqiang (Nick) Wu	University of Massachusetts Amherst, USA
Xiaohu Xia	University of Central Florida, USA
Younan Xia	Georgia Institute of Technology, USA
Yadong Yin	University of California, Riverside, USA
Francis Zamborini	University of Louisville, USA
Hua Zhang	City University of Hong Kong, Hong Kong
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Symposium EL06: Adaptive Nanophotonics—Tunable, Reprogrammable and Integrated Nanophotonics

This symposium addresses emerging topics of adaptive nanophotonics including dynamic metamaterials and metasurfaces, programable photonic integrated circuits (PICs), and neuromorphic photonics. Recent advances in nanophotonics overcome diffraction limit and have led to incredible insights and potential applications for novel optoelectronics in communications, imaging, and sensing. Realization of neuromorphic computing using PICs promises significantly higher instantaneous bandwidth and throughput over electronics-only hardware realizations. For further development of technology functioning in practical platforms, fully control over optical properties of incident light is crucial. Adaptive nanophotonics with tunability, reconfigurability, reprogrammability, and integrability are needed for the next generation of miniaturized devices and systems. The symposium overviews novel approaches achieving control over properties of nanophotonics post-fabrication utilizing phase-change materials, phase-transition materials, two-dimensional (2D) materials, transparent conductive oxides, perovskite, metal hydrides, piezo-electric materials, highly doped semiconductors, high mobility electron transistors (HEMTs), thin layer of liquid crystals, electro-optics effects, magneto-optical effects, and micro/nano-electromechanical systems (MEMS/NEMS). The symposium covers fundamental materials science, operation theory and design, advanced fabrication, devices, and applications. This symposium will not cover tunability enabled by bulk nonlinear crystals, bulk elastic substrate, and thick layer of liquid crystals.

Topics will include:

- Dynamic metamaterials and metasurfaces
- Programmable photonic integrated circuits
- Neuromorphic photonics and all-optical computing
- Physics and materials science of materials with tunable optical properties
- Dynamic nanophotonics driven by all types of materials and mechanisms suitable for miniaturization
- Operation theory and mechanism
- Advanced design based on machine-learning techniques and new algorithm
- Novel fabrication techniques
- Devices and applications

Invited speakers include:

Ali Adibi	Georgia Institute of Technology, USA
Andrea Alù	The City University of New York, USA
Harry Atwater	California Institute of Technology, USA
Sunil Bhave	Purdue University, USA
Sergey I. Bozhevolnyi	University of Southern Denmark, Denmark
Victor Brar	University of Wisconsin–Madison, USA
Mark Brongersma	Stanford University, USA
Federico Capasso	Harvard University, USA
Alfredo De Rossi	Thales, France
Jennifer Dionne	Stanford University, USA
Andrei Faraon	California Institute of Technology, USA
Juejun Hu	Massachusetts Institute of Technology, USA
Yuri Kivshar	Australian National University, USA

Arseniy I. Kuznetsov	Agency for Science, Technology and Research, Singapore
Howard Lee	University of California, Irvine, USA
Arka Majumdar	University of Washington, USA
Mitchell Nahmias	Luminous Computing, USA
Wolfram Pernice	Universität Münster, Germany
Chengwei Qiu	National University of Singapore, Singapore
Vladimir M. Shalaev	Purdue University, USA
Ranjan Singh	Nanyang Technological University, Singapore
Jason Valentine	Vanderbilt University, USA
Junqiao Wu	University of California, Berkeley, USA
Mengjie Yu	University of Southern California, USA
Nikolay Zheludev	University of Southampton, United Kingdom
Lei Zhou	Fudan University, China

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Symposium EL07: Group IV Nanostructures for Emerging Optoelectronic Applications

Group IV nanostructures such as silicon and germanium nanocrystals have potential applications in optoelectronics, biomedicine and emerging quantum technologies . This symposium will focus on the role of colloidal carbon, silicon and germanium nanostructures as earth-abundant, non-toxic, electronically and optically active solution-processable counterparts of the corresponding bulk materials. The first part of this symposium will focus on the synthesis and characterization of solution-processable group IV nanoparticles or quantum dots, concerning crystallinity, size, doping and shape control. Surface functionalization methods for these group IV nanostructures adapted from synthetic organic chemistry and surface modification of flat silicon wafers and porous silicon are of interest. The second part of this symposium will focus on correlating the physical properties of these group IV nanostructures to the behavior of their excited states by time-resolved measurements, e.g. optical characterization of electronic states. Of interest are excitonic states that result from efforts to dope these group IV nanostructures, increase the absorption cross-section of these indirect-gap nanomaterials, and control the luminescence quantum yields and emission wavelengths. Symposium contributions can also address the potential hybridization between organic or inorganic additives to the group VI nanostructures for the creation of new electronic states. Contributions focusing on the modelling of group IV nanostructures (MD, DFT, or other ab-initio techniques) are of interest. Finally, this symposium solicits abstracts on the applications of these group VI nanostructures in various technologically important fields such as optoelectronics, biomedicine and quantum technologies. Silicon or germanium quantum dots have found use in photon upconversion, singlet fission, solar concentrators, thin-film transistors, light emitting diodes, photodetectors, optoelectronic synaptic devices and quantum processes (qubits, quantum transducers, nanoscale magnetic sensors, etc). Discussion of synthetic mechanisms, surface functionalization methods, device fabrication techniques and methods to enhance potential quantum applications or otherwise, are welcome.

Topics will include:

- Colloidal synthesis of quantum-confined group IV nanostructures
- Doping/ surface functionalization of group IV nanocrystals
- Role of interfaces in energy and charge transport
- Photon upconversion/ singlet fission utilizing molecular and group IV excitons
- Exciton- charge dynamics in hybrid systems based on group IV nanostructures
- Computational methods describing excitonic group IV nanostructures
- Devices (e.g. transistors, photodetectors, light-emitting diodes, solar cells and artificial synapses) based on group IV nanostructures
- Emerging applications (e.g. biosensing, photocatalysis, neuromorphic and quantum computing)

Invited speakers include:

Mita Dasog	Dalhousie University, Canada
Joel Eaves	University of Colorado Boulder, USA
Vivian Ferry	University of Minnesota, USA
Giulia Galli	The University of Chicago, USA
Susan Kauzlarich	University of California, Davis, USA
Brian Korgel	The University of Texas at Austin, USA
Uwe Kortshagen	University of Minnesota, USA
Benjamin Levine	Stony Brook University, The State University of New York, USA
Cheng Li	Xiamen University, China

Nathan Neale	National Renewable Energy Laboratory, USA
Sean Roberts	The University of Texas at Austin, USA
Rich Schaller	Northwestern University, USA
Hiroshi Sugimoto	Kobe University, Japan
Ilya Sychugov	KTH Royal Institute of Technology, Sweden
Andrew Teplyakov	University of Delaware, USA
Jonathan Veinot	University of Alberta, Canada
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Symposium EL08: Nanogenerators and Piezotronics

The era of the Internet of Things brings new requirement of energy to sustainably power billions of devices/sensors pervasively. Recent advances in nanogenerator research demonstrated a great potential in harvesting mechanical energy from ambient environments and human body, leading to pervasive and sustainable power sources that operate over a broad range of conditions. During the past decade, the nanogenerator technologies by using piezoelectric, triboelectric, and other effects has experienced a rapid development. It has led to the implementation of various types of micro/nano-systems for portable, wearable and implantable electronics, remote and mobile sensors, nano-robotics, intelligent MEMS/NEMS, and blue energy technology. The coupling between piezoelectric polarization and semiconductor properties is a fundamental phenomenon where electrons and photons are manipulated by strain, i.e. piezotronics and piezo-phototronics, which brings unprecedented opportunities for tuning the semiconductor performance. The progressing of piezotronics and piezo-phototronics leads to compelling advancements from basic studies of piezoelectricity and semiconductor properties to the applications of smart electronics and optoelectronics, including sensing, human-machine interfacing, robotics, catalysis, energy and healthcare.

This symposium aims to promote fundamental understanding and technology advancements of nanogenerator and piezotronics. Abstracts on theoretical and experimental study of triboelectric, piezoelectric, and ferroelectric materials and devices; investigation and applications of nanogenerators for self-powered devices; fundamental coupling between piezoelectric/ferroelectric polarization and semiconductor properties in 1D/2D nanomaterials and their applications (e.g., electronics, optoelectronics, photovoltaics, thermoelectrics, photoelectrochemistry) are particularly welcomed.

Topics will include:

- Triboelectric, piezoelectric and ferroelectric nanomaterials and nanostructures: synthesis, characterization, and integration
- Theoretical analysis of nanoscale mechanical-to-electric energy conversion
- Novel piezoelectric and ferroelectric biomaterials
- Bio-inspired materials and device innovations in mechanical energy harvesting
- Technological advances in integration and manufacturing of nanogenerators
- Hybridization of nanogenerators with energy storage units: design, integration and power management
- Tribotronics and mechanisms of triboelectric charge generation and transportation
- Piezotronics and Piezophototronics in 1D/2D nanomaterials for smart adaptive electronics and optoelectronics
- Fundamental study on band structure and interface engineering using piezoelectric or ferroelectric polarization
- Theoretical and experimental study of piezotronic and piezophototronic effects for electron, photon transport and interaction
- Fundamental and technological issues in piezocatalysis: catalytic properties modulated by piezoelectric or ferroelectric polarization

A **tutorial** complementing this symposium is tentatively planned. Further information will be included in the MRS Program that will be available online in January.

Invited speakers include:

Philippe Basset	Université Gustave Eiffel, France
Ana Borras	Instituto de Ciencia de los Materiales de Sevilla, Spain
Jianhua Hao	Hong Kong Polytechnic University, Hong Kong
Hamideh Khanbareh	University of Bath, United Kingdom
Miso Kim	Sungkyunkwan University, Republic of Korea
Chengkuo Lee	National University of Singapore, Singapore
Keon Jae Lee	Korea Advanced Institute of Science and Technology, Republic of Korea
Yanchao Mao	Zhengzhou University, China
Guylaine Poulin-Vittrant	Université de Tours, France
Xiao-Ming Tao	Hong Kong Polytechnic University, Hong Kong
Sihong Wang	The University of Chicago, USA
Zhong Lin Wang	Georgia Institute of Technology, USA
Wenzhuo Wu	Purdue University, USA
Rusen Yang	Xidian University, China
Haixia Zhang	Peking University, China
John XJ Zhang	Dartmouth College, USA
Yunlong Zi	Hong Kong University of Science and Technology, Hong Kong

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Symposium EL09: Layered (2D) Optoelectronic Materials and Devices

Semiconducting materials that exist in layered (2D) form like the transition metal dichalcogenides, perovskites and metal oxides bring new opportunities for optoelectronic applications, as they combine the unique characteristics of nanomaterial with ease of fabrication because of their planar configuration. These are emerging materials, that have a potential to form a core research topic in future. This symposium will focus on new developments in layered optoelectronic materials and their applications. This symposium will cover modelling, synthesis/growth, characterisation and applications of layered (two dimensional) optoelectronic materials and will bring together chemists, physicists and engineers.

The symposium can be broadly categorised into three parts. The first part of the symposium will focus on modelling for predictions and new discoveries, material synthesis and structural and optoelectronic characterisation. Submissions on insights into material growth mechanisms, engineering structure/composition to enable new applications and large area synthesis are encouraged. Emerging materials like 2D perovskites and metal oxides and hybrid heterostructures of layered materials will be included in this section of the symposium. Second part of the symposium will focus on light manipulation applications, and will include nano-lasers and LEDs, quantum nanophotonic devices and applications of non-linear properties of layered materials. Final section of the symposium will focus on biosensing and energy related applications of layered optoelectronic materials. The planar configuration and very high surface area to volume ratio makes layered optoelectronic materials ideal for such applications. Wearable and flexible devices will be included in this section of the symposium. Submissions on novel device configurations and fabrication approaches are encouraged for the sessions on applications of layered optoelectronic material.

Topics will include:

- Synthesis of 2D optoelectronic materials and their heterostructures
- Optoelectronic characterisation and Optical/Optoelectronic properties of layered optoelectronic materials and their heterostructures
- Structural characterisation of layered optoelectronic materials
- Modelling of 2D Materials and Heterostructures: New discoveries and predictions
- Emerging 2D optoelectronic materials: perovskites, metal-oxides, hybrid heterostructures
- Light-matter interactions in layered optoelectronic materials
- Light emitters: Nano/micro-LEDs and lasers based on layered semiconductors
- Sensing, imaging and information processing applications based on layered (2D) materials
- Quantum nanophotonics: Single photon emitters and detectors based on layered materials
- Non-linear properties and applications of layered (2D) materials
- Energy applications of layered materials: catalysis and (photo)electrochemical water splitting
- 2D materials for chemical/electrochemical/electronic biosensors
- Layered (2D) materials based flexible and wearable devices

Invited speakers include:

Pulickel M. Ajayan	Rice University, USA	**Adina Luican-Mayer**	University of Ottawa, Canada
Deji Akinwande	The University of Texas at Austin, USA	**Jian Zhen Ou**	RMIT University, Australia
Susan Fullerton	University of Pittsburgh, USA	**Alexander Tartakovskii**	The University of Sheffield, United Kingdom
Giulia Grancini	Università degli Studi di Pavia, Italy	**Jorik van der Groep**	University of Amsterdam, Netherlands
Baohua Jia	RMIT University, Australia	**Zeila Zanolli**	Utrecht University, Netherlands
Bin Liu	Nanyang Technological University, Singapore	**Xiao-Xiao Zhang**	University of Florida, USA

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Symposium EL10: Dynamical Molecular-Scale Opto-Electronic Devices

This symposium will cover current and emerging developments in molecular electronic devices. Charge transport across molecules is ubiquitous in countless scientific disciplines including catalysis, biology, sensing and nanoelectronics, therefore understanding the mechanisms of charge transport across molecules and molecule-electrode interfaces is extremely important. The overall aim is to address fundamental questions regarding the mechanisms of charge transport, and how this knowledge can be applied to recent developments in new and upcoming areas including neuromorphic computing, single-molecule sensing, or biomolecular electronics. The first part of the symposium will focus on recent progress in understanding the fundamental aspects of charge transport. Topics will include new developments in theoretical approaches, collective electrostatic effects, quantum interference effects, and light-matter interactions in junctions. Also, the role of the environment and the dynamics of junctions will be covered which are important to understand redox-events in junctions. The second part of the symposium will cover new and exciting developments in molecular scale devices making it possible study new types of catalytic reactions, extremely high field enhancements important for sensing, or the dynamics of junctions important to develop new types of switches for neuromorphic computing, or reconfigurable electronics. Abstracts will be solicited in the following areas: biomolecular electronics, mechanisms of charge transport, theory, applications.

Topics will include:

- Dynamics of junctions
- Reconfigurable and neuromorphic molecular electronics
- mechanisms of charge transport
- theory and modelling methods
- light matter interactions in molecular junctions
- Sensing junctions
- Bio-active junctions
- Chemically and catalytically active junctions

Invited speakers include:

Jeremy Baumberg	University of Cambridge, United Kingdom
Lapo Bogani	University of Oxford, United Kingdom
David Cahen	Weizmann Institute of Science, Israel
Ryan Chiechi	North Carolina State University, USA
Jérôme Cornil	Université de Mons, Belgium
Iongji Cui	University of Colorado Boulder, USA
Ismael Díez-Pérez	King's College London, United Kingdom
Yonatan Dubi	Ben-Gurion University of the Negev, Israel
Maria El Abbassi	Universität Basel, Switzerland
Sreetosh Goswami	Indian Institute of Science Bangalore, India
Xuefeng Guo	Peking University, China
Joshua Hihath	University of California, Davis, USA
Takhee Lee	Seoul National University, Republic of Korea
Sierin Lim	Nanyang Technological University, Singapore
Qianqi Lin	University of Twente, Netherlands
Ran Liu	University of Central Florida, USA
Ron Naaman	Weizmann Institute of Science, Israel
Abraham Nitzan	university of Pennsylvania, USA
Spiros Skourtis	University of Cyprus, Cyprus
Gemma Solomon	University of Copenhagen, Denmark
Yoeri van de Burgt	Eindhoven University of Technology, Netherlands
Latha Venkataraman	Columbia University, USA
Ayelet Vilan	Weizmann Institute of Science, Israel
Bingqian Xu	University of Georgia, USA
Li Yuan	Tsinghua University, China

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Symposium EL11: Organic and Nanoparticle-Based Electroluminescent Materials for Display, Lighting and Future Photonic Applications

Thin film electroluminescent devices have experienced tremendous development over the last decades. Organic light emitting diodes (OLEDs) have shown many advantages over their inorganic counterparts. Considered as the best display technology, OLEDs have been embedded in today's smart phones, wearable devices, televisions, and explored for future display technologies. Despite these successes, the performance of organic/inorganic thin film electronic devices is still lag behind their inorganic crystalline counterparts in a number of aspects, and the potentials of organic and inorganic nanoparticle materials have not yet been fully realized.

In this multidisciplinary symposium, we plan to bring together the world-leading experts on organic/nanoparticle material based electronics. We intend this symposium to present and discuss the frontiers on the design, synthesis, processing, and integration of organic/nanoparticle materials for applications in displays, solid state lighting and other emerging thin film devices. Of particular interest are new material concepts, e.g. blue phosphorescent materials, thermally activated delayed fluorescence materials, quantum-dot and perovskite emissive materials, etc. Experimental and computational studies of bulk and interfacial properties at charge carrier transport, exciton dynamics, and device stability inside of thin-film electroluminescent devices will also be covered in this symposium.

Topics will include:

- Phosphorescent OLEDs
- Thermally activated delayed fluorescence
- Nanoparticle-based emissive materials
- Halide perovskites and perovskite-related materials
- Material and device stabilities
- Innovations in material and device characterizations

A **tutorial** complementing this symposium is tentatively planned. Further information will be included in the MRS Program that will be available online in January.

Invited speakers include:

Chiya Adachi	Kyushu University, Japan	**Malte Gather**	Universität zu Köln, Germany
Ji Ho Baek	LG Display, Republic of Korea	**Dongjin Kang**	Samsung Display, Republic of Korea
Marc Baldo	Massachusetts Institute of Technology, USA	**Maksym Kovalenko**	ETH Zürich, Switzerland
Jason Brooks	Universal Display Corporation, USA	**Tae-Woo Lee**	Seoul National University, Republic of Korea
Vladimir Bulovic	Massachusetts Institute of Technology, USA	**Barry Rand**	Princeton University, USA
Zhuo Chen	Beijing Oriental Electronics, China	**Franky So**	North Carolina State University, USA
Yun Chi	City University of Hong Kong, Hong Kong	**Jiang Tang**	Huazhong University of Science and Technology, China
Hyeonho Choi	Samsung Advanced Institute of Technology, Republic of Korea	**Mark Thompson**	University of Southern California, USA
Stephen Forrest	University of Michigan, USA	**Jiangeng Xue**	University of Florida, USA
Hanwei Gao	Florida State University, USA	**Haibo Zeng**	Nanjing University of Science and Technology, China

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Symposium EL12: From Molecules to Emerging Molecular Devices—Beyond Electronic Transport

Molecules with functionalities governed by quantum mechanical effects that can be engineered through rational chemical design at the atomic-scale are the ultimate building blocks to enable the next-generation nanoscale devices. Over decades of comprehensive research, the field of molecular electronics, which started with a focus on charge transport properties across self-assembled monolayer or single-molecular junctions, has now evolved to encompass unprecedented opportunities in emerging areas of plasmonics, optics, spintronics, thermoelectrics, and quantum information technologies. By serving as atomically-controlled passive or active components of nanostructures and devices, these quantum objects with unique properties have led to the discovery of fundamental physical phenomena and functionalities that are classically inaccessible. Applications ranging from single molecule sensors, neuromorphic memory, room-temperature strongly-coupled emitters, optical and spin qubits, single photon sources, and thermoelectric energy conversion devices are just a few examples. This progress is uniquely made feasible by the tremendous advancements in molecular engineering, imaging, spectroscopy, and fabrication techniques that have enabled probing, manipulation and visualization of molecular structures and processes down to a single-molecule level and with atomic-resolution. This symposium brings together interdisciplinary groups of scientists and engineers with a common interest in making, studying and using molecules as nanoscale building blocks for the next-generation devices and their emerging prospects. Topics will cover the recent experimental and theoretical advances in engineering molecules with unique functionalities by design, their imaging and characterization with atomic precision, discovery of new physical phenomena and their integration in form of single or ensembles of molecules into novel functional nanostructures and device concepts.

Topics will include:

- Engineering molecules with unique functionalities for emerging device applications
- Quantum mechanical phenomena in molecular systems beyond electronic transport
- Imaging and spectroscopy techniques for studying single molecules and molecular junctions and their properties
- Fabrication strategies for stable and reproducible molecular devices – top-down and bottom-up
- Electrode materials, interface coupling and contact stability in molecular junctions
- Switchable and responsive molecules for multifunctional devices
- Single molecule devices
- Molecules and device applications in plasmonics and optoelectronics
- Molecules and device applications in spintronics
- Molecules and device applications in thermoelectronics
- Molecules and device applications in quantum information technologies
- Molecules and device applications in mechanics and nanoelectromechanical systems
- Molecules and device applications in emerging nanoelectronics, and unconventional computing platforms

Invited speakers include:

David Awschalom	The University of Chicago, USA
Jeremy Baumberg	University of Cambridge, United Kingdom
Yonatan Dubi	Ben-Gurion University of the Negev, Israel
Lei Fang	Texas A&M University, USA
Danna Freedman	Massachusetts Institute of Technology, USA
Leo Gross	IBM Research-Zurich, Switzerland
Xuefeng Guo	Peking University, China
Joshua Hihath	University of California, Davis, USA
Maria Kamenetska	Boston University, USA
Yuxuan Cosmi Lin	Taiwan Semiconductor Manufacturing Company, USA
Pramod Reddy	University of Michigan, USA
Vahid Sandoghdar	Max Planck Institute for the Science of Light, Germany
Gemma Solomon	University of Copenhagen, Denmark
Wilfred van der Wiel	University of Twente, Netherlands
Herre van der Zant	Delft University of Technology, Netherlands
Latha Venkataraman	Columbia University, USA
Thirumalai Venkatesan	University of Oklahoma, USA
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Symposium EL13: Organic Materials and Devices for Neuronal/Neuromorphic Processing, Adaptive Sensing and Actuation

It is becoming well-known that traditional biosensors are unable to capture the efficiency and adaptive mechanisms typical of the majority of biological processes. Effectively, *in situ* processing and computation are required to capture the variability of biological phenomena of interest as well as having devices that can mechanically conform to the target biological host. Thus, a new era of smart sensor and actuation applications is emerging with systems that perceive and interact with the world and efficiently couple with biological environments. Allowing actual biological substrates to compute is an even longer-term approach to directly harness the biological level of computational efficiency. However, this approach requires materials, devices and systems that would be able to interface biology in a smart and dynamic way beyond signal acquisition. In this scenario, organic materials and neuronal-inspired electronics are the first building blocks towards efficient new systems that are able to analyze, interpret, perceive and act upon a dynamic, real-world environment. In this symposium, the latest advancements of organic materials for bio-inspired information processing and bio-computation will be covered, next to next-generation wearables devices. Emerging applications will be showcased in neuromorphic computing, sensing, actuation and bio-interfacing. This symposium aspires to bring together world-wide experts in the fields of neuromorphic computing, bioelectronics/sensing and neuroscience in order to enhance transdisciplinary interactions and thus bridge the gaps between materials science, computing and neuroscience by initiating a dialogue around the proposed emerging topic.

Topics will include:

- Bio-inspired information processing
- Neuromorphic computing
- Organic materials for neuromorphic devices
- Neuromorphic sensing and actuation
- Adaptive bio-interfacing
- Neural interface devices
- Bioelectronics and smart wearable devices
- Algorithmic advances for neuro-inspired computing and smart sensing

A **tutorial** complementing this symposium is tentatively planned. Further information will be included in the MRS Program that will be available online in January.

Invited speakers include:

Magnus Berggren	Linköping University, Sweden
Fabio Biscarini	Istituto Italiano di Tecnologia, Italy
Bianxiao Cui	Stanford University, USA
Simone Fabiano	Linköping University, Sweden
Tae-Woo Lee	Seoul national University, Republic of Korea
Andreas Offenhaeusser	Forschungszentrum Jülich GmbH, Germany
Jan Rabaey	University of California, Berkeley, USA
Jonathan Rivnay	Northwestern University, USA
Alberto Salleo	Stanford University, USA
Donghee Son	Sungkyunkwan University, Republic of Korea
Molly Stevens	Imperial College London, United Kingdom
Benjamin Tee	National University of Singapore, Singapore
Dominique Vuillaume	nstitut d’Electronique, de Microélectronique et de Nanotechnologie, France
Chen Xiaodong	Nanyang Technological University, Singapore
Joshua Yang	University of Southern California, USA
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Symposium EL14: High Throughput Discovery of the Next-Generation Semiconductors for Opto-Electronics

New types of materials utilized in opto-electronic devices can have a disruptive effect on the evolution of new technologies. In the recent past, this has been demonstrated by the emergence of halide perovskite semi-conductors in photovoltaics, which has revitalized photovoltaics research and expanded into related domains (photocatalysis, LEDs, scintillators, LASER, photo-catalysis).

Halide perovskite materials are a fascinating class of materials with a multitude of intriguing properties. Although remarkable power conversion efficiencies in photovoltaic devices have been demonstrated, knowledge gaps remain and include fundamental aspects related to formation kinetics and formation pathways. These significantly depend on the combination of synthetic variables and precursor chemistry.

In this respect combinatorial screening and high throughput synthesis present an excellent avenue to explore the composition space of emerging materials like metal halide perovskites further through high-throughput compositional screening methods. Furthermore, the methodology can also be systematically expanded to explore the composition-processing-property relationships of new material classes and aid in the optimization of processing conditions to obtain high-quality semi-conductors.

In this symposium we want to bring together the high-throughput materials discovery community focusing on the synthesis and analysis of emerging semiconductors for opto-electronic devices such as halide perovskites. The symposium will cover all aspects of the materials discovery cycle: high-throughput and combinatorial synthesis, high-throughput characterization, and accelerated as well as ML-assisted data analysis. A particular focus will be the utilization of robotized sample synthesis and analysis as well as data handling that can enable future autonomous materials discovery cycles.

Topics will include:

- High throughput synthesis & characterization
- Automation of synthesis and characterization
- Data analysis: correlation of high throughput experiments and theoretical data
- Scalable, sustainable and autonomous fabrication cycles
- Key performance identifiers to evaluate materials technological potential in early development stages
- Machine-learning guided materials discovery
- Big Data Material Science and Open Data Platforms for Collaborative Research
- Metal-halide perovskites and materials inspired by them

A **tutorial** complementing this symposium is tentatively planned. Further information will be included in the MRS Program that will be available online in January.

Invited speakers include:

Mahshid Ahmadi	University of Tennessee, USA
Hannah-Noa Barad	Max Planck Institute, Germany
Christoph Brabec	Friedrich-Alexander-Universität Erlangen-Nürnberg, Germany
Tonio Buonassisi	Massachusetts Institute of Technology, USA
Emory Chan	Lawrence Berkeley National Laboratory, USA
Claudia Draxl	Humboldt-Universität zu Berlin, Germany
Alessio Gagliardi	Technische Universität München, Germany
Marina Leite	University of California, Davis, USA
Carolin Sutter-Fella	Lawrence Berkeley National Laboratory, USA
Per Svensson	RISE Research Institutes of Sweden, Sweden
Su-Huai Wei	Beijing Computational Science Research Center, China
Jens Wenzel Andreasen	Technical University of Denmark, Denmark

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Symposium EL15: Radiation—Hard and Lightweight Next-Generation Semiconductor Electronics

Radiation-hard semiconductors are emerging as a new frontier in Materials Science & Engineering research due to the promise of space-based solar power, and increasing penetration of the near-Earth orbits by satellites and internet constellations. Solar power installation in space is expected to increase from the current value of 5 MW to a GW in the near future. This necessitates discovery of lightweight, low-cost, radiation-tolerant semiconductor electronics that can power the Internet-of-Space (IoS) revolution. This symposium will invigorate new research directions to explore next-generation lightweight semiconductors for applications where radiation-tolerance is needed, including space missions and biosciences.

The symposium will feature invited talks by experts from academia (universities, national labs) and industry to discuss next-generation semiconductors that are tolerant to space radiation (protons, electrons, alpha particles, neutrons, gamma photons, and X-rays) and other space stressors including thermal cycling and atomic oxygen. Such semiconductor candidates are also attractive for radiation detection in bioscience applications. Major focus of the symposium will be on metal-halide perovskites, and ultrathin Si & III-V technologies that are beginning to show remarkable promise and have already been launched into the low-Earth orbit (LEO) for long-term testing. The symposium will develop an understanding of space-compatibility and radiation-hardness of these novel semiconductors at a fundamental science level, and bring scientists and engineers together to establish these as a near-future space semiconductor technology. Abstracts will be solicited in areas including radiation-hardness of metal-halide perovskites, radiation-matter interactions in thin-film electronics, development of robust radiation barriers, space tandem solar cells, ultrathin Si and III-V space solar cells, novel space-compatible substrates based on polymers, and radiation detection using thin-film semiconductor devices beyond Si.

Topics will include:

- Radiation-hardness of metal-halide perovskite semiconductors
- Radiation-matter interactions in thin-film electronics
- Ultrathin Si and III-V semiconductors for space applications
- Inorganic metal-oxides and semiconductor nanocrystals for radiation tolerance and detection applications
- Novel device architectures for space compatibility
- Robust radiation barrier layers and encapsulation schemes
- Space-compatible substrates based on polymers
- Organic semiconductors for radiation detection
- Radiation detection with beyond-Si electronics
- Technoeconomic analysis for next-generation thin-film space solar cells

Joint sessions are being considered with **SF02 - Materials in Space—Design and Testing**.

Invited speakers include:

Henk Bolink	Universitat de València, Spain	**Michael McGehee**	University of Colorado Boulder, USA
Wing Chung Tsoi	Swansea University, United Kingdom	**Jesse Mee**	Air Force Research Laboratory, USA
Aldo Di Carlo	Università degli Studi di Roma Tor Vergata, Italy	**Tsotomu Miyasaka**	Toin Gakuen, Japan
Giles Eperon	Swift Solar Inc., USA	**Aditya Mohitye**	Rice University, USA
Beatrice Fraboni	Università di Bologna, Italy	**Peter Müller-Buschbaum**	Technische Universität München, Germany
Nancy Haegel	National Renewable Energy Laboratory, USA	**Heinz-Christoph Neitzert**	Salerno University, Italy
Md. Amanul Haque	The Pennsylvania State University, USA	**Timothy Peshek**	NASA Glenn Research Center, USA
Anita Ho-Baillie	The University of Sydney, Australia	**Bayram Saparov**	University of Oklahoma, USA
Jinsong Huang	University of North Carolina at Chapel Hill, USA	**Ian Sellers**	University of Oklahoma, USA
Seth Hubbard	Rochester Institute of Technology, USA	**Sam Stranks**	University of Cambridge, United Kingdom
Oana Jurchescu	Wake Forest University, USA	**Don Walker**	The Aerospace Corporation, USA
Michael Kelzenberg	California Institute of Technology, USA	**Robert Walters**	Air Force Research Laboratory, USA
Felix Lang	University of Potsdam, Germany	**Hongxia Wang**	Queensland University of Technology, Australia
Joseph Luther	National Renewable Energy Laboratory, USA		

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Symposium EL16: Plasmonics, Metasurfaces and Metamaterials—Design, Materials and Applications

The symposium will address the fundamentals and applications of multidimensional fields of plasmonics, nanophotonics, and metasurfaces, ranging from materials to biological applications. It will address emerging topics of hybrid nanophotonics including plasmonics, metamaterials, metasurfaces, and 2D materials to overcome existing limitations that prevent the development of practical photonic devices. The recent discovery of new plasmonic/metasurface materials as well as layered and two-dimensional materials with low loss, tunable optical properties, and CMOS compatibility can enable a breakthrough in the field of nanophotonics, optical metamaterials, and their applications. Novel nonlinear and quantum phenomena and advanced design based on machine learning strategies and new simulation methods for metasurface, metamaterial, and plasmonic materials/devices are also of interest to this symposium.

Topics will include:

- Metasurfaces and metamaterials
- Alternative plasmonic and metasurface materials
- Photonics with two-dimensional materials
- Materials with epsilon-near-zero and hyperbolic dispersion properties
- Tunable and quantum metasystems
- Topological photonic and parity-time symmetric materials
- Biological and chemical sensing with plasmonics and nanophotonics
- Ultrafast and nonlinear effects in metamaterials and plasmonics
- Photovoltaic applications and efficient light harvesting
- Advanced nanophotonic design based on machine learning strategies and new simulation methods
- Novel fabrication techniques for improving plasmonic/metasurface properties

A **tutorial** complementing this symposium is tentatively planned. Further information will be included in the MRS Program that will be available online in January.

Invited speakers include:

Andrea Alu	The City University of New York, USA
Antonio Ambrosio	Harvard University, USA
Christos Argyropoulos	University of Nebraska–Lincoln, USA
Harry Atwater	California Institute of Technology, USA
Mark Brongersma	Stanford University, USA
Wenshan Cai	Georgia Institute of Technology, USA
Nader Engheta	University of Pennsylvania, USA
Eyal Feigenbaum	Lawrence Livermore National Laboratory, USA
Patrice Genevet	Centre National de la Recherche Scientifique, France
Vincent Ginis	Vrije Universiteit Brussel, Belgium
Robin (Chen-Bin) Huang	National Tsing Hua University, Taiwan
Min Seok Jang	Korea Advanced Institute of Science and Technology, USA
Nathaniel Kinsey	Virginia Commonwealth University, USA
Mark Lawrence	Washington University in St. Louis, USA
Yu-Jung Lu	Academia Sinica, Taiwan
Stefan Maier	Ludwig-Maximilians-Universität München, Germany
Francesco Monticone	Cornell University, USA
Gururaj Naik	Rice University, USA
Teri Odom	Northwestern University, USA
Junghyun Park	Samsung Advanced Institute of Technology, Republic of Korea
Michelle Povinelli	University of Southern California, USA
Junsuk Rho	Pohang University of Science and Technology, Republic of Korea
Ming-Lun Tseng	National Yang Ming Chiao Tung University, Taiwan
Augustine Urbas	Air Force Research Laboratory, USA
Jason Valentine	Vanderbilt University, USA
Nanfang Yu	Columbia University, USA
Seokho Yun	Samsung Advanced Institute of Technology, Republic of Korea
Nikolay Zheludev	University of Southampton, United Kingdom

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Symposium EL17: Halide Perovskite and Other Low-Dimensional Light Emitters—Synthesis, Defect Passivation and Optoelectronic Applications

Light-emitting nanomaterials are key components for future applications such as near-eye displays (augmented/virtual reality), autonomous vehicles, laser diodes, quantum communications, wearable smart healthcare devices, biosensors, and other optoelectronic applications. With these possibilities, recent research in the field of light-emitting nanomaterials has mainly focused on achieving high-efficiency, high-stability materials and devices, as well as developing alternative environmentally benign light-emitting materials.

This symposium will cover various emerging low-dimensional light-emitting materials, including metal halide perovskites and their derivatives, inorganic semiconductor nanocrystals, carbon dots, graphene quantum dots, and other low-dimensional nanostructures. The discussion in the proposed symposium will comprehensively encompass precise material synthesis, surface defect passivation, thin-film processing, device interface engineering, and in-depth photophysical/electrical characterization to achieve high-performance optoelectronic devices. Therefore, the proposed symposium will cover a complete range of topics regarding emerging light-emitting low-dimensional materials from fundamental chemistry and physics to related practical applications.

Topics will include:

- Low-dimensional metal halide perovskite emitters (*e.g.,* quasi-2D, 1D and 0D)
- Colloidal perovskite nanocrystals
- Colloidal inorganic quantum dots and other low-dimensional nanostructures
- Lead-free perovskite and perovskite-derivative emitters
- Carbon-based nanoscale emitters
- Novel synthetic routes and growth mechanisms of emitters
- Photophysics of light-emitting materials
- Surface chemistry and ligand engineering
- Novel defect passivation processes
- Novel device architectures for light-emitting diodes
- Degradation mechanism of emitters and their devices
- Alternative patterning methods
- Down/up-conversion emitters, films, and display/lighting devices
- Progress towards electrically pumped lasing and devices

Invited speakers include:

Osman Bakr	King Abdullah University of Science and Technology, Saudi Arabia
Hilmi Volkan Demir	Nanyang Technological University, Singapore
Letian Dou	Purdue University, USA
Feng Gao	Linköping University, Sweden
Chris Giebink	The Pennsylvania State University, USA
Giulia Grancini	Università degli Studi di Pavia, Italy
Bin Hu	The University of Tennessee, Knoxville, USA
Libai Huang	Purdue University, USA
Jae-Il Kim	Seoul National University, Republic of Korea
Young-Hoon Kim	Hanyang University, Republic of Korea
Victor Klimov	Los Alamos National Laboratory, USA
Maksym Kovalenko	ETH Zürich, Switzerland
YunHui Lin	National Renewable Energy Laboratory, USA
Biwu Ma	Florida State University, USA
Lea Nienhaus	Florida State University, USA
Annamaria Petrozza	Istituto Italiano di Tecnologia, Italy
Ted Sargent	Northwestern University, USA
Richard Schaller	Argonne National Laboratory, USA
Dmitri V. Talapin	The University of Chicago, USA
Zhi Kuang Tan	National University of Singapore, Singapore
William A. Tisdale	Massachusetts Institute of Technology, USA
Zhengguo Xiao	University of Science and Technology of China, China
Jingbi You	Institute of Semiconductors, Chinese Academy of Sciences, China
Haizheng Zhong	Beijing Institute of Technology, China

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Symposium EL18: Material, Device, and Fabrication Innovations for Flexible, Stretchable, and Printed Electronics

The rapidly growing desire of integrating electronics with human bodies for ubiquitous healthcare and communication applications has generated a new wave in the development of electronics, that is to achieve human-compatible mechanical flexibility and stretchability. In the meantime, to support the expanded uses of such electronics, large-area and low-cost manufacturing are also needed, for which, solution printing is the most appealing avenue. In recent years, significant progress has been made in the creation of new functional materials and device designs to achieve flexible and/or stretchable properties, and solution-printing capability, which expand to semiconductors, conductors, dielectrics, gels, various types of sensors and energy harvesters, light-emitting diodes, actuators, transistors, and circuits. These advancements have been coming from both inorganic electronics and organic/polymeric electronics, based on different types of design strategies. This symposium will provide a venue for the discussion of both fundamental and applied research progresses in this broad field, with the topics expanding from the design of mechanically soft, flexible, stretchable, and printable materials, and functional devices; to the development of new fabrication approaches for high-density, large-area electronics, especially printing-based methods; and the emerging applications for interfacing with human bodies and biological systems as wearable or implantable devices.

Topics will include:

- Flexible, stretchable and printable designs of inorganic and organic conductors, semiconductors, dielectrics, electroluminescent materials
- Flexible, stretchable, and printable transistors and circuits
- Flexible and stretchable, and printable pressure, strain, tactile, electrophysiological, chemical, optical, temperature sensors
- Flexible and stretchable, and printable energy devices, including solar cells, thermoelectric devices, etc.
- Advanced printing technological for electronics, including 3D printing, aerosol printing, electrospinning, roll-to-roll printing, etc.
- System integration of flexible, stretchable, and printable electronics for wearable, bio-interfaced, soft robotic applications
- Soft electronics with other bioinspired properties, such as transient, healable, trainable properties

Joint sessions are being considered with **SB09 - Polymeric Electronic Materials and Devices for Biological Interfaces**.
Also, a **tutorial** complementing this symposium is tentatively planned. Further information will be included in the MRS Program that will be available online in January.

Invited speakers include:

Zhenan Bao	Stanford University, USA
Derya Baran	King Abdullah University of Science and Technology, Saudi Arabia
Magnus Berggren	Linköping University, Sweden
Mariano Campoy-Quiles	Institute of Materials Science of Barcelona, Spain
Xiaodong Chen	Nanyang Technological University, Singapore
Ying Diao	University of Illinois at Urbana-Champaign, USA
Aristide Gumyusenge	Massachusetts Institute of Technology, USA
Dae-Hyeong Kim	Seoul National University, Republic of Korea
Do Hwan Kim	Hanyang University, Republic of Korea
Stéphanie P. Lacour	École Polytechnique Fédérale de Lausanne, Switzerland
Ying-Chih Lai	National Chung Hsing University, Taiwan
Pooi See Lee	Nanyang Technological University, Singapore
Chenghui Li	Nanjing University, China
Zong-Hong Lin	National Tsing Hua University, Taiwan
Nan Liu	Beijing Normal University, China

Yuxin Liu	National University of Singapore, Singapore
George Malliaras	University of Cambridge, United Kingdom
Jianguo Mei	Purdue University, USA
Joon Hak Oh	National Seoul University, Republic of Korea
Qibing Pei	University of California, Los Angeles, USA
Luisa Petti	Free University of Bozen-Bolzan, Italy
Jonathan Rivnay	Northwestern University, USA
John A. Rogers	Northwestern University, USA
Robert F. Shepherd	Cornell University, USA
Takao Someya	The University of Tokyo, Japan
Vincent C. Tung	Tokyo University, Japan
Jie Xu	Argonne National Laboratory, USA
Wentao Xu	Nankai University, China
Tomoyuki Yokaota	The University of Tokyo, Japan
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Symposium EL19: Advanced Materials in Scalable Miniaturized Technologies for Future Electronics

Over the last two decades, the advanced materials landscape has made remarkable progress in terms of novel materials and functionalities, promising potentially faster, more efficient computing and its ultimate integration with a plethora of functionalities (sensing, energy, photonics, etc) into an ever -smaller package to provide almost seamless human-technology integration capabilities. In addition, progress in the area of novel nano(structured) materials (2D materials, nanowires, metamaterials) has also been matched by novel advanced synthesis and patterning processes (from 3D printing to atom -based processes), in parallel to the further development of new computing paradigms such as quantum and neuromorphic approaches.The R&D cycle that can bring novel functional materials from discovery to a successful implementation in silicon technologies can last more than a decade. The time is thus ripe to focus on bridging the requirements that will enable these new materials and techniques to bring unprecedented capabilities to the new computing and integration paradigms. In collaboration with the IEEE Electron Devices Society, the emphasis of our Symposium will be on bridging the R&D gap in electronic materials from lab discovery to implementation in semiconductor devices. Focus is hence on the on the applied aspects of electronic materials, as opposed to fundamental discoveries, and will cover areas from computing devices to interconnects and advanced packaging. Materials will include advanced thin-films as well as nanomaterials (nanowires, nanotubes, 2D materials and their combination). Manufacturing platforms will include wafer -level, roll-to-roll as well as direct-write and additive technologies. Aspects of interest include advances in scalability, large-scale structuring and patterning, robustness and control of interfaces, integrated performance and reliability, and related novel metrics, all while keeping an eye out for long-term sustainability of a large-scale deployment in semiconductor manufacturing.

Topics will include:

- Nanometer -scale devices for computing, memory and their interconnects
- Integration and large-scale deployment aspects of advanced materials technologies for More than Moore, beyond CMOS and additional integrated functionalities, including flexible electronics
- MEMS, photovoltaics, wearables, nearables, IoT sensor nodes
- Large -scale manufacturing, including wafer -scale, and roll-to-roll
- Material integration processes and strategies, from monolithic to heterogeneous and package -level
- Direct-write and additive manufacturing technologies for electronics
- Novel electrical, physical and mechanical characterisation methods and metrics for integrated materials and their interfaces
- Material scalability, quality & reliability metrics
- Sustainability, particularly sourcing, processing and recycling aspects in view of large -scale deployment

Joint sessions are being considered with **EL01 - Phase-Change Materials for Emerging Applications in Reconfigurable Devices, Memory and Computing**, **EL18 - Material, Device, and Fabrication Innovations for Flexible, Stretchable, and Printed Electronics**, and **EL21 - Materials Research Opportunities for Energy Efficient Computing**.

Invited speakers include:

Inge Asselberghs	imec, Belgium
Ageeth Bol	University of Michigan, USA
Ricardo Donaton	IBM Research, USA
Mark Eriksson	University of Wisconsin–Madison, USA
Paolo Gargini	IEEE International Roadmap for Devices and Systems, USA
Christine Hau-Riege	Qualcomm, USA
Andriy Hikavyy	imec, Belgium
Sean King	Intel, USA
Mario Lanza	King Abdullah University of Science and Technology, Saudi Arabia
Benji Maruyama	Air Force Research Laboratory, USA

Masaaki Niwa	The University of Tokyo, Japan
Marko Radosavljevic	Intel, USA
Joan Redwing	The Pennsylvania State University, USA
TY Tseng	National Chiao Tung University, Taiwan
William Vandenberghe	The University of Texas at Dallas, USA
Philip Wong	Stanford University, USA
Yang Yang	University of Technology Sydney, Australia
Cezar Zota	IBM Research-Zurich, Switzerland
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Symposium EL20: Photo and Radiation Detection with Organic, Perovskite and Nano-crystalline Semiconductors

Efficient, sensitive and wavelength-selective light detection has become central to modern consumer electronics, science and technology. Photodetectors based on crystalline inorganic elemental materials are the core of today's photodetectors and cameras. However, a new trend has begun: next-generation semiconductors such as organics, perovskites, and nanocrystals are now becoming increasingly interesting candidates for low noise and color-selective photodetection as well as radiation detection required for novel applications such as machine vision. These novel semiconductor materials, have many desirable features compared to their inorganic counterparts including room-temperature processing from solution and reduced manufacturing costs, while delivering large area lightweight, flexible devices with strong light absorption, optical and electronic tuneability. New emerging applications for photodetectors require self-powered, cost-effective, highly sensitive and flexible devices, conditions which could be largely satisfied using photodiodes base on these novel active materials. The routes to obtain highly sensitive sensors require to minimise, for example, the dark current as a mean to limit the noise in the devices and to improve performance. The dark current values reported so far in the photo and radiation detectors using organics, perovskites and nano-crystals are several orders of magnitudes larger than what predicted from simple thermodynamic perspective. One of the main ongoing challenges is to understand and minimise the dark/noise current, to increase the temporal response, and to extend the dynamic range.

This symposium will be multi-material platform on next-generation photodetectors and radiation detectors. This will include organic, perovskite, 2D, and nanocrystals, covering visible and infrared light detection extending into X-Ray, UV and far-infrared radiation. There will be foci for new materials, device architectures, and characterisation protocols for photodetectors and radiation detectors. The symposium welcomes abstracts that investigate above-mentioned challenges as well as new approaches for narrowband color detection using organic, perovskites and nanocrystals.

Topics will include:

- Organic photodetectors
- Perovskite photodetectors
- Nanocrystals and low dimensional systems for photodetection
- Color-selective and infrared photodetection
- Image sensors with new generation semiconductors
- Thermodynamic limit of the sensitivity of next generation photodetectors
- Photodetector characterisation methods
- Perovskite-based Radiation detectors
- Photomultiplication and amplification
- LiFi and optical wireless communication
- Biological applications of photodetectors and wearable sensors
- 2D-based Photodetectors
- X-ray detectors

Invited speakers include:

Dae-Sung Chung	Pohang University of Science and Technology, Republic of Korea
Beatrice Fraboni	Università di Bologna, Italy
Gerardo Hernandez-Sosa	Karlsruhe Institute of Technology, Germany
Rene Janssen	Eindhoven University of Technology, Netherlands
Mercouri Kanatzidis	Northwestern University, USA
Qianqian Lin	Wuhan University, China
Franziska Muckel	Universität Duisburg-Essen, Germany
Doron Naveh	Bar-Ilan University, Israel

Tse Nga (Tina) Ng	University of California, San Diego, USA
Wanyi Nie	Los Alamos National Laboratory, USA
Kyung-Bae Park	Samsung Advanced Institute of Technology, Republic of Korea
Vincenzo Pecunia	Simon Fraser University, Canada
Ifor Samuel	University of St Andrews, United Kingdom
Ted Sargent	Northwestern University, USA
Koen Vandewal	Hasselt University, Belgium
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Symposium EL21: Materials Research Opportunities for Energy Efficient Computing

The explosion of data witnessed in the fourth industrial revolution, and the processing required to turn that data into useful information, bring an unprecedented need for energy efficient data movement and computation. In the last decade, the rate at which data was generated outpaced improvements in compute efficiency: Data centers consume more than 200 TWh each year, exceeding the total energy consumption of entire countries. Expanded use of the internet, smart phones, and computation in general as billions of people interact with each other and consume processed data is causing all those numbers to escalate. Making computation more energy efficient reduces not only computation cost, but also its energy consumption, enabling batteries to last longer or be smaller for mobile computing. There has been a collective effort among academia, industry, and government to explore multi-faceted approaches for advancing low energy computing. Making computation more energy-efficient saves money, reduces energy use, and herald the advent of entire systems built into high-performance, compact form factors. New materials make possible compute hardware stack elements needed for this revolution. Starting at the smallest scale, there are switching elements that comprise logic and/or memory. These elements are put together at the package level with passives and thermal management solutions by employing fast, low-energy connections to form the most advanced systems-on-a-chip. As materials touch every one of these components, the goal of this Symposium is bringing to front and center the challenges and opportunities that will accelerate materials innovations that enable energy efficient computation. There is already a substantial body of knowledge in this field spanning multiple approaches. The Symposium co-organizers have decided to concentrate specifically on the areas described below.

This Symposium will focus on the microelectronics area and will not cover quantum computing-related materials research and development.

Topics will include:

- Fundamental limits for computation driving materials solutions
- Charge based energy efficient devices
- Non-charge based energy efficient devices
- Future low energy memory solutions
- Low energy Interconnects
- Efficient thermal management
- Microelectronic packaging (advanced solutions with materials emphasis only)
- Neuromorphic computing (with materials thrust)

A **tutorial** complementing this symposium is tentatively planned. Further information will be included in the MRS Program that will be available online in January.

Invited speakers include:

Inge Asselberghs	imec, Belgium
Xinyu Bao	Taiwan Semiconductor Manufacturing Company Limited, Taiwan
Florin Ciubotaru	imec, Belgium
Saptarshi Das	The Pennsylvania State University, USA
Regina Dittmann	Forschungszentrum Jülich GmbH, Germany
Julie Grollier	Centre National de la Recherche Scientifique, France
Tuo-Hung (Alex) Hou	National Chiao Tung University, Taiwan
Loius Hutin	Commissariat à l’énergie atomique et aux énergies alternatives, France
Asif Khan	Georgia Institute of Technology, USA
Tsu-Jae King Liu	University of California, Berkeley, USA
Mario Lanza	King Abdullah University of Science and Technology, Saudi Arabia
Thomas Mikolajick	NaMLab, Germany
Tomás Palacios	Massachusetts Institute of Technology, USA
Wolfram Pernice	Universität Münster, Germany

Shaloo Rakheja	University of Illinois at Urbana-Champaign, USA
Jayakanth Ravichandran	University of Southern California, USA
Sayeef Salahuddin	University of California, Berkeley, USA
Abu Sebastian	IBM Research-Zurich, Switzerland
Fabio Sebastiano	Technische Universiteit Delft, Netherlands
Changhwan Shin	Sungkyunkwan University, Republic of Korea
Saima Siddiqui	Intel, USA
Sabina Spiga	CNR Institute for Microelectronics and Microsystems, Italy
Susanne Stemmer	University of California, Santa Barbara, USA
Sheng-Kai Su	Taiwan Semiconductor Manufacturing Company Limited, Taiwan
Jamie Teheranie	Texas Instruments, USA
Huili Grace Xing	Cornell University, USA
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Symposium EN01: Electrochemical Capacitors and Related Devices—Fundamentals, Materials and Cell Design

This symposium will focus on electrochemical capacitors covering fundamentals, materials, and device design. Different classes of electrode materials will be covered including 2D materials (e.g., MXenes and chalcogenides), oxides, nitrides, polymers, metal-organic, and covalent-organic frameworks. Electrode materials with varying dimensionality (0D/1D/2D/3D) and their heterostructures can have a strong impact on electrochemical capacitor performance and will therefore be included in this symposium. In addition, studies on charge storage mechanisms in these electrode materials including electrochemical double-layer (EDL), pseudocapacitance, and intercalation pseudocapacitance will be discussed. The design of the cell is another important parameter that can be engineered to optimize the power and energy densities of the electrochemical capacitors. For example, symmetric, asymmetric (where one negative electrode is combined with a positive one to expand the voltage window), and hybrid (where one of the electrodes acts as a battery electrode) electrochemical capacitors will be part of the program. In addition, the symposium will cover microscale supercapacitors for on-chip energy storage, frequency filtering, and self-powered modules that couple microsupercapacitors with energy-harvesting devices for IoT and sensor network applications. Developing cost-effective fabrication methods to fabricate such microsupercapacitors is equally important . In addition, various electrolytes are being developed such as organic electrolytes, redox electrolytes, and solid-state electrolytes, and will be discussed. Modeling and simulation of supercapacitor performance is another aspect of capacitive energy storage that we will cover in this symposium.

Topics will include:

- Materials for supercapacitor electrodes
- Fast battery-type electrode materials for hybrid devices
- Charge storage mechanisms in electrochemical capacitors
- Conventional supercapacitors & microsupercapacitors
- Asymmetric supercapacitors & hybrid supercapacitors
- Metal-ion capacitors (Li, Na, K, ...)
- Microfabrication technologies for microsupercapacitors
- Integrated supercapacitors (capacitors with sensors, energy harvesters, transistors, etc)
- Flexible and fiber-based supercapacitors
- Modeling & simulation of supercapacitor materials and devices

Invited speakers include:

Maria Arnaiz Gonzalez	CIC EnergiGUNE, Spain
Andrea Balducci	Friedrich-Schiller-Universität Jena, Germany
Majid Beidaghi	Auburn University, USA
Bruce Dunn	University of California, Los Angeles, USA
Frédéric Favier	Université de Montpellier, France
Krzysztof Fic	Poznan University of Technology, Poland
Elzbieta Frackowiak	Poznan University of Technology, Poland
Yury Gogotsi	Drexel University, USA
Masashi Ishikawa	Kansai University, Japan
Kai Landskron	Lehigh University, USA
Maria Lukatskaya	ETH Zürich, Switzerland
Celine Merlet	Laboratoire de Chimie et Physique Quantiques, France
Huisheng Peng	Fudan University, China
Dominic Rochefort	University of Montreal, Canada
Debra Rolison	U.S. Naval Research Laboratory, USA
Patrice Simon	Université Toulouse III - Paul Sabatier, France
Francesca Soavi	Università di Bologna, Italy
Wataru Sugimoto	Shinshu University, Japan
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Symposium EN02: Thin-Film Compound Semiconductor Photovoltaics

As aggressive decarbonization goals are set around the world it is important that we maintain a pipeline of high-performance photovoltaic (PV) materials, both well-known and novel, to meet growing demand. Thin-film compound semiconductor PV materials are well suited to help meet this demand as they continue to demonstrate their potential for generating sustainable and cost-efficient electrical energy. Both fundamental understanding and processing techniques have enabled advantages in manufacturing and materials costs, with power conversion efficiencies now above 20%, but cutting-edge materials research is still needed for these technologies to flourish. Emerging areas of research include the materials science of degradation, understanding the roles of passivation and compensation, reducing interface and grain boundary recombination, tandem, bifacial, and semitransparent devices. The symposium will focus on the science and technology of polycrystalline films, single crystal model systems, defects, interfaces, the interplay of materials and band structure, characterization methods, modeling, scaling and advanced manufacturing in thin-film compound semiconductor photovoltaics. Relevant materials include those based on chalcogenide semiconductors such as copper indium gallium (di)selenide (CIGS) and a cadmium telluride (CdTe) as well as the associated alloys, heterojunction partner materials, and buffer layers. Novel absorber materials, heterojunction partner layers, and (semi-) transparent absorber layers are also of high interest.

Topics will include:

- Novel, earth abundant, and/or non-toxic materials
- Absorbers with high carrier concentration
- High bandgap absorbers
- Carrier selective and passivating contacts
- Transparent back contacts, bifacial and semitransparent devices
- Tandem and multijunction devices
- Thin-film modules and industry
- Deposition, growth, and fabrication
- Surfaces, interfaces, and extended defects
- Characterization, theory, and modeling
- Degradation and reliability

A **tutorial** complementing this symposium is tentatively planned. Further information will be included in the MRS Program that will be available online in January.

Invited speakers include:

Mariana Bertoni	Arizona State University, USA
Maria Chan	Argonne National Laboratory, USA
Mirjana Dimitrievska	Empa - Swiss Federal Laboratories for Materials Science and Technology, Switzerland
Randy Ellingson	The University of Toledo, USA
Denis Flandre	Université catholique de Louvain, Belgium
Maarja Grossberg	Tallin Univeristy of Technology, Estonia
Stuart Irvine	Swansea University, United Kingdom
Shogo Ishizuka	National Institute of Advanced Industrial Science and Technology, Japan
William Jo	EWHA Womans University, Republic of Korea
Jan Keller	Uppsala University, Sweden
Johan Lauwaert	Ghent University, Belgium

Marco Nardone	Bowling Green State University, USA
Edgardo Saucedo	Universitat Politecnica de Catalunya, Spain
Phillip Schulz	Centre National de la Recherche Scientifique, France
Donghyeop Shin	Korea Institute of Energy Research, Republic of Korea
James Sites	Colorado State University, USA
Jiang Tang	Huazhong University of Science and Technology, China
Lydia Wong	Nanyang Technological University, Singapore
Yanfa Yan	The University of Toledo, USA
Heayoung Yoon	The University of Utah, USA
Andriy Zakutayev	National Renewable Energy Laboratory, USA

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Symposium EN03: Caloric Materials for Heating and Cooling

Caloric materials display reversible thermal changes due to changes in magnetic, electric or mechanical field. These materials could replace the harmful fluids that are currently used in heating and cooling systems, and improve their energy efficiency. However, these low-carbon heating and cooling technologies are in their infancy compared to fluid-based systems, and therefore it is important to understand the underlying phenomena behind these materials in order to improve system performance in terms of cooling-power density, temperature span and energy efficiency.

This symposium will range from fundamental aspects to applications, and will cover magnetocaloric materials and devices, electrocaloric materials and devices, and mechanocaloric (elastocaloric and barocaloric) materials and devices. Invited talks will provide state-of-the-art research on multidisciplinary topics related to the physics, chemistry, materials science and engineering of materials and devices, and will bring together scientist and engineers from all caloric strands.

Topics will include:

- Advances in magnetocaloric materials
- Advances in electrocaloric materials
- Advances in elastocaloric materials
- Advances in barocaloric materials
- Advances in multicaloric materials
- Materials: alloys, ceramics, polymers, hybrids and composites
- Advances in theory, modelling and simulations
- New measurement techniques
- Devices and applications

A **tutorial** complementing this symposium is tentatively planned. Further information will be included in the MRS Program that will be available online in January.

Invited speakers include:

Franca Albertini	CNR Institute of Materials for Electronics and Magnetism, Italy
Radhika Barua	Virginia Commonwealth University, USA
Ray Baughman	The University of Texas at Dallas, USA
Daoyong Cong	University of Science and Technology Beijing, China
Brahim Dkhil	CentraleSupélec, France
Ian Fisher	Stanford University, USA
Maximilian Fries	Magnotherm, Germany
Asaya Fujita	National Institute of Advanced Industrial Science and Technology, Japan
Tino Gottschall	Helmholtz-Zentrum Dresden-Rossendorf, Germany
Huilong Hou	Beihang University, China
Jiyeob Kim	University of California, Berkeley, USA
Andrej Kitanovski	University of Ljubljana, Slovenia
Manfred Kohl	Karlsruhe Institute of Technology, Germany
Peter Littlewood	The University of Chicago, USA

Pol Lloveras	Universitat Politecnica de Catalunya, Spain
Barbara Malič	Jozef Stefan Institute, Slovenia
Jarad Mason	Harvard University, USA
Neil Mathur	University of Cambridge, United Kingdom
Vitalij Pecharsky	Ames Laboratory, USA
Qibing Pei	University of California, Los Angeles, USA
Xiaoshi Qian	Shanghai Jiao Tong University, China
Andrew Rowe	University of Victoria, Canada
Huseyin Sehitoglu	University of Illinois at Urbana-Champaign, USA
Enric Stern-Taulats	Universitat de Barcelona, Spain
Ichiro Takeuchi	University of Maryland, USA
Ken-Ichi Uchida	National Institute for Materials Science, Japan
Helen Walker	Science and Technology Facilities Council, United Kingdom
Qiming Zhang	The Pennsylvania State University, USA

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Symposium EN04: Two-Dimensional Materials for Energy Conversion

This symposium will cover recent advances of two-dimensional (2D) materials and vdW heterostructures for energy conversion applications. The symposium consists of two parts, i.e., catalytic energy conversion, and other forms of energy conversion including photothermal, piezoelectric, electrical-magnetic, thermochemical, biochemical etc. The first part of the symposium will focus on the catalysis application of 2D materials in photochemical, electrochemical, and photoelectrochemical reactions. Symposium contribution should cover the recent development of new 2D catalysts for water electrolysis, carbon dioxide/nitrate reduction, nitrogen fixation, polysulfide conversion, biomass reforming etc. Discussion of mechanistic investigation of the reaction principles using in-situ/operando characterization and/or atomistic modelling of 2D catalysis are also welcomed. Discussion of large-scale synthesis, fabrication, other scaling-up breakthrough, and modelling challenges on both atomistic level and device level are also welcomed. The second part of the symposium will focus on other types of energy conversion including but not limited to photothermal (such as phototherapy and solar-to-heat), thermoelectric (thermal-to-electric), piezoelectric (mechanical-to-electric), electromagnetic (e.g., magnetic 2D materials), thermochemical (e.g., olefin conversion), and biochemical catalysis. Symposium contribution should cover the recent advances of new 2D materials, device configuration, and scientific understanding of the role of 2D materials in these energy conversion process. Reports on emerging energy conversion applications of new 2D materials are also welcomed.

Topics will include:

- Photocatalysis
- Electrocatalysis
- Photoelectrocatalysis
- Thermal catalysis
- Solar-to-heat conversion
- Phototherapy application
- DFT calculation
- Device modeling
- Large-scale synthesis
- Emerging catalysis applications

Joint sessions are being considered with **NM02 - 2D Materials for Electrochemical Applications—Leading the Charge Through Thermodynamic and Kinetic Knowledge Gaps**.

Invited speakers include:

Pulickel M. Ajayan	Rice University, USA
Markus Antonietti	Max Planck Institute of Colloids and Interfaces, Germany
Harry Atwater	California Institute of Technology, USA
Michel Bosman	National University of Singapore, Singapore
Manish Chhowalla	University of Cambridge, United Kingdom
María Escudero-Escribano	University of Copenhagen, Denmark
Christophe Galindo	Thales, France
Yury Gogotsi	Drexel University, USA
Dmitri Golberg	Queensland University of Technology, Australia
Yu Huang	University of California, Los Angeles, USA
Deep Jariwala	University of Pennsylvania, USA
Jeehwan Kim	Massachusetts Institute of Technology, USA
Juyoung Leem	Stanford University, USA
Zhongfan Liu	Peking University, China
Hari Manoharan	Stanford University, USA
Cecilia Mattevi	Imperial College London, United Kingdom
SungWoo Nam	University of California, Irvine, USA
Jens Norskov	Technical University of Denmark, Denmark
Xiaofeng Qian	Texas A&M University, USA
Archana Raja	Lawrence Berkeley National Laboratory, USA
Hua Zhang	City University of Hong Kong, Hong Kong

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Symposium EN05: Advances in Materials for Concentrating Solar Thermal Technologies

Concentrating solar thermal (CST) technology is a rapidly increasing R&D topic due to its potential in renewable energy generation and decarbonisation of industrial processes. As a renewable source of electricity generation, concentrating solar power (CSP) uses heat to power a steam turbine or next-generation supercritical CO(2) power block. It can also “charge” a thermal storage system for production of electricity off-sun at potentially greater scales and lower costs than traditional batteries. CST also has the potential to drive high temperature chemical processes for production of renewable hydrogen, fuels, or commodity chemicals, and to decarbonise energy intensive industrial processes such as water desalination, mineral purification, or biorefining.

Current CST facilities operate at a temperature range of 500–600°C, but next generation plants are aiming for temperatures of greater than 700°C for electricity generation and well above 1000°C for solar thermochemical processes. The high operating temperatures require material systems that can withstand heat and thermal expansion, are resistant to corrosion and degradation, and can efficiently conduct heat. Thermal storage materials (e.g., molten salts, metal hydrides) with improved thermal stability and storage capacity are required. Materials development is imperative for solar thermochemical reactions such as water splitting, chemical and fuel production, and industrial decarbonisation.

This symposium aims to further the discussion on materials for CST technologies and bring together researchers of diverse backgrounds (theoretical, computational, experimental, characterization, and analysis) to address the multidisciplinary challenges of this emerging field. Graduate students, post-docs, and early-career researchers are encouraged to submit abstracts. The symposium expects to draw participation and support from a national and international demographic from academia, national labs, and the commercial sector.

Topics will include:

- High temperature materials discovery and development through computational models and AI/machine learning
- Thermal and thermochemical energy storage materials (e.g. molten salts, metal hydrides/hydroxides)
- Advanced in situ and ex situ materials screening and characterisation of materials, including performance, durability, reliability, and degradation
- Materials for solar thermochemical production of hydrogen, fuel, and fine chemicals
- Solar thermal methods and materials for decarbonisation of industrial processes (e.g. pyrolysis, gasification, desalination, sterilisation, bleaching)
- Design and manufacture of materials for operation under extreme conditions (heat, pressure, corrosivity) for thermal storage, heat transfer, and power blocks (steam and supercritical CO2)
- Advancements in coating materials and application methods for receivers, heliostats, and interior tube surfaces for heat transfer/storage transport
- Theory, simulation, and modelling of thermomechanical, thermochemical, and thermo-optical properties of emerging materials

Invited speakers include:

Harish Barshilia	Council of Scientific & Industrial Research–National Aerospace Laboratory, India	**Gema San Vicente**	Center for Energy, Environmental and Technological Research, Spain
Yulong Ding	University of Birmingham, United Kingdom	**Chris Sansom**	University of Derby, United Kingdom
Malay Mazumder	Boston University, USA	**Aldo Steinfeld**	ETH Zürich, Switzerland
Christopher Muhich	Arizona State University, USA	**Judith Vidal**	National Renewable Energy Laboratory, USA
Cristina Prieto	Universidad de Sevilla, Spain		

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Symposium EN06: Advances in Solid-State Electrolyte Development

This symposium aims to stimulate discussion how to accelerate development of solid electrolytes for high energy and stable solid-state batteries (SSBs). The global rise of electric vehicle (EV) market calls for a higher energy battery alternative. SSBs are very promising as they allow for the use of metal anodes and offer greater thermal stability and safety due to the absence of organic liquid components. Despite these conspicuous advantages, SSBs are still at research stage, leaving a substantial gap before practical adoption. The SSB system brings additional constraints due to ‘solid-state’ form of electrolytes, compared to liquid electrolytes in the conventional Li-ion batteries. Thus, the quest of novel solid electrolytes with high Li ion conductivity, wide electrochemical stability window, excellent compatibility with electrodes, and scalable manufacturability is still ongoing. The discussion in this symposium will cover broad research areas of materials design, high-throughput experimentations, automated experimentations, artificial intelligence/machine learning for materials search, and advanced manufacturing of SSBs. Discussion from experts in materials development, characterization, computation, theory, and production will provide an overview of the state-of-the-art technologies for new solid electrolyte discovery, the current status of solid electrolyte development, and critical insights to advance SSB development. In this symposium, all forms of solid electrolytes, including ceramics, glasses, polymers and composites will be considered, along with their integration in cathode and anode components.

Topics will include:

- Ceramic solid-state conductors, including oxides, sulfides, and halides
- Amorphous and glass-ceramics electrolytes
- Ceramic-polymer composite electrolytes
- Computation-guided materials discovery
- High-throughput experimentations for materials discovery
- Artificial intelligence/machine learning for materials discovery
- Scale up for solid state battery manufacturing

Joint sessions are being considered with **EN08 - Solid-State Batteries—Devices, Interfaces and Characterization**.

Invited speakers include:

Peter Bruce	University of Oxford, United Kingdom	**Linda F. Nazar**	University of Waterloo, Canada
Gerbrand Ceder	University of California, Berkeley, USA	**Mauro Pasta**	University of Oxford, United Kingdom
Raphaële Clément	University of California, Santa Barbara, USA	**Jennifer Rupp**	Massachusetts Institute of Technology, USA
Marca Doeff	Lawrence Berkeley National Laboratory, USA	**Naoki Suzuki**	Samsung R&D Institute Japan, Japan
Kelsey Hatzell	Princeton University, USA	**Glenn Teeter**	National Renewable Energy Laboratory, USA
Xin Li	Harvard University, USA	**Eric Wachsman**	University of Maryland, USA
Christian Masquelier	Université de Picardie Jules Verne, France	**Yan Wang**	Samsung Semiconductor, Inc., USA
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Symposium EN07: Critical Materials for Energy—Enhanced Functionality, Sustainable Supply and Replacement

The goal of this symposium is to provide an interactive forum for scientists from various fields who work towards novel and more efficient extraction and utilization of critical materials and minerals to enable sustainable energy technologies. Critical materials and minerals, including rare-earth elements (REE), platinum group elements (PGE), and lithium/cobalt/nickel that possess unique electronic, magnetic, catalytic, transport, and luminescent properties, are key components of many clean energy and high-tech applications that enable wind turbines, solar panels, electric vehicles, and energy-efficient lighting and transportation for accelerating decarbonization economy and realizing Net-Zero-World ecosystem. However, uneven resource distribution and limited as well as vulnerable supply chains of critical materials pose an immense risk to the development and deployment of clean energy technologies both domestically and globally. Therefore, a sustained, multidisciplinary effort by integrating scientific research and engineering innovation to develop solutions across the materials lifecycle, including mineral processing, materials manufacturing, elemental substitution, efficient use, and end-of-life recycling is timely and highly needed. To address the pressing opportunities and challenges, we envision this symposium to highlight most recent trends in fundamental and applied research on enhancing functional behavior and discovery of new properties of REE/PGE-based materials, mining, harnessing, substituting, and recycling critical materials in a wide range of energy and electronic applications. This symposium will bridge expertise on theoretical materials design, materials synthesis, functional measurement/control, advanced characterization, high-throughput computations and machine-learning/artificial intelligence methods (tentative joint sessions).

Topics will include:

- REEs and PGEs enabled/enhanced (electro)chemistry, photocatalysis, light-harvesting, ionotronic/neuromorphic applications
- Relevance of REEs in the operation of photovoltaics, from purely inorganic to hybrid-materials (e.g. perovskites)
- Theory, high-throughput computations and machine-learning/artificial intelligence for predictive modeling and design of critical materials
- Progress and challenges with substituting REE/PGE with more abundant elements
- Imaging and control of REEs and PGEs dynamically in bulk, surface, interface and grain boundary of energy and electronic materials
- Migration and enrichment of critical materials in the earth's environments (magmatic, hydrothermal, sedimentary, and weathering)
- New separation and recycling principles and approaches (e.g., chemical, electrochemical, bio-inspired, microbes-based) for REEs, PGEs, lithium, cobalt, nickel, and magnesium in circular economy processes
- Life cycle analysis and assessment strategies on critical materials for environmental sustainability and socio-economic viability

Joint sessions are being considered with **MD02 - Data-Driven Multiscale Studies of Materials—Computations and Experiments**.
Also, a **tutorial** complementing this symposium is tentatively planned. Further information will be included in the MRS Program that will be available online in January.

Invited speakers include:

Rebecca Abergel	University of California, Berkeley, USA	**Judson Marte**	MP Materials, USA
Paul Anderson	University of Birmingham, United Kingdom	**Sascha Nowak**	Universität Münster, Germany
Michael Bau	Jacobs University, Germany	**Gianfranco Pacchioni**	University of Milano-Bicocca, Italy
Vyacheslav Bryantsev	Oak Ridge National Laboratory, USA	**Tanya Prozorov**	Ames Laboratory, USA
Jeffrey Catalano	Washington University in St. Louis, USA	**George Schatz**	Northwestern University, USA
Steven Chu	Stanford University, USA	**Swetlana Schauermann**	Kiel University, Germany
Yoshiko Fujita	Idaho National Laboratory, USA	**Kathleen Stebe**	University of Pennsylvania, USA
Laura Gagliardi	The University of Chicago, USA	**Kelsey Stoerzinger**	Oregon State University, USA
Saw Wai Hla	Argonne National Laboratory, USA	**Ahmet Uysal**	Argonne National Laboratory, USA
Hideo Hosono	Tokyo Institute of Technology, Japan	**Frances Wall**	University of Exeter, United Kingdom
Dongsheng Li	Pacific Northwest National Laboratory, USA	**Yan Wang**	Worcester Polytechnic Institute, USA
Long Luo	Wayne State University, USA		

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Symposium EN08: Solid-State Batteries—Devices, Interfaces and Characterization

Solid state batteries (SSBs) based on alkali-metal (Li, Na, Mg, etc) chemistry have attracted much attention from both academia and industry in the last decade. They are considered as promising alternatives for conventional Li-ion batteries for a number of important applications (e.g. electrified transportation and grid storage), owing to the enhanced safety properties and potentially much higher energy density. For instance, SSBs with Li metal anodes have the potential for specific energy >500 Wh/kg, energy density >1500 Wh/L, and potential lower cost of <$100/kWh; SSBs with Na metal anode have the potential for specific capacity> 1100 mAh/g, energy density ~ 400-500 Wh/kg, and power density >5 kW/kg and potential lower cost due to abundant raw material reserves on earth. After a decade of extensive research efforts, many novel high-performance solid electrolyte materials have been discovered and reported. So far, there are significant challenges in structure/interface design, characterization, and manufacturing of SSBs. The anodes and cathodes in solid-state could impart significant stresses at interfaces; and the interplay between stresses, electrochemistry, interfacial and layer structures could lead to morphological evolution of the layers to form interphases and chemo-mechanical degradation during cycling. In addition, fast charging such as in automotive applications could drive the SSBs towards early performance degradation with reduced reliability and safety margins. Moreover, manufacturing challenges also impede the practical applications of SSBs towards to technology commercialization.

This symposium aims to provide an interdisciplinary forum for colleagues from both academia and industry, to address the fundamental and technological aspects and the challenges involved in the development of SSB devices and characterizations. Key focus areas of the symposium include: development of new solid electrode materials, new device fabrication methodologies, fast charging of SSBs, in-operando and in-situ characterization of interfaces and layer morphologies, application of artificial intelligence and machine learning concepts for battery diagnostics and estimating the state of charge (SOC) and the state of health (SOH), and multiscale electrochemical modeling to analyze the performance and safety aspects of SSBs, manufacture methods and life cycle analysis, etc.

Topics will include:

- Alkali-metal anode (Li, Na, Mg, etc) for SSBs
- New cathodes and cathode-electrolyte composites for SSBs
- Electrode/electrolyte interface design and studies;
- Interfacial stability, stresses, defect formation and failure mechanism
- Theoretical understanding SSBs (simulation and modeling of materials and battery system, e.g. DFT, MD, continuum and multi-physics modeling, etc.)
- Advanced processing and manufacturing towards to scale-up mass production
- Advanced characterizations (in situ, ex situ) to study materials and interface in solid batteries
- System safety and regulatory requirements for large-scale implementation
- Impact of fast charging on electrochemical degradation and failure.

Joint sessions are being considered with **EN06 - Advances in Solid-State Electrolyte Development**.
Also, a **tutorial** complementing this symposium is tentatively planned. Further information will be included in the MRS Program that will be available online in January.

Invited speakers include:

Stefan Adams	National University of Singapore, Singapore	**David Mitlin**	The University of Texas at Austin, USA
Peter Bruce	University of Oxford, United Kingdom	**Jagjit Nanda**	Oak Ridge National Laboratory, USA
Josh Buettner-Garrett	Solid Power, USA	**Linda F. Nazar**	University of Waterloo, Canada
Marca Doeff	Lawrence Berkeley National Laboratory, USA	**Yue Qi**	Brown University, USA
Kristina Edström	Uppsala University, Sweden	**Jeniffer Rupp**	Technische Universität München, Germany
Kelsey Hatzell	Princeton University, USA	**Xueliang Sun**	University of Western Ontario, Canada
Liangbing Hu	University of Maryland, USA	**Lianzhou Wang**	The University of Queensland, Australia
Yoon Seok Jung	Yonsei University, Republic of Korea	**Thomas Yersak**	General Motors, USA
Marina Leite	University of California, Davis, USA	**Yang Zhao**	University of Western Ontario, Canada
Amy Marschilok	Stony Brook University, The State University of New York, USA		

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Symposium EN09: Polymeric and Organic Materials for Electrochemical Energy Storage

This symposium will provide a forum to share and discuss recent advances in the development and application of organic small molecule and polymeric materials in electrochemical energy storage devices, including but not limited to lithium-ion batteries, sodium-ion batteries, and redox flow systems. The first part of the symposium will focus on the design and synthesis of new materials, and the second part of the symposium will cover advances in understanding of charge transport and reactivity in organic and polymeric materials.

The synthesis focused portion of this symposium will highlight efforts to develop new molecules for liquid electrolytes, new polymeric materials for solid state ion conduction, and new organic redox active materials. New electrolyte materials are critical to enable stable cycling and safe operation of new high energy density electrode materials such as lithium metal. Furthermore, development of beyond lithium-ion chemistries based in Na, Mg, Ca, or Al and new flow battery systems require new electrolyte and electrode materials for practical operation. Symposium contributions should address the design and synthesis of new organic materials as ion conductors, active materials, functional additives, and binders or other inactive components for electrochemical energy storage applications.

The second part of this symposium will cover advances in the understanding of charge transport and reactivity of organic materials in electrochemical energy storage devices. Mechanistic understanding of ion transport within electrolytes and their reactivity at the solid/cathode electrolyte interphase (SEI/CEI) is key to informing the design of new high-performance materials. Symposium contributions should address the use of analytical techniques, theoretical analysis, or computational studies of ion transport or reactivity of organic materials in devices, including but not limited to lithium-ion batteries, sodium-ion batteries, and redox flow systems.

Topics will include:

- Polymers for solid-state electrolytes
- Small molecule solvents and additives for liquid electrolytes
- Ion transport
- Solid/Cathode Electrolyte Interphase (SEI/CEI) formation
- Artificial interphases
- Organic active materials
- Polymer binders and separators
- Functional current collectors

Invited speakers include:

Zhenan Bao	Stanford University, USA
Daniel Brandell	Uppsala University, Sweden
Hye Ryung Byon	Korea Advanced Institute of Science and Technology, Republic of Korea
Isidora Cekic-Laskovic	Forschungszentrum Jülich GmbH, Germany
Jun Chen	Nankai University, China
Jang Wook Choi	Ulsan National Institute of Science and Technology, Republic of Korea
Nam-Soon Choi	Korea Advanced Institute of Science and Technology, Republic of Korea
Clare Grey	Cambridge University, United Kingdom

Brett Helms	Lawrence Berkeley National Laboratory, USA
Liangbing Hu	University of Maryland, USA
Jeremiah Johnson	Massachusetts Institute of Technology, USA
Jodie Lutkenhaus	Texas A&M University, USA
Jennifer Schaefer	University of Notre Dame, USA
Ulrich Schubert	Friedrich-Schiller-Universität Jena, Germany
Rachel Segalman	University of California, Santa Barbara, USA
Yan Yao	University of Houston, USA

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Symposium EN10: Decomposing Materials Wastes—Physical, Chemical and Biological Approaches

As the rate of production of new materials outnumber the rate of their consumption, recycling, and decomposition, the accumulation of waste is expected to rise. Of the 292.4 million tons municipal solid waste (MSW) generated in 2018, which is equivalent to approximately 5 pounds/person/day, only 32% was recycled or composted (epa.gov). This symposium will broadly cover the effects of materials waste on the natural environment and the current and emerging approaches in decomposing a wide range of materials waste from organic paper and plastic to inorganic metals and ceramics. Part one of the symposium will focus on the current physical, chemical, and biological approaches in material waste processing, from single streams to complex mixtures of materials such as electronics. The innovations and breakthrough research in waste processing, including those inspired by natural processes, will be the focus of part two. The latest techniques in characterization of the waste materials to enable screening of best- performing process will also be presented. In part three, the considerations in materials design paradigms from-cradle-to-gate/grave and emerging technologies will be presented along with recycle-by-design materials for the future. The symposium will conclude with highlights of industry trends and their considerations in ensuring sustainable waste handlings of materials towards net- zero.

Abstracts are solicited in the following areas: plastic, electronic, concrete, and textile waste recycling and processing, new materials characterizations tools/techniques, material designs for consumer products, compostable new materials, recycle-by-design plastics, and perspectives.

Topics will include:

- Materials design and characterisation
- Plastic waste
- Electronic waste
- Building materials waste
- Materials recycling
- Materials upcycling
- Biomimicry
- Microbial engineering for materials decomposition
- Enzyme engineering for materials deconstruction
- Circular materials economy

Invited speakers include:

Kathryn Beers	National Institute of Standards and Technology, USA
Seung Jin Kim	Alliance to End Plastic Waste, Singapore
Grzegorz Lisak	Nanyang Technological University, Singapore
Alain Marty	Institut National des Sciences Appliquées, France
Kevin McGuigan	3M, USA
Nicolas Rorrer	National Renewable Energy Laboratory, USA
Kirsty Salmon	BP, United Kingdom
Madhavi Srinivasan	Nanyang Technological University, Singapore
Bian Wu	Institute of Microbiology, Chinese Academy of Sciences, China

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Symposium EN11: Advanced Materials for Thermal Management of Human-Building-Energy Nexus

In developed countries, buildings consume approximately 40% of the total primary energy, resulting from the essential need for the human body thermal comfort. The symposium will focus on the materials innovation in optical and thermal science for building energy efficiency as well as occupants' thermoregulation, aiming to gather materials scientists, physicists, chemists, and thermal and civil engineers to share the research progress and vision for mitigating the energy consumption and carbon emissions associated with building sectors. The symposium will focus on materials innovation in synthesis, characterization, measurement, and computation that can lead to better harvesting and utilization of renewable energy resources and lower building energy consumption. Topics will include but not limited to chromic materials, solar heating, radiative cooling, caloric materials, materials for non-vapor compression refrigeration and heat pumps, low global warming potential refrigerants, phase change materials, thermal storage, thermal switches, thermal insulators/sealants, and wearable personal thermoregulation. To facilitate the integration of research lab-scale fundamental materials science and building-scale implementation, the symposium also welcomes relevant research in life cycle assessment (LCA) and techno-economic assessment (TEA), which are critical for scalable and impactful energy sustainability research.

Topics will include:

- Chromic materials
- Solar heating and radiative cooling
- Thermal insulators and advanced sealants
- Thermal storage
- Thermal switch
- Caloric materials
- Thermogalvanic cells
- Materials for non-vapor compression refrigeration and heat pump
- Wearable thermoregulation materials
- Novel characterizations of materials' thermal and optical properties
- Life cycle assessment and techno-economic assessment

Joint sessions are being considered with **EL03 - Frontiers in Electrochromic Materials and Devices**, and **EN03 - Caloric Materials for Heating and Cooling**.
Also, a **tutorial** complementing this symposium is tentatively planned. Further information will be included in the MRS Program that will be available online in January.

Invited speakers include:

Nastaran Barhemmati	Viking Cold Solutions Inc., USA
Chuck Booten	National Renewable Energy Laboratory, USA
Yanfeng Gao	Shanghai University, China
Kyle R Gluesenkamp	Oak Ridge National Laboratory, USA
Lin Vivien Lu	Hong Kong Polytechnic University, China
Zhengmao Lu	Massachusetts Institute of Technology, USA
Arun Majumdar	Stanford University, USA
Michael McGehee	University of Colorado Boulder, USA
Delia Milliron	The University of Texas at Austin, USA
Hong Chul Moon	University of Seoul, Republic of Korea

Sven Mumme	Office of Energy Efficiency and Renewable Energy, USA
Hidefumi Odaka	AGC Glass Asia Pacific, Japan
Qibing Pei	University of California, Los Angeles, USA
Ravi Prasher	Lawrence Berkeley National Laboratory, USA
Junsuk Rho	Pohang University of Science and Technology, Republic of Korea
Gang Tan	Zhejiang University, China
Junqiao Wu	University of California, Berkeley, USA
Ronggui Yang	Huazhong University of Science and Technology, China
Shu Yang	University of Pennsylvania, USA
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Symposium MD01: Integrating Machine Learning and Simulations for Materials Modeling

Numerical simulations have enabled a new paradigm in materials discovery. However, they face various challenges, including: (i) high computational cost, which usually prevents the simulation of large systems over extended timescales, (ii) limited accuracy (e.g., due to lack of reliable interatomic forcefields), and (iii) difficulties when it comes to the inverse design optimization of materials (simulations are often not differentiable). On the other hand, artificial intelligence and machine learning offer a promising pathway for materials modeling and accelerated discovery of new materials with exceptional properties. However, machine learning models also face some limitations as they: (i) rely on the existence of large, consistent, and accurate datasets, (ii) excel at interpolating materials' properties but tend to have challenges with extrapolations, (iii) by solely relying on data, can violate the laws of physics and chemistry, and (iv) typically offer limited interpretability. In that regard, data-driven machine learning models and knowledge-driven high-fidelity simulations have the potential to inform, advance, and complement each other—and to address each other's deficiencies. This symposium builds on the idea that the lack of intimate integration between data- and knowledge-driven modeling is a missed opportunity in materials science. This symposium will explore new modeling approaches that seamlessly combine and integrate machine learning and simulations—wherein simulation informs machine learning, machine learning advance simulations, or closed-loop integrations thereof. It will bring together experts in numerical simulations and machine learning, both from academia and industry.

Topics will include:

- Multi-fidelity models, data-fusion, and transfer learning approaches
- Machine learning to inform simulations (e.g., machine-learned interatomic forcefields)
- Physics-informed machine learning and symbolic learning
- "Self-driving" simulations, reinforcement learning, and active learning
- Graph neural networks for materials modeling
- Automatic differentiation, inverse problems, and deep generative models
- Machine learning for "finding needles in haystacks" in simulation output data
- Rare events sampling and automated identification of collective variables
- Machine learning for structural and topology optimization
- Development of machine-learned surrogate simulators
- Natural language processing for materials modeling
- Use of hardware dedicated to deep learning (e.g., TPUs) to accelerate simulations

A **tutorial** complementing this symposium is tentatively planned. Further information will be included in the MRS Program that will be available online in January.

Invited speakers include:

Amanda Barnard	Australian National University, Australia	**Sinan Keten**	Northwestern University, USA
Peter Battaglia	DeepMind, United Kingdom	**Arif Masud**	University of Illinois at Urbana-Champaign, USA
Kristen Brosnan	Superior Technical Ceramics, USA	**Rampi Ramprasad**	Georgia Institute of Technology, USA
Chiara Daraio	California Institute of Technology, USA	**Sam Schoenholz**	Google Brain, USA
Pratibha Dev	Howard University, USA	**Yizhou Sun**	University of California, Los Angeles, USA
Claudia Draxl	Humboldt-Universität zu Berlin, Germany	**Adama Tandia**	Corning Inc., USA
Victor Fung	Oak Ridge National Laboratory, USA	**Shingo Urata**	Asahi Glass Company, Japan
Mario Geiger	Massachusetts Institute of Technology, USA	**Adri van Duin**	The Pennsylvania State University, USA
Brian Giera	Lawrence Livermore National Laboratory, USA	**Xiaonan Wang**	National University of Singapore, Singapore
Pawan Goyal	Indian Institute of Technology Kharagpur, India	**Qimin Yan**	Temple University, USA
Demis Hassabis	DeepMind, United Kingdom	**Bilge Yildiz**	Massachusetts Institute of Technology, USA
Sergei Kalinin	Oak Ridge National Laboratory, USA	**Xiaolin Zheng**	Stanford University, USA

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Symposium MD02: Data-Driven Multiscale Studies of Materials—Computations and Experiments

Multiscale methods have been widely used in material studies, allowing us to gain insights into material behaviors at quantum, atomistic, micro-, meso- and macro-scales. The recent developments in data-driven methods, such as machine learning and artificial intelligence, and their integration with multiscale approaches are creating new research opportunities. Data-driven multiscale studies of materials have shown promising results in developing interatomic potentials for atomistic modeling, designing new materials, discovering new constitutive laws, identifying processing-structure-performance correlations, and analyzing microscopy images, among many others. In this symposium, we will include the new developments of data-driven methods in computational and experimental studies of materials, the data-driven studies crossing different scales, the studies bridging computations and experiments, and the new understandings of material behaviors enabled by the data-driven multiscale methods. This symposium will bring together researchers from a broad spectrum of disciplines with a data- or multiscale-relevant component in their research to exchange research progress and inspire new research ideas.

Topics will include:

- Data-driven design of new materials
- Data-driven characterization of materials
- Data-driven identification of constitutive relations
- Process-structure-performance correlations
- The development of new data-driven methods for material studies
- Machine-learning potentials for atomistic simulations
- Model-order reduction in multiscale computations
- Uncertainty quantifications in multiscale computations
- Scale-bridging methods for material studies

Invited speakers include:

Christos Athanasiou	Georgia Institute of Technology, USA	**Yen Ting Lin**	Los Alamos National Laboratory, USA
Wei Cai	Stanford University, USA	**Nithin Mathew**	Los Alamos National Laboratory, USA
Ivano E. Castelli	Technical University of Denmark, Denmark	**Shyue Ping Ong**	University of California, San Diego, USA
Victor Fung	Oak Ridge National Laboratory, USA	**Danny Perez**	Los Alamos National Laboratory, USA
Wei Gao	Texas A&M University, USA	**Brandon Runnels**	University of Colorado Colorado Springs, USA
Johann Guilleminot	Duke University, USA	**Alejandro H. Strachan**	Purdue University, USA
Ozgur Keles	San Jose State University, USA	**Aidan Thompson**	Sandia National Laboratories, USA
John Lambros	University of Illinois at Urbana-Champaign, USA	**Wenbin Yu**	Purdue University, USA

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Symposium NM01: Janus Nanomaterials—Design, Fabrication and Applications

This symposium will cover a range of topics within the areas of design, fabrication, and application of Janus nanomaterials. Named after the two-faced Roman god, Janus nanomaterials have two distinct sides with different chemistry and polarity. Submissions to this symposium should cover how asymmetric structure enables the combination of different or even incompatible physical, chemical, and mechanical properties within a single unit, leading to unique properties and potential applications. The symposium will highlight recent advances in this field, which has experienced rapid growth in both fundamental and applied aspects. New morphologies, functions, dynamics, and useful properties of Janus nanomaterials will be covered in this symposium. Contributions focused on the response of these materials to externally or internally generated fields, facilitating propulsion or complex assemblies, are also welcome. Researchers from both academia and industry will attend this symposium to discuss the latest progress, current challenges, and future opportunities.

Topics will include:

- Theory, rational design, and simulation of Janus nanostructures;
- Synthesis, scale-up, and characterizations of Janus materials
- Assembly and suprastructures of Janus nanomaterials
- Interfacial properties and phenomena of Janus nanomaterials
- Dynamics of Janus nanomaterials in solution and at interfaces
- Janus nanomaterials for sensing and controllable delivery applications
- Janus nanomaterials for catalysis and energy-storage applications
- Janus nanomaterials for emulsion stabilization and oilfield chemistry applications
- Janus nanomaterials as building blocks for active matter

Invited speakers include:

Bhuvnesh Bharti	Louisiana State University, USA
Sehoon Chang	Aramco Americas, USA
Síle Nic Chormaic	Okinawa Institute of Science and Technology, Japan
Shan Jiang	Iowa State University, USA
Eugenia Kumacheva	University of Toronto, Canada
Dan Luo	University of Houston, USA
Sepideh Razavi	The University of Oklahoma, USA
Kathleen J. Stebe	University of Pennsylvania, USA
Timothy Swager	Massachusetts Institute of Technology, USA
Peiran Wei	Texas A&M University, USA
Zhenzhong Yang	Tsinghua University, China

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Symposium NM02: 2D Materials for Electrochemical Applications—Leading the Charge Through Thermodynamic and Kinetic Knowledge Gaps

2D materials have enormous potential as lightweight and flexible electrode materials for photoelectrocatalysis, energy storage, sensing, and the manipulation and storage of quantum information. Yet, several challenges prevent us from realizing these exciting applications, ranging from the inability to mass-produce 2D materials into electrochemical devices with high precision, to probing and elucidating their electronic excitations and energy relaxation mechanisms that lead to energy and charge transfer. Our symposium will highlight recent developments in 2D materials synthesis, characterization, theoretical treatment, and emerging applications. Topics will focus on current understanding of interfacial energetics and charge flow across the 2D material/electrolyte interface, which are central to the success of these emerging technologies. At graphene and TMD electrodes, the charged ions of the double layer act cumulatively as an effective electrostatic ‘gate’ that shifts the Fermi level relative to the band edges of the material via dynamic electron/hole doping. Additional effects of quantum capacitance on electrochemical reactions at 2D materials are not usually fully appreciated. We lack a concrete understanding of the best thermodynamic and dynamic description of the 2D material/electrolyte interface. Hence, this symposium aims to bring together a diverse group of materials scientists, synthetic chemists, electrochemists, theorists, and spectroscopists who are interested in addressing current knowledge gaps in the field of 2D electrochemistry.

Topics will include:

- Novel synthetic strategies and device integration
- Bandgap renormalization in 2D electrochemistry
- Theoretical description of the 2D electrode/electrolyte interface
- Novel electrochemical applications using 2D materials
- Nanoscale imaging and in situ spectroscopy
- Quantum capacitance of 2D electrodes

Joint sessions are being considered with **EN04 - Two-Dimensional Materials for Energy Conversion**.

Invited speakers include:

K.V. Adarsh	Indian Institute of Science Education and Research Bhopal, India
Zakaraia Al Balushi	University of California, Berkeley, USA
Harry Atwater	California Institute of Technology, USA
Justin Caram	University of California, Los Angeles, USA
Guilio Cerullo	Politecnico di Milano, Italy
Alexey Chernikov	Technical University of Dresden, Germany
Manish Chhowalla	University of Cambridge, United Kingdom
Felipe da Jornada	Stanford University, USA
Keshav Dani	Okinawa Institute of Science and Technology, Japan
Daniel Frisbie	University of Minnesota, USA
Hirendra Ghosh	Institute of Nano Science and Technology, India
Naomi Ginsberg	University of California, Berkeley, USA
Tony Heinz	Stanford University, USA
Libai Huang	Purdue University, USA
Andreas Knorr	Technische Universität Berlin, Germany
Amber Krummel	Colorado State University, USA
Andrea Marini	National Research Council, Italy
Elisa Miller-Link	National Renewable Energy Laboratory, USA
Diana Qiu	Yale University, USA
Archana Raja	Lawrence Berkeley National Laboratory, USA
Sivan Refaely-Abramson	Weizmann Institute of Science, Israel
Søren Ulstrup	Aarhus University, Denmark
Patrick Unwin	Warwick University, United Kingdom
Jao Van de Lagemaat	National Renewable Energy Laboratory, USA
Jesus Velasquez	University of California, Davis, USA
Matej Velicky	J. Heyrovský Institute of Physical Chemistry, Czech Republic
Venkat Viswanathan	Carnegie Mellon University, USA
Yu Zhong	Cornell University, USA
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Symposium NM03: Nano-Sized Photocatalysts—From Fundamentals to Applications

This symposium focuses on all aspects relating to the use of nanomaterials as photocatalysts and photosensitizers, including the synthesis, structural and functional characterization, modelling, and application. Nanomaterials offer two crucial properties: a large surface-to-volume ratio and size-dependent light matter interactions, which motivate the exploration of this field in order to solve the urgent problems of our time, energy production and storage, as well as carbon-neutral production of chemicals.

The aim and purpose of this symposium is to bring together the community that develops the next generation of nanomaterials-based catalysis and will identify mechanisms, bottlenecks and potentials that drive this important field forward. Possible topics include, but are not limited to, solar fuel production, water purification, or light-induced transformations of organic molecules, interfaces and heterojunctions, excited state dynamics, non-linear optics, and plasmonic enhancement. We hope to cover a broad range of factors and methodologies that are crucial for the field and constitute a universal and multi-faceted approach, including structural characterization with atomic resolution, state-of-the-art spectroscopic and electrochemical methods, evaluation of actual photocatalytic activity, and theoretical calculations of the catalytic processes and size-dependent effects. We therefore encourage everybody working in this field to submit an abstract and participate in the symposium.

Topics will include:

- Nanoscale photocatalyst synthesis
- Advanced methodologies for structural characterization down to atomic resolution
- Excited state dynamics in nanocrystal photocatalysts: time-resolved spectroscopy, (spectro-)electrochemistry
- *Operando* studies of photocatalytic systems
- Quantum mechanical treatment of nanocrystal surfaces, electronic states, or catalytic processes
- Plasmon-enhanced photocatalysis
- Bio-hybrid and bio-inspired photocatalytic systems
- Novel applications and devices

Invited speakers include:

Nadja Bigall	Leibniz University Hannover, Germany
Maytal Caspary Toroker	Technion–Israel Institute of Technology, Israel
Kazunari Domen	The University of Tokyo, Japan
Gordana Dukovic	University of Colorado Boulder, USA
Robert Godin	The University of British Columbia, Canada
Naomi Halas	Rice University, USA
Prashant Jain	University of Illinois at Urbana-Champaign, USA

Christine Kranz	Universität Ulm, Germany
Masaru Kuno	University of Notre Dame, USA
Greta Patzke	University of Zürich, Switzerland
Peng Zeng	University of Electronic Science and Technology of China, China
Haimei Zheng	Lawrence Berkeley National Laboratory, USA
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Symposium NM04: Advanced Manufacturing of 2D Materials at the Atomic Scale

Manufacturing of new materials, new structures, and traditional materials with new architectures represents a new way to engineer materials functions and relies on understandings from materials and mechanical sciences. Recent advancement in fabricating 2D materials and manipulating materials structures with high precision has extended our capability to build and study the emerging mechanical, chemical, and electronic properties from the atomic scale. This symposium will cover recent progress in techniques that allow the manufacturing of 2D material-based devices and characterization of their fabrication and operation. The program will emphasize the development of new tools, including those using electron, ion, optical, and scanning probes, for reliable, repeatable, and scalable, nano- and atomic-scale fabrication of 2D materials or other low dimensional structures. Additionally, this symposium will focus on the properties, such as transport, heat transfer, and mechanical strength, and their correlation with the dimension and assembly of the new structures. Methods of *in situ* characterization, big data analysis, machine learning approaches, and high throughput experimentations and calculations to understand the dynamics and probe-materials interactions are welcome. The symposium will identify potential and promising methods in advanced manufacturing of low-dimensional structures, bridge mechanistic studies with practical fabrications, and encourage the application of atomistic understanding to applied science.

Topics will include:

- Electron beam engineering of 2D materials
- New structure formation under high energy ions
- 2D electronics
- *In situ* characterization of materials dynamics during advanced materials manufacturing
- Materials chemistry confined on 2D surfaces
- Interaction of high energy electron, ion, and laser with materials
- Artificial intelligence guided new manufacturing
- Mechanical properties of hybrid 2D materials
- New instrumentation for atomic scale materials fabrication

A **tutorial** complementing this symposium is tentatively planned. Further information will be included in the MRS Program that will be available online in January.

Invited speakers include:

Wei Chen	Northwestern University, USA
Miaofang Chi	Oak Ridge National Laboratory, USA
Shen Dillon	University of California, Irvine, USA
Xiangfeng Duan	University of California, Los Angeles, USA
Xinliang Feng	Technische Universität Dresden, Germany
Tobin Filleter	University of Toronto, Canada
Micah Green	Texas A&M University, USA
Julia Greer	California Institute of Technology, USA

Pinshane Huang	University of Illinois at Urbana-Champaign, USA
Sergei Kalinin	Oak Ridge National Laboratory, USA
Junhao Lin	Southern University of Science and Technology, China
Jun Lou	Rice University, USA
Paul Midgley	Cambridge University, United Kingdom
Michael Pope	University of Waterloo, Canada
Haimei Zheng	Lawrence Berkeley National Laboratory, USA
Wu Zhou	The University of the Chinese Academy of Sciences, China

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Symposium QM01: Novel Approaches to Manipulate and Detect 2D Magnetism in van der Waals Quantum and Topological Materials

The discovery of 2D magnets has rapidly generated remarkable breakthroughs for intriguing fundamental science and potential next-generation applications. In this context, numerous van der Waals magnets have been discovered and many routes were employed to manipulate and control their spin states. Moreover, several sophisticated experimental and theoretical methods have been developed and applied to detect their magnetic ordering. This symposium explores the recent advances in manipulating magnetism through moiré engineering, twisting, gating, proximity effect, intercalation, photoexcitation, and pressure. This symposium also covers the experimental (scanning magnetic probes, scanning SQUID, scanning NV center microscopy, etc.) and theoretical methods (e.g. higher-order spin interactions, etc.) to fully understand such strongly correlated magnetism. The material systems include atomically thin chromium trihalides, metallic magnets, chalcogen-based van der Waals magnets, twisted magnets/graphene, magnetic topological insulators, and Weyl semimetals. This symposium's primary goal is to bring together both experimentalists and theoreticians investigating the physics, chemistry, materials science, and engineering aspects of magnetic quantum materials. This symposium will enable researchers to receive a more in-depth perception of this emerging field and its grand challenges and opportunities in the field of quantum magnetism.

Topics will include:

- Twisted 2D Magnets, Moire Engineering, the interplay between magnetism and topology
- Gate Tunable 2D Magnetism and Proximity Effects
- Effect of Intercalation on 2D Magnetism
- Ultrafast Manipulation of 2D Magnetism, and Pressure Controllable 2D Magnets
- Advanced experimental probes to directly characterize 2D magnetism
- Theoretical developments and computational methodologies of Quantum Magnets

Joint sessions are being considered with **NM04 - Advanced Manufacturing of 2D Materials at the Atomic Scale**.
Also, a **tutorial** complementing this symposium is tentatively planned. Further information will be included in the MRS Program that will be available online in January.

Invited speakers include:

Luis Balicas	The National High Magnetic Field Laboratory, USA
Wenli Bi	The University of Alabama, USA
John Cenker	University of Washington, USA
Pengcheng Dai	Rice University, USA
Claudia Felser	Max Planck Institute for Chemical Physics of Solids, Germany
Albert Fert	Thales, France
Robert Hicken	University of Exeter, United Kingdom
Angela R Hight Walker	National Institute of Standards and Technology, USA
Mikhail Katsnelson	Radboud University, Netherlands
Chin-Shan Lue	National Cheng Kung University, Taiwan
Silvia Milana	Nature Springer, United Kingdom

Katja Nowack	Cornell University, USA
Je-Geun Park	Seoul National University, Republic of Korea
Stuart Parkin	Max Planck Institute of Microstructure Physics, Germany
Charudatta Phatak	Argonne National Laboratory, USA
Martino Poggio	Universität Basel, Switzerland
Junyi Shan	California Institute of Technology, USA
Meenakshi Singh	Colorado School of Mines, USA
Seonghoon Woo	IBM T.J. Watson Research Center, USA
Joerg Wrachtrup	Universität Stuttgart, Germany
Amir Yacoby	Harvard University, USA

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Symposium QM02: Functional Ferroic Materials for Unconventional Computing

Ferroic materials with spontaneous magnetic or electric long-range order are a rich source for emergent functional phenomena, enabling conceptually new pathways towards unconventional computing. The dynamical properties of spin- and dipole-systems displaying frustration or competing interactions, for example, can be utilized for the implementation of reservoir computing. Furthermore, tunnel junctions with ferroelectric barriers allow continuous conductivity changes that can be leveraged for multilevel data storage in memristor chips, whereas magnetic tunnel junctions behave as oscillators, to be used as artificial synapsis and neuron devices for neuromorphic computing. Recently, topological solitons have moved into focus, adding a strong cross-disciplinary dimension to the field, connecting the ferroelectrics and the magnetism communities. Innovative device concepts based on magnetic materials and ferroelectrics, as well as overarching theoretical descriptions, are now being investigated and combined to develop a joint fundamental understanding, propelled by the recent developments in theory, synthesis and characterization.

This symposium aims to bring together scientific experts and young scientists with an interest in ferroic materials (ferroelectric, ferromagnetic, and multiferroic), topological phenomena and innovative technologies, fostering interactions and advancing knowledge of emergent functional properties and related hardware concepts for unconventional computing.

Topics will include:

- Multi-level resistance control / resistive switching
- Device concepts and signal control
- Functional topological electric and magnetic solitons (skyrmions, polar vortices, domain walls)
- Theoretical simulation and modelling of electrically and magnetically driven processes
- Emergent functional properties, including interface phenomena and defects
- Materials (bulk crystals, thin films, superlattices, 2D systems, novel topological materials, novel spintronic semiconductors)
- Controlled formation, excitation/activation and movement functional entities (domains, solitons, interfaces, spin waves)
- *In situ/operando* characterization of dynamic processes
- Material-based concepts for unconventional computing
- Top-down fabrication and bottom-up design of neuromorphic devices / circuitry

Joint sessions are being considered with **QM04 - Charged Topological Defects in Functional Materials**.

Invited speakers include:

Laura Bégon-Lours	IBM Research-Zurich, Switzerland	**Jean-Anne Incorvia**	The University of Texas at Austin, USA
Erika Covi	NaMLab, Germany	**Fumitaka Kagawa**	Tokyo Institute of Technology, Japan
Karin Everschor-Sitte	Universität Duisburg-Essen, Germany	**Alexander Khatjetoorians**	Radboud University, Netherlands
Giovanni Finocchio	Università degli Studi di Messina, Italy	**Hermann Kohlstedt**	Kiel University, Germany
Yukako Fujishiro	The University of Tokyo, Japan	**Igor Lukyanchuk**	Université de Picardie Jules Verne, France
Vincent Garcia	Centre National de la Recherche Scientifique, France	**Vijaykrishnan Narayanan**	The Pennsylvania State University, USA
Marty Gregg	Queen's University Belfast, Ireland	**Stefan Slesazeck**	NaMLab, Germany
Alexei Gruverman	University of Nebraska–Lincoln, USA	**Masaki Uchida**	Tokyo Institute of Technology, Japan
Axel Hoffmann	University of Illinois at Urbana-Champaign, USA	**Xiuzhen Yu**	RIKEN, Japan

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Symposium QM03: Symmetry-Guided Rational Design and Control of Transient and Metastable Quantum Phenomena

Recent advances in the field of quantum materials have demonstrated the fundamental importance of symmetry breaking and topological classification. Notable examples include the strongly correlated cuprates and nickelates with unidirectional orders that break the rotational symmetry, as well as the zoo of topological systems with novel boundary states that are protected by time reversal and inversion symmetries. Understanding and controlling symmetry, therefore, provide a powerful means towards rational design and realization of material properties. Over the last few years, there has been increasing excitement over transient, hidden, and metastable phases induced using external stimuli. The creation of these novel phases fundamentally involves the breaking or conservation of symmetry. This symposium will present recent progress in the prediction, modeling, detection, and control of out-of-equilibrium quantum phenomena, and highlight the role of symmetry as the guiding principle. Key focus areas include new material properties induced using optical, electric, and magnetic stimuli and new synthesis and fabrication paradigms enabled through non-equilibrium methods. The symposium will also harness the capabilities of emerging research tools, e.g. exascale modeling, artificial intelligence, ultrafast optics and X-ray free electron lasers, and advanced synthesis capabilities. The proposed symposium will drive the field forward by creating synergy across diverse and sometimes disparate communities, to realize new materials and new properties towards future quantum technologies.

Topics will include:

- Strain and pressure induced phases and phase transitions
- Interfacial and superlattice physics in heterostructures
- Moire superlattice and strain superlattice engineered phases
- Topological phenomena and Floquet states
- Driven phase transitions through symmetry changes
- Higher order symmetry breaking, metastable and hidden phases
- Ultrafast X-ray and electron studies of quantum materials
- Exascale modeling of out-of-equilibrium behaviors aided by artificial intelligence

Joint sessions are being considered with **QM04 - Charged Topological Defects in Functional Materials**.

Invited speakers include:

Youngjun Ahn	University of Michigan, USA
Antia Botana	Arizona State University, USA
Alberto de la Torre Duran	Brown University, USA
Gregory Fiete	Northeastern University, USA
Dillon Fong	Argonne National Laboratory, USA
Er-Jia Guo	Institute of Physics, Chinese Academy of Sciences, China
Rui He	Texas Tech University, USA
Wanzheng Hu	Boston University, USA
Long Ju	Massachusetts Institute of Technology, USA
Roland Kawakami	The Ohio State University, USA
Hyunjung Kim	Sogang University, Republic of Korea
Anshul Kogar	University of California, Los Angeles, USA
David Lederman	University of California, Santa Cruz, USA
Nadya Mason	University of Illinois at Urbana-Champaign, USA
James McIver	Max Planck Institute, Germany
Joel Moore	University of California, Berkeley, USA
Keith Nelson	Massachusetts Institute of Technology, USA
Seongshik Oh	Rutgers University, USA
Chong-Yu Ruan	Michigan State University, USA
Justin Song	Nanyang Technological University, Singapore
Jörn Venderbos	Drexel University, USA
Yao Wang	Clemson University, USA
Haidan Wen	Argonne National Laboratory, USA
Stephen Wilson	University of California, Santa Barbara, USA
Liang Wu	University of Pennsylvania, USA
Jiaqiang Yan	Oak Ridge National Laboratory, USA
Ming Yi	Rice University, USA
Shuyun Zhou	Tsinghua University, China

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Symposium QM04: Charged Topological Defects in Functional Materials

Topological defects, such as dislocations, vortices, and textures, have been sought after in diverse fields spanning materials science to cosmology. In condensed matter systems, three major classes of materials have been studied for topological defects. These include spin systems such as ferromagnets (spin textures), liquid crystals (dislocations), and dipolar systems such as ferroelectric heterostructures (dislocations, and dipolar textures). Topological defects offer a flexible approach to modify material and device properties, locally and/or globally, and can therefore greatly expand potential functionality and application profile. In addition to that, charged defects can provide the ability to modify and control those additional properties via external fields.

While topological spin structures, such as skyrmions, have been studied extensively over the years, their charge counterparts with breaking of rotational symmetry have started to garner renewed attention. Recent reports on the observation of polar vortices/antivortices in ferroelectric/dielectric oxide heterostructures, and chiral order in halide and chalcogenide materials with reduced dimensionality have created new excitement in this field of study. Motivated by these discoveries, there is a growing interest in tailoring unconventional charged topological defects in a variety of materials that are responsive to electromagnetic radiations, electric and magnetic fields, opening up the prospect of unique coupling between order parameters that was not possible previously, and potentially achieving the levels of control necessary to increase information storage density and decrease power consumption in electronic devices. This emerging field of study therefore provides a novel platform to realize materials, structures and novel devices in electronics and photonics.

In this symposium, we will bring together experts in academia, and national laboratories from around the world, who are pursuing novel approaches to realize, control and understand polarization textures in a broad range of quantum materials such as oxides and chalcogenides. This symposium will cover a range of topics such as charge textures in confined ferroelectric oxides and visible-infrared responsive chalcogenides, novel probes for polarization textures, and development of new foundational theory to explain and guide the realization of polar textures.

Topics will include:

- Phenomenological and first-principles models to describe stability, dynamics, and properties of charged topological defects
- Synthesis and characterization of functional materials with charged topological defects
- Advanced diffraction, scattering and spectroscopic probes of stability and dynamics of charged topological defects
- Imaging methods to visualize charged topological defects
- Bulk, surface and interfacial properties arising from topological defects
- Probing the effect of dimensionality on charged defects such as dislocations, textures, domain boundaries
- Effect of phase transformations on topological charged defects
- Applications of charged topological defects in functional materials

Joint sessions are being considered with **QM02 - Functional Ferroic Materials for Unconventional Computing**, and **QM03 - Symmetry-Guided Rational Design and Control of Transient and Metastable Quantum Phenomena**.

Invited speakers include:

Ritesh Agarwal	University of Pennsylvania, USA	**Beatriz Noheda**	University of Groningen, Netherlands
Long-Qing Chen	The Pennsylvania State University, USA	**Stuart Parkin**	Max Planck Institute of Microstructure Physics, Germany
Weibo Gao	Nanyang Technological University, Singapore	**Sergei Prokhorenko**	University of Arkansas, USA
Berit Goodge	Cornell University, USA	**Ramamoorthy Ramesh**	University of California, Berkeley, USA
Marty Gregg	Queen's University Belfast, United Kingdom	**Yu-Tsun Shao**	Cornell University, USA
Jorge Íñiguez	Luxembourg Institute of Science and Technology, Luxembourg	**Naoya Shibata**	The University of Tokyo, Japan
Gwan-Yeong Jung	Washington University in St. Louis, USA	**Nagarajan Valanoor**	University of New South Wales, Australia
Qiong Ma	Boston College, USA	**Haidan Wen**	Argonne National Laboratory, USA
Petro Maksymovych	Oak Ridge National Laboratory, USA	**Shuyun Zhou**	Tsinghua University, China
Yufeng Nie	Nanjing University, China		

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Symposium SB01: Fundamentals and Applications of Engineered Living Materials

This symposium will broadly cover work that integrates materials with living organisms or other biologically active structures to create multifunctional composites and systems. Exciting advances in this field include new materials synthesis and processing approaches that combine natural/synthetic polymers with living cells, synthetic biology approaches to engineer materials properties, and emerging applications that utilize the unique, multifunctional nature of engineered living materials. Living organisms self-replicate, sense and respond to subtle changes in the surrounding environment, and heal damage using abundant energy sources. Despite many advances in non-living responsive materials, these behaviors can only be partially replicated. In recent years, strategies have emerged that directly integrate living cells, from bacteria and yeast to myocytes, with engineered materials. Importantly advances in synthetic biology have been leveraged to engineer the behavior of the living material. The resulting composites have properties that originate from living organisms, such as programmed responses to specific environmental cues, and properties dictated by the non-living material, including processability and engineered mechanical properties. Related efforts that incorporate engineered materials, organelles, and even some multicellular organisms will also be discussed. Integration of synthetic materials and systems with living organisms (e.g., insects) to augment their functional attributes (e.g., sensing, actuation, navigation) while not compromising their natural abilities is also of interest.

This symposium will cover basic research including new approaches to use synthetic biology in engineered living materials and structure-processing-property relationships of this class of materials. This symposium will also address advances in the areas of biosensing, drug delivery, sustainable manufacturing, soft robotics, and others. The invited speakers will include leaders in academia, government, and industry. The symposium will seek to foster collaboration in this growing research area between materials scientists, synthetic biologists, and engineers interested in a variety of applications.

Topics will include:

- Sustainable manufacturing
- Biofilms
- Biomineralization
- 3D/4D Printing
- Materials and systems for cyborgs
- Cell-material interactions
- Living soft robots
- Living drug delivery systems
- Living biosensors
- Living construction materials and infrastructure
- Self-healing living materials
- Stimuli-responsive living materials
- Synthetic biology for living materials

Invited speakers include:

Aranzazu del Campo	INM – Leibniz Institute for New Materials, Germany
Sarah Glaven	U.S. Naval Research Laboratory, USA
Chelsea Heveran	Montana State University, USA
Neel Joshi	Northeastern University, USA
David Kaplan	Tufts University, USA
Jinyao Liu	Shanghai Jiao Tong University, China
Anne Meyer	University of Rochester, USA
Anne Meyer	University of Rochester, USA
Alshakim Nelson	University of Washington, USA
Meredith Silberstein	Cornell University, USA
Silvia Vignolini	University of Cambridge, United Kingdom
Ilja Voets	Eindhoven University of Technology, Netherlands
Qiming Wang	University of Southern California, USA

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Symposium SB02: Emerging Nanotechnologies for Cellular Interrogation and Manipulation

Simple, controllable, and versatile access to the intracellular space with minimal perturbation is crucial to advancing biomedicine. Emerging materials, such as nanoneedles and nanomechanical cell squeezers—are transforming our capacity to sample, sense, perturb, control and deliver to the intracellular environment, and rapidly translating to impact cell and gene therapy, mechanobiology, spatial biology, and neural interfaces. This symposium aims to establish an essential discussion across the relevant research communities in micro- and nano-fabrication, biomaterials design, bioengineering, advanced therapies and medical device manufacturing across three areas: First, the design and manufacturing of devices for cell manipulation including theory and practice of device design and its integration with electronics, fluidics and mechanics; manufacturing methods; control of physical and chemical properties; technology-readiness progress. Second, biointerface design, including analytical, numerical, and machine learning modelling to predict interactions; biomaterial design and surface modifications; characterisation of the biointerface. Third, biomedical applications including intracellular delivery; intracellular biosensing; biophysical interrogation. The symposium will discuss the potential market, the scale of interest and investment, regulatory issues with input from biomedical industry leaders.

Topics will include:

- Design and manufacturing of cell manipulation devices
- Device integration with electronics, fluidics and mechanics
- Approaches for surface modification
- Design, modelling and characterisation of the biointerface
- Ultrasensitive nanoprobes for cell traction forces.
- Engineering biophysical interactions.
- Intracellular recording and stimulation.
- Intracellular delivery.
- Minimally invasive intracellular biosensing.
- Biomedical applications.

A **tutorial** complementing this symposium is tentatively planned. Further information will be included in the MRS Program that will be available online in January.

Invited speakers include:

Paolo Actis	Leeds University, United Kingdom	**John A. Rogers**	Northwestern University, USA
Pascal Behr	Cytosurge AG, Switzerland	**Menahem (Hemi) Rotenberg**	Technion–Israel Institute of Technology, Israel
Jannick Coffinier	University of Lille, France	**Francesca Santoro**	Istituto Italiano di Tecnologia, Italy
Bianxiao Cui	Stanford University, USA	**Mark Schvartzman**	Ben-Gurion University of the Negev, Israel
Chi Hwan Lee	Purdue University, USA	**Ruchi Sharma**	Stemnovate, United Kingdom
Song Li	University of California, Los Angeles, USA	**Peng Shi**	City University of Hong Kong, Hong Kong
Chwee Teck Lim	National University of Singapore, Singapore	**Koukou Suu**	ULVAC, Inc., Japan
Dingchang Lin	Johns Hopkins University, USA	**Andy Tay**	National University of Singapore, Singapore
Karen Martinez	University of Copenhagen, Denmark	**Bozhi Tian**	The University of Chicago, USA
Roisin Owens	Cambridge University, United Kingdom	**Nicolas Voelcker**	Monash University, Australia
Hongkun Park	Harvard University, USA	**Chong Xie**	Rice University, USA
Christelle Prinz	Lund University, Sweden	**Sheng Xu**	University of California, San Diego, USA
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Symposium SB03: Thin-Film Devices, Barriers and Their Reliability -

Next-generation devices and products are trending towards economically and environmentally favorable thin and lightweight biomaterials, opening new opportunities for scientific, social, and industrial benefits. Novel materials and their applications should perform adequately under required environment to be viable; systematic studies under extreme conditions in the various points of view are in need of more attention: optimization of electronics manufacturing and packaging technique, device functionality, and reliability assessment. To this end, this symposium will focus on the reliability aspects of testing the latest biomaterials and applications under extreme conditions. First, we will introduce recent advances in thin-film applications and the effort made towards viability: medical products, implantable/wearable electronics, bioelectronics, RF devices, smart packaging, bioproducts, green electronics, and energy harvesting. Other recent applications in food and pharmaceuticals, composite materials in the engineering of all kinds, gaining attention as future products, are welcomed. Another focus of this symposium is on developing diffusion barrier materials used in the packaging and encapsulation of these applications. Hermetic encapsulations using nanocomposite materials with thin film deposition and processing technologies, (e.g. vacuum processed depositions, polymer processing of 2D nanoparticles) can potentially reach a lifespan of several years to decades under implanted conditions. Such barrier materials are processed with flexible organic matrices and/or substrates to improve reliability. Discussion of various quality control methods used in the lifetime and performance evaluation will be welcomed. Examples include corrosion test, leakage current monitoring, and high temperature and electro-mechanical fatigue cycling of conductive functional layers. This symposium aims at gathering researchers interested in viable next-generation biomaterial and thin-film applications, bridging the gap between lab-based prototypes and ones available off the shelf.

Topics will include:

- Recent advances toward viable soft, thin-film biomaterials and devices
- Miniaturization and scalable manufacturing processes for reliable soft materials and biomaterials applications
- Electronics packaging, integration of rigid components (e.g. flip-chip) and brittle layers (e.g. passivation) on soft frames
- Smart packaging, near-field communication, RF devices, wireless infrastructure on thin films
- Thin-film interfaces, adhesion, mechanical stabilities
- Thin, soft, stretchable diffusion barriers, functional diffusion barriers
- Encapsulation of functional composites, flexible or implantable electronic devices, food and bioplastics packaging
- Harsh environment test, corrosion, thermal and electro-mechanical fatigue

Joint sessions are being considered with **EL18 - Material, Device, and Fabrication Innovations for Flexible, Stretchable, and Printed Electronics**, and **SB09 - Polymeric Electronic Materials and Devices for Biological Interfaces**.

Invited speakers include:

Megan Cordill	Austrian Academy of Sciences, Austria
Adriana Creatore	Eindhoven University of Technology, Netherlands
Reinhold Dauskardt	Stanford University, USA
Jaime C. Grunlan	Texas A&M University, USA
Tequila A. L. Harris	Georgia Institute of Technology, USA
Jack. W. Judy	University of Florida, USA
Sunjong Kim	CJ Biomaterials Inc., USA
Stéphanie P. Lacour	École Polytechnique Fédérale de Lausanne, Switzerland
Nanshu Lu	The University of Texas at Austin, USA
Lucian A. Lucia	North Carolina State University, USA
Ellis Meng	University of Southern California, USA
Alberto Perrotta	National Research Council, Italy
Rahim Rahimi	Purdue University, USA
Tsuyoshi Sekitani	Osaka University, Japan
Florian Solzbacher	The University of Utah, USA
Enming Song	Fudan University, China
Gregory Sotzing	University of Connecticut, USA
Thomas Stieglitz	Universität Freiburg, Germany
Manos M. Tentzeris	Georgia Institute of Technology, USA
Preeti Tyagi	North Carolina State University, USA
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Symposium SB04: Flexible Bioelectronics for *In Situ* Analysis

The collaboration of materials- and biomedical scientists with electronic engineers resulted in the emerging of a new and multidisciplinary direction: bioelectronics. Generally, it is based on the application of electronic and electrochemical sensors developed to solve problems in the biomedical field, including both *in vitro* and *in vivo*. The conventional rigid electronic devices typically based on metal and silicon electrodes cannot effectively meet the requirements of soft tissues. Indeed, if a rigid device is attached to the skin or when implanted into the body, the surrounding tissues may get hurt and the resulting scars will damage or even disable the devices. To respond to the different needs in the biomedical field and to be conform with biomedical applications, increasing interest has been attracted to develop the next-generation of bioelectronics: flexible bioelectronics. They can be paper-based platforms for *multiplexed electrochemical sensing* of biomarkers (e.g. pH, dopamine, glucose) in biological fluids, smart wound dressings with implemented sensor for the detection of oxygen, pH and inflammation in the wound or smart fabrics using textile threads where bioelectronic devices are implemented. These biocompatible and sometimes degradable sensing devices are a large step forward towards detecting diseases, understanding mechanisms of biological activities and providing feed-back to therapeutic tools.

It is the aim of this proposed symposium to bring together expertise in soft materials science, organic electronics and biology. We aim at elucidating the fundamentals of the electronic materials/biology interface and to present and discuss new bioelectronic materials, technologies, and applications.

Topics will include:

- Flexible, stretchable electronics
- Flexible (plastic) substrates
- *In vivo* and *in vitro* diagnostics
- Personalized sensing
- Neuroengineering
- Electronic plants

Invited speakers include:

Omar Azzaroni	INIFTA, La Plata, Argentina	**Anass Jawhari**	Biosensing Diagnostics, France
Zhenan Bao	Stanford University, USA	**Evangelos Kotsopoulos**	Sonic Healthcare Germany, Germany
Yael Hanein	Tel-Aviv University, Israel	**Luisa Torsi**	Università degli studi di Bari Aldo Moro, Italy

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Symposium SB05: Nano-Bio Interactions—From Design to Biological Response

The design and use of nanomaterials for medical applications requires a detailed understanding of structure-property relationships, which are becoming more well-understood by the community. One aspect of vital importance towards exploiting nanomaterials for biological applications is designing, understanding, and mapping the interactions of materials with the biological interface. This symposium will cover recent and emerging advances in nanomaterial design for tailored biological applications and their ultimate fate in the body. Themes within the symposium will map the journey of engineered nanostructures, from their synthesis and development, their properties and medical benefits and further to their specific interactions with biological environments, human cells and eventual fate within the body. The first part of the symposium will concentrate on design, synthesis and characterisation of new and emerging (nano)materials with properties which demonstrate clear medical/clinical applications, such as medical imaging, cancer theranostics, *in vivo* sensing, and targeting. Within this theme, welcome topics include the exploration of materials preparation mechanisms and methods, including scale-up, optimisation of properties of relevance for medical applications, and advancements and drive towards understanding fundamental materials science for use at the biological interface. The second part of the symposium will explore the specific interactions that nanomaterials face within biological environments. These include the complex modifications nanomaterials encounter after application in a biological environment, thus the formation of the biomolecule corona and its implications for nanomaterial interactions at the cellular and organism levels, immune responses, short- and long-term accumulation effects, novel targeting methods, and evidence of alternative mechanisms to the enhanced permeability and retention (EPR) effect for nanomaterial targeting. Within this theme, recent findings which challenge or provide crucial alternatives to widely-accepted mechanisms are encouraged. Discussion of the behaviour of new materials as well as emerging evidence of the behaviour of clinically-used materials are welcomed. All classes of materials relating to the bio-nano interface are welcomed.

Key to linking materials preparation with their use at the biological interface is the ability to characterise nano-bio interactions. This bridging theme within the symposium will focus on current and promising tools and methodologies for reporting on nano-bio interactions. This can include materials with self-reporting mechanisms, or materials capable of informing on or monitoring interactions at the biological interface, and can range from molecular probes to analytical devices.

Topics will include:

- Designer medical imaging agents
- Responsive nanotheranostics
- Nanomaterial targeting mechanisms
- Clinical translation of nanomaterials
- Biomolecular corona of nanomaterials
- Cellular interactions of nanomaterials
- Nanomaterials and the blood brain barrier
- Toxicity studies (*in vitro* and *in vivo*) of nanomaterials
- Immune responses of nanomaterials
- Effects of nanomaterials characteristics (including size, shape, composition, surface characteristics) on toxicity
- Emerging methods to characterise the nano-bio interface
- Nanostructures and methods for in vivo and/or in vitro reporting on nano-bio interactions

Joint sessions are being considered with **SB06 - Peptide and Protein-Based Materials**.

Invited speakers include:

Michelle Bradbury	Memorial Sloan Kettering Cancer Center, USA
Weibo Cai	University of Wisconsin-Madison, USA
Kenneth Dawson	University College Dublin, Ireland
Clare Hoskins	University of Strathclyde, United Kingdom
Taeghwan Hyeon	Seoul National University, Republic of Korea
Nick Kotov	University of Michigan, USA
Cristianne Rijcken	Cristal Therapeutics, Netherlands
Jesus Ruis-Cabello	University of Madrid, USA
Molly Stevens	Imperial College London, United Kingdom
Ben Zhong Tang	Hong Kong University of Science and Technology, Hong Kong
Nyugen Thanh	University College London, United Kingdom
Claire Thompson	Agility Life Sciences, United Kingdom
Matt Trau	The University of Queensland, Australia
Gayle Woloschak	Northwestern University, USA

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Symposium SB06: Peptide and Protein-Based Materials

Proteins and peptides are attractive green building blocks for the next generation of functional materials, offering great chemical diversity to encode biochemical signals. They can be biologically produced and engineered, processed in aqueous media, and are inherently biodegradable resulting in low environmental impact. These materials and building blocks can be functional in their own right, but they can also interact with each other, and with other biomolecules, or catalyze biochemical cascades, so as to exploit their hierarchical self-organization into dynamic systems. Revolutionary approaches are sprouting at the interface between supramolecular chemistry and biotechnology, to address key needs of our society, spanning from green catalysis, sustainable materials production to tissue engineering and organoids, to new paradigms to treat cancer, neurodegeneration and infections. This symposium will foster scientific discussions on the latest progress on the design and mechanisms that enable the hierarchical assembly of peptides, proteins, and their derivatives, to address diverse societal needs. Emphasis will be given to smart systems that respond to external stimuli (*e.g.* electric, magnetic, light, and shear) and/or physicochemical variations within the local environment (*e.g.* temperature, pH, oxidative stress, metabolites). Dynamic systems can be envisaged with spatial-, temporal- and dosage-controlled functionalities for diverse applications in chemical engineering (*e.g.* catalysis and separation), biomedicine (*e.g.* tissue engineering, drug delivery, biosensing), bioelectronics, energy harvesting, and high-performance structural materials. Advances in synthetic chemistry and biology, biotechnology and biochemical engineering, open the door to large-scale use and commodity smart materials, to replace polymers/catalysts of limited sustainability.

Topics will include:

- Building supramolecular complex nanostructure through bio-inspired and green self-assembly (incl. peptide and protein origami, computation and simulation)
- Novel hybrid molecules for functional materials designs (incl. peptoids, peptide-derivatives, biomolecule conjugates with other molecules such as synthetic polymers, DNA, metal particles)
- Use of non-natural amino acids in synthetic peptides and recombinantly expressed proteins for material design, formation, and function
- Designing of 3-D functional structures (incl. hydrogel and organogel networks, colloidal particle assemblies, membranes, auxetic materials)
- Designing 1-D nanostructured functional materials (incl. nanowires, nanotubes, nanofibers)
- 2-D templating (incl. membranes, sheets, and surfaces) of inorganic materials
- Controlling biological interactions by design (incl. cell behavior, protein adhesion, immune responses, cross-talk with cytokines)
- Design of bio-inspired materials for biological application (incl. tissue engineering, cellular therapies, controlled and targeted drug delivery, in vitro and in vivo implants)
- Design of bio-inspired materials for energy applications (incl. biosensing, energy harvesting and electronic applications, supercapacitors)
- Design of bio-inspired materials with exotic physical behaviors (incl. extreme extensibility and stiffness, ability to deform under extreme pressures or catalyze in exotic places)
- 3D and 4D advanced additive manufacturing and bioengineering of peptide and protein-based systems

Joint sessions are being considered with **SB05 - Nano-Bio Interactions—From Design to Biological Response**.
Also, a **tutorial** complementing this symposium is tentatively planned. Further information will be included in the MRS Program that will be available online in January.

Invited speakers include:

Mibel Aguilar	Monash University, Australia	**Aline Miller**	Manchester Biogel, United Kingdom
David Baker	University of Washington, USA	**Sebastien Perrier**	University of Warwick, United Kingdom
Honggang Cui	Johns Hopkins University, USA	**Meital Reches**	The Hebrew University of Jerusalem, Israel
Debapratim Das	Indian Institute of Technology Guwahati, India	**Jose Carlos Rodriguez Cabello**	University of Valladolid, Spain
Dibyendu Das	Indian Institute of Science Education and Research Kolkata, India	**Joel Schneider**	National Institutes of Health, USA
Sarah Heilshorn	Stanford University, USA	**Molly Stevens**	Imperial College London, United Kingdom
Daniela Kalafatovic	University of Rijeka, Croatia	**Samuel Stupp**	Northwestern University, USA
Lorraine Leon	University of Central Florida, USA	**Akif Tezcan**	University of California, San Diego, USA
Julie Liu	Purdue University, USA		

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Symposium SB07: Frontiers of Unconventional Polymer Networks

Traditional polymer networks are typical composed of flexible polymer chains that are chemically crosslinked by covalent bonds. Recent research effort have been devoted to engineering unconventional polymer networks by incorporating dynamic bonds, chemical diversity, or modulating network architectures. For example, polymer networks with dynamic bonds have shown great capability in adapting their environment and exhibiting unprecedented properties, such as ultra-stretchability, high-toughness, recyclability and self-healing, as well as enhanced mass transport and thermal, ionic, or electrical conductivities. In this field, dynamic bonds, including dynamic covalent bonds and physical bonds (such as ioinic bonds, hydrogen bonds, metal-ligand coordination, and hydrophobic interactions), have been utilized to program macroscopic response of polymer networks by regulating their molecular architectures. As another example, polymer networks with mechanochemicallly responsive groups have deomstrated unconventional properties such as color-change, molecular releas, self-strengthening and self-growing, in response to typically destructive loads. Moreover, polymer networks with different polarities such as color-change, molecular release, self-strengthening and self-growing, in response to typical destrucitve loads. Moreover, polymer networks with different polarities or stimuli-responsive bonds can be reconfigured or even degraded with external stimuli or solvent. These unique properties of polymer networks have led to many innovative advances in different areas including wearable/implantable devices, smart windows, soft robotics, stretchable (bio)electronics, safe batteries, and 3D/4D printing. This symposium will bring together researchers working in the field of polymer networks with unconventional bonds and architectures. Both experimental and theoretical contributions, including computational studies, dedicated to the understanding and advancement of the field of unconventional polymer networks are anticipated.

Topics will include:

- Self-healing polymer networks
- Self-strengthening/softening polymer networks
- Self-growing polymer networks
- Self-adaptive polymer networks
- Stimuli-responsive polymer networks
- Programmable polymer networks
- Toughening hydrogels and elastomers
- Polymer mechanochemistry
- Degradable polymers with active chemical groups
- Chemical recyclable polymer networks
- CO2 or light tunable polymer networks.
- Constructive polymer networks in response to destructive environmental stressors
- Design unconventional polymers for additive manufacturing

Invited speakers include:

Zhenan Bao	Stanford University, USA	**Stuart Rowan**	The University of Chicago, USA
Stephan Craig	Duke University, USA	**Takamasa Sakai**	The University of Tokyo, Japan
Costantino Creton	ESPCI Paris, France	**Zhigang Suo**	Harvard University, USA
Filip Du Prez	Ghent University, Belgium	**Mark Tibbitt**	ETH Zürich, Switzerland
Jianping Gong	Hokkaido University, Japan	**Marek Urban**	Clemson University, USA
Zhibin Guan	University of California, Irvine, USA	**Tao Xie**	Zhejiang University, China
Jeremiah Johnson	Massachusetts Institute of Technology, USA	**Xuzhou Yan**	Shanghai Jiao Tong University, China
Julia Kalow	Northwestern University, USA	**Xuanhe Zhao**	Massachusetts Institute of Technology, USA
Ali Khademhosseini	Terasaki Institute, USA		

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Symposium SB08: Soft Matter Materials and Mechanics for Haptic Interfaces

Haptic devices create or measure tactile sensations for the human perception of touch. Applications for haptic devices are far-reaching, from virtual or augmented reality to prosthetics, telesurgery, rehabilitation, and education. However, there are technical and scientific challenges behind fabricating lightweight and flexible devices, measuring or mimicking natural tactile stimuli, and fundamental knowledge between material properties and tactile sensations. The human-machine interface in haptic devices is mechanically complex and currently poorly served by materials innovations. The goal of this symposium is to bring together experts in haptics devices and systems with experts in soft matter chemistry, mechanical actuation and contact mechanics.

This symposium will cover applied and fundamental haptics materials research. Topics include soft matter interfaces and adhesion phenomena, tactile perception, soft robotics, new methods for actuation and sensing, wearable or flexible device integration and manufacture, and stimuli-responsive materials for actuation. Advances in haptic interfaces will require an interdisciplinary team representing materials sciences, contact mechanics, robotics, device engineering, human psychophysics, and neuromechanics.

We hope that this symposium will bridge haptics and materials innovation to generate new interdisciplinary ideas and collaborations.

Topics will include:

- Soft matter mechanics
- Soft robotics
- Haptics
- Wearable actuators and sensors
- Tactile perception
- Stimuli responsive materials
- Flexible electronics
- Thin film sensors
- Soft actuators

Invited speakers include:

Cagatay Basdogan	Koc University, Turkey
Roland Bennewitz	INM – Leibniz Institute for New Materials, Germany
Edward Colgate	Northwestern University, USA
Greg Gerling	University of Virginia, USA
Cindy Harnett	University of Louisville, USA
Cynthia Hipwell	Texas A&M University, USA
Astrid Kappers	Eindhoven University of Technology, Netherlands
Laure Kayser	University of Delaware, USA
Rebecca Kramer-Bottiglio	Yale University, USA
Katherine Kuchenbecker	Max Planck Institute for Intelligent Systems, Germany
Darren Lipomi	University of California, San Diego, USA

Domenico Prattichizzo	Università degli Studi di Siena, Italy
John A. Rogers	Northwestern University, USA
Romke Rouw	University of Amsterdam, Netherlands
Veronica Santos	University of California, Los Angeles, USA
Hasti Seifi	University of Copenhagen, Denmark
Herbert Shea	École Polytechnique Fédérale de Lausanne, Switzerland
Robert F. Shepherd	Cornell University, USA
Benjamin Tee	National University of Singapore, Singapore
Nitish Thakor	Johns Hopkins University, USA
Xueju Wang	University of Connecticut, USA

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Symposium SB09: Polymeric Electronic Materials and Devices for Biological Interfaces

Recent advances in electronic materials and devices have created bioelectronics that enable new functions to sense, stimulate, control, and re-engineer the biosystems. However, living biological systems involve dynamic movement from the three-dimensional (3D) tissues and organs with genetically defined different types of cells all connected together, which are difficult to be interfaced by conventional electronic devices. Resolving these challenges would require new efforts in the development of materials and devices. This symposium will focus on the development of advanced polymeric electronic materials and devices to address the challenges. Examples include intrinsically stretchable and tissue-level soft bioelectronics for long-term stable, gliosis-free biointerface, chronically stably recording cellular-level activities. Self-healable, tough adhesive and shape-morphing devices for adapting to the dynamic evolving and changing environment of the biological system. Genetically encoded polymeric electronics for genetically targeted biointerface. Dual conductive polymeric electronic materials for low impedance bioelectric interface and neuromorphic devices. These methods span across a broad spectrum of materials science and device engineering, leading to polymeric electronic tools for bio-integration at multiple length scales with unprecedented opportunities and addressing many urgent demands spanning from artificial skins, wearable and implantable electronics, neuroscience, tissue engineering, and other areas.

Topics will include:

- Synthesis and characterization of polymeric electronic materials
- Fabrication of polymeric devices for biointegration
- Biocompatibility of polymeric electronic materials and devices
- Intrinsically stretchable and tissue-level soft bioelectronics
- Implantable bioelectronics
- Genetically targeted and cell-type-specific bioelectronics
- Living bioelectronics built from polymeric materials
- Self-healable, tough adhesive and shape-morphing bioelectronics

Invited speakers include:

Polina Anikeeva	Massachusetts Institute of Technology, USA
Zhenan Bao	Stanford University, USA
Wenlong Cheng	Monash University, Australia
Xiaojie Duan	Peking University, China
John Ho	National University of Singapore, Singapore
YongAn Huang	Huazhong University of Science and Technology, China
Jae-woong Jeong	Korea Advanced Institute of Science and Technology, Republic of Korea
Dion Khodagholy	Columbia University, USA
Stéphanie P. Lacour	École Polytechnique Fédérale de Lausanne, Switzerland
Nan Liu	Beijing Normal University, China
Nanshu Lu	The University of Texas at Austin, USA
George Malliaras	University of Cambridge, United Kingdom
Iain McCulloch	University of Oxford, United Kingdom
Le Floch Paul	Axoft, Inc., USA
Mikyung Shin	Sungkyunkwan University, Republic of Korea
Takao Someya	The University of Tokyo, Japan
Eleni Stavrinidou	Linköping University, Sweden
Bozhi Tian	The University of Chicago, USA
Helen Tran	University of Toronto, Canada
Nicolas Vachicouras	Neurosoft Bioelectronics, Switzerland
Cunjiang Yu	University of Houston, USA
Hyunwoo Yuk	SanaHeal, USA
Haijun Zhang	Shandong Baiduoan Medical Equipment Co., Ltd., China
Ting Zhang	Suzhou Institute of Nanotechnology and Nano-Bionics, Chinese Academy of Sciences, China
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Symposium SF01: High Entropy Materials—From Fundamentals to Potential Applications

High-entropy materials (HEMs) have become an exciting and vibrant field of materials science as a new generation of materials. The HEM design concept shifts the focus away from the corners of phase diagrams toward their centers, and allows compositions beyond the scope of traditional materials, offering unprecedented properties, challenges, and opportunities for a wide range of structural and functional applications. Although we understand HEMs much better today, there are still significant gaps in our knowledge that hinder the widespread use of HEMs. The goal of this symposium is to share the latest research advances in materials with high configurational entropy, including high-entropy and complex concentrated alloys, high-entropy oxides/ nitrides, high-entropy metallic glasses, etc., and discuss major materials issues for HEMs from property-targeted alloy design to process optimization, from structures to properties, and from the fundamental science to viable industrial applications. This symposium will cover fundamental theory and data-driven material design, fabrication, processing, and microstructure control, such as homogenization, precipitation, nanostructure, and grain-boundary engineering using conventional equipment, combinatorial fabrication, additive manufacturing, etc., phase stability and diffusivity under extreme environment, mechanical behavior under different deformation mechanisms, corrosion, physical, magnetic, electric, thermal, coating, and biomedical behavior, advanced characterization, such as synchrotron, three-dimensional atom probe, and 4-D STEM, computational modeling and simulations, and industrial applications, such as structural, mechanical, biomedical, energy applications. In this symposium, we hope to deepen our understanding of why HEMs attract such intensive interest and highlight some challenging issues awaiting resolution to provide viable paths to the widespread application and adoption of HEMs.

Topics will include:

- Fundamental Theory and Data-driven Design of HEMs
- Process Development for Tailor-made Synthesis and Microstructure Control
- Phase Transformation (thermodynamics and kinetics) under Extreme Environments
- Structural/Mechanical Properties of HEMs, such as fatigue, creep, and fracture behavior
- Dynamic Mechanical Behavior under Different Deformation Mechanisms
- Physical, Chemical and Functional Properties of HEMs
- Intensive Structural Characterization using Cutting-edge Analysis Techniques
- Theoretical Modeling and Computational Simulations
- Innovative Industrial Applications, e.g. Structural Parts, Catalysis and Energy Storage Materials

Invited speakers include:

Brian Cantor	University of Oxford, United Kingdom
Hyunjoo Choi	Kookmin University, Republic of Korea
Jürgen Eckert	Montanuniversität Leoben, Austria
Katharine Flores	Washington University in St. Louis, USA
Easo George	Oak Ridge National Laboratory, USA
Michela Geri	Massachusetts Institute of Technology, USA
Daniel S. Gianola	University of California, Santa Barbara, USA
Martin Heilmaier	Karlsruhe Institute of Technology, Germany
Haruyuki Inui	Kyoto University, Japan
Veerle M. Keppens	University of Tennessee, USA
Zhaoping Lu	University of Science and Technology Beijing, China
Andrew M. Minor	University of California, Berkeley, USA
Daniel B. Miracle	Air Force Research Laboratory, USA
Hyunseok Oh	Massachusetts Institute of Technology, USA
Katharine Page	The University of Tennessee, Knoxville, USA
Dierk Raabe	Max-Planck-Institut für Eisenforschung GmbH, Germany
Weili Ren	Shanghai University, China
Robert Ritchie	Lawrence Berkeley National Laboratory, USA
Koichi Tsuchiya	National Institute for Materials Science, Japan
An-Chou Yeh	National Tsing Hua University, Taiwan

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Symposium SF02: Materials in Space—Design and Testing

Space is known for its inhospitable conditions and the extreme operating requirements it demands of materials. In low Earth orbit (LEO), atomic oxygen erodes susceptible materials, and extreme thermal cycling threatens dissimilar material interfaces. Micrometeoroid or debris impacts are also a constant and growing threat in LEO. Additionally, materials must perform in vacuum conditions under variable but persistent ultraviolet and ionizing radiation, as well as plasma and surface charging threats. Early materials space exposure experiments were flown on the Long Duration Exposure Facility (LDEF), the Russian space station Mir, and the space shuttle. Currently, materials space exposure experiments are conducted on the International Space Station (ISS) on external platforms such as the Materials International Space Station Experiment (MISSE) Flight Facility and the Japanese Experiment Module Exposed Facility (JEM EF). As humanity ventures outside of Earth's orbit, new threats will include unshielded solar winds and galactic cosmic rays. Difficulties assessing and repairing damaged materials await. Foreign worlds also present new challenges, such as pervasive sharp-edged lunar and Martian regolith. Spacecraft will require materials with a high degree of reliability because spare parts are not readily available and replacement is typically not an option. Addressing these challenges will also inform the design and testing of materials for use on Earth.

This symposium will discuss the design, development, and testing of different materials and devices to withstand the extreme conditions of space. These materials include metals, ceramics, composites, textiles, semiconductors, glasses, polymers, and coatings. Devices such as photovoltaics, radiation-hardened electronics, and variable emissivity devices will also be discussed. This symposium is soliciting abstracts on ground- and space-based materials research as well as spaceflight facilities. Materials for space applications encompass space stations (the ISS and Gateway), satellites, and commercial space vehicles for the Moon, Mars, and beyond. Materials research using space-based platforms will also provide accelerated degradation data for terrestrial applications.

Topics will include:

- Atomic oxygen
- Radiation effects and shielding (UV, charged particles, cosmic rays)
- Micrometeoroid and orbital debris (MMOD)
- Temperature extremes and thermal cycling
- Contamination
- Lunar and Martian regolith and environments
- Spacecraft materials
- Photovoltaics and devices
- Spaceflight experiments – design and results
- Spaceflight facilities and platforms
- Ground-testing and modeling

Joint sessions are being considered with **EL15 - Radiation—Hard and Lightweight Next-Generation Semiconductor Electronics**.

Invited speakers include:

Miria Finckenor	NASA Marshall Space Flight Center, USA	**Timothy Minton**	University of Colorado Boulder, USA
Irina Gouzman	Soreq Nuclear Research Center, Israel	**Stephanie Remaury**	Centre National d'Etudes Spatiales, France
Eitan Grossman	Soreq Nuclear Research Center, Israel	**Keita Sakamoto**	Japan Aerospace Exploration Agency, Japan
Maria Katzarova	University of Delaware, USA	**Masahito Tagawa**	Kobe University, Japan
Jacob Kleiman	Integrity Testing Laboratory Inc., Canada	**Adrian Tighe**	The European Space Agency, Netherlands
Sharon Miller	NASA Glenn Research Center, USA	**Claus Zimmerman**	Airbus Defence and Space GmbH, Germany
Joseph Minow	NASA Marshall Space Flight Center, USA		

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Symposium SF03: Emerging Thermal Materials—From Nanoscale Heat Transport, Devices and Applications, to Theories

This symposium will broadly cover current and emerging thermal materials, with aspects ranging from nanoscale and non-equilibrium heat transport, thermal Hall effect, devices, applications, to new theories. The first part of the symposium will focus on emerging materials with extremely high or extremely low thermal conductivity for thermal management, materials systems for thermoelectric, thermophotovoltaics, thermo-electrochemical, thermo-acoustic, -ferroelectric, and -magnetic energy harvesting, storage, as well as advanced control and functionalities. Discussions will include the rational design, chemical synthesis, growth mechanisms, fabrication routes, property optimization and external field control, and new fundamental science. The Second part of the symposium will focus on recent developments of nanoscale heat transport with both new experimental metrologies and theoretical methods from density functional theory (DFT) to machine learning. In particular, with continuing miniaturization of devices, as well as continuing development of experimental techniques, unprecedented length and time scales can now be probed, thus enabling new insights of non-Fourier heat conduction, convection, near-field radiation, and their interactions with materials, all now being intensively investigated. Discussions will include recent measurements over nanoscales and interfaces using advanced characterization techniques such as pump-probe thermoreflectance measurements, Raman thermometry, atomic force microscopy based thermometry, and recent modeling using atomistic tools such as ab initio DFT, molecular dynamics, and Wigner and Green's function formalisms, etc., as well as multi-scale modeling such as phonon Boltzmann Equation and Monte Carlo simulations. Possible topics of interest are thermal transport in extreme environments (high pressure/temperature), non-Fourier thermal transport and conductance via other than phonon and electrons heat carriers, thermal radiation from metamaterials, nano-thermodynamics. The Third part of the symposium will focus on devices and applications at across multiple time and length scales: examples include but are not limited to nanoscale thermal rectification devices, mesoscopic scale phononic crystals, and macroscopic thermal batteries, solar thermal plants, data farms, and the Internet of things.

Topics will include:

- Materials for thermoelectrics and thermal energy harvesting; Thermal management of electronics, photonics, batteries, and the Internet of things
- Emerging thermal materials for extreme properties and conditions; Thermal transport in 2D, 1D, and 0D nanomaterials
- Emerging thermal interface materials and interface phonon and electron states; Quantum phenomena and coupling between phonons, electrons, and spins
- Phonon thermal Hall effect and underlying interactions; Non-equilibrium and femto- to pico-second thermal transient behaviors
- Radiative cooling and thermal metamaterials; Ab initio and atomistic theory for designing, predicting, and analyzing thermal properties
- Interplay of propagating and diffusing heat transport from particle and wave descriptions; Modelling and simulations of energy transport from atomic scale to micrometer and macroscopic scales
- Coherent and ballistic thermal transport; Thermal management for sustainable buildings and environments
- Thermal insulation and multifunctional materials (mesosporous materials, ambient gels, aerogels); Materials defects on nanoscale energy transport;Materials discovery through machine learning and artificial intelligence

A **tutorial** complementing this symposium is tentatively planned. Further information will be included in the MRS Program that will be available online in January.

Invited speakers include:

David Broido	Boston College, USA
Renkun Chen	University of California, San Diego, USA
Xiao-Jia Chen	Center for High Pressure Science and Technology Advanced Research, China
Sukwon Choi	The Pennsylvania State University, USA
David Clarke	Harvard University, USA
Chris Dames	University of California, Berkeley, USA
Davide Donadio	University of California, Davis, USA
Elif Ertekin	University of Illinois at Urbana-Champaign, USA
Giulia Galli	The University of Chicago, USA
Samuel Graham	University of Maryland, USA
Costas Grigoropoulos	University of California, Berkeley, USA
Jeff Grossman	Massachusetts Institute of Technology, USA
Cynthia Hipwell	Texas A&M University, USA
Matthias Ihme	Stanford University, USA
Raymond Jeanloz	University of California, Berkeley, USA
Philip Kim	Harvard University, USA
Irena Knezevic	University of Wisconsin–Madison, USA
Martin Kuball	University of Bristol, United Kingdom
Jung-Fu Lin	The University of Texas at Austin, USA
Jonathan Malen	Carnegie Mellon University, USA
Nicola Marzari	École Polytechnique Fédérale de Lausanne, Switzerland
Peter Maurer	The University of Chicago, USA
Natalio Mingo	Commissariat à l'énergie atomique et aux énergies alternatives, France
Vidvuds Ozolins	Yale University, USA
Xiaoqing Pan	University of California, Irvine, USA
Dimos Poulikakos	ETH Zürich, Switzerland
Junichiro Shiomi	The University of Tokyo, Japan
Jeff Snyder	Northwestern University, USA
Chris Van de Walle	University of California, Santa Barbara, USA
Sebastian Volz	CentraleSupélec, France
Robert Wang	Arizona State University, USA
Xiaojia Wang	University of Minnesota, USA
Nuo Yang	Huazhong University of Science and Technology, China

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2023 MRS SPRING MEETING & EXHIBIT

50 YEARS

April 10-14, 2023 | San Francisco, California
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Symposium SF04: Development and Design of Responsive Architected Materials

Architected materials have garnered increasing attention from researchers across diverse scientific fields due to their superior and sometimes counterintuitive effective properties and macroscale performance stemming from a cleverly designed internal architecture. Advancements in additive manufacturing (e.g., improved resolution, material property selection, multi-material composition) have made possible the realization of the complex geometries across multiple length scales, which enables rational design of architected materials to achieve enhanced properties and novel functionalities. In addition, the properties and behaviors of architected materials do not have to be stagnant after their fabrication; a temporal degree of freedom can be encoded into the architectural design such that they can evolve in time. In response to various forms of stimuli (e.g., mechanical deformation, temperature changes, electromagnetic fields, acoustic wave), architected materials could attain different mechanical properties or chemical reactivity, release cargo via structural changes, or undergo controlled and deterministic failure. This built-in responsiveness could enable novel functionalities in *intelligent matter* that reacts, deploys, and evolves in specific environments or conditions directly at the material level, in ways similar to how living matter interacts with the surrounding environment. Furthermore, a system-level integration of sensing, computation, and communication functions with these programmable materials will enable materials intelligence guided by data-driven methods. The Development and Design of Responsive Architected Materials Symposium will gather prominent researchers in the area of architected materials to discuss topics related to their design, physics, and applications, including but not limited to bio-inspired and multi-functional design, harnessing of instabilities, dynamic mechanical responses, methods of activation, modulation and automation, and a wide range of potential applications (e.g., energy harvesting, signal transmission, robotics, wearable and implantable medical devices, analytical chemistry, etc.).

Topics will include:

- Mechanical multi-stability in architected materials
- Thermally, electromagnetically, and chemically tunable responses in architected materials
- Dynamic responses of mechanical metamaterials
- Programmable metamaterials
- Data-driven design of responsive architected materials
- Applications of responsive architected materials

Invited speakers include:

Andrea Alu	The City University of New York, USA	**Kon-well Wang**	University of Michigan, USA
Corentin Coulais	University of Amsterdam, Netherlands	**Qiming Wang**	University of Southern California, USA
Julia Greer	California Institute of Technology, USA	**Yifan Wang**	Nanyang Technological University, Singapore
Jonathan Hopkins	University of California, Los Angeles, USA	**Stefano Zapperi**	Università degli Studi di Milano, Italy
Yun Jing	The Pennsylvania State University, USA	**Ruike (Renee) Zhao**	Stanford University, USA
Lorenzo Valdevit	University of California, Irvine, USA	**Xiaoyu (Rayne) Zheng**	University of California, Berkeley, USA

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Symposium SF05: Building Advanced Materials via Aggregation and Self-assembly

This symposium will cover a broad range of topics that focus on building advanced materials via aggregation and/or self-assembly, both experimentally and theoretically. Aggregation and self-assembly are important pathways in the formation of nature, including minerals and living systems, and has become important methods to fabricate advanced materials in both laboratory and industrial scales. To date, plentiful materials synthesized via aggregation or self-assembly have been applied in various fields such as biomedicine, energy, environment, catalysis, optics, electrics, and magnetics. For example, the interconnected nanoparticle superlattices, which were fabricated by self-assembly of Fe_3O_4 nanoparticles, have been used as anodes to improve the performance of lithium-ion batteries; the advanced luminescent materials have been prepared by aggregation-induced emission (AIE) of intrinsically non-emissive molecules.

One of the challenges facing this fast-growing field of advanced materials is to develop a fundamental understanding of aggregation/self-assembly mechanisms, which will be addressed in this symposium. Contributions will include but are not limited to 1) Advances in the synthesis of advanced materials via aggregation or self-assembly pathways; 2) Investigations into aggregation or self-assembly mechanisms; 3) Observation of the aggregation or self-assembly pathways via *in situ* techniques; 4) Theoretical development on the particle-based crystallization; 5) Materials with aggregation-induced emission and their applications. The Symposium aims to bring the researchers updated information on the fundamental aggregation or self-assembly research through theory to experiments. It is also designed for experienced researchers to reinforce their knowledge on the scopes of development of new techniques, especially the state-of-the-art *in situ* characterization tools, to understand aggregation or self-assembly mechanisms.

Topics will include:

- Building advanced materials via macromolecules, cluster, or particle aggregation or self-assembly
- Observation of the aggregation or self-assembly pathways via in situ techniques
- Mechanism studies of aggregation or self-assembly pathways
- Control of morphology and size during synthesis of advanced materials via aggregation or self-assembly pathways
- Driving forces for particle interactions
- Fluorescent and phosphorescent AIE-based polymers, oligomers and molecules
- Design principles and operational mechanisms of the AIE based molecules
- Biocompatible AIE probes for sensing, imaging and other biomedical applications
- Applications of these advanced materials in areas of energy, environment, biomedicine, etc.
- Dynamic intervention with high-throughput and big data of aggregation and self-assembly mechanism

A **tutorial** complementing this symposium is tentatively planned. Further information will be included in the MRS Program that will be available online in January.

Invited speakers include:

Qian Chen	University of Illinois at Urbana-Champaign, USA	**Zhaoming Liu**	Zhejiang University, China
Jim De Yoreo	Pacific Northwest National Laboratory, USA	**Thomas Müller**	Heinrich-Heine-Universität Düsseldorf, Germany
Hongyou Fan	Sandia National Laboratories, USA	**Anjun Qin**	South China University of Technology, China
Kristen Fichthorn	The Pennsylvania State University, USA	**Kevin Rosso**	Pacific Northwest National Laboratory, USA
Oleg Gang	Columbia University, USA	**Elena Sturm**	Universität Konstanz, Germany
Yunning Hong	La Trobe University, Australia	**Kazuo Tanaka**	Kyoto University, Japan
Andrey Klymchenko	Université de Strasbourg, France	**Youhong Tang**	Flinders University, Australia
Gen-ichi Konishi	Tokyo Institute of Technology, Japan	**Dong Wang**	Shenzhen University, China
Nicholas Kotov	University of Michigan, USA	**Zheng Zhao**	The Chinese University of Hong Kong, China
Bin Liu	National University of Singapore, Singapore	**Haimei Zheng**	Lawrence Berkeley National Laboratory, USA

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