Symposium BI01: Materials Research by the LGBTQIA+ Community and a Vision for Inclusivity

This symposium highlights research in materials science and engineering contributed by LGBTQIA+-identifying researchers and welcomes all conference attendees to join for discussion. Research will include, but is not limited to, materials synthesis, processing, characterization, and performance, the interaction of the MSE discipline with society, and the experiences of LGBTQIA+ scholars in STEM. The breadth of topics in this interdisciplinary session may enable new, unexpected scientific discussions and collaborations. LGBTQIA+ scholars from all career paths, spanning academia, industry, and national labs, and from all career stages are invited to contribute abstracts. Alongside their research, speakers are welcome to share their personal experiences and discuss historical and ongoing challenges faced by LGBTQIA+ scholars in STEM, as well as experiences and initiatives that have led to a greater sense of inclusion and belonging. In addition to research-oriented technical sessions, the symposium will incorporate a panel discussion on opportunities, challenges, and perspectives related to LGBTQIA+ identities in MSE. We anticipate that the topics discussed in this session will leave a lasting impact with attendees.

Topics will include:

- LGBTQIA+ Identities in STEM
- Interdisciplinary materials science and engineering
- Diversity
- Equity
- Inclusion

Invited speakers include:

Clara Barker	University of Oxford, United Kingdom	**Bryce Hughes**	Montana State University, USA
Ty Christoff-Tempesta	University of Delaware, USA	**Xiaosong Li**	University of Washington, USA
Bruce Cohen	Lawrence Berkeley National Laboratory, USA	**Kristin Poduska**	Memorial University of Newfoundland, Canada

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Symposium BI02: Broadening Participation in Materials Research and STEM

This symposium will cover promising practices within the Materials Research (MR) community that move the needle in broadening participation (BP). Despite efforts to date, participation has not broadened with sufficient speed, reach, or sustainability. Indeed, such efforts often feel disconnected from daily practice in the lab, classroom, and research design. We plan to illustrate that effective and lasting integration of technical knowledge with inclusive impact throughout MR outreach to K-12, undergraduate research, and beyond is possible. Gathering a coalition of international experts on outreach excellence and MR, we aim to equip participants with practices and a collaborative network. Through a series of invited speakers, oral presentations, interspersed small group discussions, and interdisciplinary poster sessions, our goal is to provide an impactful experience to share and develop highly effective and sustainable MR outreach.

Specifically, our objectives are to: 1.) Investigate the intersectionality of MR and BP; 2.) Establish a network of practitioners engaged in BP within MR; 3.) Identify and apply promising practices for BP in MR and STEM; 4.) Provide a space for early career researchers, in particular, to share their experiences and expertise.

Facilitated by a team of Education and DEI Directors from NSF Science and Technology Centers and other interdisciplinary STEM research centers, our goal is to address the disparities in opportunities for women and other minoritized groups in MR. We welcome abstracts from individuals with a MR background and active engagement in the BP space as well as those who seek knowledge and best practices in incorporating BP strategies into the MR field.

The purpose of this symposium is to provide a platform for students, early career researchers, and senior researchers to share tangible examples of successful broadening participation efforts within material research science and STEM. Our symposium will move beyond the siloing of broadening participation and science as separate entities and will be designed to encourage discussions that integrate education, broadening participation, art, and science. We hope to craft a collaborative document that synthesizes promising practices shared during the symposium. We specifically encourage abstracts from students (high school to graduate students) and early career researchers.

Topics will include:

- Broadening Participation
- Inclusive Outreach
- Diverse Perspectives
- Interdisciplinary Science
- Practitioner Network
- K-12 Students
- Undergraduate Students
- Graduate Students
- Early Career
- First Generation College Students
- Diversity, Equity, Inclusion, & Access
- Materials Science in STEM
- STEAM
- Inclusive Pedagogy

Invited speakers include:

Tugce Bilgin Sonay	Columbia University, USA	**Ngozi Ezeokeke**	Boeing, USA
Sibrina Collins	Lawrence Technological University, USA	**Kyle Johnson**	University of Washington, USA
Michael Curry	Tuskegee University, USA	**Debora Monego**	Heidelberg University, Germany

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Friday, September 15, 2023
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Wednesday, October 18, 2023 (11:59 PM ET)

Symposium CH01: Characterizing Dynamic Processes of Materials Synthesis and Processing via *In Situ* Techniques

In situ imaging and spectroscopy techniques have emerged as primary tools for characterizing the dynamics of materials formation. The development of *in situ* capabilities, such as liquid/gas cell holders for transmission electron microscopy (TEM) and atomic force microscopy (AFM), has led to rapid advances in our understanding of a range of dynamic processes, that can not be fully understood via *ex situ* experiments. For example, recently developed 3D fast force mapping of interfacial structures via AFM provides a deep understanding of interfacial-driven processes of self-assembly in colloidal solution. This symposium primarily focuses on studies of dynamic processes of materials synthesis, self-assembly, and processing via *in situ* techniques. The symposium covers a range of topics including particle nucleation, crystal growth, phase transformations, polymeric and organic/inorganic self-assembly, electrochemical processes, and interface dynamics in gases and liquids. This symposium aims to provide a platform of discussion to understand the physics and chemistry of materials formation for researchers from various fields.

Topics will include:

- Self-assembly in colloidal, polymeric, and biomolecular systems
- Self-assembly, oriented attachment, and nanoparticle-mediated growth
- Hierarchical structural through nanoparticle-mediated growth and oriented attachment
- Interface-driven processes and interface dynamics in gases and liquids
- The interfacial structure between solid and liquid and the interplay of the solution structures
- Mechanically, electrically, or magnetically driven processes
- Phase transformation process and its related structure-function relationship
- Nucleation and crystal growth from solutions, melts, and vapors
- Developments in microscopes, data analysis and mining, and practical challenges for microscopy

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:

See Wee Chee	Fritz Haber Institute of the Max Planck Society, Germany
Qian Chen	University of Illinois at Urbana-Champaign, USA
Jim De Yoreo	Pacific Northwest National Labotatory, USA
Yu Deng	Nanjing University, China
Yu Han	King Abdullah University of Science and Technology, Saudi Arabia
Matthew Jones	Rice University, USA
Oh-Hoon Kwon	Ulsan National Institute of Science and Technology, Republic of Korea

Penghan Lu	Forschungszentrum Jülich GmbH, Germany
Heiko Muller	Corrected Electron Optical System GmbH, Germany
Xiaoqing Pan	University of California, Irvine, USA
Jungwan Park	Seoul National University, Republic of Korea
Shu Fen Tan	Nanyang Technological University, USA
Jianbo Wu	Shanghai Jiao Tong University, China
Haimei Zheng	Lawrence Berkeley National Laboratory, USA

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Symposium CH02: Utilizing Advanced *In Situ/Operando* Transmission Electron Microscopy and Spectroscopy for the Investigation of Functional, Energy and Quantum Materials

In situ/operando transmission electron microscopy (TEM) is a promising technique to investigate functional materials and devices down to the atomic scale under the influence of a controlled stimulus. By using heat, stress, light, electric or magnetic fields, or even gas or liquid atmospheres inside a TEM, it is possible to capture phase transitions, and other dynamic processes, aiming at understanding about device operation mechanisms in their proposed working environments. However, the implementation of traditional *in situ* TEM experiments is challenging due to difficult sample preparation and set up, specimen instability and fragility under high-energy electron beam exposure. The recent development of MEMS-based *in situ* TEM holders presents a significant advancement in comparison with previously available technologies and have greatly increased the experimental possibilities of TEM systems. Moreover, the progress in advanced spectroscopy, electron detector, and cryo- microscopy techniques enable us to observe the structural and chemical dynamics within material interfaces and devices under actual working conditions with high spatial resolution and low electron dose, which are extremely helpful for investigating beam sensitive materials such as 2D materials, batteries materials, soft matter, and quantum materials. This symposium focuses on the recent advances and developments of utilizing *in situ/operando* TEM techniques and spectroscopy in the study of functional, energy and quantum materials.

Topics will include:

- Advancements in *in situ/operando* TEM holders and sample preparation
- Advances in (Cryo-) S/TEM study of beam sensitive materials at low-energy and low-dose beam conditions
- *Operando* study of advanced functional materials *e.g.* transition metal oxides, transition metal dichalcogenides, halide perovskites etc.
- Characterization of electrode-electrolyte interfaces including solid-electrolyte interphase (SEI), cathode-electrolyte interphase (CEI), and solid-solid interface in solid state batteries.
- *In situ* S/TEM and EELS study of nanoelectronics devices including memristors, ferroelectric random-access memory (FeRAM) devices etc.
- Advances in *in situ* studies of energy materials such as batteries, fuel cells, solar cells etc.
- Advances in cryogenic S/TEM and EELS for quantum materials *e.g.* skyrmions, topological insulators and superionics.
- Utilizing *in situ* S/TEM experiments for materials dynamics study such as growth mechanisms, self-assembly, and fatigue/degradation etc.
- Combination of *in situ* S/TEM with other advanced TEM techniques such as 4D-STEM, Lorentz TEM, DPC, Electron Holography etc.
- Advances in automated *in situ* S/TEM experiments for data acquisition and analysis using advanced AI and machine learning algorithms.

Joint sessions are being considered with **CH01 - Characterizing Dynamic Processes of Materials Synthesis and Processing via *In Situ* Techniques**.

Invited speakers include:

Miryam Arredondo	Queen's University Belfast, Ireland
Judy Cha	Cornell University, USA
Renchao Che	Fudan University, China
Aiping Chen	Los Alamos National Laboratory, USA
Miaofang Chi	Oak Ridge National Laboratory, USA
Michele Conroy	Imperial College London, United Kingdom
Peter Crozier	Arizona State University, USA
Elizabeth Dickey	Carnegie Mellon University, USA
Vinayak Dravid	Northwestern University, USA
Lin Gu	Tsinghua University, China
Sarah Haigh	The University of Manchester, United Kingdom
Juan Carlos Idrobo	University of Washington, USA
Yuichi Ikuhara	The University of Tokyo, Japan
Sungkyu Kim	Sejong University, Republic of Korea
James LeBeau	Massachusetts Institute of Technology, USA

Yuzhang Li	University of California, Los Angeles, USA
Y. Shirley Meng	The University of Chicago, USA
Anmin Nie	Yanshan University, China
Xiaoqing Pan	University of California, Irvine, USA
Naoya Shibata	The University of Tokyo, Japan
Steven R. Spurgeon	Pacific Northwest National Laboratory, USA
Eric Stach	University of Pennsylvania, USA
Yunlong Tang	Institute of Metal Research, Chinese Academy of Sciences, China
Jianbo Wu	Shanghai Jiao Tong University, China
Huolin Xin	University of California, Irvine, USA
Xiuzhen Yu	RIKEN, Japan
Haimei Zheng	Lawrence Berkeley National Laboratory, USA
Yimei Zhu	Brookhaven National Laboratory, USA
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Symposium CH03: *In Situ* Characterization Methods for Nuclear Materials Applications

Materials exposed to nuclear reactor environments have their microstructure and therefore properties continuously changing under the impact of high temperature, irradiation, corrosion and mechanical stress happening all at once. The microstructure evolution of nuclear materials is thus a dynamic process where atomic displacements occur continuously due to irradiation, diffusion processes happen due to high operating temperatures, dislocation dynamics happen due to mechanical stress and corrosion builds up and dissolution occurs due to the corrosive environment.

Due to the dynamic nature of these phenomena, *in situ* experiments are often useful, if not necessary, to understand the processes at play because they allow observation during exposure to track the response of the material in real time under irradiation, annealing, straining and their coupling.

For each process of interest, an *in situ* characterization technique may be more adapted than others. The goal of this symposium is to gather the material science community involved with *in situ* experiments that allow for the characterization of the microstructure and property evolution of nuclear materials in general, to discuss the perks and limitation of each technique, as well as their complementarity, and the state of the art. It is also the intent of this symposium to include how *in situ* experiments are used for benchmarking of models developed computationally.

Topics will include:

- *In situ* electron microscopy methods including SEM or TEM for probing the microstructure response to irradiation and/or temperature and/or mechanical stress.
- *In situ* diffraction methods, including *in situ* synchrotron experiments and *in situ* neutron diffraction (SANS, HEXRD, etc.)
- *In situ* tomographic experiments for crack propagation and precipitate/void formation
- *In situ* positron annihilation spectroscopy (PAS) that allow to probe the point defect behavior of materials under irradiation or temperature
- *In situ* cell experiments to investigate the effect of liquid or gas environments
- *In situ* atomic force microscopy to probe surface conditions during exposure
- Approaches that couple modelling (such as rate theory based modelling) and *in situ* experiments
- Combination of advanced *in situ* techniques to discuss the perks and limitation of each technique, as well as their complementarity

Invited speakers include:

Kory Burns	University of Virginia, USA
Wei-Ying Chen	Argonne National Laboratory, USA
Benjamin Derby	Los Alamos National Laboratory, USA
Kevin Field	University of Michigan, USA
Raymond Friddle	Sandia National Laboratories, USA
Yangling Ge	Aalto University, Finland
Gaelle Gutierrez	Commissariat à l'énergie atomique et aux énergies alternatives, France
Khalid Hattar	The University of Tennessee, Knoxville, USA
Patrick Hopkins	University of Virginia, USA
Enrique Jimenez-Melero	The University of Manchester, United Kingdom

Stephanie Jublot-Leclerc	Université Paris-Saclay, France
Marie Loyer-Prost	Commissariat à l'énergie atomique et aux énergies alternatives, France
Frederic Mompiou	Centre d'Élaboration des Matériaux et d'Etudes Structurales, France
Yvette Ngono	Grand Accélérateur National d'Ions Lourds, France
Eric Prestat	United Kingdom Atomic Energy Authority, United Kingdom
Jie Qiu	Xi'an Jiaotong University, China
Franziska Schmidt	University of California, Berkeley, USA
Farida Selim	Bowling Green State University, USA
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Symposium CH04: Characterization of Materials Dynamics

In recent years, aberration-corrected transmission electron microscopy (TEM) and synchrotron X-ray techniques coupled with advanced detectors and data science techniques have enabled the study of materials structure and functional dynamics with unprecedented spatiotemporal resolution. For instance, *in situ/operando* electron microscopy are being employed to investigate the transformation of energy materials (catalysts, battery electrodes, etc.) at the atomic scale. The new generation of synchrotron X-ray technology with greatly improved coherence offers emerging opportunities for *in situ* characterization of the structural and chemical evolution of functional materials using a suite of techniques, including imaging, scattering and spectroscopy. Further, integrated electron and X-ray microscopy provides insight into materials growth, transformation and degradation in application-relevant environments. Ptychography method in both electron and x-ray microscopy provides the record resolution for imaging of material structures. The newly developed data science (4D-STEM) and artificial intelligence algorithm speeds up the data analysis with improved accuracy and accelerates science discovery. The goal of this symposium is to bring together renowned researchers in materials science and engineering, chemistry, and physics and to promote the crosstalk and development of future directions in the characterization of materials dynamics with advanced TEM and X-ray techniques and explore the correlation with other characterization methods.

Topics will include:

- Phase transition phenomena in materials (temperature, pressure, environmental)
- Microscopy of materials growth
- Operando study of catalysis
- Evolution of energy materials (eg. Li/Na ion battery)
- External-driven processes of functional materials
- Self-assembly
- Ultrafast process of materials science
- Electron beam/x-ray interaction with materials
- Creative *in situ* characterization techniques
- Theoretical modeling of materials dynamics
- Machine learning and artificial intelligence in *in situ* characterizations
- Advanced microscopy method

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:

Ilke Arslan	Argonne National Laboratory, USA	**Ruiping Li**	Brookhaven National Laboratory, USA
Qian Chen	University of Illinois at Urbana-Champaign, USA	**Eva Olsson**	Chalmers University of Technology, Sweden
Jennifer Dionne	Stanford University, USA	**Eric Stach**	University of Pennsylvania, USA
Hongyou Fan	Sandia National Laboratories, USA	**Tao Sun**	University of Virginia, USA
Peijun Guo	Yale University, USA	**Xijie Wang**	Stanford University, USA
Martin Holt	Argonne National Laboratory, USA	**Haimei Zheng**	Lawrence Berkeley National Laboratory, USA
Ido Kaminer	Technion, Israel Institute of Technology, Israel	**Yimei Zhu**	Brookhaven National Laboratory, USA
Luxi Li	Argonne National Laboratory, USA		

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Symposium EL01: Surfaces and Interfaces in Electronics and Photonics

Surfaces and interfaces have become increasingly important factors for the integration of emerging materials and the implementation of latest fabrication processes into new generation of electronic and photonic devices. When interfaces are formed at the junction between materials surfaces with dissimilar properties, surprising new properties not present in either parent phase emerge at the intersection. These intriguing interfacial properties play key roles in organizing the multilayered device structures and modulating the charge-transfer dynamics across connecting layers. As system dimensions are scaled downward for future electronic device applications and heterogeneous integration of inorganic and organic surfaces are getting prevalent in wearable devices, the nature and complexity of materials interfaces bring tremendous challenges to scientists and engineers resulting in slowing down the progress towards emerging applications. Advanced characterization techniques to study these complex interfaces accurately are also rare. Methods of film and surface preparation and interface formation are often coupled, and they significantly affect the operation of devices. Thus, this symposium is aimed at bringing together experts in the different aspects of materials surfaces and interfaces ranging from advanced characterization, to unconventional film-growth, patterning and device level integration. Both experimental and theoretical papers are welcome. Special emphasis will be given to papers in areas of *in situ* characterization techniques as well as modelling and multiscale simulations.

Topics will include:

- Supply chain for materials and tools to address surfaces and interfaces in Electronics and Photonics
- Interfaces in area-selective ALD enabled nanopatterns
- Self-assembled monolayers (SAM) growth and *in situ* characterization
- Next generation interconnects-interfacial challenges
- Surface activation, deactivation, patterning, and spectroscopic studies
- Mechanistic understanding of interface defect formation and mitigation
- Interfacial challenges in printed hybrid electronics
- Emerging deposition equipments
- Control of surfaces, interfaces and grain-boundaries to tailor properties and functionalities
- Surfaces of emerging electronic and photonic materials
- Interface engineering in emerging photovoltaics including perovskites
- CHIPS Act and its impact on materials science industry

Joint sessions are being considered with **EL03 - Next-Generation Interconnects (Materials, Processes and Integration)—Toward Sustainable Microelectronics**.

Invited speakers include:

Julien Bachmann	Friedrich-Alexander-Universität Erlangen-Nürnberg, Germany
Katherine Develos Bagarinao	National Institute of Advanced Industrial Science and Technology, Japan
Stacey Bent	Stanford University, USA
Rebecca Kramer Bottiglio	Yale University, USA
Marla L. Dowell	National Institute of Standards and Technology, USA
Catherine Dubourdieu	Helmholtz-Zentrum Berlin, Germany
Lara A. Estroff	Cornell University, USA
Steven George	University of Colorado Boulder, USA
Oki Gunawan	IBM T.J. Watson Research Center, USA
Melissa Hines	Cornell University, USA

Erwin Kessels	Technische Universiteit Eindhoven, Netherlands
Adrie Mackus	Technische Universiteit Eindhoven, Netherlands
Tse Nga Ng	University of California, San Deigo, USA
Ola Nilsen	University of Oslo, Norway
Robert Opila	University of Delaware, USA
Jeongwon Park	University of Ottawa, Canada
Sang-Hee Park	Korea Advanced Institute of Science and Technology, Republic of Korea
Gregory Parsons	North Carolina State University, USA
Riikka Puurunen	Aalto University, Finland

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Symposium EL02: Towards Atomically Precise Colloidal Materials for Conventional and Quantum Optoelectronics

Colloidal materials, with their solution processability, offer a number of opportunities for developments and future applications in various fields including (opto)electronic and quantum technologies. Research in the past several decades has witnessed remarkable progress in the synthesis and understanding of structures, surface chemistry, dopants, defects, energy conversion, and light absorption and emission properties of many colloidal systems such as pnictide-, chalcogenide-based, and perovskite nanocrystals. Along with these advances, many novel device integration techniques and unique device architectures have also been accomplished, contributing to improving the performance of (opto)electronic and integrated quantum devices including quantum dot-based light emitting diodes, laser diodes, photosensors, photovoltaics, and integrated quantum nanophotonic circuits. Further innovations in this multidisciplinary field to realize low-cost devices with optimal efficiency and high scalability will require discussions from many scientific communities.

The purpose of this symposium is to provide a platform for such discussions among theorists and experimentalists working in various fields including materials synthesis and characterization; structural engineering; and device integration, optimization, and simulations. Besides participants from academia, we also expect this symposium to attract strong participation from the industry since state-of-the-art devices using emerging colloidal systems are projected to replace traditional technologies. The series of symposiums on colloidal nanoparticles, metal halide perovskites, nanostructures for emerging optoelectronic applications, emerging materials for quantum information technologies, etc. over the past few years has received great interest from international leaders and researchers in both academic and industry. To elaborate on that success, this symposium hopes to bring together experts from different fields to share their cutting-edge science to bridge the gaps among fundamental materials research, device implementation, and current industrially available technologies in the fields of display, lighting, and quantum information.

Topics will include:

- Quantum optoelectronics of colloidal materials - applications and fundamental studies of colloidal materials as sources of quantum light and single-photon non-linear optical elements, super radiance.
- High performance classical light source -- high brightness and high color purity LEDs and lasers.
- Advances in the colloidal synthesis and atomically precise synthesis of nanomaterials -- approaching the limits of both homogeneous and heterogeneous linewidths.
- Electronic structure, spin, carrier dynamics, energy transfers, and surface chemistries of nanomaterials.
- Computational, data- driven, and machine learning accelerated discovery of nanomaterials applicable for optoelectronic device integration and their properties.
- Large area and scalable integration of nanoparticles including assembly, patterning, printing, and coatings.

Joint sessions are being considered with **SF01 - High Entropy Oxides and Related Materials**.

Invited speakers include:

Milad Abolhasani	North Carolina State University, USA
Daniel Gamelin	University of Washington, USA
Philippe Guyot-Sionnest	The University of Chicago, USA
Zeger Hens	Ghent University, Belgium
Jennifer Hollingsworth	Los Alamos National Laboratory, USA
Taeghwan Hyeon	Seoul National University, Republic of Korea
Maria Ibáñez	Institute of Science and Technology Austria, Austria
Ivan Infante	Basque Center on Materials, Applications and Nanostructures, Spain
Sohee Jeong	Sungkyunkwan University, Republic of Korea
Joonggoo Kang	Daegu Gyeongbuk Institute of Science and Technology, Republic of Korea
Paul Kenis	University of Illinois at Urbana-Champaign, USA
Sungjee Kim	Pohang University of Science and Technology, Republic of Korea
Kevin Kittilstved	University of Massachusetts Amherst, USA
Victor Klimov	Los Alamos National Laboratory, USA
Dong-Kyun Ko	New Jersey Institute of Technology, USA
Maksym Kovalenko	ETH Zürich, Switzerland
Tae-Woo Lee	Seoul National University, Republic of Korea
Arka Majumdar	University of Washington, USA
David Norris	ETH Zürich, Switzerland
Jacob Olshansky	Amherst College, USA
Loredana Protesescu	University of Groningen, Netherlands
Hunter Ripberger	University of Washington, USA
Dong Hee Son	Texas A&M University, USA
Dmitri Talapin	The University of Chicago, USA
Zhi Kuang Tan	National University of Singapore, Singapore
Yuanyuan Wang	Nanjing University, China
Kui Yu	Sichuan University, China

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Symposium EL03: Next-Generation Interconnects (Materials, Processes and Integration)—Toward Sustainable Microelectronics

Even as conventional Cu/Ultra-low-k interconnect technology has slowed in recent years due to challenges in both ultra-low k integration and metal barrier scaling, a plethora of options are being investigated for technology nodes below 10 nm, including new conductors, dielectrics, barrier layers, and process integration methods. In parallel, emerging packaging technology such as 2.5D/3D Integrated circuit integration are demonstrating means to improve circuit density and performance. Technologies including Through Silicon Vias are increasingly utilizing recent interconnect material and process advances to further packaging innovations. Moreover, using interconnects as a backbone, the introduction of additional functionality in the back-end of line (BEOL) has constituted new areas of research and opportunity. At the same time, a fundamental trend is emerging with the growing awareness of the environmental impacts of technologies. In this context, increasing performance is no longer the only driver of innovation with sustainability and supply chain resiliency for BEOL materials, additives, and processes receiving increased consideration.

This session will focus on both continued advances in conventional interconnect technology and novel interconnect integration and architecture schemes. Topics will include advances in dielectric materials and integration, novel etch stop and hard-mask materials, advanced metallization materials and processes, area selective deposition and supervia scaling boosters, alternatives to conventional interconnect technology (3D, optical interconnects), the introduction of additional functionalities in the BEOL and interconnect developments for flexible electronics and wearables devices. This symposium will also looks at advances to simplify or economize for materials, processes and tools for a sustainable microelectronic.

Topics will include:

- Materials, processes and tools for sustainable microelectronics
- Inter layer dielectric Materials : ULK synthesis, spin-on, sol-gel, fillable, flowable, PECVD precursors, Metal-organic and covalent-organic frameworks (MOF/COF), periodic mesoporous silica, iCVD and VDP, photo-patternable low-*k*
- Novel Etch Stop and Hardmask Materials
- Metallization for advanced interconnects, CVD, PVD, ALD, ECD, ELD, advances in liner, Cu seed, and fill
- Barrier-free metallization and self-forming barriers, bottom-up metallization schemes
- Selective Depositions, Metal on Metal (MoM), Metal on Dielectric (MoD), Dielectric on Dielectric (DoD), Dielectric on Metal (DoM)
- Surface modification for ALD/CVD/ELD and self-assembled monolayer (SAM)/polymer deposition
- RIE, plasma processing, bonding, planarization, and cleaning technologies
- Reliability and failure analysis methods and techniques, electromigration, TDDB
- Directed assembly technology and molecular self-assembling technologies
- Alternative to Cu/ULK interconnects, 2.5/3D ICs integration, Through Silicon Vias, Optical interconnect, RF, Carbon-based, beyond Cu, use of 1D or 2D materials, Flexible interconnects
- Introduction of additional functionality in the back-end of line (BEOL) : BEOL capacitors, transistors, resistive RAM, and sensors: materials, integration and electrical testing and reliability

Joint sessions are being considered with **EL01 - Surfaces and Interfaces in Electronics and Photonics**.
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:

Andy Antonelli	Onto Innovations, USA
Masahisa Fujino	National Institute of Advanced Industrial Science and Technology, Japan
Patrick Hopkins	University of Virginia, USA
Seonhee Jang	University of Louisiana at Lafayette, USA
Simon Jeannot	STMicroelectronics, France
Joshua Knobloch	University of Colorado Boulder, USA
Mauro Kobrinsky	Intel Corporation, USA
Gayle Murdoch	imec, Belgium

Michelle Paquette	University of Missouri–Kansas City, USA
Jean-Philippe Soulie	imec, Belgium
Nick Strandwitz	Lehigh University, USA
Kazumasa Tanida	Tower Partners semiconductor, Japan
Dina Triyoso	Tokyo Electron Limited, USA
Latha Venkataraman	Columbia University, USA
Fabien Volpi	Université Grenoble Alpes, France

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Symposium EL04: Wide and Ultra-Wide Bandgap Materials, Devices and Applications

Research in wide and ultra-wide-bandgap (WBG/UWBG) semiconductor materials and devices continues to progress rapidly. Materials beyond silicon carbide and gallium nitride, such as gallium oxide, diamond, cubic boron nitride, aluminum nitride, and others, are at the frontier of semiconductor materials research and device physics. While such materials hold great promise for applications such as ultraviolet optoelectronic emitters and detectors, more compact and efficient energy converters, higher power high-frequency amplifiers, and quantum information science, many materials and processing challenges must still be addressed before UWBG semiconductors mature and can have significant impact. For example, many of the fundamental properties of these emerging materials are still poorly understood, including the physics of high-energy carrier scattering and transport responsible for electrical breakdown. Practical challenges such as efficient and controllable n- and p-type doping, synthesis of large area, low-defect-density substrates, the formation of reliable, low-resistance electrical contacts, and the integration of dielectric films with high quality interfaces are also areas that need to be further advanced before delivery of mature, viable, and cost competitive UWBG technologies can occur. This symposium will address a comprehensive set of topics related to the materials science, device physics, and processing of ultra-wide-bandgap materials, with a view towards the applications that are driving research in the field. The concept of co-design, whereby research topics such as those described above as well as their potential impact on applications are considered concurrently, is anticipated to be a theme of the symposium. Topics of current interest in the more traditional wide-bandgap materials will also be considered for this symposium.

Topics will include:

- Bulk crystals and substrates
- Epitaxial growth
- Defects and Doping
- First-principles theory
- Electronic transport and carrier dynamics
- Advanced materials characterization and techniques
- Heterointergration approaches
- WBG/UWBG electronic and optoelectronic devices
- Materials and device processing
- Ultraviolet emitters and detectors
- Thermal properties and electro-thermal co-design
- Color centers for quantum technologies

Invited speakers include:

Elaheh Ahmadi	University of Michigan, USA
Fikadu Alema	Agnitron Technology, USA
Patrick Fiorenza	Istituto per la Microelettronica e Microsistemi, Consiglio Nazionale delle Ricerche, Italy
Steve Goodnick	Arizona State University, USA
Mark Goorsky	University of California, Los Angeles, USA
Asa Haglund	Chalmers University of Technology, Sweden
Jennifer Hite	U.S. Naval Research Laboratory, USA
Ahmad Islam	Air Force Research Laboratory, USA
Motoaki Iwaya	Meijo University, Japan
Breanna Klein	Sandia National Laboratories, USA
Akito Kuramata	Novel Crystal Technology, Inc., Japan
Jingyu Lin	Texas Tech University, USA
Nadeemullah Mahadik	U.S. Naval Research Laboratory, USA
Baishakhi Mazumder	University at Buffalo, The State University of New York, USA
Matthew McCluskey	Washington State University, USA
Farid Medjdoub	Institut d'électronique de microélectronique et de nanotechnologie, France
Dallas Morisette	Purdue University, USA
Digbijoy Nath	Indian Institute of Science, India
Spyridon Pavlidis	North Carolina State University, USA
Lorenzo Rigutti	Universite de Rouen, France
Kornelius Tetzner	Ferdinand Braun Institut Berlin, Germany
Filip Tuomisto	University of Helsinki, Finland
Joel Varley	Lawrence Livermore National Laboratory, USA
Tim Wernicke	Technische Universität Berlin, Germany
Man Hoi Wong	Hong Kong University of Science and Technology, China
Yuhao Zhang	Virginia Tech, USA

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Symposium EL05: Two-Dimensional (2D) Materials and Heterostructures—Large-Scale Growth and Device Integration

Due to their structural and physical properties, such as high inherent mobility, scalability, and superior electrostatic control, two-dimensional (2D) semiconductors and ultrathin materials have demonstrated a significant promise to enhance cutting-edge transistor and memory technologies. Record-high mobility values have been consistently demonstrated with sub-nm body thicknesses, manifesting desirable properties in many high-density applications with augmented functionalities. To realize this potential, significant efforts have recently focused on the materials aspects for controlled synthesis of 2D materials and their device fabrication, including the channel material quality, contact resistance, and dielectric material performance. This symposium will bring together the leading experts from academia and industry to discuss the recent advancements in the integration of 2D semiconductors in high-performance electronics and optoelectronics, with a special emphasis on large-scale integration for both front-end-of-line (FEOL) and back-end-of-line (BEOL) applications.

The sessions will cover controlled low- and high-temperature synthesis of homogeneous 2D transition metal dichalcogenides (TMDs) at the wafer-scale including, but not limited to, (metalorganic) chemical vapor deposition and atomic layer deposition. Furthermore, the recent advancement in controlling the contact resistance at the metal-2D interface and formation of high-k dielectrics on the dangling bond-free 2D surface will be covered. New device designs integrating crystalline and polycrystalline 2D materials and their heterostructures for electronic and photonic device applications will be of interest as well as the advanced characterization methods focused on the structure-property correlation in 2D materials.

Topics will include:

- Large-scale synthesis of 2D materials and their heterostructures
- Back-end-of-line (BEOL) and front-end-of-line (FEOL) applications of 2D materials
- Low-temperature synthesis of ultrathin materials
- New device concepts based on 2D materials and ultrathin materials
- Scalable device fabrication and heterogeneous integration
- Contact engineering for 2D materials
- Integration of high-k dielectrics
- Controlled transfer methods for 2D materials
- Advanced characterization methods including *in situ* atomic scale methods of 2D materials and interfaces
- 2D device reliability and failure mechanisms
- Industry-related adoption of 2D materials

Invited speakers include:

Kah Wee Ang	National University of Singapore, Singapore	**Mario Lanza**	King Abdullah University of Science and Technology, Saudi Arabia
Yang Chai	The Hong Kong Polytechnic University, Hong Kong	**Sean Li**	University of New South Wales, Australia
Manish Chhowalla	University of Cambridge, United Kingdom	**Eric Pop**	Stanford University, USA
Chelsey Dorow	Intel Corporation, Belgium	**Joan Redwing**	The Pennsylvania State University, USA
Xiangfeng Duan	University of California, Los Angeles, USA	**Minsu Seol**	Samsung Advanced Institute of Technology, Republic of Korea
Ali Javey	University of California, Berkeley, USA	**Hyeon-Suk Shin**	Ulsan National Institute of Science and Technology, Republic of Korea
Holger Kalisch	Aachen University, Germany	**Aaron Thean**	National University of Singapore, Singapore
Jehwoon Kim	Massachusetts Institute of Technology, USA	**Han Wang**	University of Southern California, USA
Andras Kis	École Polytechnique Fédérale de Lausanne, Switzerland		

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Symposium EL06: Complex Oxide Epitaxial Thin Films—From Synthesis to Microelectronics

The interplay between charge, spin, lattice, and orbital degrees of freedom in strongly correlated oxide materials leads to a wide range of emergent quantum phenomena. This symposium covers recent advances in the synthesis and characterization of complex oxide thin films, heterostructures, superlattices and vertical nanocomposites, strain/microstructure/property correlation and their applications towards microelectronics. Topics of interest include epitaxy of complex oxides, stabilization, heterointerface engineering, emergent interfacial properties, new materials discovery, advanced characterizations, and device applications. Contributions that connect advances in synthesis science to structure and property trends are of particular interest, as are those which link theoretical/computational and experimental efforts.

The goal of this symposium is to bring together international and interdisciplinary researchers with an interest in epitaxial thin films to exchange ideas and foster collaboration. The topics listed for this symposium reflect the needs and opportunities of strongly correlated oxide thin films towards the applications in quantum information science and microelectronics.

Topics will include:

- The growth and characterization of complex oxide epitaxial thin films, heterostructures, superlattices and nanocomposites
- Defect, strain and interface engineering in complex oxide thin films
- Magnetism, ferroelectricity, multiferroicity and superconductivity
- (Strain, entropy and interface) stabilized thin films
- Synthesis and characterization of metastable materials in thin film form
- Structure-property correlation
- Phase changing materials in thin film form
- Theoretical simulation and modelling of oxide heterostructures
- Emergent interface phenomena and defects
- Free-standing membranes and functionalities
- Advanced characterization of structural and functional properties in complex oxide thin films by atomic/piezo force microscopy, electron microscopy, neutron scattering, and synchrotron radiation
- Oxide thin films based spintronic and electronic devices
- Oxide thin film based emergent devices for novel computing

Joint sessions are being considered with **SF02 - Actinide Materials**.

Invited speakers include:

Agnès Barthélémy	CNRS Thales, France	**Jaekwang Lee**	Pusan National University, Republic of Korea
Ivan Bozovic	Brookhaven National Laboratory, USA	**Xiuling Li**	The University of Texas at Austin, USA
Judith Driscoll	University of Cambridge, United Kingdom	**Jian Liu**	The University of Tennessee, Knoxville, USA
Chang-Beom Eom	University of Wisconsin–Madison, USA	**Lane W. Martin**	Rice University, USA
Jennifer Fowlie	Stanford University, USA	**Beatriz Noheda**	University of Groningen, Netherlands
Alex Georgescu	Nortwestern University, USA	**Hiromichi Ohta**	Hokkaido University, Japan
Er-Jia Guo	Institute of Physics, Chinese Academy of Sciences, China	**Nini Pryds**	Technical University of Denmark, Denmark
Yachin Ivry	Technion–Israel Institute of Technology, Israel	**Jacobo Santamaría**	Universidad Complutense de Madrid, Spain
Bharat Jalan	University of Minnesota, USA	**Darrell Schlom**	Cornell University, USA
Quanxi Jia	University at Buffalo, The State University of New York, USA	**Junwoo Son**	Pohang University of Science and Technology, Republic of Korea
Gertjan Koster	University of Twente, Netherlands	**Brooks Tellekamp**	National Renewable Energy Laboratory, USA
James LeBeau	Massachusetts Institute of Technology, USA	**Pu Yu**	Tsinghua University, China
Ho Nyung Lee	Oak Ridge National Laboratory, USA	**Xiaofang Zhai**	ShanghaiTech Univeristy, China

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Symposium EL07: Emerging Ferroic Materials—Synthesis, Properties and Applications

Ferroic materials with one or more primary ferroic orders (ferroelectricity, ferromagnetism, multiferroicity) exhibit rich physics and great potential for applications in next-generation electronics. Significant research efforts over the past decades have spurred unprecedented advances in the study of these materials. Recent breakthroughs in materials synthesis, characterization, and device fabrication have led to emerging materials and phenomena, including nanomembranes, 2D ferroelectrics, exotic topological structures, and novel high-k dielectrics, etc. These advancements have attracted world-wide interest and opened up a new era toward understanding fundamental ferroic phenomena.

This symposium aims to bring together scientific experts and young scientists with an interest in theory and modeling, synthesis, characterization, and device fabrication of ferroic materials, advancing the fundamental understanding, development of modern experimental techniques, and exploration of new devices and applications. In addition to providing an interdisciplinary platform for sharing and discussing latest advances, this symposium will help in formulating the research opportunities, key challenges, and development pathways for this continuously growing field.

Topics will include:

- Advanced synthesis and characterization techniques for ferroic materials
- Ferroic thin-films, heterostructures, nanostructures, and membranes
- Emerging ferroics: 2D ferroelectrics and high entropy dielectrics
- Hafnium oxides and novel high-k dielectrics
- Piezoelectric and pyroelectric materials for devices
- Bulk magnetoelectric and multiferroic materials
- Multiscale theory and modeling of ferroic materials
- Voltage control of magnetization and spin textures
- Ferroic materials for neuromorphic computing
- Ferroic materials for spintronics and memory devices
- Magnetoelectric sensors and antennas

Invited speakers include:

Laurent Bellaiche	University of Arkansas, USA
Manuel Bibes	Centre National de la Recherche Scientifique, France
Ying-Hao Chu	National Tsing Hua University, Taiwan
Amal El-Ghazaly	Cornell University, USA
Chang-beom Eom	University of Wisconsin–Madison, USA
Xia Hong	University of Nebraska–Lincoln, USA
Harold Hwang	Stanford University, USA
Jorge Iniguez	Luxembourg Institute of Science and Technology, Luxembourg
Lane W. Martin	Rice University, USA
Dennis G. Meier	Norwegian University of Science and Technology, Norway

Peter Meisenheimer	University of California, Berkeley, USA
Yuefeng Nie	Nanjing University, China
Beatriz Noheda	University of Groningen, Netherlands
Bhagwati Prasad	Indian Institute of Science, India
Ramamoorthy Ramesh	Rice University, USA
Susan Trolier-McKinstry	The Pennsylvania State University, USA
Nagarajan Valanoor	University of New South Wales, Australia
Chan-Ho Yang	Korea Advanced Institute of Science and Technology, Republic of Korea
Yuewei Yin	University of Science and Technology of China, China
Pu Yu	Tsinghua University, China

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Symposium EL08: Plasmonics and Metasurfaces—Design, Materials and Applications

The symposium will address the fundamentals and applications of multidimensional fields of plasmonics, nanophotonics, and metasurfaces. It will address emerging topics of hybrid nanophotonics utilizing plasmonics, metasurfaces, and two-dimensional materials to overcome existing limitations that prevent the development of practical photonic devices. The symposium seeks to provide a general overview of recent advances in new material platforms and structure design, including fabrication techniques and promising applications. 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, advanced design based on machine learning, and new simulation methods for metasurface and plasmonic materials/devices are also of interest to this symposium.

Topics will include:

- Plasmonics and Metasurfaces
- Alternative plasmonic and metasurface materials
- Materials with epsilon-near-zero and hyperbolic dispersion properties
- Active tunable plasmonics and metasurfaces
- Biological and chemical sensing with plasmonics and metasurfaces
- Quantum and thermal plasmonics and metasurfaces
- Ultrafast and nonlinear effects in metamaterials and plasmonics
- Photonics with two-dimensional materials
- Photovoltaic applications and efficient light harvesting
- Novel fabrication techniques for improving plasmonic/metasurface properties
- Advanced nanophotonic design strategies including machine learning, topological optimizations, and inverse design, as well as new simulation methods

Invited speakers include:

Andrey A. Sukhorukov	Australian National University, Australia
Amir Arbabi	University of Massachusetts Amherst, USA
Harry Atwater	California Institute of Technology, USA
Mark Brongersma	Stanford University, USA
Federico Capasso	Harvard University, USA
Jennifer Dionne	Stanford University, USA
Jonathan Fan	Stanford University, USA
Andrei Faraon	California Institute of Technology, USA
Patrice Genevet	CNRS-CRHEA, France
Juejun Hu	Massachusetts Institute of Technology, USA
Volker J. Sorger	George Washington University, USA
Boubacar Kanté	University of California, Berkeley, USA
Nathaniel Kinsey	Virginia Commonwealth University, USA
Yuri Lu	Academia Sinica, Taiwan
Stefan Maier	Monash University, Australia

Arka Majumdar	University of Washington, USA
Asger Mortensen	University of Southern Denmark, Denmark
Xingjie Ni	The Pennsylvania State University, USA
Junsuk Rho	Pohang University of Science and Technology, Republic of Korea
Markus Schmidt	Leibniz Institute of Photonic Technology, Germany
Matthew Sheldon	Texas A&M University, USA
Ruzan Sokhoyan	California Institute of Technology, USA
Din-Ping Tsai	City University of Hong Kong, Hong Kong
Ming-Lun Tseng	National Yang Ming Chiao Tung University, Taiwan
Kiyoul Yang	Harvard University, USA
Yuanmu Yang	Tsinghua University, China
Nanfang Yu	Columbia University, USA
Yang Zhao	University of Illinois at Urbana-Champaign, USA
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Symposium EN01: Application Targets for Next-Generation Photovoltaics

The emergence of photovoltaic (PV) technologies based on thin-film semiconductor materials has been one of the most disruptive events in the field of solar energy for many years. While silicon dominates the solar market today, emerging semiconductors such as perovskites, organics and new compounds are seen as promising candidates for new applications in low cost and low embodied energy, spectrally tuned light harvesting. This potential is now underpinned by impressive laboratory-scale efficiencies (for example 19% for organic solar cells and > 25% for organohalide perovskites) achieved by sophisticated molecular engineering and a deep understanding of loss mechanisms.

The time has now come to drive these technologies into market adoption and certain ‘application targets’ such as agrivoltaics, space application, non-conventional and extreme environments and indoor light-harvesting for IoT seem ideal platforms to enable this adoption. This symposium endeavours to gather leading experts from around the world aiming to identify and describe application targets for next-generation photovoltaic devices. In this regard, the symposium will particularly focus on areas such as upscaling, stability/lifetime, state-of-the-art materials for photoactive layers and ancillary components, green solvent processing, new material processing and device fabrication techniques, upscaled device characterization and simulation, differences in device physics between standard solar illumination, and more bespoke conditions such as indoor lighting, and cost evaluation of technologically relevant ‘whole systems’.

Topics will include:

- Ultra-light-weight, high power density PV for communications/aerospace-related technologies
- Scaling of organic and perovskite solar cells for large-area devices
- Semi-transparent solar cells and building integration of PV technologies
- Indoor PV for Internet of Things (IoT)
- PV-battery integration and system architectures
- Printable solar cells and environmentally friendly manufacturing
- PV cost and life cycle analysis
- Agrivoltaic
- Integration of PV in non-conventional and extreme environments
- Stability/lifetime analysis
- Organic, perovskite and quantum dot solar cell fabrication using green solvents
- Emerging inorganic semiconductors for photovoltaic

Joint sessions are being considered with **EN04 - Beyond 20% Efficiencies with Organic Solar Cell Devices**.

Invited speakers include:

Harald Ade	North Carolina State University, USA
Derya Baran	King Abdullah University of Science and Technology, Saudi Arabia
Kethinni Chittibabu	Ambient Photonics, USA
Paul Dastoor	The University of Newcastle, Australia
Aldo di Carlo	Università degli studi di Roma Tor Vergata, Italy
Martin Green	University of New South Wales, Australia
Rene Janssen	Technische Universiteit Eindhoven, Netherlands
Paul Meredith	Swansea University, United Kingdom
Laura Miranda-Perez	Oxford PV, United Kingdom
Dieter Neher	University of Potsdam, Germany
Jenny Nelson	Imperial College London, United Kingdom
Thuc-Quyen Nguyen	University of California, Santa Barbara, USA
Ian Marius Peters	Forschungszentrum Jülich GmbH, Germany
Safa Shoaee	University of Potsdam, Germany
Marko Topič	University of Ljubljana, Slovenia
Iris Visoly-Fisher	Ben-Gurion University of the Negev, Israel
Guillaume Wantz	Laboratoire de l’Intégration du Matériau au Système, France

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Symposium EN02: Cutting-Edge Materials Design Toward Advanced Energy Harvesting—From Modeling to Manufacturing

Energy harvesting is the technology where the sources such as mechanical loading, vibrations, frictions, temperature gradients, magnetic waves, light, biological energy, etc. are converted into device levels of electric power, usually in the μW-mW ranges. These fields are attracting wide attention as "feasible technology" that boosts the IoT and electronic device industry, enriches people's lives, and minimizes environmental risks and impacts. For energy optimum harvesting, materials development, device design and power management are essential. Even though significant progress has been made on the development of high-performance nanomaterials and device design, there is still much room for further optimization, particularly using machine learning-driven approaches such as deep learning and data mining. Therefore, some imaginary and theoretical modeling studies for developing new energy harvesting materials are also crucial in this symposium. This symposium focuses on the state-of-the-art materials, devices and systems, including piezoelectric, triboelectric, electromagnetic, thermoelectric, piezoelectrochemical, flexoelectric, magnetoelectric, mechanoradical, ionic, pyroelectric, photovoltaic, biological-induced, capacitive, and other all miscellaneous energy harvesting principles for harnessing omnipresent energy sources in our daily life.

Topics will include:

- Dielectric, piezoelectric and ferroelectric
- Triboelectric and electrostatic
- Magenetic materials and devices related to energy harvesting
- Electrocaloric, thermoelectric, pyroelectric, other thermal-related energy generations
- Other all miscellaneous energy harvesting
- Nanogenerators and power capacitors
- Various simulations: emergent theories, modeling, computations and calculations for energy harvesting
- Electrical and circuit management for energy harvesting
- Self-powered and self-sufficient electronics and sensor applications
- Energy harvesting and conversion efficiency evaluation methods, criteria and standardization
- Diverse up-to-date materials processing (surface modifications, patterning, deposition, sintering, etc.)

Invited speakers include:

Yang Bai	University of Oulu, Finland
Sergejus Borodinas	Vilnius Gediminas Technical University, Lithuania
Ana Borrás	Instituto de Ciencia de los Materiales de Sevilla, Spain
Thiago A. L. Burgo	Universidade Federal de Santa Maria, Brazil
Jun Chen	University of California, Los Angeles, USA
Dukhyun Choi	Sungkyunkwan University, Republic of Korea
Anthony Dichiara	University of Washington, USA
Noelle Gogneau	Université Paris-Saclay, France
Lisa Hall	The Ohio State University, USA
Wook Jo	Ulsan National Institute of Science and Technology, Republic of Korea
Chong-Yun Kang	Korea Institute of Science and Technology, Republic of Korea
Seung-Hyun Kim	Brown University, USA
Keon Jae Lee	Korea Advanced Institute of Science and Technology, Republic of Korea
Pooi See Lee	Nanyang Technological University, Singapore
Christopher Li	Drexel University, USA
Louis Madsen	Virginia Tech, USA
Daniel Prades	Universitat de Barcelona, Spain
Peter Sherrell	Royal Melbourne Institute of Technology, Australia
Henry A. Sodano	University of Michigan, USA
Alain Sylvestre	Université Grenoble Alpes, France
Xudong Wang	University of Wisconsin–Madison, USA
Rusen Yang	Xidian University, China
Yong Zhang	Wuhan University of Technology, China

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Symposium EN03: Sustainability of Emerging Photovoltaics

The proposed symposium will address one of the few major remaining challenges in solar energy: improving the sustainability of emerging photovoltaics. Silicon solar cells, the market leader, face challenges when it comes to recycling solar panels. These challenges are due to design constraints and material properties which support a long life of use, their sustainable feature. Emerging, printable photovoltaics, including perovskite and organic solar cells, feature auspicious properties that include materials and design elements that facilitate the separation of solar cells and modules, and enable circular remanufacturing and recycling at currently impossible levels. Material properties and design concepts for improved sustainability of solar cells and solar panels are at the core of this suggested symposium.

The first part of the symposium will focus on concepts that enable circular strategies in emerging photovoltaic applications. Here, we will focus on material and solvent combinations that facilitate the separability of the different materials used in the solar cell stack. Using materials with complementary solubility allows a reversible design in which solar cells can be assembled and disassembled using similar procedures. Challenges in this topic include the integration of concepts to facilitate cell and module disassembly.

The second part of the symposium specifically concentrates on lead in high-efficiency perovskite solar cells. All perovskite solar cells with the perspective for market introduction today contain lead in a bio-available form. Lead is potentially hazardous and has caused distrust and conflicts with legislation in some regions. To avoid potential lead contamination, material solutions are required to prevent lead leakage in broken modules. Additionally, strategies are needed to recover lead from end-of-life modules completely.

The third part of the symposium addresses material recovery after degradation. Emerging materials in solar panels degrade during operation. Degrading can be caused, among other things, by phase changes or impurities. When recovered, materials need to be re-purified for circular usage. This is always possible, yet the amount of energy, new material, and capital required for the process may make using freshly mined or produced materials preferable. Material solutions are needed that make material recovery simple and cheap.

The fourth and final part of the symposium concerns itself with the integration of materials to extend the lifetime and operation of emerging photovoltaic technologies. Such concepts include strategies for material recovery or self-healing processes. These concepts are especially needed for emerging materials that do not have the same intrinsic stability as established materials like Si or CdTe.

Topics will include:

- Energy Conversion and Storage, and Sustainability
- Recycling procedures for emerging PV
- Lead recovery and prevention of lead contamination in perovskite soalr cells
- Self-healing processes in emerging PV
- Restoring material quality after degradation
- Synthesis of sustainable materials

Invited speakers include:

Tonio Buonassisi	Massachusetts Institute of Technology, USA	**Dario Pasini**	Università degli Studi di Pavia, Italy
Heather Mirletz	National Renewable Energy Laboratory, USA	**Kai Zhu**	National Renewable Energy Laboratory, USA

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Symposium EN04: Beyond 20% Efficiencies with Organic Solar Cell Devices

The organic semiconductor community has witnessed a rapid increase of the power conversion efficiency (PCE) of organic solar cells (OSCs). This is largely due to the introduction of properly designed non-fullerene acceptors, NFAs, replacing formerly used soluble fullerene derivatives. Single junction OSCs with PCEs of above 19 % have been reported, slowly closing the gap to other thin film PV technologies. Nevertheless, the understanding of the fundamental processes limiting the device performance is still insufficient. Also, with commercialisation of this technology in reach, other issues such as upscaling and stability move into the focus of research. Finally, the facile tuning of the bandgap of organic semiconductors makes them attractive partners to be combined with other materials in multijunction solar cells. This symposium endeavours to gather leading experts from around the world to discuss and resolve processes that limit or assist photocurrent and photovoltage generation in state of the art organic solar cells, but will also address issues related to the application to these fascinating materials in single- and multijunction devices.

Topics will include:

- Design of materials - small bandgap materials
- The quantum nature of interfacial excitations
- Charge carrier generation and recombination - from femtoseconds to steady state
- Non-thermal processes in generation and recombination
- Novel experimental and theoretical approaches to exciton and charge carrier dynamics
- Multicomponent blends
- Advancement of analytical models and characterization methods
- 3D device simulations
- Multijunction devices and novel cell architectures
- Concepts to beat the Shockley Queisser limit
- Semi-transparent solar cells
- Device reliability and degradation
- Upscaling
- Sustainability

Joint sessions are being considered with **EN01 - Application Targets for Next-Generation Photovoltaics**.

Invited speakers include:

Tayebeh Ameri	The University of Edinburgh, United Kingdom
Thomas Anthopoulos	King Abdullah University of Science and Technology, Saudi Arabia
Ardalan Armin	Swansea University, United Kingdom
Natalie Banerji	University of Bern, Switzerland
Christoph J. Brabec	Friedrich-Alexander-Universität Erlangen-Nürnberg, Germany
Mariano Campoy-Quiles	Institut de Ciència de Materials de Barcelona, Spain
Brian A. Collins	Washington State University, USA
Alexander J. Gillett	University of Cambridge, United Kingdom
Ivan Kassal	The University of Sydney, Australia
Weiwei Li	Institute of Chemistry, Chinese Academy of Sciences, China
Xinhui Lu	The Chinese University of Hong Kong, Hong Kong
Jenny Nelson	Imperial College London, United Kingdom
Chad Risko	University of Kentucky, USA
Safa Shoaee	University of Potsdam, Germany
Keisuke Tajima	RIKEN Center for Emergent Matter Science (CEMS), Japan
Tao Wang	Wuhan University of Technology, China
Yingping Zou	Central South University, China

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Symposium EN05: Advances in Material, Catalyst and Device Design for Scalable Solar Fuel Production

Solar fuel production has made significant progress over the past couple of years, as research evolves from laboratory prototypes towards real-world applications. Accordingly, this symposium will focus on key emerging research directions including metal halide perovskite materials for artificial photosynthesis, earth abundant alternatives, system design and scalability, or high-throughput automation for material discovery. Several sessions will focus on lead halide perovskite for solar fuel production. Here, submissions are welcome on the use of perovskite materials in PV-electrolysis systems, as photocatalyst particles in suspension, or as photoelectrodes for H_2 evolution, CO_2 reduction and water oxidation. These sessions will bridge the gap between the fields of photovoltaics, quantum dots and solar fuels, providing a broad interest to researchers working on sustainable energy harvesting systems. These design principles apply to a vast range of solar fuel systems, hence sessions will be dedicated to lead-free, earth-abundant carbonaceous and oxide-based materials for light harvesting, photo- and electrocatalysis, as well as moisture protection. Discussions are welcome on the suitability of these approaches towards large-scale implementation, where focus will be placed on real-world benchmarking, stability, device integration, or reactor design. Here, submissions can address practical considerations on the end-of-life of devices, sustainable material sourcing and recycling. In addition, the symposium will touch upon state-of-the-art directions including experimental automation, high-throughput characterization and autonomous optimization, which will be crucial for the wide-spread implementation of solar fuel production systems.

Topics will include:

- Metal halide perovskites for solar fuel production
- Oxides and earth-abundant photoelectrode materials
- Carbonaceous light absorbers and moisture protective layers
- Automation and high-throughput experimentation for material discovery
- Scalability and engineering challenges
- Photo- and electrocatalysis, photoelectrodes, PV-electrolysis
- Rational design of devices and reactor design
- Scalable fabrication techniques: spray coating, roll-to-roll, 3D printing
- Computational simulations and machine learning driven design of solar devices
- Eco-design and circularity in design and production of solar devices

Joint sessions are being considered with **EN11 - Emerging Inorganic Semiconductors for Solar Energy and Solar Fuels**.
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:

Fatwa Abdi	City University of Hong Kong, Hong Kong	**Yang Shao-Horn**	Massachusetts Institute of Technology, USA
Claire Carmalt	University College London, United Kingdom	**Byungha Shin**	Korea Advanced Institute of Science and Technology, Republic of Korea
Todd Deutsch	National Renewable Energy Laboratory, USA	**Ludmilla Steier**	University of Oxford, United Kingdom
Kazunari Domen	The University of Tokyo, Japan	**Magda Titirici**	Imperial College London, United Kingdom
Robert Godin	The University of British Columbia, Canada	**Francesca Toma**	Helmholtz-Zentrum Hereon, Germany
Joanna Kargul	University of Warsaw, Poland	**Peidong Yang**	University of California, Berkeley, USA
Iain McCulloch	University of Oxford, United Kingdom		

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Symposium EN06: Make Energy Materials Sustainable Again

A strategic goal of healthy social development is an increasing use of resources. The key to a cleaner future is the sustainable use of these resources, which ultimately requires non-destructive resource lifecycles. Materials and Energy are the intertwined resources that enable life on Earth. Energy requires materials and vice versa, hence the central role of materials and the future need to make our use of them as sustainable as possible. Although complete sustainability of the materials we need and use is impossible (entropy!), the nearly “inexhaustible” combination of solar and geothermal energy sources can provide a sufficiently high level of sustainability, say < ~0.5% / year critical material “loss”, for the foreseeable and imaginable future. Achieving such a level will facilitate evolving towards as circular an economy as possible, but also requires major research in materials design and recycling, as well as up-front design and development of materials, technologies and devices. This circular thinking can be extended to a number of industrial sectors requiring Materials and Energy, e.g. electronics, which generates impressive amounts of waste (e-waste). Apart from increasing the fraction of energy materials that can be recycled for re-use and minimizing peripheral waste all-through the manufacturing processes, we need to extend useful lifetimes, in terms of their function, of these materials and the products made with them. In general, we want our energy materials and infrastructure to become more resilient, because they are sturdier, easier to repair, or can (self-) heal.

Topics will include:

- Designing sustainable energy materials
- Improving sustainability in chemical processing and manufacturing
- Life cycle analysis relevant to energy materials
- Approaches to enabling self-repair of materials
- Composite materials designed for recyclability
- Catalytic recycling
- Defect chemistry
- High entropy materials
- Materials in extreme environments and/or conditions: stability and durability
- Bioeconomy and bio-inspired circularity
- Photosynthesis-inspired approaches
- Materials, processes and devices for sustainable electronics
- E-waste valorization and urban mining

Joint sessions are being considered with **EN08 - Advancements in Thermoelectric Materials, Module Technology and Applications**.
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:

Daniel Brandel	Uppsala University, Sweden
David Cahill	University of Illinois at Urbana-Champaign, USA
Kyoung-Shin Choi	University of Wisconsin–Madison, USA
Claudia Felser	Max Planck Institute for Chemical Physics of Solids, Germany
David Ginley	National Renewable Energy Laboratory, USA
Klaus Hellgardt	Imperial College London, United Kingdom
Maria Holuszko	The University of British Columbia, Canada
Dong-Pyo Kim	Pohang University of Science and Technology, Republic of Korea
Igor Lubomirsky	Weizmann Institute of Science, Israel
Christine Luscombe	Okinawa Institute of Science and Technology, Japan
Deepa Madan	University of Maryland, USA

Ana Flavia Nogueira	UNICAMP, Brazil
Ange Nzihou	Ecole des Mines d'Albi-Carmaux, France
Elsa Olivetti	Massachusetts Institute of Technology, USA
Vincenzo Pecunia	Simon Fraser University, Canada
Dierk Raabe	Max-Planck-Institut für Eisenforschung GmbH, Germany
Federico Rosei	Institut national de la recherche scientifique, Canada
Sabrina Sartori	University of Oslo, Norway
Alp Sherlioglu	Case Western Reserve University, USA
Naoya Sibata	The University of Tokyo, Japan
Susana Cordoba de Torresi	University of São Paulo, Brazil
Wenjie Xie	Technische Universität Darmstadt, Germany

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Symposium EN07: Thermal Transport and Energy Conversion

Advanced materials for thermal transport are becoming crucial with the trend of integration and miniaturization of electronic devices and the urgent need for sustainable future energy in various sectors to develop thermal interface materials, heat exchangers, thermal storage, manufacturing, bio/chemical sensors, building, and personal thermal regulation, etc. Heat transport in solids is governed by the diffusion process of phonons and electrons. Advanced thermal characterization tools with high spatial- and temporal resolutions and theoretical modeling have defied understanding of micro and nanoscale thermal transport processes for many decades, yet far from complete. Beyond the diffusive regime when dimensions get smaller than the phonon mean free path or comparable to the thermal phonon wavelength, ballistic and hydrodynamic phonon conduction arise. The exploration of novel thermal transport behaviors in nanostructures has attracted great interest. The understanding of heat transport in amorphous and soft matters is still at the nascent stage. The discussion will encompass more than phonons, and will include the transportation of electrons and photons within materials and its interplay with phonons. This symposium further extends the topics to cover advanced thermal management and energy conversion from materials to devices, e.g. heat dissipation of the chiplet-based packaging, thermoelectric energy harvesting and thermoregulation, radiative cooling for passive thermal management, triboelectric nanogenerator and so on.

Topics will include:

- Measurement technologies and tools for nanoscale thermal transport
- Modeling and theory of nanoscale heat transport
- Heat transport in soft and amorphous matters
- Nondiffusive thermal transport
- Radiation at the nanoscale
- Emerging thermal interface materials and phase change materials
- Emerging phonon and electron dynamics in complex bulk and nanostructured materials
- Materials and devices for thermoelectric energy harvesting and cooling
- Materials and devices for solar-thermal energy harvesting and passive radiative cooling
- Materials and devices for multi-caloric energy conversion
- Materials and devices for triboelectric energy harvesting.
- Thermal management technologies for microelectronics, buildings, and individuals
- Advanced application on medical devices, carbon neutralization, etc.

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:

Gang Chen	Massachusetts Institute of Technology, USA
Renkun Chen	University of California, San Diego, USA
Emmanuel Guilmeau	École nationale supérieure d'ingénieurs de Caen, France
Keddar Hippalgaonkar	Nanyang Technology of University, Singapore
Yongjie Hu	University of California, Los Angeles, USA
Chung In	Seoul National University, Republic of Korea
Sangwoo Kim	Yonsei University, Republic of Korea
Yee Kan Koh	National University of Singapore, Singapore
Bongjae Lee	Korea Advanced Institute of Science and Technology, Republic of Korea
Baowen Li	Southern University of Science and Technology, China
Deyu Li	Vanderbilt University, USA
Tengfei Luo	University of Notre Dame, USA
Jonathan Malen	Carnegie Mellon University, USA
Masahiro Nomura	The University of Tokyo, Japan
Pramod Reddy	University of Michigan, USA
Neogi Sanghamitra	University of Colorado Boulder, USA
Li Shi	The University of Texas at Austin, USA
Junichiro Shiomi	The University of Tokyo, Japan
Jae Sung Son	Ulsan National Institute of Science and Technology, Republic of Korea
Clivia Sotomayor	Catalan Institute of Nanoscience and Nanotechnology, Spain
Xiaojia Wang	University of Minnesota, USA
Dongyan Xu	The Chinese University of Hong Kong, Hong Kong
Ilaria Zardo	Universität Basel, Switzerland

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Symposium EN08: Advancements in Thermoelectric Materials, Module Technology and Applications

The development of sustainable, efficient energy generation technologies is at the forefront of current research efforts. One such technology is thermoelectrics, a process that can convert heat into electricity. Recent advances in synthesis, characterization, and modeling have led to the creation of materials with thermoelectric figures of merit approaching zT = 3, a significant improvement over the traditional TEGs materials based on Bi-Te with limits around zT = 1. One of the main advantages of thermoelectric technology is its ability to recover wasted heat, which can contribute to counteracting the energy crisis. However, the lack of appropriate thermoelectric generators and coolers for different temperature ranges has limited their applications so far.

The proposed symposium will discuss the latest developments regarding thermoelectric materials, new approaches to predict thermal and electronic transport in complex materials, and the translation of these advances into working generators. It will target the international community of researchers and engineers working on thermoelectric technologies, from academia to industry. The symposium will focus on material issues, such as synthesis, transport properties, phase stability, and phase transformations of high-performance thermoelectrics, but also on the development of thermoelectric modules, generators and devices, and will deal with technological challenges related to joining techniques, stability issues, optimization of thermal and electrical resistances, effective design principles, construction methods and thermal management aspects. Additionally, TEG applications will also be covered by the symposium.

Topics will include:

- Advanced synthesis and characterization of thermoelectric materials: novel enhancements of bulk, thin film, heterostructures, and nanostructures.
- Artificial Intelligence and Machine Learning for the prediction of thermoelectric materials
- Modeling and simulations of electronic and phononic transport
- Thermal management aspects
- Translation of materials into working thermoelectric modules: fabrication, design, electrical and thermal contacts, and mechanical aspects
- Thermal management aspects
- Advances in applications, ranging from energy harvesting for the Internet of Things, to mid and high- temperature energy saving waste heat recovery and refrigeration

Invited speakers include:

Thierry Caillat	NASA Jet Propulsion Laboratory, USA
Lidong Chen	Shanghai Institute of Ceramics, Chinese Academy of Sciences, China
In Chung	Seoul National University, Republic of Korea
Johannes de Boor	German Aerospace Center, Germany
Elif Ertekin	University of Illinois at Urbana-Champaign, USA
Jiaqing He	Southern University of Science and Technology, China
Ran He	Leibniz-Institut für Festkörper- und Werkstoffforschung Dresden, Germany
Mercouri Kanatzidis	Northwestern University, USA
Tsutomu Kanno	Panasonic Corporation, Japan
Susan Kauzlarich	University of California, Santa Barbara, USA

Theodora Kyratsi	University of Cyprus, Cyprus
Saniya LeBlanc	George Washington University, USA
Lucas Lindsay	Oak Ridge National Laboratory, USA
Koji Miyazaki	Kyushu University, Japan
Akitoshi Nakano	Nagoya University, Japan
Neophytos Neophytou	University of Warwick, United Kingdom
Zhifeng Ren	University of Houston, USA
Jeff Snyder	Northwestern University, USA
Lilia Woods	University of South Florida, USA
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Symposium EN09: Nanostructured Electrocatalysts for Energy Applications

The deployment of clean and affordable energy is a global sustainable development goal, and green energy has been identified as a key pillar for mitigating climate change. Renewable clean energy, new energy carriers, carbon-free fuels like hydrogen and electric energy storage and conversion technologies like advanced batteries and fuel cells are at the heart of the new green economy roadmap. This symposium aims to cover recent advances in nanostructured materials related to electrochemical energy devices , hydrogen and carbon free carriers (hydrogen storage, hydrates, ammonia, metal fuels, complex compounds, green hydrogen) as well as electro catalysts for sustainable resourcification (water splitting, fuel generation, power generation). This symposium will consider the major issues of energy related to materials design, characterization and modeling to achieve better performance and decipher the mechanisms that take place in different types of devices such as fuel cells, and electrolyzers.

The objective of this symposium is therefore to bring together various actors around themes related to nanomaterials for the field of energy storage and conversion. Four sessions are planned around: 1) the synthesis and characterization of new functional materials- the characterization part will include recent aspects around operando analysis using large instruments such as synchrotron radiation, 2) electrochemical devices and associated performances at lab or pilot scale 3) simulation and computational modeling in materials;.

Topics will include:

- Fuel cell, Hydrogen and Oxygen Evolution Reactions
- Green fuels synthesis and associated catalysts
- Artificial Photosynthesis
- Hydrogen electrolysis
- Molecular and heterogeneous electro catalysis
- CO(2) reduction related to hydrocarbon fuel generation
- Sustainable resourcification
- *In situ* materials characterisation
- DFT simulations of novel nanomaterials properties and synthesis
- Electrochemical Energy Storage (EES)
- Organic, biodegradable batteries or photo-batteries
- Supercapacitors
- Hydrogen storage

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:

Shannon Boettcher	University of Oregon, USA
Dominic Bresser	Karlsruhe Institute of Technology, Germany
Sophie Cassaignon	Sorbonne Université, France
Jacques Huot	Université du Québec, Canada
Sandrine Lyonnard	Commissariat à l'énergie atomique et aux énergies alternatives, France
Cedric Tard	École Polytechnique, France
Sara Thoi	Johns Hopkins University, USA
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Symposium EN10: Novel Approaches to Synthesize and Characterize Stable Halide Perovskites and their Devices

In the last decade, perovskite solar cells (PSCs) have emerged as a low-cost, thin-film technology with unprecedented efficiency gains from 3.8% in 2009 to 25.7% in 2022. Perovskites can be processed from inexpensive solution-based methods and have exceptional material properties that are comparable to established GaAs or Si. The combination of high-quality semiconductors with low-cost deposition techniques are an attractive match creating great excitement and anticipation far beyond academia because PSCs may have the potential to outcompete established thin-film technologies or can be combined with them for further performance enhancements. Although progress has been related mostly to the short-term performance of devices, initially little attention was paid so far to their long-term implications. With a current photovoltaic conversion efficiency compatible with commercialization, long-term stability and up-scaling are receiving more and more attention.

In the past 2 years, there has been a push to understand further the mechanisms that drive stability in perovskite materials, with rapid progress towards stable devices in the long-term. This symposium explores fundamental questions and challenges, focusing on the material's properties that make perovskites so remarkable, and the current understanding of the device physics, including the raising of lead-free alternatives with a fast growth in the last few years. One main driver were novel synthesis and characterization methods having established a distinct direction within the research community now. The outstanding properties of halide perovskites have not just been successfully applied in solar cells but also in a wide range of optoelectronic devices, such as light-emitting devices, lasers, memristors or detectors. The scope beyond photovoltaics will thus be one main focus of the symposium.

Finally, there is a designated session on the progress of long-term stability, and the evolution towards modules, in order to provide an outlook on how close PSCs are to commercialization.

Topics will include:

- Material properties
- Lead-free, fully inorganic, or perovskite-like materials
- Stability (phase stability, long-term stability, degradation mechanisms, encapsulation…)
- Testing protocols
- Space applications
- Advances in synthesis and characterization
- Scaling-up: from lab to application
- Selective contacts: organic and inorganic materials at the interface with the perovskite
- Perovskite in tandem with other photovoltaic materials
- Perovskite based light emitting devices, photodetector, photocatalytic or memristors

Invited speakers include:

Antonio Abate	Helmholtz-Zentrum Berlin, Germany
Colin Bailie	Tandem PV, USA
Pablo Boix	Universitat de València, Spain
Henk Bolink	Universitat de València, Spain
Sascha Feldmann	Harvard University, USA
Anita Ho Baillie	University of New South Wales, Australia
Lethy Jagadamma	University of St Andrews, United Kingdom
Hyun Suk Jung	Sungkyunkwan University, Republic of Korea
Mercouri Kanatzidis	Northwestern University, USA
Jin-Wook Lee	Sungkyunkwan University, Republic of Korea
Tae-Woo Lee	Seoul National University, Republic of Korea
Marina Leite	University of California, Davis, USA
Mónica Lira-Cantú	Catalan Institute of Nanoscience and Nanotechnology, Spain
Olga Malinkiewicz	Saule Technologies, Poland
Nam Gyu Park	Sungkyunkwan University, Republic of Korea
Erin Ratcliff	University of Arizona, USA
Uwe Rau	Forschungszentrum Jülich GmbH, Germany
Qing Shen	The University of Electro-Communications, Japan
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Symposium EN11: Emerging Inorganic Semiconductors for Solar Energy and Solar Fuels

Photovoltaic (PV) and photoelectrochemical (PEC) solar cells are energy technologies that convert sunlight into electricity or fuels. The main component common to both technologies is the semiconductor absorber, where photoactivated charge carriers are generated and transported. Established absorber technologies have matured to the point where PV is now cost competitive against all other energy sources for electricity production, but work remains to achieve higher efficiencies, lower costs, and diversify the materials space. On the other hand, the technology of generating fuels from photocatalytic processes is far less mature than energy generated by PV, due to stringent selection criteria for suitable photoelectrodes. In addition to spectrum-matched band gaps and favorable charge transport required for PV technologies, PEC absorbers must also have band edges that can drive chemistry with photogenerated carriers, stability in operating environments, and catalytic selectivity toward the desired reaction. Thus, additional research and development of emerging inorganic semiconductor absorber materials is needed to diversify the portfolio of existing PV—and especially PEC—solar cell technologies.

This symposium will cover all aspects of emerging inorganic photoabsorbers, with particular emphasis on materials for photovoltaic and photoelectrochemical solar cells including novel oxides, chalcogenides, nitrides, and phosphides. In addition, we will consider contributions focusing on emerging photocatalysts, absorber/catalyst interactions, catalyst surface decoration, PEC cell designs, device encapsulants, and other materials supporting photocatalytic processes. Contributions on emerging contacts, buffers, transparent conductors, and other supporting materials for semiconductors as well as solid-state lighting and photodetectors are also welcome.

Topics will include:

- Materials chemistry & physics, interface science, photoelectrochemistry
- Theory, computation, synthesis, characterization, modeling, and device integration
- Photon, electron, and chemical processes in PEC materials and cells
- Absorber materials, photocatalysts, contact layers, transparent conductors
- Aqueous stability, grain boundaries, defects & dopants, surface passivation
- Data-driven, high-throughput computational and experimental methods

Invited speakers include:

Sage Bauers	National Renewable Energy Laboratory, USA	**Sebastian Siol**	Empa–Swiss Federal Laboratories for Materials Science and Technology, Switzerland
Mirjana Dimitrievska	Empa–Swiss Federal Laboratories for Materials Science and Technology, Switzerland	**Thomas Unold**	Helmholtz-Zentrum Berlin, Germany
Geoffroy Hautier	Dartmouth College, USA	**Aron Walsh**	Imperial College London, United Kingdom
Gerasimos Konstantatos	ICFO–The Institute of Photonic Sciences, Spain	**Lydia Helena Wong**	Nanyang Technological University, Singapore
Stephan Lany	National Renewable Energy Laboratory, USA	**Andriy Zakutayev**	National Renewable Energy Laboratory, USA
Jose' Marquez Prieto	Humboldt-Universität zu Berlin, Germany		

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Symposium ES01: Next-Generation EV Battery Materials—Bridging Academic, Government and Industry Research

This symposium will broadly cover emerging materials, technologies, and techniques relevant to electric vehicles (EVs), with a focus on building connections between academic, government, and industrial researchers. The symposium will have portions dedicated to materials for each major cell component (*i.e.,* anodes, cathodes, electrolytes) as well a full cell construction and performance. Symposium contributions should address fundamentals of these materials (*e.g.,* synthesis, properties, degradation mechanisms), the development of practical, industrially relevant technologies from these materials (*e.g.*, performance, scalability, cost, manufacturing), or modelling and/or diagnostics of these materials (*e.g.,* Multiscale modeling from materials to devices, and machine learning approach for failure analysis, *in situ/operando* characterization). There will also be sessions and speakers dedicated to more forward-looking topics, including battery recycling/sustainability, and the process of, and challenges associated with, bringing new materials to market. This symposium will provide a snapshot of the current state-of-the-art for EV battery materials by bringing together researchers and highlighting invited speakers from all three research sectors.

Topics will include:

- Emerging Anode Materials: Si and Li Metal
- Low-cost, Abundant, and High-Performance Cathode Materials
- Electrolyte Design for Li-Ion Batteries
- Solid-State Batteries: Performance and Manufacturing
- Advances in Scale-Up and Manufacturing of Next-Generation Cell Technologies
- Theoretical Understanding and Design of Battery Materials
- *In situ/Operando* Characterization of Battery Materials/Interfaces
- Advances In Battery Recycling
- Diversifying Battery Materials
- Sustainability In Battery Technology

Invited speakers include:

Chibueze Amanchukwu	The University of Chicago, USA	**Y. Shirley Meng**	The University of Chicago, USA
Mei Cai	General Motors, USA	**Rana Mohtadi**	Toyota Research Institute, USA
Jang Wook Choi	Seoul National University, Republic of Korea	**Elsa Olivetti**	Massachusetts Institute of Technology, USA
Yi Cui	Stanford University, USA	**Jennifer Rupp**	Technische Universität München, Germany
Jessica Durham Macholz	Argonne National Laboratory, USA	**Jeff Sakamoto**	University of Michigan, USA
Chengchang Fang	Michigan State University, USA	**Kazunori Takada**	National Institute for Materials Science, Japan
Ali Firouzi	Cuberg, USA	**Yoshitaka Tateyama**	National Institute for Materials Science, Japan
Daniel Friebel	Natron Energy, Inc., USA	**Steven Torrisi**	Toyota Research Institute, USA
Louis Hector	General Motors, USA	**Jie Xiao**	Pacific Northwest National Laboratory, USA
Brett Helms	Lawrence Berkeley National Laboratory, USA	**Gleb Yushin**	Georgia Institute of Technology, USA

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Symposium ES02: *Operando* Characterization of Energy Storage Materials

The recent advances in improving energy storage materials can be partially attributed to the mechanistic understanding of spatial and temporal phenomena at relevant lengths and time scales. Electrochemical storage systems comprise multiple components and are intrinsically out-of-equilibrium, necessitating an in-depth understanding of the reactions within and between individual parts under operating conditions. In the past decade, progress in operando characterization led to a paradigm shift in our understanding of mechanical and electrochemical processes during intercalation and charge transport. Nevertheless, the complexity of the multi-component electrochemical storage systems requires further developments, particularly a concerted effort in multimodal characterization.

This symposium will highlight the most recent developments in the operando characterization of electrochemical systems, including x-ray characterization, electron microscopy, nuclear magnetic resonance, and electron paramagnetic resonance. The symposium will cover various scientific topics, including intercalation, ionic diffusion, reduction-oxidation reactions, and structural rearrangements in materials for lithium-ion energy storage and beyond. The symposium aims to provide a discussion platform and to facilitate a combination of multiple operando techniques for the future multimodal characterization of electrochemical systems.

Topics will include:

- *Operando* x-ray diffraction (XRD)
- *Operando* X-ray imaging
- *Operando* X-ray spectroscopy
- *Operando* Nuclear Magnetic Resonant Spectroscopy (NMR)
- *In situ* Transmission Electron Microscopy (TEM)
- *Operando* Electron paramagnetic resonance spectroscopy (EPR)

Invited speakers include:

Peng Bai	Washington University in St. Louis, USA
Hye Ryung Byon	Korea Advanced Institute of Science and Technology, Republic of Korea
EunAe Cho	Korea Advanced Institute of Science and Technology, Republic of Korea
Tijmen Euser	Cambridge University, United Kingdom
Donal Finegan	National Renewable Energy Laboratory, USA
Enyuan Hu	Brookhaven National Laboratory, USA
Yan-Yan Hu	Florida State University, USA
Sooyeon Hwang	Brookhaven National Laboratory, USA
Minkyung Kim	Kwangwoon University, Republic of Korea
Lu Xi Li	Argonne National Laboratory, USA
Johanna Nelson Weker	Stanford University, USA
Elodie Salager	Centre National de la Recherche Scientifique, France
Feifei Shi	The Pennsylvania State University, USA
Vasiliki Tileli	École Polytechnique Fédérale de Lausanne, Switzerland
Claire Villevieille	Institut polytechnique de Grenoble, France
Naoaki Yabuuchi	Yokohama National University, Japan
Yao Yang	University of California, Berkeley, USA

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Symposium ES03: Solid-State Batteries

Solid-state batteries (SSB) are one of the most promising candidates for next-generation energy storage technologies due to their improved safety and energy density. The performance of SSBs depends critically on the ionic/electronic transport that occurs across multiple length scales in a cell under a multi-physics coupling field (electro-chemo-mechanics). The outstanding challenges in SSBs, including chemical, electrochemical, and mechanical degradations, are deeply rooted in the inter-correlated mass, charge, and heat transport processes. Therefore, multidisciplinary research efforts are imperative for realizing economical and long-lasting SSBs.

This symposium will convene state-of-the-art research in solid-state energy-storage systems. It covers the latest discovery and progress in: (1) the fundamental transport mechanisms in SSBs due to electro-chemo-mechanical coupling, (2) the advanced characterizations in the field of SSBs, and (3) the development and practical applications of SSB technology.

Topics will include:

- Materials design for solid-state ionic conductors for Li, Na, and emerging batteries
- Dendrite suppression in SSBs
- Ion diffusion and charge transfer in electrode materials and interfaces for SSBs
- Investigations on electro-chemo-mechanics in SSBs
- Advanced characterization of transport phenomena in materials and interfaces for SSB
- Novel cell and architecture design for SSBs

Invited speakers include:

Peter Bruce	University of Oxford, United Kingdom	**Y. Shirley Meng**	The University of Chicago, USA
Gerbrand Ceder	University of California, Berkeley, USA	**Yifei Mo**	University of Maryland, USA
Raphaele Clement	University of California, Santa Barbara, USA	**Rana Mohtadi**	Toyota Research Institute, USA
Valentino Cooper	Oak Ridge National Laboratory, USA	**Linda F. Nazar**	University of Waterloo, Canada
Dongmin Im	Samsung Advanced Institute of Technology, Republic of Korea	**Yue Qi**	Brown University, USA
Xin Li	Harvard University, USA	**Jeff Sakamoto**	University of Michigan, USA
Christian Masquelier	Université de Picardie Jules-Verne, France	**Wolfgang Zeier**	Universität Münster, Germany

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Symposium ES04: Metal Anodes in Rechargeable Batteries—Electrolyte, Interface and Mechanism

Metals (Li, Na, Mg, Ca, Zn, etc.) are the next-generation anodes to achieve high-energy-density rechargeable batteries. However, the reversible plating and stripping of metal anodes is plagued by the unstable electrolyte|electrode interface, which is manifested in the continuously evolving solid electrolyte interphase (SEI), as well as electrically disconnected metal following nonuniform stripping of highly porous and branched deposits. Tackling these challenges requires a systematic approach that integrates fundamental knowledge of interfacial processes and metal growth mechanisms with rational electrolyte and substrate design.

This timely symposium will cover the latest advances on metal anodes in the following aspects: 1) Fundamental understanding of the formation mechanism, composition, structure, and function of the SEI; 2) Mechanistic understanding revealing the growth and dissolution mechanisms of metal deposits and their dependence on the operation conditions (current, pressure, temperature) and chemistry (electrolyte, substrate); 3) Advanced electrolyte and substrate design for achiving highly reversible metal anodes; 4) Advanced characterization methods and tools that enable new insights to fill the above-mentioned knowledge gaps; and 5) Manufacturing and scaling up metallic anodes in the battery industry . The symposium aims to stimulate constructive discussions and foster collaboration between experts on these different topics. Synergizing these five complementary thrusts will facilitate connections among atomic and molecular scale understanding and design of electrolyte/SEI structure, meso-scale reaction/transport phenomena that support metal deposition and stripping, and device-scale engineering efforts.

The necessity of a sperate symposium on metal anodes lies in several asepects: 1) the research on metal anodes spans different subtopics of material science, such as metal material, ceramic materials, carbon material, polymer material, liquids, characterization, computation, interfacial chemistry, etc, which can not be simply covered by any other existing topics. 2) metal anodes are regarded as the holy-grail of battery research, and significant progress were made in the past few years in different aspects of this topic, but there was no dedicated symposium that can bring the experts on this topic together.

Topics will include:

- Formation mechanism, composition, structure, and function of SEI
- Growth and dissolution mechanisms of metal deposits
- Advanced electrolyte and substrate for highly reversible metal anodes
- Advanced characterization methods and tools for metal anodes
- Engineering and Manufacturing of rechargeable metal batteries
- Modeling and theoretical understanding of metal anodes
- Crosstalk between metal anodes and cathode materials

Invited speakers include:

Lynden Archer	Cornell University, USA	**Robert Kostecki**	Lawrence Berkeley National Laboratory, USA
Perla Balbuena	Texas A&M University, USA	**Bryan McCloskey**	University of California, Berkeley, USA
Yi Cui	Stanford University, USA	**Y. Shirley Meng**	The University of Chicago, USA
Chengcheng Fang	Michigan State University, USA	**Munekazu Motoyama**	Nagoya University, Japan
Maximilian Fitchner	Karlsruhe Institute of Technology, Germany	**Stefano Passerini**	Karlsruhe Institute of Technology, Germany
Claire Grey	Cambridge University, United Kingdom	**Debra Rolison**	U.S. Naval Research Laboratory, USA
Axel Groß	Universität Ulm, Germany	**Kimberley See**	California Institute of Technology, USA
Katherine Harrison	Sandia National Laboratories, USA	**Kang Xu**	U.S. Army Research Laboratory, USA
Kelsey Hatzell	Princeton University, USA	**Atsuo Yamada**	The University of Tokyo, Japan
Timo Jacob	Universität Ulm, Germany	**Jiguang Zhang**	Pacific Northwest National Laboratory, USA
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Symposium ES05: Materials Challenges for Flow-based Energy Conversion and Storage

Flow-based energy conversion and storage technologies, such as redox flow batteries, are considered prominent solutions to long-duration energy storage and intermittency from renewable energy sources. These technologies present unique advantages as well as challenges, ranging from redox active material stability/solubility, kinetic limitation, membrane limitation, etc. For example, the molecular structure of redox-active species and their dynamic interaction with the solvent are critical to understanding the electrolyte properties. On the other hand, developments of organic redox active materials have revealed the material stability challenge especially when they are at charged state, which is critical for long-duration energy storage technology. Recent advancements in flow battery technology have positioned them for transformational performance improvement. However, the continuing success in this field is hinged upon the development of new materials development with improved functionality and properties.

This symposium will provide a forum to discuss the advanced materials and challenges for flow-based energy conversion and storage technologies, as well as their applications and economic effectiveness as both stationary and transportation energy systems. The topical list of this symposium is intended to cover a diverse range of materials science, design, synthesis, characterization, theory, simulation, device, and application of advanced electrolyte, electrode, membrane, and stacks for flow-based energy cells and systems.

Topics will include:

- Development of novel aqueous/nonaqueous electrolytes
- Membranes and separators
- Fundamental study of electrolyte solution chemistry and structure
- Nanomaterials for advanced electrode
- Electrode-electrolyte interface
- Advanced characterizations
- Aqueous/nonaqueous flow chemistries
- Hybrid systems (aqueous/nonaqeuous, Li/redox, metal/organic, solid/liquid)
- Flow field and stack design
- Transport phenomenon
- Computational modeling of flow-based systems

Invited speakers include:

Doug S. Aaron	The University of Tennessee, Knoxville, USA
Michael J. Aziz	Harvard University, USA
Hye Ryung Byon	Korea Advanced Institute of Science and Technology, Republic of Korea
Dawei Feng	University of Wisconsin–Madison, USA
Brett Helms	Lawrence Berkeley National Laboratory, USA
Xianfeng Li	Dalian Institute of Chemical Physics, Chinese Academy of Sciences, China
Tianbiao Liu	Utah State University, USA
Ellen Matson	University of Rochester, USA
Shelley Minteer	The University of Utah, USA
Trung Van Nguyen	University of Kansas, USA
Joaquín Rodríguez-López	University of Illinois at Urbana-Champaign, USA
Ana Jorge Sobrido	Queen Mary University of London, United Kingdom
Changwon Suh	U.S. Department of Energy—Office of Energy Efficiency and Renewable Energy, USA
Qing Wang	National University of Singapore, Singapore
Wei Wang	Pacific Northwest National Laboratory, USA
Guihua Yu	The University of Texas at Austin, USA
Lu Zhang	Argonne National Laboratory, USA
Yu Zhu	The University of Akron, USA

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Symposium ES06: Sulfur and Sulfide Chemistry in High Performance Electrochemical Energy Storage

Sulfur and sulfide chemistry play a critical role in the development of next-generation energy storage technologies featuring extremely both high energy and low cost. Rechargeable sulfur based battery technologies particularly lithium-sulfur (Li-S) battery have gained enormous research interest from academic and industry in the past decades due to its high theoretical capacity and low cost (compared with Co- or Ni-based transition metal oxides. Despite advances in liquid Li-S battery, deployment of the technology is still hindered by the low practical energy and limited cycle life with unsolved fundamental barriers of insulating sulfur/sulfides, polysulfide dissolution/shuttling, electrolyte depletion, and undesirable Li corrosion and dendrite. Achieving a high energy in practical Li-S cell is feasible only through the simultaneous integration of a high-loading sulfur cathode, thin Li anode, and most importantly lean electrolyte. However, this often leads to both a low reversible capacity and poor cycle life. Understanding of fundamental mechanisms and identifying effective strategies to address those issues at realistic conditions still need more efforts. The other important application of sulfur/sulfide chemistry is the development of sulfide-based solid state electrolytes (SSEs) and all-solid-state batteries (ASSBs). Compared to polymer- and oxide- SEs, sulfide SSEs are arguably more viable for bulk-type ASSBs. This stems from sulfides' low material density, low elastic modulus, and high ionic conductivity, which allows intimate contact with active materials and practical processing. More promisingly, sulfide-SSEs are compatible with sulfur both chemically and electrochemically and thus are feasible for direct sulfur cathode application without using protective cathode coating. Despite high expectations for sulfide-SSEs, there are significant materials, interface, and processing challenges that need to be addressed before practical technology deployment, particularly the moisture sensitivity, Li/SSE interfacial stability, and scalable manufacturing and separator processing. In this symposium, we will invite world-leading experts/researchers to discuss state-of-the-art advances in utilizing low-cost sulfur and sulfide chemistry for energy storage. The topics broadly cover sulfur/metal sulfide cathodes, sulfide solid electrolytes, and liquid/solid-state Li batteries including new materials chemistry, synthesis and characterization, interfacial studies and design, advanced processing/manufacture, and device integration/demonstration. Both experimental and computational studies are encouraged.

Topics will include:

- Solid-state alkali metal-sulfur batteries
- Synthesis and processing of sulfide-based solid electrolytes
- Li metal anodes and interface with solid electrolytes
- High sulfur content cathodes with high sulfur utilization rate for liquid or solid Li-S batteries
- Durable liquid electrolytes/additives for high energy Li-S batteries;
- Theoretical simulations (DFT, MD) across materials, electrode and cell levels
- Novel structural design of anode, interface and current collectors;
- Advanced characterizations of materials, interfaces and cells;
- Advanced manufacturing and processing for electrodes and electrolytes
- Electro-chemo-mechanics of solid-state cells;

Invited speakers include:

Torsten Brezesinski	Karlsruhe Institute of Technology, Germany
Gerbrand Ceder	University of California, Berkeley, USA
Jang Wook Choi	Seoul National University, Republic of Korea
Kyung Yoon Chung	KIST, Republic of Korea
Kyu Tae Lee	Seoul National University, Republic of Korea
Xin Li	Harvard University, USA
Ping Liu	University of California, San Deigo, USA
Arumugam Manthiram	The University of Texas at Austin, USA
Steve Martin	Iowa State University, USA
Mattew McDwell	Georgia Institute of Technology, USA
Y. Shirley Meng	The University of Chicago, USA
Linda F. Nazar	University of Waterloo, Canada
Yue Qi	Brown University, USA
Deyang Qu	University of Wisconsin–Milwaukee, USA
Donghai Wang	The Pennsylvania State University, USA
Xiayin Yao	Ningbo Institute of Materials Technology and Engineering, Chinese Academy of Sciences, China
Yan Yao	University of Houston, USA
Thoms Yersak	General Motors, USA
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Symposium MF01: Advances in Polymer-based Soft Matter for Additive Manufacturing

Additive manufacturing (AM) is transforming how we approach materials manufacturing and design. Without the design constraints associated with traditional manufacturing processes, AM has shifted the emphasis in part design from manufacturability to functionality, enabling the production of more material-efficient parts. Furthermore, the ability to architect a material into precisely defined topologies has allowed us to utilize architecture as a design handle to access new material property spaces and go beyond just simple composition and microstructure. The numerous advantages conferred by using AM has led to rapid advances in both AM hardware and with the materials compatible with them. In particular, the development of novel 3D-printable polymer-based soft matter has led to new classes of functional materials with designer properties — materials with tunable biological, mechanical, and chemical properties, sustainable materials, and stimuli-responsive materials. This symposium will span several key topics in the field of polymer AM, including functional material development (sustainable materials, stimuli-responsive materials, multi-material printing, bioprinting, etc.), post-processing of polymers, and novel applications of 3D polymer-based soft matter. This interdisciplinary session will bring together prominent researchers in the field of polymer-based AM to discuss topics related to the design, synthesis, and fabrication of functional 3D printed polymer-based soft matter, with the unifying theme of utilizing chemical advances to fabricate materials with designer properties.

Topics will include:

- Innovations in extrusion-based 3D printing of materials
- Innovations in vat photopolymerization-based 3D printing of materials
- Chemistry enabled multi-material printing
- Sustainable materials for 3D printing
- Stimuli-responsive 3D printed materials
- Polymer rheology and processing considerations for vat photopolymerization
- Polymer rheology and processing considerations for material extrusion
- Materials with designer mechanical properties
- Materials with designer functional properties
- Materials for bioprinting / bio-applications
- Structure-processing-property relationships in printable polymeric materials
- Emergent properties in architected polymer-based soft matter

Invited speakers include:

Christopher Barner-Kowollik	Queensland University of Technology, Australia	**Julia Greer**	California Institute of Technology, USA
		Charlotte Hauser	King Abdullah University of Science and Technology, Saudi Arabia
Christopher Bates	University of California, Santa Barbara, USA		
Matthew Becker	Duke University, USA	**Sarah Heilshorn**	Stanford University, USA
Eva Blasco	Heidelberg University, Germany	**Howon Lee**	Seoul National University, Republic of Korea
AJ Boydston	University of Wisconsin–Madison, USA	**Alshakim Nelson**	University of Washington, USA
Lesley Chow	Lehigh University, USA	**Eleftheria Roumeli**	University of Washington, USA
Daniel Congreve	Stanford University, USA	**Melissa Smith**	Massachusetts Institute of Technology, USA
Ying Diao	University of Illinois at Urbana-Champaign, USA	**Yue Wang**	University of California, Merced, USA
Andrew Dove	University of Birmingham, United Kingdom	**Wei Zhai**	National University of Singapore, Singapore

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Symposium MF02: Laser-Induced Nanomaterials—Synthesis, Properties and Applications

Nanomaterials have emerged as revolutionary components in science and technology, elevating and enhancing functionalities across diverse fields such as sensing, energy storage, electronics, biotechnology, and optics. While numerous fabrication procedures exist, the successful industrial implementation of nanomaterials and devices relies on cost-effective and reproducible production. Recently, laser-induced micro/nanostructures have gained recognition as a leading scalable nanomanufacturing process for a broad range of functional materials. These structures, when applied to various metals, semiconductors, dielectrics, or polymers, unlock unique material properties with specialized functionalities. By manipulating material parameters and structure morphology, novel devices such as water-repelling surfaces, optical storage devices, biosensors, and antifraud features can be realized.

Beyond their direct applications, laser nanotextured surfaces offer additional benefits. They can enhance the tribological properties of specialized tools, minimizing friction losses and wear. They can modify surface wettability, as well as influence the growth properties of cells and biofilms. Furthermore, laser-induced micro/nanostructures can serve as decorative elements, refining precious goods. This symposium serves as an international platform for the discussion of synthesis, properties, and applications of various laser-induced micro/nanostructures. It encompasses fundamental, experimental, and theoretical research aspects related to laser-induced nanomaterials. Topics include materials discovery and synthesis, as well as the comprehensive characterization of their electrical, electrochemical, optical, thermal, and mechanical properties. Additionally, the symposium explores their utilization in diverse functional devices.

Topics will include:

- Laser-induced graphene processing methods
- Laser-induced metal oxides processing methods
- Atomic structure and surface chemistry of laser treated metals and polymers
- Optical and electronic properties of Laser-induced periodic surface structures
- Electrochemical properties and applications of Laser-induced nanomaterials
- Catalytic properties and applications of Laser-induced nanomaterials
- Laser-induced thin films, composites, hybrids, and 3D structures and their applications
- Laser-induced nanomaterials for sensors, actuators, and other devices
- Laser surface nanotexturing for Biomedical applications
- Thermal and thermoelectric properties of Laser-induced nanomaterials
- Mechanical and tribological properties of Laser processed surfaces

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:

Christopher Arnusch	Ben-Gurion University of the Negev, Israel	**Carmel Majidi**	Carnegie Mellon University, USA
Amit Bandyopadhyay	Washington State University, USA	**Ibo Matthews**	Lawrence Livermore National Laboratory, USA
Joao Coehlo	Universidade NOVA de Lisboa, Portugal	**Eric McLamore**	Clemson University, USA
Simon Dunham	Cornell University, USA	**Roger Narayan**	North Carolina State University, USA
Wei Gao	California Institute of Technology, USA	**Lia Stanciu**	Purdue University, USA
Carmen Gomes	Iowa State University, USA	**Michael Stanford**	General Graphene Corporation, USA
Micah Green	Texas A&M University, USA	**James Tour**	Rice University, USA
Keon Jae Lee	Korea Advanced Institute of Science and Technology, Republic of Korea	**Nongnoot Wongkaew**	Universität Regensburg, Germany
Richard Kaner	University of California, Los Angeles, USA	**Xianfan Xu**	Purdue University, USA
Jian Lin	University of Missouri–Columbia, USA	**Zheng Yan**	University of Missouri–Columbia, USA
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Symposium MF03: Sustainable Polymers—From Fundamentals to Advanced Manufacturing and Applications

With polymeric material consumption constantly increasing and plastic waste accumulating and contaminating our land, water, and air, we are now facing a global challenge that has never been more pressing. The emerging concept of a circular bioeconomy, unravels opportunities to create a sustainable society that uses widely available bioresources while simultaneously lowering the net carbon footprint. Some of the most promising avenues currently studied in the field of sustainable polymers are to substitute fossil-derived monomers with equivalents derived from abundant and renewable biomass, utilize natural biopolymers, biosynthesized hierarchical structures or entire organisms, redesign manufacturing processes to be less wasteful and consume less energy, integrate synthetic biology tools, and develop viable end-of-life strategies. Yet, for biomass-based materials there are important remaining fundamental challenges including the fractionation, improving extraction or conversion yields, handling, and low-waste and low-energy processing, adaptation to advanced manufacturing methods. In addition, understanding of constituent materials and structures, and embracing innovations using bottom-up platforms such as cell cultures or protein design to tailor the structure and properties of biopolymer-based materials present an alternative and less explored pathway.This symposium will be centered around these topics, which require materials scientists, chemical and process engineers, synthetic biologists, environmental and bioresource scientists and chemists to collaboratively provide solutions to address this multifaceted global challenge.

Topics will include:

- Nanocellulose, lignin, chitin and other biological polymers: Extraction and characterization of materials and their hierarchical structures
- Fundamental Science of Biopolymers: Mechanical, thermal, barrier, and optical properties. Nanostructuring and multi-scale modeling
- Lignocellulose based functional structures and Nanomanufacturing: Multifunctional composites, functionalization, lightweight and strong composites
- Transparent substrates, magnetic nanostructures, 3D aerogel, hydrogel, nanomanufacturing, 3D printing
- Wood Nanotechnology: Wood nanostructure understanding, nanostructural control, and multi-functional materials design
- Development of novel biodegradable or recyclable polymers, polymers obtained from low energy or wasteless processing methods, waste-derived polymers.
- Biobased, bioderived or self-grown polymers and their composites
- Engineered living materials, cell-based and biopolymer-based materials. Including mycelium, yeast, plant and algal cell based materials, and protein-based materials.
- Studies of biodegradation and recycling or regeneration of sustainable polymers
- Emerging advanced applications based on biopolymers and biodegradable polymers such as electronics, biodevices, energy management
- Advanced manufacturing including 3D printing with sustainable polymers, and expanding functionality through composite design
- Life-cycle-assessment of sustainable materials

Invited speakers include:

Tiffany Abitbol	École Polytechnique Fédérale de Lausanne, Switzerland
Marie-Eve Aubin-Tam	Delft University of Technology, Netherlands
Diego Barriero	University College London, United Kingdom
Andrew Dove	University of Birmingham, United Kingdom
Johan Foster	The University of British Columbia, Canada
Olli Ikkala	Aalto University, Finland
Martin Kaltenbrunner	Johannes Kepler Universität Linz, Austria
Eero Kontturi	Aalto University, Finland
Tian Li	Purdue University, USA
Bradley Olsen	Massachusetts Institute of Technology, USA
Thomas Parton	University of Cambridge, United Kingdom
Megan Robertson	University of Houston, USA
Lynn Rothschild	NASA Ames Research Center, USA
Tsuguyuki Saito	The University of Tokyo, Japan
Mika Sipponen	Stockholm University, Sweden
Gilberto Siqueira	Empa–Swiss Federal Laboratories for Materials Science and Technology, Switzerland
Daniel Söderberg	KTH Royal Institute of Technology, Sweden
Wim Thielemans	KU Leuven, Belgium
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Fuzhong Zhang	Washington University in St. Louis, USA

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Symposium MT01: Integrating Machine Learning and Simulations for Materials Modeling

A new generation of computational approaches for materials modeling has emerged from innovative applications of machine learning to numerical simulations of materials. In this nascent and vibrant field, conventional methods of computational materials science are blended with data-science tools to produce physically-consistent models and conceptual knowledge. Moreover, this combined approach has also led to progress on long-standing technical challenges for numerical methods in materials modeling, such as alleviating length and time-scale limitations, improved accuracy, reducing computational costs, development inverse-design capabilities, model interpretability and transferability, visualization of materials representations in high-dimensional spaces, and handling of scarce and heterogeneous data sets. This symposium will explore emerging trends in combining data-driven frameworks with physics-based materials simulations across scales, from ab initio electronic structure calculations to large-scale atomistic simulations, mesoscale models, and continuum approaches. Applications will be considered for systems of relevance in materials science broadly construed: from structural materials to soft matter, functional materials, and quantum materials. Our goal is to deepen our understanding of novel methodological capabilities and highlight challenging issues that need to be tackled in order to enable widespread application and adoption of these approaches in academia and industry.

Topics will include:

- Uncovering structural and dynamical complexity in large-scale simulations
- Machine learning potentials for crystal defects and other heterogeneities
- Physics-based materials modeling with machine learning
- Reduced-order machine learning models for atomistic simulations
- Multi-fidelity models, data-fusion, and transfer learning approaches
- End-to-end differentiable frameworks, inverse problems, and deep generative models
- Rare-events sampling and automated identification of collective variables
- Topology optimization and development of tailored microstructure using machine learning

Invited speakers include:

Joshua Agar	Drexel University, USA
Amartya Banerjee	University of California, Los Angeles, USA
Christopher Bartel	University of Minnesota, USA
Mathieu Bauchy	University of California, Los Angeles, USA
Brad Boyce	Sandia National Laboratories, USA
Penghui Cao	University of California, Irvine, USA
Gábor Csányi	University of Cambridge, United Kingdom
Felipe da Jornada	Stanford University, USA
Brian DeCost	National Institute of Standards and Technology, USA
Julia Dshemuchadse	Cornell University, USA
Diego Gomez-Gualdron	Colorado School of Mines, USA
Sara Kadkhodaei	University of Illinois at Chicago, USA
Boris Kozinsky	Harvard University, USA
Mihai-Cosmin Marinica	Commissariat à l'énergie atomique et aux énergies alternatives, France
Benji Maruyama	Air Force Research Laboratory, USA
Katsuyuki Matsunaga	Nagoya University, Japan
Megan McCarthy	Sandia National Laboratories, USA
Dane Morgan	University of Wisconsin–Madison, USA
Danny Perez	Los Alamos National Laboratory, USA
James Rondinelli	Northwestern University, USA
Christopher Schuh	Massachusetts Institute of Technology, USA
Daniel Schwalbe-Koda	Lawrence Livermore National Laboratory, USA
Ryan Sills	Rutgers University, USA
Taylor Sparks	The University of Utah, USA
Alejandro Strachan	Purdue University, USA
Wenhao Sun	University of Michigan, USA
Aidan Thompson	Sandia National Laboratories, USA
Eric Vanden-Eijnden	New York University, USA
Wennie Wang	The University of Texas at Austin, USA

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Symposium MT02: Battery Manufacturing—Emerging Opportunities in Data-Driven Experimentation, Analysis and Modeling

Rechargeable batteries are among the key technologies for decarbonization, with expanding applications in electronics, transportation and power grids. The demand for lighter devices and safer, longer-duration energy storage continues to fuel the need for battery innovation. This need, in turn, requires designing new materials, understanding how they function and, ultimately, developing scalable processes to manufacture them. However, moving from early discovery to commercial deployment may take a decade or longer due to multifaceted requirements related to lifetime, safety, cost, and environmental impact. With the advances in artificial intelligence (AI) and machine learning (ML), in silico tools and workflows for automated characterization and data analysis are emerging. These data-driven approaches show great promise in high-throughput autonomous experimentation and in silico design pipelines. When combined, data-driven characterization, analysis and modeling can greatly accelerate the otherwise ultra-long process from battery materials discovery to commercial deployment and the impact can be transformative.

This symposium highlights the crucial roles of data-driven experimentation, analysis and modeling in accelerating the process of moving from lab-scale battery research and development to large-scale battery manufacturing. This symposium aims to advocate the emerging opportunities in using AI/ML to close the loop from early discovery to commercial deployment and to gather insights from the battery community regarding research needs. It will serve as a platform for developing collaborations among AI/ML developers, data scientists, theorists, and battery researchers broadly from industry, academia and national laboratories.

Topics will include:

- Advanced artificial intelligence and machine learning (AI/ML) techniques for battery materials development and manufacturing
- Ontologies for the adoption of AI/ML in battery sciences
- AI/ML for battery informatics
- AI/ML for data analytics and high-throughput experimentation
- AI/ML for *in situ*/in-line metrology in battery manufacturing
- AL/ML for automated high-throughput modeling
- AI/ML for supply-chain analysis and management
- Data-driven process design for materials synthesis, processing, and surface/interface engineering
- Digital twins applied to optimization of materials synthesis, electrode/cell fabrication, and recyclability

Joint sessions are being considered with **ES01 - Next-Generation EV Battery Materials—Bridging Academic, Government and Industry Research**. 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:

Abraham Anapolsky	Toyota Research Institute, USA
Mark Bailey	Wildcat Discovery Technologies, USA
Piero Canepa	National University of Singapore, Singapore
Maria Chan	Argonne National Laboratory, USA
Simon Clark	Stiftelsen for industriell og teknisk forskning, Norway
Eric Dufek	Idaho National Laboratory, USA
David Howey	University of Oxford, United Kingdom
Weihan Li	RWTH Aachen University, Germany
Elsa Olivetti	Massachusetts Institute of Technology, USA
Noah Paulson	Argonne National Laboratory, USA
Krishna Rajan	University at Buffalo, The State University of New York, USA
Venkat Srinivasan	Argonne National Laboratory, USA
Changwon Suh	U.S. Department of Energy—Office of Energy Efficiency and Renewable Energy, USA
Shailesh Upreti	Charge CCCV (C4V), USA
Venkat Viswanathan	Carnegie Mellon University, USA
Wei Wang	Pacific Northwest National Laboratory, USA
Karim Zaghib	Concordia University, Canada
Yuepeng Zhang	Argonne National Laboratory, USA

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Symposium MT03: Machine Learning Methods, Data and Automation for Sustainable Electronics

The need for optimized design, synthesis, and processing conditions is ubiquitous in materials science and technology, impacting fields as diverse as solar energy conversion, electronics, medicine, metallurgy, and energy storage. However, obtaining a target material with desired properties is time-intensive because of the high-dimensional and complex synthetic and processing parameters space. The sampling of the large synthetic and processing landscape is generally done through human intuition, based on the knowledge of physical chemistry principles, and trial-and-error approaches, leading to clustered, sparse and incomplete datasets. In the past decade, automated robotic technologies have been shown to markedly increase productivity in medicine, synthetic biology, chemistry/physics and materials science research fields by offloading repetitive works from human scientists and performing experiments at a faster speed, with greater precision, and better accuracy. With the aid of high-performance computing in recent years, artificial intelligence (AI) has been successfully applied to inorganic materials and small molecule discovery and engineering. Physics-informed machine learning approaches applied to clustering, regression, and Bayesian methods, as well as artificial neural networks, have emerged, and have used and contributed to publicly accessible databases producing new insights. This new integrated experimental and computational paradigm has enormous potential benefits, as the robotic hardware and AI software technologies required to realize this goal are just reaching maturity. The proposed symposium will address the main progress and challenges in the research of AI-guided sustainable (e.g., energy conversion and storage, climate, plastic upcycling) and electronic materials synthesis and processing, and cover the entire life cycle of these studies, from computational design, physically-guided AI, experimental automation, to control methods, synthetic databases, and robotic integration.

Topics will include:

- ML-assisted computational designs of sustainable and electronic materials
- Experimental automation for energy and electronic materials discovery
- High-throughput characterization, laboratory and synchrotron data analytics
- Autonomous systems for materials research with humans in/out-of-the loop
- Data standardization, management, graphical database and ontology
- Workflow design and process engineering for accelerated materials development
- Self-driving laboratories for organic and inorganic materials discovery
- AI-assisted microstructure, interface, and device optimization
- Robotics and control theory to guide scientific experiments
- Materials informatics for batteries, catalysts, optoelectronics, solar cells, and fuel cells, and quantum devices, etc.
- Explainable, physics-informed and small dataset machine learning

Invited speakers include:

Chibueze Amanchukwu	The University of Chicago, USA
Nong Arthrith	University of Utrecht, Netherlands
Simon Billinge	Columbia University, USA
Christoph J. Brabec	Friedrich-Alexander-Universität Erlangen-Nürnberg, Germany
Maria Chan	Argonne National Laboratory, USA
Janine George	Federal Institute for Materials Research and Testing, Germany
Rafael Gomez-Bombarelli	Massachusetts Institute of Technology, USA
Jason Hattrick-Simpers	University of Toronto, Canada
Arun Mannodi Kanakkithodi	Purdue University, USA
Rachel Kurchin	Carnegie Mellon University, USA
Benji Maruyama	Air Force Research Laboratory, USA
Reinhard Maurer	University of Warwick, United Kingdom
Austin Mroz	Imperial College London, USA
Lilo Pozzo	University of Washington, USA
Brett Savoie	Purdue Univeristy, USA
Junichiro Shiomi	The University of Tokyo, Japan
Steven Torrisi	Toyota Research Institute, USA
Tejs Vegge	Technical University of Denmark, Denmark
Aron Walsh	Imperial College London, United Kingdom
Martijn Zwijnenburg	University College London, United Kingdom

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Symposium NM01: Advances in 2D MXenes

Transition metal carbides, nitrides and carbonitrides (also known as MXenes) represent a quickly expanding family of two-dimensional (2D) materials, including more than 50 members and multiple new structures and compositions added every year. They induce an ever-growing interest within the scientific community, owing to their unique, versatile and wide-ranging portfolio of physical and chemical properties. During the last few years, MXenes have been explored in many applications, such as catalysis, energy harvesting and storage, sensing, electromagnetic interference shielding, wireless communications, electronics and biomedicine.

This Symposium will represent an international forum for discussing advances in synthesis, chemistry and physics of MXenes, their hybridization with other materials, along with industrial developments. It will cover all aspects of the fundamental, experimental and theoretical research on MXenes, including state-of-the-art findings related to their synthesis and characterization of electrical, electrochemical, optical, thermal and mechanical properties, as well as integration into functional devices.

Topics will include:

- Synthesis of MXenes – Experimental and Theoretical Approaches
- Structural, Morphological, Chemical and Surface Characterization of MXenes
- Optical and Electronic Properties of MXenes
- Electrochemical Properties and Applications of MXenes
- Thermal and Thermoelectric Properties of MXenes
- Mechanical and Tribological Properties of MXenes
- Catalytic Properties and Applications of MXenes
- Optoelectronic and Electronic Devices based on MXenes
- Sensing Applications of MXenes
- Biomedical Applications of MXenes
- Electromagnetic Interference Shielding Applications of MXenes
- MXene Composites, Hybrid and 3D Structures

Invited speakers include:

Husam Alshareef	King Abdullah University of Science and Technology, Saudi Arabia
Babak Anasori	Indiana University-Purdue University Indianapolis, USA
Christina Birkel	Arizona State University, USA
Lucia Gemma Delogu	University of Padua, Italy
Yury Gogotsi	Drexel University, USA
Tae Hee Han	Hanyang University, Republic of Korea
Qing Huang	Ningbo Institute of Materials Technology and Engineering, Chinese Academy of Sciences, China
Agnieszka Jastrzebska	Warsaw University of Technology, Poland
De-en Jiang	Vanderbilt University, USA
Seon Joon Kim	Korea Institute of Science and Technology, Republic of Korea

Chong Min Koo	Sungkyunkwan University, Republic of Korea
Pooi See Lee	Nanyang Technological University, Singapore
Maria Lukatskaya	ETH Zürich, Switzerland
Vadym Mochalin	Missouri University of Science and Technology, USA
Per Persson	Linköping University, Sweden
Volker Presser	INM – Leibniz Institute for New Materials, Germany
Johanna Rosen	Linköping University, Sweden
Dmitri Talapin	The University of Chicago, USA
Flavia Vitale	University of Pennsylvania, USA
Huanyu Zhou	Seoul National University, Republic of Korea

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Symposium NM02: Advances in Nanodiamonds

Nanodiamond is a unique class of carbon nanomaterial with crystal sizes ranging from ~3 nm to several hundred nm. Nanodiamond has favorable properties for biomedical applications including non-toxic, biocompatible, and flexible surfaces for a wide range of functionalization. Moreover, color centers (atomic size point defects in nanodiamond) give the nanodiamonds unique photonic and spin properties and are rapidly driving the development of nanoscale quantum sensing capabilities. In this symposium the broader community will discuss how production methods can affect the size, morphology, surface chemistry of nanodiamonds and the corresponding yield and orientation of color centers. Understanding and developing advanced nanodiamond processing methods promises to enable nanodiamond materials with improved photonic and spin properties. This is of critical importance to both sensing and communication applications, where both longer spin coherence times and brighter single photon emission are needed. In addition, rapidly growing interests in nanodiamonds have also been driven by applications in nanotherapies (antibacterial agents, implantation coating, bone implant, etc.), drug delivery (cancer treatment, vaccination, stem cell therapy, etc.) and medical imaging. The large breadth of research has demonstrated that nanodiamonds can be used as a multi-modal platform for diagnostics and delivery of both traditional and emerging therapeutic molecules. Nanodiamonds have additional advantages of uniform shape, hardness, non-porosity, and unique surface chemistries that lead to their applications as nanocomposites. This symposium provides a platform for the presentation of recent advances of nanodiamond synthesis, functionalization, quantum sensing, biomedical theranostic applications, and other novel applications like catalysis, photoelectrocatalysis, and nanocomposites.

Topics will include:

- Nanodiamond-based nanosensors for imaging, temperature, spin, and field sensing
- Nanodiamond for imaging contrast enhancement
- Advances in nanodiamond fabrication for better control of size, shape, defects, doping and spin
- Advances in single digit, well-dispersed nanodiamonds
- Advances in characterization and modeling of nanodiamond particles and dispersions
- Advances of *in situ* and *in operando* characterization of nanodiamonds
- Advances in surface chemistry modifications of nanodiamonds
- Nanodiamonds for drug delivery: mechanisms and clinical translation
- Nanodiamond toxicity, biodistribution and pharmacokinetics
- Nanodiamond-based composites
- Nanodiamond for catalysis or photoelectrocatalysis
- Other novel applications unique to nanodiamonds

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:

Petr Cigler	Institute of Organic Chemistry and Biochemistry of the Czech Academy of Sciences, Czech Republic
E.A. Ekimov	Institute for High Pressure Physics Russian Academy of Sciences, Russian Federation
Yoshie Harada	Osaka University, Japan
Phil Hemmer	Texas A&M University, USA
Fedor Jelezko	Universität Ulm, Germany
Pik Kwan Lo	City University of Hong Kong, Hong Kong
Gavin Morley	University of Warwick, United Kingdom
Keir Neuman	National Institute of Health, USA
Taras Plakhotnik	The University of Queensland, Australia
Ramona Schirhagl	University of Groningen, Netherlands
Olga Shenderova	Adámas Nanotechnologies, USA
Stepan Stehlik	Institute of Physics of the Czech Academy of Sciences, Czech Republic
A. Nick Vamivakas	University of Rochester, USA
David Waddington	The University of Sydney, Australia
Tanja Weil	Max Planck Institute for Polymer Research, Germany
Taro Yoshikawa	Daicel Corporation, Japan
Alexander Zaitsev	The City University of New York, USA

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Symposium NM03: Nanoscale Mass Transport Through 2D and 1D Nanomaterials

2D and 1D nanomaterials offer fundamentally new opportunities to control nanoscale mass transport and present potential for breakthrough advances in gas separation, nanofiltration, desalination, ionic/molecular separation, proton transport, DNA translocation, dialysis and protein desalting, among others. The outstanding properties of 2D and 1D nanomaterials provides unique opportunities to overcome the historical trade-off in permeance vs selectivity endemic to nanoscale mass transport. However, challenges in scalable synthesis, controlled assembly and integration into functional devices using scalable manufacturing processes have limited progress towards practical applications. Recent research progress has helped to overcome many of the challenges, allowing progress towards practical applications. This interdisciplinary symposium aims to bring together the community of researcher working on nanoscale mass transport through 2D and 1D nanomaterials including fundamental physics, theory, material synthesis and characterization, device integration and scalable manufacturing, to disseminate the latest advances. The symposium will help promote the field of nanoscale mass transport through 2D and 1D nanomaterials and help to form connections between researchers to accelerate innovation and move these materials towards practical applications.

Topics will include:

- Water, ion and liquid transport through 2D and 1D membranes
- Gas transport through 2D and 1D membranes
- Synthesis and Characterization of 2D and 1D materials for transport/membrane applications
- Advances in membrane fabrication with 2D and 1D materials
- Fundamentals of nanoscale transport phenomena: theory and experiments

Invited speakers include:

Varoon Kumar Agarwal	École Polytechnique Fédérale de Lausanne, Switzerland	**Rohit Karnik**	Massachusetts Institute of Technology, USA
Narayana Aluru	The University of Texas at Austin, USA	**Manish Kumar**	The University of Texas at Austin, USA
Radha Boya	The University of Manchester, United Kingdom	**Mainak Majumder**	Monash University, Australia
Scott Bunch	Boston University, USA	**Baoxia Mi**	University of California, Berkeley, USA
Chi Cheng	The University of Melbourne, Australia	**Aleksandr Noy**	Lawrence Livermore National Laboratory, USA
Marija Drndic	University of Pennsylvania, USA	**Hyun Gyu Park**	Pohang University of Science and Technology, Republic of Korea
Slaven Garaj	National University of Singapore, Singapore	**Alexandra Radenovic**	École Polytechnique Fédérale de Lausanne, Switzerland
Lonzardo Marcelo Hidalgo	The University of Manchester, United Kingdom	**Michael Strano**	Massachusetts Institute of Technology, USA
De-en Jian	Vanderbilt University, USA	**Luda Wang**	Peking University, China
Rakesh Joshi	University of New South Wales, Australia		

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Symposium QT01: Ultrafast Light-Matter Interactions in Quantum Materials

Quantum materials host a wide range of many-body and topological phenomena that are promising for next-generation technologies. From unconventional superconductivity to topologically protected edge modes, the remarkable physics of quantum materials emerges from the complex interactions between spin, charge, lattice, orbital degrees of freedom and the topological aspects of their wave functions. These materials host multiple quantum phases that can be independently accessed by external perturbations such as electromagnetic fields, pressure, strain, and chemical doping. The search for new ways to create and control their macroscopic properties keeps improving our fundamental understanding of the interactions among the underlying degrees of freedom, which in turn may lead to new functionalities. One promising route to understand and control quantum materials is through ultrafast light-matter interactions. Photoinduced nonequilibrium states have functionally relevant properties which are not accessible at thermal equilibrium. Given the scale of recent developments and activity in this field, this symposium aims at promoting communication among researchers investigating theoretically and experimentally (i) the fundamental linear and nonlinear optical properties of quantum materials using ultrafast spectroscopy, (ii) their fabrication by using physical and chemical approaches and (iii) their applications in different areas of materials science, condensed matter physics, and device engineering for photonics, optoelectronics and quantum technologies. The symposium will primarily focus on ultrafast light-matter interactions to control the macroscopic properties of van der Waals materials, including - but not limited to - 2D heterostructures and strongly correlated systems. We will focus on the experimental and theoretical aspects for the investigation of a variety of nonequilibrium effects, such as electron-electron and electron-phonon interactions in exciton and spin dynamics. Finally, we will also discuss different approaches for synthesizing quantum materials at the nanoscale, and for exploring dynamical decoupling of microscopic degrees of freedom, light-induced magnetization and superconductivity, photon-dressed topological states, as well as nonlinear optical effects in ultracompact systems.

Topics will include:

- Ultrafast exciton and spin dynamics in 2D semiconductors and heterostructures;Ultrafast electronic/optical/magnetic properties of quantum materials
- Ultrafast dynamics in strongly correlated materials;Topological phenomena, surface and edge states in quantum materials
- Ultrafast techniques for characterizing quantum materials;Tunable photon emission from quantum materials
- Hybrid quasiparticles and mixed light-matter states; Metasurfaces and optical devices from quantum materials
- Photonic and optoelectronic devices based on quantum materials; Ultrafast plasmonics and polaritonics in hybrid quantum materials
- Exfoliation, growth and synthesis techniques for the fabrication of quantum materials; First principles, charge transport and electromagnetic modeling of devices based on quantum materials
- Analytical methods for the description of ultrafast light-matter interactions in quantum materials

Joint sessions are being considered with **BI01 - Materials Research by the LGBTQIA+ Community and a Vision for Inclusivity**, **BI02 - Broadening Participation in Materials Research and STEM**, and **CH01 - Characterizing Dynamic Processes of Materials Synthesis and Processing via *In Situ* Techniques**. 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:

Dmytro Afanasiev	Radboud Universiteit, Netherlands	**Dante Kennes**	Aachen University, Germany
Unai Atxitia	Instituto de Ciencia de Materiales de Madrid, Spain	**Peter Kraus**	Advanced Research Center for Nanolithography, Netherlands
Youn Jue (Eunice) Bae	Columbia University, USA	**Xiaoqin (Elaine) Li**	The University of Texas at Austin, USA
Daniele Brida	University of Luxembourg, Luxembourg	**Ermin Malic**	Philipps-Universität Marburg, Germany
Andrea Caviglia	University of Geneva, Swaziland	**Sheng Meng**	Institute of Physics, Chinese Academy of Sciences, China
Alexei Chernikov	Technische Universität Dresden, Germany	**Prineha Narang**	University of California, Los Angeles, USA
Elisabetta Collini	Università di Padova, Italy	**Shovon Pal**	National Institute of Science Education and Research, India
Stefano Dal Conte	Politecnico di Milano, Italy	**Eva Pogna**	Politecnico di Milano, Italy
Alberto de la Torre Duran	Northwestern University, USA	**Su-Ying Quek**	National University of Singapore, Singapore
Steffen Michaelis de Vasconcellos	Universität Münster, Germany	**Archana Raja**	Lawrence Berkeley National Laboratory, USA
Daniele Fausti	Friedrich-Alexander-Universität Erlangen-Nürnberg, Germany	**Claus Ropers**	Max Planck Institute for Multidisciplinary Sciences, Germany
Giulia Grancini	Università degli Studi di Pavia, Italy	**Chong-Yu Ruan**	Michigan State University, USA
Antonija Grubišic Cabo	University of Groningen, Netherlands	**Shawn Sederberg**	Simon Fraser University, Canada
Deep Jariwala	University of Pennsylvania, USA	**Michael Sentef**	Max Planck Institute for the Structural and Dynamics of Matter, Germany
Aaron Kelly	Dalhousie University, Canada	**Klaas-Jan Tielrooij**	Technische Universiteit Eindhoven, Netherlands

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Symposium QT02: Low-Dimensional Magnetic Quantum Materials

This symposium will cover recent efforts in engineering, measuring, understanding, and employing magnetism in emerging quantum materials with a focus on reduced dimensionality, which is essential for device applications. The symposium's first part will focus on large-scale thin film and bulk crystals synthesis, new functionalities, and electronic, photonic, and magnetic memory device applications. Contributions on synthesis will discuss recent progress in the growth of magnetic quantum materials such as materials with topologically non-trivial band structures, Kagome materials, magnetic topological insulators, frustrated magnetic systems, and spin textures. Symposium contributions from experimentalists and theoreticians will address challenges in growth and discuss how novel magnetic states in quantum materials can be engineered starting from individual atoms and symmetries. Emerging devices discussed will include proposals for the use of magnetic materials in quantum computations and dissipationless energy transfer, spintronics devices, magnetic tunnel junctions (MTJs), and other emerging magnetic devices. Symposium contributions will emphasize how engineering and controlling magnetic states can result in novel device functionalities. The second part of the symposium will bridge synthesis and applications and focus on new frontiers of probing magnetic states within the bulk and in nanoscale materials with high precision. Topics will include measurements of magnetic moments with scanning probe techniques, non-linear optical probes, and emerging applications of transmission electron microscopy for studying magnetic moments with atomic resolution. Contributions exploring the use of *in situ* probes to examine non-equilibrium states and extreme conditions will also be welcomed. This symposium will bring together a diverse pool of young scientists and established leaders to identify major challenges and opportunities within emerging magnetic quantum materials and devices.

Topics will include:

- Scalable growth of thin films of magnetic materials, including van der Waals materials, Kagome, and frustrated magnets
- The growth of layered crystals of magnetic materials, Kagome magnets, magnetic topological insulators, and materials hosting spin textures
- Measurement and manipulation of magnetism with high precision - atomically resolved scanning transmission electron microscopy (STEM), Lorentz TEM, scanning tunneling microscopy (STM), scanning NV-centers, magnetic symmetry probes, ultrafast perturbation and control of magnetism
- The measurements and manipulation of magnetism in low-dimensional materials, which includes the application of high pressures, high electric fields, and ultrafast excitation techniques.
- Magnetic devices, novel device concepts, and novel approaches to employ magnetization in energy-efficient storage, reading, and writing
- New theory developments including magnetic topological materials predictions and high-throughput calculations

Invited speakers include:

James Analytis	University of California, Berkeley, USA	**Mathieu Munsch**	Qnami, Switzerland
Ahmet Avsar	National University of Singapore, Singapore	**Prineha Narang**	University of California, Los Angeles, USA
Valentina Bisogni	Brookhaven National Laboratory, USA	**Xavier Roy**	Columbia University, USA
Andrea Caviglia	University of Geneva, Switzerland	**Kyle Seyler**	The University of Arizona, USA
Cui-Zu Chang	The Pennsylvania State University, USA	**Yu-Tsun Shao**	University of Southern California, USA
Matthew Daniels	National Institute of Standards and Technology, USA	**Tyler Slade**	Iowa State University, USA
Punyashloka Debashis	Intel Corporation, USA	**Zdenek Sofer**	University of Chemistry and Technology, Prague, Czech Republic
Jaroslav Fabian	Universität Regensburg, Germany	**Veronika Sunko**	University of California, Berkeley, USA
Eric Fullerton	University of California, San Diego, USA	**Weiwei Xie**	Michigan State University, USA
Marco Gibertini	Università degli studi di Modena e Reggio Emilia, Italy	**Xiaodong Xu**	University of Washington, USA
Xia Hong	University of Nebraska–Lincoln, USA	**Li Yang**	Washington University in St. Louis, USA
Juan Carlos Idrobo	University of Washington, USA	**Oleg Yazyev**	École Polytechnique Fédérale de Lausanne, Switzerland
Anna Isaeva	University of Amsterdam, Netherlands	**Linda Ye**	California Institute of Technology, USA
Roland Kawakami	The Ohio State University, USA	**Hongtao Yuan**	Nanjing University, China
Tracy Lovejoy	Nion Co., USA		

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Symposium QT03: Physics of 2D Halide and Chalcogenides Semiconductors

The discovery of mechanically exfoliated graphene in 2004 triggered a “two-dimensional (2D) fever” in the fields of condensed matter physics, material science, chemistry, and nanotechnology. Since then, research on ultrathin 2D nanomaterials has grown exponentially, highlighting their compelling physical, chemical, and optoelectronic properties. Among the plethora of semiconducting layered materials, the families of transition metal dichalcogenides (TMDCs) and 2D perovskites have received particular attention over the past few years. Their unique properties make them particularly attractive for a new generation of optoelectronic and energy-harvesting devices. They also constitute an excellent playground for exploring new exotic phenomena in the ultimate 2D limit associated with strong interactions between electronic, photonic, and vibrational excitations. Moreover, the advent of van der Waals nature introduced a new paradigm of heterostructure engineering free of lattice matching constraints and offering new avenues for condensed matter physics. In turn, to understand the associated fundamental phenomena that make these materials exceptional for basic science and novel application routes requires close collaborations and intense exchange within a broad community of researchers in material science, physics, and chemistry.

This symposium will serve as a platform for researchers currently working at the forefront of semiconducting 2D materials with a focus on the fundamental properties of these systems and their development towards future applications. Bringing together experts from different fields such as inorganic, hybrid, and colloidal 2D materials will lead to exciting exchange of ideas in view of the similarities and distinctions of these systems, thus providing the participants with a broad perspective on 2D materials physics. Research topics covered in the symposium will include developments in materials chemistry and growth mechanisms, latest advances in photophysics, transport of charge carriers and excitons, as well as ultrafast spectroscopy and theoretical modeling. Submitted abstracts may focus on various novel material platforms such as low-dimensional perovskites, transition metal dichalcogenides, colloidal systems, and van der Waals heterostructures bridging different families of these materials. The experimental sessions will be complemented by sessions focusing on the theoretical description and the development of new methods and approaches.

Topics will include:

- Excitons in layered semiconductors
- Charge carrier and exciton transport in 2D
- Role of defects and impurity doping
- Heterostructures: charge and energy transfer
- Lattice dynamics, carrier-phonon coupling and polaron formation
- Growth and fabrication
- Ultrafast phenomena and many-body effects
- Theoretical modeling and computational approaches
- Chirality and spin phenomena
- Strain engineering

Invited speakers include:

Claudia Backes	University of Kassel, Germany
Milan Delor	Columbia University, USA
Goki Eda	National University of Singapore, Singapore
Sascha Feldmann	Harvard University, USA
Marina R. Filip	University of Oxford, United Kingdom
Jonathan Finely	Walter Schottky Institut Technische Universität München, Germany
Naomi Ginsberg	University of California, Berkeley, USA
Cherie Kagan	University of Pennsylvania, USA
Erik Kirstein	Technische Universität Dortmund, Germany
Maria Loi	University of Groningen, Netherlands
Ermin Malic	Philipps-Universität Marburg, Germany
David Mitzi	Duke University, USA
Archana Raja	Lawrence Berkeley National Laboratory, USA
Sivan Refaely-Abramson	Weizmann Institute of Science, Israel
Tomasz Smolenski	ETH Zürich, Switzerland
Costas Stoumpos	University of Crete, Greece
Yana Vaynzof	Technische Universität Dresden, Germany
Yorgos Volonakis	Université de Rennes, France

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Symposium QT04: Superconducting Materials

The symposium will broadly cover superconducting materials with emphasis on recent developments from basic science to applications. The symposium will have several focused areas: 1) newly discovered unconventional superconductors that include kagome superconductors, nickelates, twisted bilayer graphene/TMD, and topological superconductors; 2) novel synthesis approaches and induced superconductivity that include high pressure, interfacial coupling, doping, and out-of-equilibrium methods; 3) applications of superconducting materials in quantum computation and sensors, and energy and large-scale systems, such as prototype superconducting power devices, conductors for high field magnets, accelerators, and newly proposed fusion reactors. The symposium encourages discussions on addressing challenges in the development of superconducting qubits through the identification of the noise sources, so are discussions addressing the performance of superconducting wires, such as homogeneity through length, cost-effectiveness, high throughput, and scalability.

The superconducting materials of interest include conventional low-temperature superconductors for electronics and sensors, intermetallic superconductors, medium- and high-Tc superconductors (cuprates, iron-based compounds, MgB_2), and very high-T_c hydride superconductors, as well as other emergent materials exhibiting unconventional superconductivity.

Topics will include:

- Kagome superconductors, nickelate thin films, topological and other novel superconductors
- Superconductivity in twisted graphene and TMD
- Tuning superconductivity by high pressure, ionic gating, and light
- Theories and predictions for novel superconductors
- Superconducting qubits: materials issues, gates and error corrections
- Josephson junctions technology and interface
- REBCO wires and coated conductors
- Fe-based superconductors and potential applications
- Bi-based, Nb-based, MgB(2) tapes and round wires: processing and applications
- Flux pinning and critical currents
- Energy applications and devices based on superconducting materials

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:

Xianhui Chen	University of Science and Technology of China, China
Paul Chu	University of Houston, USA
Seamus Davis	University of Oxford, United Kingdom
Nathalie de Leon	Princeton University, USA
Hong Ding	Shanghai Jiao Tong University, China
Hiroshi Eisaki	National Institute of Advanced Industrial Science and Technology, Japan
Russell Hemley	University of Illinois at Chicago, USA
Philip Kim	Harvard University, USA
Takanobu Kiss	Kyushu University, Japan
Danfeng Li	City University of Hong Kong, Hong Kong

Kaname Matsumoto	Kyushu Institute of Technology, Japan
Teresa Puig	Institut de Ciència de Materials de Barcelona, Spain
Mary Ann Sebastian	University of Dayton, USA
Venkat Selvamanickam	University of Houston, USA
Jun-ichi Shimoyama	Aoyama Gakuin University, Japan
Yoshihiko Takano	National Institute for Materials Science, Japan
John Tranquada	Brookhaven National Laboratory, USA
Haihu Wen	Nanjing University, China
Maw-Kuen Wu	Academia Sinica, Taiwan
Xingjiang Zhou	Institute of Physics, Chinese Academy of Sciences, China

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Symposium QT05: Advances in Detection Methods for Emergent Phases in Quantum Materials

Quantum materials, such as superconductors and topological insulators, all display exotic emergent phases with non-trivial topology that require characterisation at multiple extremes: ultrafast timescales, nanometre length scales, cryogenic temperatures, and high applied fields (magnetic, strain, pressure). This symposium covers recent progress in the multiscale advanced characterization, synthesis and theoretical modeling of exotic quantum objects and emergent phases within materials to disentangle and understand the complex interactions at these extremes. We showcase a range of characterisation techniques, including ultrafast near-field imaging and spectroscopy, attosecond spectroscopy, magnetometry, and transmission electron microscopy, and their application on multiferroics, topological insulators, Moiré van der Waals materials, and other emerging systems. The symposium will also showcase state-of-the-art material platforms such free-standing thin-film oxide membranes, stacks of two-dimensional materials, and combinations thereof. This symposium aims to highlight theoretical developments in understanding complex electronic interactions, non-equilbrium dynamics, and emergent nano-/meso-scale textures in quantum materials. The contributions will address basic scientific issues, discovery of new phenomena, limiting factors in the practical application of emergent topological phases in quantum materials and device design. This symposium aims to bring together scientific experts and young scientists from synthesis, characterization, and modeling, to foster interactions and surpass current technical limitations to the discovery of novel materials and quantum functionalities.

Topics will include:

- Time-resolved and ultrafast measurements
- *In situ/operando* characterization of dynamic processes via electron and local probe microscopy
- Three dimensional characterisation and reconstruction of higher order topologies
- Atomic-scale charge, spin and phonon characterization
- Controlled formation and movement of topological structures
- Theoretical simulation and modeling of mechanically, electrically and magnetically driven processes
- Advancements in cryogenic electron microscopy holders, such as temperature control and extreme low liquid helium temperatures
- Synergies with theoretical methods and data science
- Advanced data acquisition and analysis methods (including AI/ML) for operando characterisation techniques
- Phase transitions and dynamic process at cryogenic temperatures

Joint sessions are being considered with **QT06 - Quantum Phenomena in Oxides—Synthesis, Characterization and Automation**.
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:

Zakaria Al Balushi	University of California, Berkeley, USA
Sarah Burke	University of British Columbia, Canada
Fabrizio Carbone	École Polytechnique Fédérale de Lausanne, Switzerland
Lesley Cohen	Imperial College London, United Kingdom
Richard Curry	University of Manchester, United Kingdom
Seamus Davis	University College Cork, Ireland
Claire Donnelly	Max Planck Institute for Chemical Physics of Solids, Germany
Rafal Dunin-Borkowski	Forschungszentrum Jülich GmbH, Germany
Jennifer Fowlie	Stanford University, USA
Jordan Hachtel	Oak Ridge National Laboratory, USA
Jorge Íñiguez	Luxembourg Institute of Science and Technology, Luxembourg
Cameron Johnson	Lawrence Berkeley National Laboratory, USA

Olga Kazakova	National Physical Laboratory, United Kingdom
Budhika Mendis	Durham University, United Kingdom
David Muller	Cornell University, USA
Margaret Murnane	University of Colorado Boulder, USA
Amanda Petford-Long	Argonne National Laboratory, USA
Quentin Ramasse	SuperSTEM National Laboratory, United Kingdom
Satoshi Sasoski	University of Leeds, United Kingdom
Yu-Tsun Shao	University of Southern California, USA
Naoya Shibata	The University of Tokyo, Japan
Sandhya Susarla	Arizona State University, USA
Jessica Wade	Imperial College London, United Kingdom
Haidan Wen	Argonne National Laboratory, USA

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Symposium QT06: Quantum Phenomena in Oxides—Synthesis, Characterization and Automation

In strongly correlated electron systems, intimate coupling between spin, charge, and lattice degrees of freedom are governed by quantum mechanical effects and can provide pathways to new applications and translational innovations. The synergy between synthesis, characterization, and theory is critical to advance the discovery of new materials and properties, such as ferroelectricity, magnetism, and unconventional superconductivity.

Precise synthesis techniques, remote epitaxy, and topotactic transformation will pave the way for the tailored fabrication of oxide-based quantum materials. Moreover, atomic scale heterogeneity in the form of abrupt interfaces and defects can give rise to unique functionalities in bulk crystals or epitaxially designed heterostructures. State-of-art characterization tools will enable spatial- and time-resolved imaging and spectroscopy, elucidating structure-property relationships, emergent interface effects, and nanoscale/mesoscale order/disorder of spins and polarization. Computational methods lie at the forefront to predict the origin of the structure-property interactions and bridge the gap between synthesis and characterization.

The symposium proposed here will focus on a wide range of oxide-based quantum materials. Abstracts will be solicited from (but not limited to) experimental or theoretical studies of correlated phenomena, new states of matter, manipulation of spin and polar order, and more in bulk or thin film oxide materials. Studies on novel characterization methods and/or synthesis techniques are welcome, including those based on machine learning-assisted synthesis methods, characterization techniques, and data processing.

Topics will include:

- Unconventional superconductivity in oxides
- Magnetism, ferroelectrics, and relaxors
- Remote epitaxy, freestanding oxides, and topotactic transformation
- X-ray and electron diffraction and imaging characterization techniques
- Computational methods for understanding and exploring oxide materials
- Single crystal and thin film synthesis
- Machine learning methods and automation for synthesis and characterization

Joint sessions are being considered with **QT05 - Advances in Detection Methods for Emergent Phases in Quantum Materials**.

Invited speakers include:

Marco Bernardi	California Institute of Technology, USA	**Demie Kepaptsoglou**	University of York, United Kingdom
Mariona Coll	Institut de Ciència de Materials de Barcelona, Spain	**Matthias Kläui**	Johannes Gutenberg-Universität Mainz, Germany
Ryan B. Comes	Auburn University, USA	**Judith MacManus-Driscoll**	University of Cambridge, United Kingdom
Michele Conroy	Imperial College London, United Kingdom	**Dennis G. Meier**	Norwegian University of Science and Technology, Norway
Regina Dittmann	Forschungszentrum Jülich GmbH, Germany	**Yousra Nahas**	University of Arkansas, USA
Ismail El Baggari	Harvard University, USA	**Nini Pryds**	Technical University of Denmark, Denmark
Sinead Griffin	Lawrence Berkeley National Laboratory, USA	**Ramamoorthy Ramesh**	Rice University, USA
Gael Grissonnanche	École Polytechnique, France	**Steven R. Spurgeon**	Pacific Northwest National Laboratory, USA
Matthias Hepting	Max Planck Institute for Solid State Research, Germany	**Ruijuan Xu**	North Carolina State University, USA
Bharat Jalan	University of Minnesota Twin Cities, USA		

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Symposium QT07: 3D Topological Semimetals—From Fundamentals to Applications

The existence of three-dimensional Dirac or Weyl cones and their associated massless quasiparticles in 3D topological semimetals is a relative recent discovery that has invigorated a vibrant new research field. Using the quasiparticles as analogs of (currently undiscovered) elementary particles, these materials provide a means to study aspects of fundamental particle physics. Their peculiar electronic structure properties are a rich playground for studying electron and phonon transport, optical and magnetic phenomena, as well as the interplay between band-structure topology with correlation effects. Finally, their exceptional electron and phonon transport properties also promise applications in novel technologies. This symposium invites contributions covering the full scientific spectrum of 3D topological semimetals, both in bulk and thin film form, from fundamentals to applications.

Topics will include:

- Dirac vs Weyl semimetals
- Electronic and magnetic structure
- Topological states in correlated electron systems
- Dirac materials with charge density wave order
- Opto-electronic and magneto-optical properties
- Collective excitations in topological semimetals
- Controlling materials properties by predictive synthesis
- Bulk and thin film synthesis of topological semimetals and heterostructures
- Materials design and discovery
- Defects, doping, and atomic disorder
- Novel applications of Dirac and Weyl semimetals
- Topological semimetal devices
- Topological materials for energy harvesting, thermoelectrics, and interconnects

Invited speakers include:

Junyeong Ahn	Harvard University, USA
Kirstin Alberi	National Renewable Energy Laboratory, USA
Bogdan Bernevig	Princeton University, USA
Ching-tzu Chen	IBM Corporation, USA
Mark Edmonds	Monash University, Australia
Claudia Felser	Max Planck Institute for Chemical Physics of Solids, Germany
Liang Fu	Massachusetts Institute of Technology, USA
Sinead Griffin	Lawrence Berkeley National Laboratory, USA
Shin-ichi Kimura	Osaka University, Japan
Qiong Ma	Boston College, USA
Prineha Narang	University of California, Los Angeles, USA

Stuart Parkin	Max Planck Institute of Microstructure Physics, Germany
Silke Paschen	Technische Universitat Wien, Austria
Nitin Samarth	The Pennsylvania State University, USA
Niels Schröter	Max Planck Institute of Microstructure Physics, Germany
Bahadur Singh	Tata Institute of Fundamental Research, India
Pawel Starowicz	Jagiellonian University, Poland
Susanne Stemmer	University of California, Santa Barbara, USA
Fazel Tafti	Boston College, USA
Masaki Uchida	Tokyo Institute of Technology, Japan
Suyang Xu	Harvard University, USA
Yang Zhang	The University of Tennessee, Knoxville, USA

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Symposium SB01: Bioresponsive Nanotheranostics

This symposium will broadly cover the vibrant research field of the design and development of novel nanomaterials that can integrate therapeutic (e.g. drug/gene/radioisotope delivery, radiation, thermal/dynamic therapy, etc.) and diagnostic (e.g. noninvasive imaging, in vivo/ex vivo sensing, etc.) capabilities, in response to various cues in the biological/physiological environment (e.g. pH, redox potential, enzymes, glucose, oxygen level, biomimicry, etc.), as well as certain physical stimuli (e.g. temperature, magnetic field, ultrasound, radiation, self-assembly/disassembly, etc.).

Despite significant advances in biomedical approaches, many critical questions still remain: How to realize accurate prognosis to guide personalized/precision treatment? How to achieve desirable therapeutic efficacy while minimizing adverse systematic toxicity? How to spatiotemporally monitor drug fate and drug response for precision medicine? How to facilitate clinical translation? By harnessing the modular structure and bioresponsive properties of functional nanomaterials, nanotheranostics hold tremendous potential to provide accurate diagnostic and therapeutic capabilities, and has been a flourishing field over the last 2 decades. This 3-day symposium on "Bioresponsive Nanotheranostics" will gather the brightest minds with academic, industrial, and clinical backgrounds from various international institutes to share cutting-edge research and inspirational opinions, which will foster/catalyze exciting opportunities for (international) interdisciplinary and multidisciplinary collaborations.

Topics will include:

- Nanotheranostics in response to biological stimuli
- Nanotheranostics in response to physical stimuli
- Biomimetic nanotheranostics
- Clinical translation of nanotheranostics
- Nanomaterials for biomedical imaging
- Nanomaterials for new type of treatments
- Nanomaterials as drug delivery systems
- Preclinical and 3D models for nanomedicine

Invited speakers include:

Frank Caruso	The University of Melbourne, Australia
Rona Chandrawati	University of New South Wales, Australia
Gemma-Louise Davies	University College London, United Kingdom
Stefaan De Smedt	Ghent University, Belgium
Zi (Sophia) Gu	University of New South Wales, Australia
Qianjun He	Shanghai Jiao Tong University, China
Hao Hong	Nanjing University, China
Dale Huber	Sandia National Laboratories, USA
Daishun Ling	Shanghai Jiao Tong University, China
Zhuang Liu	Soochow University, China
Chad Mirkin	Northwestern University, USA
Samir Mitragotri	Harvard University, USA
Kanyi Pu	Nanyang Technological University, Singapore
Stefaan Soenen	KU Leuven, Belgium
Kristofer Thurecht	The University of Queensland, Australia
Jiajia Xue	Beijing University of Chemical Technology, China
Xiyun Yan	Institute of Biophysics, Chinese Academy of Sciences, China
Chun-Xia Zhao	The University of Adelaide, Australia
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2024 MRS® SPRING MEETING & EXHIBIT
April 22-26, 2024 | Seattle, Washington
May 7-9, 2024 | Virtual

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Abstract Submission Opens Friday, September 15, 2023
Abstract Submission Closes Wednesday, October 18, 2023 (11:59 PM ET)

Symposium SB02: Charge Carrier Transport in Organic and Organic-Inorganic Hybrid Materials

Understanding the intricacies of charge-carrier transport in organic semiconductors, and more recently organic-inorganic hybrid semiconductors remains a significant challenge. Despite the growing number of applications of these materials, being as charge-carrier transport interlayers in optoelectronic devices, active materials in thermoelectric generators, electrode or binder materials in batteries, to name a few, the design of high-performing semiconductors continues to be difficult due to limited knowledge related to the intricate interplay among molecular and polymer structure, dopant chemistry, dopant-host interactions, and semiconductor morphology. This symposium will deliver an interdisciplinary platform to discuss the most recent advances in molecular and material design and charge-carrier transport theory to address the most pressing challenges with regard to material engineering to enable the development of next-generation semiconducting materials and emerging device technologies. Examples include intrinsic conductors such as open-shell polymers and organo-metallic coordination polymers demonstrating unprecedented charge-carrier transport properties (>1000 S cm^{-1}), thereby pushing the boundaries of current transport models and theory. Novel dopant and host material design approaches to enhance dopant miscibility and improve molecular doping through innovative processing such as ion exchange, Lewis acid doping, thermally activated doping and double doping to name a few. Advances in model and theory development will be deeply integrated into materials and characterization-focused sessions to demonstrate the critical roles of the synthesis-processing-characterization-modeling-application feedback loops that are required to move beyond trial-and-error approaches to materials design and discovery.

Topics will include:

- Design and synthesis of organic semiconductors and dopants
- Open-shell materials
- Organo-metallic coordination polymers
- Novel doping approaches
- Charge-carrier transport modelling
- Interlayers for opto-electronic devices
- Organic thermoelectrics
- Morphology and phase behaviour for doped systems

Joint sessions are being considered with **CH01 - Characterizing Dynamic Processes of Materials Synthesis and Processing via *In Situ* Techniques**.

Invited speakers include:

John Anderson	The University of Chicago, USA
Jason Azoulay	Georgia Institute of Technology, USA
Derya Baran	King Abdullah University of Science and Technology, Saudi Arabia
Mariano Campoy-Quiles	Institut de Ciència de Materials de Barcelona, Spain
Jerome Cornil	Univeristy of Mons, Belgium
Ying Diao	University of Illinois at Urbana-Champaign, USA
Oliver Fenwick	Queen Mary University of London, United Kingdom
Samson Jenekhe	University of Washington, USA
Oana Jurchescu	Wake Forrest University, USA
Ting Lei	Peking University, China
Christine Luscombe	Okinawa Institute of Science and Technology, Japan
Jodie Lutkenhaus	Texas A&M University, USA
Seth Marder	University of Colorado Boulder, USA
Jianguo Mei	Purdue University, USA
Murata Michihisa	Osaka Institute of Technology, USA
Christian Mueller	Chalmers University of Technology, Sweden
Jenny Nelson	Imperial College London, United Kingdom
Alexandra Paterson	University of Kentucky, USA
Erin Ratcliff	The University of Arizona, USA
Guillaume Schweicher	Université libre de Bruxelles, Belgium
Henning Sirringhaus	University of Cambridge, United Kingdom
Nguyen Thuc-Nguyen	University of California, Santa Barbara, USA
Alessandro Troisi	University of Liverpool, United Kingdom
Igor Zozoulenko	Linköping University, Sweden

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Symposium SB03: Materials, Devices and Systems for Neuromorphic Electronics—From Artificial Synapses to Bionic and Wearable Systems

Neuromorphic electronics are inspired by biological systems and aim to revolutionise the next generation of computing, especially in wearable and robotic applications. The emulation of adaptive learning and massively parallel processing of sensory input by the brain in novel neural-like computing architectures holds promise for low power consumption, fast response and high-density integration electronics. Therefore, inherently flexible, multi-functional and biocompatible materials are sought after to develop artificial synapses and neuromorphic sensory systems, which integrate sensing, data storage and processing capabilities. Organic semiconductors, perovskites, metal oxides and transition metal dichalcogenides are some examples of material classes that fulfil these requirements.This symposium will cover latest advances in materials and devices emulating synaptic functionalities, such as organic electrochemical transistors and optoelectronic/photonic artificial synapses, and their integration into intelligent sensory systems (tactile, visual, olfactory, auditory). The future development of bionic perception in robotics relies in the efficient processing of different sensing signals using low power. To this end, photonic synapses hold promise for wide bandwidth and faster computation, properties particularly attractive in image recognition. Additionally, their fabrication using flexible substrates, such as polymer, paper or textile, favours their application in wearable electronics. Finally, coupling electrons with ions necessitates the use of bioinspired ionotronics to serve as the interface between the biological and electronic systems. This symposium will present contributions from an interdisciplinary pool of world-renowned speakers, from materials chemists to device physicists and from electronics engineers to neuroscientists, to invoke discussions that will lead to further advancements in this emerging technological field.

Topics will include:

- Organic, inorganic and hybrid materials for neuromorphic devices
- Optoelectronic/Photonic artificial synapses
- Devices and circuits for neuromorphic computing
- Novel device architectures
- Manufacturing of flexible neuromorphic devices and circuits
- Smart wearable devices
- Adaptive bio-interfacing
- Neural interface devices
- Bio-inspired information processing

Joint sessions are being considered with **SB10 - Bioinspired Organic Materials and Devices for Sensing and Computing**.

Invited speakers include:

Ana Claudia Arias	University of California, Berkeley, USA	**Robert Nawrocki**	Purdue University, USA
Harish Bhaskaran	University of Oxford, United Kingdom	**Sung Kyu Park**	Chung-Ang University, Republic of Korea
Doug Durian	University of Pennsylvania, USA	**Jonathan Rivnay**	Northwestern University, USA
Wei Gao	California Institute of Technology, USA	**Alberto Salleo**	Stanford University, USA
Sahika Inal	King Abdullah University of Science and Technology, Saudi Arabia	**Jeff Shainline**	National Institute of Standards and Technology, USA
John Labram	University College London, United Kingdom	**Benjamin Tee**	National University of Singapore, Singapore
Björn Lüssem	University of Bremen, Germany	**Ioulia Tzouvadaki**	Ghent University, Belgium
Sayani Majumdar	VTT Technical Research Centre of Finland, Finland	**Qiangfei Xia**	University of Massachusetts Amherst, USA
Nripan Mathews	Nanyang Technological University, Singapore		

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Symposium SB04: Innovative Device and Characterization Concepts for Organic Electronics

Organic semiconductors provide structural tunability at the level of both synthesis and processing. Such tunable structure promises equally tunable function, a concept being realized in the myriad of devices with application in healthcare, energy harvesting and storage, wearable electronics, etc. Thanks to a enormous cross-disciplinary research effort, high-performance transistors, photovoltaic cells, and LEDs have been realized and will continue improving. Benchmarks are being defined, set, and broken in more recent device concepts, such as OECTs, biomimetics, and more. The focus of this symposium is recent research related to the advancement of organic electronic devices including challenges such as green fabrication strategies and stability. Of further interest are creative architectures improving transport and operation; functional defects and interlayers; charge, ion, and quasi-particle transport. For further improvement of performance, detailed analysis and inventive characterization approaches capturing the behavior of films, interfaces and devices are paramount. Hence, this symposium aims to highlight progress in and foster discussions on high precision metrology, as well as multi-modal and *in situ/operando* characterization . The goal is to create an interdisciplinary platform to discuss emerging strategies and challenges to understand and improve organic electronic devices.

Topics will include:

- Charge/ion transport, charge injection and charge trapping as well as doping and functional defects
- Structure-property relationships
- Operational and environmental device stability as well as high-throughput characterization
- *In situ/operando* characterization and multi-modal characterization/ coupled methods
- Transistors (field-effect, vertical, bi-polar, and electrochemical)
- Light-emitting devices (e.g. OLEDs, OLETs, lasers) as well as power generators (e.g. thermoelectric, photovoltaic, ratchets)
- Bioelectronic devices (e.g. sensors, memory, neuromorphic) as well as conformable and stretchable devices
- Green processing and transient, biodegradable electronics

Joint sessions are being considered with **EN04 - Beyond 20% Efficiencies with Organic Solar Cell Devices**, **SB02 - Charge Carrier Transport in Organic and Organic-Inorganic Hybrid Materials**, **SB10 - Bioinspired Organic Materials and Devices for Sensing and Computing**, and **SB11 - Bio-based and Biomimetic Polymers in Soft Robotics**.

Invited speakers include:

Derya Baran	King Abdullah University of Science and Technology, Saudi Arabia
Emily Bittle	National Institute of Standards and Technology, USA
Paul Blom	Max Planck Institute for Polymer Research, Germany
Lisa A. Fredin	Lehigh University, USA
C. Daniel Frisbie	University of Minnesota, USA
Ives Geerts	Université Libre de Bruxelles, Belgium
Xiaodan Gu	University of Southern Mississippi, USA
Sahika Inal	King Abdullah University of Science and Technology, Saudi Arabia
Oana Jurchescu	Wake Forest University, USA
Laure Kayser	University of Delaware, USA
Hagen Klauk	Max Planck Institute for Solid State Research, Germany
Hans Kleemann	Technische Universität Dresden, Germany
Mario Leclerc	Université Laval, Canada
Karl Leo	Technische Universität Dresden, Germany
Wei Lin Leong	Nanyang Technological University, Singapore
Christine Luscombe	Okinawa Institute of Science and Technology, Japan
Iain McCulloch	Oxford University, United Kingdom
Christian Müller	Chalmers University of Technology, Sweden
Tse Nga Ng	University of California, San Diego, USA
Thuc-Quyen Nguyen	University of California, Santa Barbara, USA
Vitaly Podzorov	Rutgers University, USA
Barry Rand	Princeton University, USA
Erin Ratcliff	The University of Arizona, USA
Garry Rumbles	National Renewable Energy Laboratory, USA
Alberto Salleo	Stanford University, USA
Tsuyoshi Sekitani	Osaka University, Japan
Henning Sirringhaus	University of Cambridge, United Kingdom
Natalie Stingelin	Georgia Institute of Technology, USA
Jun Takeya	The University of Tokyo, Japan
Deepak Venkateshvaran	University of Cambridge, United Kingdom

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Symposium SB05: Materials and Systems for Fully Implantable Organ Interfaces

Surgically implantable electronic devices are critical to basic research in biomedicine and enable novel medical solutions for diagnosis and treatment. This rapidly growing field recently focuses on increasing miniaturization, multifunctionality and fidelity. Implantable devices that directly interface with organs present unique challenges to materials. Biocompatibility, toxicity, interface performance and mechanical durability in a demanding physiological environment needs to be united with extremely soft and conformable mechanics. Increasing capabilities of soft materials, miniaturized electronics, radios, and advanced ways to supply power are resulting in a new generation of implantable organ interfaces. This device class is poised to offer high fidelity readouts of physiological processes, enable stimulation and provide control over many organs to realize new therapeutic and diagnostic applications. Key to advances are materials and material systems that create implantables with mechanical properties closely matched to the target organ and at the same time deliver functionality that support high fidelity sensors and stimulators. Another key aspect for the proliferation of this device class is the control over device lifetime, anywhere from acute temporary needs to lifetimes matching those of the target subject. This symposium will provide a forum for the presentation of newest results in the areas of implantable materials, micro and nanoscaled devices, soft materials, novel active opto(electronic) materials, new solutions to passivation/encapsulation/packaging, and organ interface design.

Topics will include:

- Soft materials for implants
- Electronic materials
- Implant system design
- Electromagnetic organ interfaces
- Photonic organ interfaces
- Thermal organ interfaces
- Biohybrid materials and interfaces
- Stretchable bioelectronic materials and interfaces
- Biologically transient materials
- Wireless power transfer
- Materials for energy harvesting
- Body networks and in-body communication

Joint sessions are being considered with **SB08 - Advanced Biomaterials and Bioelectronics for Neural Interfacing**.

Invited speakers include:

Polina Anikeeva	Massachusetts Institute of Technology, USA	**Duygu Kuzum**	University of California, San Diego, USA
Maria Asplund	Chalmers University of Technology, Sweden	**Jia Liu**	Harvard University, USA
Tzahi Cohen-Karni	Carnegie Mellon University, USA	**Yuxin Liu**	National University of Singapore, Singapore
Tracy Cui	University of Pittsburgh, USA	**George Malliaras**	University of Cambridge, United Kingdom
Shadi Dayeh	University of California, San Diego, USA	**Jonathan Reeder**	Science Corp, USA
Yael Hanein	Tel Aviv University, Israel	**Jonathan Rivnay**	Northwestern University, USA
Guosong Hong	Stanford University, USA	**Jacob Robinson**	Rice University, USA
Dion Khodagholy	Columbia University, USA	**John A. Rogers**	Northwestern University, USA
Dae-Hyeong Kim	Seoul National University, Republic of Korea	**Alexandra Rutz**	Washington University in St. Louis, USA

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Symposium SB06: Biohybrid Materials and Devices for Sensing, Robotics, Energy and Biomedicine

Biohybrid systems combine biological and artificial units to enable advancements in sensing, robotic, energy, and biomedical applications. The symposium will address biohybrid devices where biological components such as cells, tissues and even organisms are vital for the device operation. The symposium will also explore biohybrid materials that consist of biological and artificial components. Bioelectronics, photonics, and nanotechnology give handles for coupling with biological entities, while functional materials design and engineering and synthetic biology facilitate bidirectional communication at the biotic/abiotic interface. A key focus will be sensors and actuators where microorganisms, cells or tissues are actively involved in signal transduction or actuation, such as living electrodes and soft robots. Plants also present numerous opportunities for technological integration as they are sun-powered machines with hierarchical structures, sense and sample their surroundings, and possess rich biocatalytic properties. Therefore, we will give particular emphasis on plant-based biohybrid systems for sensing, energy, and robotics applications. Beyond natural organization, additive manufacturing enables programmed patterning of microorganisms and cells and their amalgamation with functional materials resulting in complex 3D structures that can self-heal, regenerate and adapt to environmental cues. Furthermore, the rich biocatalytic activity of the in-vivo environment can be harnessed for the integration of functional components into natural materials that are either harvested or remain within the biological environment. The symposium will cover a diverse range of biohybrid systems to bring together experts that, even though they do not target the same application, all work towards advancing the integration of biological components in technology. In this way we expect cross-fertilization of knowledge and expertise resulting in more sophisticated biohybrid systems. The symposium will focus on both understanding the fundamental processes that govern the coupling between biology and technology, and materials and device engineering for improving the biotic- abiotic communication. Challenges such as long-term operation, scale up and high performance will be addressed.

Topics will include:

- Electronic/optical/electrochemical coupling with cells and microorganisms
- Plant micro- and nanobionics
- Plant biohybrid systems
- Microorganisms and cells engineering for biosensing and energy applications
- Bio(electro)catalysis, Bio fabrication
- 3D-4D engineered living materials and devices
- Cell-based biohybrids systems for biomedical applications

Invited speakers include:

Maria Rosa Antognazza	Istituto Italiano di Tecnologia, Italy
Marie-Eve Aubin-Tam	Delft University of Technology, Netherlands
Damiano Barone	University of Cambridge, United Kingdom
Bianxiao Cui	Stanford University, USA
Zhuojun Dai	Henzhen Institute of Advanced Technology, Chinese Academy of Sciences, China
Susan Daniel	Cornell Unversity, USA
Chiara Daraio	California Institute of Technology, USA
Matteo Grattieri	Università degli Studi di Bari Aldo Moro, Italy
Tedrick Thomas Salim Lew	National University of Singapore, Singapore
Jia Liu	Harvard University, USA

Ben Maoz	Tel Aviv University, Israel
Barbara Mazzolai	Istituto Italiano di Tecnologia, Italy
Anna Maria Pappa	Khalifa University, United Arab Emirates
Christine Selhuber-Unkel	Heidelberg University, Germany
Orit Shefi	Bar-Ilan University, Israel
Brian Timko	Tufts University, USA
Sihong Wang	The University of Chicago, USA
Taylor Ware	Texas A&M University, USA
Shu Yang	University of Pennsylvania, USA
Xuanhe Zhao	Massachusetts Institute of Technology, USA

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Symposium SB07: Lipid Materials—Theory, Fundamentals and Applications

Lipids are the building blocks of all living membranes. Understanding how biomembranes synthesize themselves, remodel, and operate has inspired numerous advances in materials development. From uses in lubricant additives, soaps, and cosmetics to biological applications ranging from mRNA delivery nanoparticles to inorganic nanocrystal ligands and supported bilayers for sensing, lipid matter is everywhere. Lipids and their synthetic analogues offer complex toolkits for designing and/or templating functional and responsive materials having 2D and 3D superstructures mimicking the rich polymorphism of biomembranes. The synthesis design space is well established for ground state equilibrium assembly or kinetically trapped systems. However, a current challenge in making lipid-based materials is being able to capture the process of living systems operating under out-of-equilibrium, active, and energy dissipative conditions.

This symposium will highlight experimental and theoretical topics of lipid materials impacting fundamental soft matter research as well as a broad range of biotechnology and biomedicine applications. We aim to connect research communities working on different scientific aspects of lipid structure, assembly, and function, including lipid synthesis, phase equilibria, lipid nanoparticles, active membranes, and surface patterning.

Topics will include:

- Advances in lipid chemical synthesis
- Lipid nanoparticles for therapy and beyond
- Active membranes
- Biomembranes
- Lipid assembly in and out of equilibrium
- Advances in processing and characterization tools for lipid systems
- Hybrid materials
- Biointerfaces
- Advances in theory and simulation of lipid materials

Invited speakers include:

Michael Best	The University of Tennessee, Knoxville, USA	**Kurt Ristroph**	Purdue University, USA
Itay Budin	University of California, San Diego, USA	**Gaurav Sahay**	Oregon State University, USA
Susan Daniel	Cornell University, USA	**Jeanne Stachowiak**	The University of Texas at Austin, USA
Irep Gözen	University of Oslo, Norway	**Emad Tajkhorshid**	University of Illinois at Urbana-Champaign, USA
Sarah Keller	University of Washington, USA	**Petia Vlahovska**	Northwestern University, USA
Niren Murthy	University of California, Berkeley, USA	**Yan Yu**	Indiana University, Bloomington, USA
Maikel Rheinstadter	McMaster University, Canada	**Joseph Zasadzinski**	University of Minnesota, USA

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Symposium SB08: Advanced Biomaterials and Bioelectronics for Neural Interfacing

Neuroscientists have recently made significant progress in understanding how brain circuits govern different aspects of normal and abnormal behaviors utilizing new neural interfacing tools. On the other hand, clinical doctors have also started to apply the newly developed neural interfacing technologies for diagnostics, monitoring, and treatment of neurological diseases, such as Parkinson's disease, Alzheimber's disease, epilepsy, and depression. Advanced biomaterials and bioelectronics are playing increasingly significant roles in neural interfacing technology developments, with examples ranging from conductive polymers for low impedance neural recording interface, flexible/stretchable electronics for biocompatible neural interface with minimal immune response, to magnetic nanoparticles based technology for non-invasive neural stimulation. However, there are still pressing needs for developing new neural interfacing systems that combine multiple desirable properties for neural recordings and modulation, such as high spatiotemporal resolution, cell-type specificity, large areas, minimum invasiveness, and long-term stability. The focus of this symposium will discuss the current materials-enabled approaches for achieving unprecedented performance in these desirable properties, including the design of advanced nanomaterials and organic materials, novel fabrication technologies for electronic devices, innovative formulation strategies for therapeutic delivery to the nervous system, as well as synergistic strategies that combine the innovations of materials science and genetic/protein engineering. These emerging neural interfacing approaches encompass a wide range of modalities, ranging from electrical, optical, magnetic, to ultrasound. With these emerging neural interfacing technologies, we expect future abilities to study the brain and treat neurological diseases with heretofore impossible resolution and precision.

Topics will include:

- Conductive polymers for neural interfacing
- Flexible and stretchable bioelectronics fabrication
- Stimuli-responsive (optical/magnetic/ultrasound) nanomaterials for neuromodulation
- Cell-type specific neuromodulation
- Drug/gene delivery materials for neural interfacing
- Neural electrode developments
- Minimally-invasive neural interfacing method
- Integrated Devices with multiple neural interfacing modality

Joint sessions are being considered with **SB05 - Materials and Systems for Fully Implantable Organ Interfaces**.

Invited speakers include:

Polina Anikeeva	Massachusetts Institute of Technology, USA	**John Madden**	The University of British Columbia, Canada
Zhenan Bao	Stanford University, USA	**George Malliaras**	University of Cambridge, United Kingdom
Jinwoo Cheon	Yonsei University, Republic of Korea	**Jacob Robinson**	Rice University, USA
Bianxiao Cui	Stanford University, USA	**John A. Rogers**	Northwestern University, USA
Shaoyi Jiang	Cornell University, USA	**Takao Someya**	The University of Tokyo, Japan
Won Jong Kim	Pohang University of Science and Technology, Republic of Korea	**Bozhi Tian**	The University of Chicago, USA
Stéphanie P. Lacour	École Polytechnique Fédérale de Lausanne, Switzerland	**Chong Xie**	Rice University, USA
Hyunjoo (Jenny) Lee	Korea Advanced Institute of Science and Technology, Republic of Korea	**Xuanhe Zhao**	Massachusetts Institute of Technology, USA
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Symposium SB09: Bioelectricity and Recapitulation of 3D Environment in Microbial and Tissue Engineering

Spurred by decades of success with pacemakers and cochlear implants, and by advances in miniaturized technology, interest is surging in electroceuticals that stimulate nerves to treat disease. This mainly encompasses technological advancements in the field of cardiac, cochlear, retinal, central nervous system and peripheral nervous system implants. However, implementing bioelectronics as a primary or complementary treatment for cancer has also garnered momentum in the recent years.

The evolving momentum is due to the modest knowledge in basic biological functions of cancer, at a cellular level. This lack of in depth understanding of its physiology significantly limits the development of new, targeted and more effective treatment strategies. The emergence of innovative composite materials, comprising different morphologies and designs are of utmost importance to interface, probe, decode, and modulate cancer cells signalling in for example 3D solid tumour models, such as spheroids and organoids - for recreating tumorigenesis in vitro.

Bioelectricity seeks to become an important biophysical indicator beyond cancer physiology. Biomaterials may be applied to monitor and/or modulate communication within other electroactive microorganisms such as bacteria and algae, with the aim of developing new microelectronic technologies, eventually AI-assisted, capable of recreating and controlling metabolic and signalling pathways on-a-chip.

The scope of this interdisciplinary symposium is to deliver a setting for discussion on the field of bioelectricity in living microbe-inspired materials. The symposium englobes and seeks to bridge the disciplines of materials science, physics, electronics, bioinformatics, and biology to enable the development of next-generation of biomaterials and devices.

Topics will include:

- Bioelectronic interfaces and devices
- Electrophysiology in non-electrogenic cells
- Signaling transduction in microbial communities
- Novel biocompatible composite materials
- Lab-on-a-chip devices for monitoring and modulating cells
- Bioinformatics and machine learning applied to signal analysis

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:

Paola Alberte	Instituto Superior Técnico, Portugal	**Michael Levin**	Tufts University, USA
Daniel Chew	GlaxoSmithKline, United Kingdom	**George Malliaras**	Cambridge University, United Kingdom
Sonia Contera	University of Oxford, United Kingdom	**Ann Rajnicek**	University of Aberdeen, United Kingdom
Leyla Esfandiari	University of Cincinnati, USA	**Cynthia Reinhart-king**	Vanderbilt University, USA
Paschalis Gkoupidenis	Max Planck Institute for Polymer Research, Germany	**Nuno Reis**	University of Bath, United Kingdom

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Symposium SB10: Bioinspired Organic Materials and Devices for Sensing and Computing

The functions of electronics have been quickly expanding to new application areas including wearable healthcare, implantable therapeutics, brain-machine interfaces, internet-of-things, soft robotics, artificial intelligence, and self-driving cars. Along this trend, the integration of data acquisition, i.e., sensing, and data analysis, i.e., computing, is becoming more and more important. For the realization of ubiquitous sensing and intelligent computing, taking inspiration from biological systems for the creation of new operation mechanisms and the incorporation of unconventional properties can bring a wealth of benefits, such as enhanced sensitivity, higher compatibility for bio-integration, better mechanical compatibility, more efficient computing operation, reduced power consumption, the deployment of edge computing, and simplified system design. In the recent decade, this new technological trend has spurred a new research area that encompasses the development of new physics and chemistry, new electronic materials (e.g., organic semiconductors and electronic-ionic mixed conducting polymers, ionic hydrogels), new device categories (e.g., organic electrochemical transistors, artificial synaptic devices, soft devices, memory devices), new system designs, and new algorithms. This symposium aspires to bring together worldwide experts to discuss both fundamental and applied research progress in this broad field, with the topics expanding from the design of bio-inspired conductors, semiconductors, dielectrics, the development of flexible and stretchable bioelectronic devices, the creation of new biosensors, the development of brain-inspired neuromorphic computing, and the combination of artificial intelligence with bio-integrated sensing, etc.

Topics will include:

- Electronic-ionic mixed conducting polymers
- Organic electrochemical transistors
- Organic field-effect transistors
- Biosensing based on organic and polymer materials
- Flexible and stretchable polymer electronics
- Organic neuromorphic computing, artificial synaptic devices, artificial neurons
- Bioelectronic polymer devices
- Organic-material-based brain-machine interfaces
- Wearable systems

Invited speakers include:

Fabien Alibart	University of Lille, France
Magnus Berggren	Linköping University, Sweden
Fabio Biscarini	Università di Modena, Italy
Ardemis Boghossian	École Polytechnique Fédérale de Lausanne, Switzerland
Xiaodong Chen	Nanyang Technological University, Singapore
Fabio Cicoira	Polytechnique Montréal, Canada
Antonio Facchetti	Flexterra Inc., USA
Toshinori Fujie	Tokyo Institute of Technology, Japan
Kenjiro Fukuda	RIKEN, Japan
Paschalis Gkoupidenis	Max Planck Institute for Polymer Research, Germany
Ximin He	University of California, Los Angeles, USA
Wei Huang	University of Electronic Science and Technology of China, China
Dion Khodagholy	Columbia University, USA
Hans Kleemann	Technische Universität Dresden, Germany

Tae-Woo Lee	Seoul National University, Republic of Korea
Karl Leo	Universität Dresden, Germany
Wei Lin Leong	Nanyang Technological University, Singapore
Takeo Miyake	Waseda University, Japan
Thuc-Quyen Nguyen	University of California, Santa Barbara, USA
Francesca Santoro	RWTH Aachen University, Germany
Donghee Son	Sungkyunkwan University, Republic of Korea
A. Alec Talin	Sandia National Laboratories, USA
Benjamin CK Tee	National University of Singapore, Singapore
Bozhi Tian	The University of Chicago, USA
Yoeri van de Burgt	Technische Universiteit Eindhoven, Netherlands
Changjin Wan	Nanjing University, China
Shunsuke Yamamoto	Tohoku University, Japan
Cunjiang Yu	The Pennsylvania State University, USA

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Symposium SB11: Bio-based and Biomimetic Polymers in Soft Robotics

Robots are anticipated to becoming an indispensable part of our daily lives. Traditional robots (e.g., autonomous vacuum cleaners) are expected to transform into more complex robots to care for the ill, or collaborate with human beings in difficult working environments from underwater and space operations to minimally invasive surgeries. Exoskeletal robots can enhance the physical capabilities of human body, and the components of robots can be implanted into the human as active prostheses that are controlled through human-machine interfacing. To accomplish these expected tasks, next-generation robots will require functional soft materials. Specifically, for a better robot-human interface, a soft, flexible, and dynamic outer layer is necessary to cover the rigid, stiff surface of robots, as the hard human skeletal system is covered by soft skin. The motivation for this Symposium originates from the suitability of multifunctional polymer films as artificial skins for robots, which allow for all-terrain adaptability and mobility. In the ideal case, the skin of such robot can withstand extreme environments while maintaining its functions, such as sensing, energy conversion and storage, actuating, computing information, and the self-healing - once damages and injuries occur on the skin. Furthermore, biocompatibility, including foreign body reactions, and immune responses, should be addressed for long-term contact between human skin and robot skin in the example of active prostheses. It is believed that adapting bioinspired, bio-enabled, and biomimetic polymeric materials is the approach to providing innovation for the future of robotics. Therefore, it is the aim of this Symposium is to stimulate the collaboration of scientists and engineers who are working in robotics, synthetic chemistry, biochemistry, physiology, biology, biomaterial science, and conventional materials science.

Topics will include:

- Soft robots
- Biomimetic materials
- Bio-enabled materials
- Shape-memory materials
- Protein-based polymeric materials
- Stimuli-responsive polymers
- Self-healable polymers
- Sensors and actuators
- Artificial detectors and skins
- Polymer heterostructures, laminates and composites
- Dynamics of/in polymers
- Analysis, assessment, and diagnostics of soft matter

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
Gurthwin Bosman	Stellenbosch University, South Africa
Blair Brettmann	Georgia Institute of Technology, USA
Qing Chen	Empa–Swiss Federal Laboratories for Materials Science and Technology, Switzerland
Mmantsae M. Diale	University of Pretoria, South Africa
Michael Dickey	North Carolina State University, USA
Peter Fratzl	Max Planck Institute of Colloids and Interfaces, Germany
David Gracias	Johns Hopkins University, USA
Olle Inganas	Linköping University, Sweden
Christoph Keplinger	Max Planck Institute for Intelligent Systems, Germany
Tjaart Kruger	University of Pretoria, South Africa
Wendimagegne Mammo	Addis Ababa University, Ethiopia
Abdon Pena-Francesch	University of Michigan, USA
Huisheng Peng	Fudan University, China
Ritu Raman	Massachusetts Institute of Technology, USA
John A. Rogers	Northwestern University, USA
Stephan V. Roth	Deutsches Elektronen-Synchrotron, Germany
Niyazi Serdar Sariciftci	Johannes Kepler Universität Linz, Austria
Robert Shepherd	Cornell University, USA
Helen Tran	University of Toronto, Canada
Jie Xu	Argonne National Laboratory, USA
Shu Yang	University of Pennsylvania, USA

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Symposium SF01: High Entropy Oxides and Related Materials

High entropy materials have emerged as a highly tunable platform for fundamental inquiry and functional properties. These high entropy materials, with their deliberately high configurational disorder due to multiple elements sharing a single crystalline lattice, are a fundamentally new platform for engineering materials with designer properties. The high configurational entropy in these materials allows new phases to be stabilized and imbues them with enhanced structural stability, a necessary characteristic for a wide-range of applications. High entropy materials have been linked to a wide range of possibly transformative functional behaviors related to their electronic and thermal transport, magnetic order and frustration, and ion conductivity. While configurational disorder is assumed to underlie the formation and properties exhibited by some of these materials, there are many open questions in the quest to understand precisely how that entropy acts and how it intersects with other relevant energy scales. This symposium will emphasize understanding the role of entropy in determining materials properties and the design of new materials platforms. Special attention will be paid to identifying novel features of high entropy systems containing both cation and anion sublattice(s), such as high entropy oxides, carbides, nitrides and di-borides which may be expected to provide unique solutions to unresolved fundamental and applied problems in physics, materials science, and chemistry.

Topics will include:

- Theoretical modeling and machine learning approaches to high entropy materials
- Local structure and distortions in high entropy oxides and related materials
- Synthesis methods and crystal growth of high entropy oxides and related materials
- Functional behaviors of high entropy materials including electrochemical properties and catalysis
- Thermal, electrical, and magnetic properties of high entropy oxides
- Thermodynamics and kinetics of high entropy oxides
- New high entropy polytypes: sulfides, selenides, fluorides, mixed anion systems
- Ultra-hard high entropy ceramics (carbides, nitrides, di-borides)

Invited speakers include:

Solveig Aamlid	The University of British Columbia, Canada
Jasmin Aghassi-Hagmann	Karlsruhe Institute of Technology, Germany
Lavina Backman	U.S. Naval Research Laboratory, USA
Subramshu Bhattacharya	Indian Institute of Technology Madras, India
Torsten Brezesinski	Karlsruhe Institute of Technology, Germany
Valentino Cooper	Oak Ridge National Laboratory, USA
Ismaila Dabo	The Pennsylvania State University, USA
Sheng Dai	Oak Ridge National Laboratory, USA
Theresa Davey	Bangor University, United Kingdom
Nita Dragoe	Université Paris-Sud, France
Alan Farhan	Baylor University, USA
Horst Hahn	Karlsruhe Institute of Technology, Germany
Christian Kübel	Technische Universität Darmstadt, Germany
Alfred Ludwig	Ruhr-Universität Bochum, Germany
Yanjiao Ma	Nanjing Normal University, China
Alessandro Mazza	Los Alamos National Laboratory, USA
Katharine Page	The University of Tennessee, Knoxville, USA
Christina Rost	James Madison University, USA
Saveria Santangelo	Università degli Studi Mediterranea di Reggio Calabria, Italy
Simon Schweidler	Karlsruhe Institute of Technology, Germany
Cormac Toher	The University of Texas at Dallas, USA
Qingsong Wang	Universität Bayreuth, Germany
Ayako Yamamoto	Shibaura Institute of Technology, Japan

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Symposium SF02: Actinide Materials

Actinide materials exhibit unique and diverse electronic, transport, and chemical properties, largely resulting from the complexity of their 5*f* electronic structure. This Symposium will focus on a range of topics in physics, chemistry, and materials science of actinides that are of contemporary interest. Emphasis will be on 5*f* electronic and magnetic characteristics; synthesis; surface science; radiation damage and Pu aging; bulk, thin-film, and nanoparticle properties; and applications of each to nuclear energy and security-related issues. The role of fundamental and targeted actinide science in resolving challenges in actinide materials processing and environmental and technical issues with actinide materials will be stressed, particularly regarding energy applications, including novel nuclear fuels and structural materials, waste remediation, and waste disposal. Experimental approaches, including state-of-the-art techniques and synchrotron radiation- and neutron-based investigations, as well as theoretical modeling, are parts of the Symposium. Actinide issues related to nuclear forensics, non-proliferation, security, and the renaissance in nuclear energy, including fuel synthesis, oxidation, corrosion, actinide stability in extreme environments and biological media, prediction of properties via simulations, separation science, and environmental impact are all critical to the future of actinide science that will be discussed herein. The previous eleven Actinide Symposia were held in Boston, San Francisco, Phoenix, Seattle, and most recently in Honolulu (Spring 2022).

Topics will include:

- Actinide and actinide process chemistry
- 5f electronic structure and emerging electronic behaviors including strong electron-electron correlations, heavy-fermions, magnetism, and superconductivity
- Synthesis and characterization of actinide materials including nanoparticles
- Actinide materials in extreme conditions (radiation damage, pressure, aging, and others)
- Surface science, oxidation, and corrosion
- Radiation damage, aging and related physical properties
- Theory, modeling, and simulations
- Nuclear forensics, safeguards, and stewardship
- Energy applications, nuclear fuels, waste remediation, and waste disposal
- Advanced characterization techniques and actinide science at user facilities
- Actinide environmental science

Invited speakers include:

Rebecca Abergel	Lawrence Berkeley National Laboratory, USA
Ana Arteaga	Pacific Northwest National Laboratory, USA
Peter Burns	University of Notre Dame, USA
Nick Butch	National Institute of Standards and Technology, USA
Scott Donald	Lawrence Livermore National Laboratory, USA
Thomas Dumas	Commissariat à l’énergie atomique et aux énergies alternatives, France
Krzysztof Gofryk	Idaho National Laboratory, USA
Lingfeng He	North Carolina State University, USA
Sarah Hickam	Los Alamos National Laboratory, USA
Greg Horne	Idaho National Laboratory, USA
Gabe Kotliar	Rutgers University, USA
Karen Kruska	Pacific Northwest National Laboratory, USA
Marisa Monreal	Los Alamos National Laboratory, USA
Liane Moreau	Washington State University, USA
Paul Roussel	Atomic Weapons Establishment, United Kingdom
Babak Sadigh	Lawrence Livermore National Laboratory, USA
Jenifer Shafer	Colorado School of Mines, USA
Thorsten Stumpf	Helmholtz-Zentrum Dresden-Rossendorf, Germany
Valerie Vallet	University of Lille, France
Jennifer Wacker	Lawrence Berkeley National Laboratory, USA
Angela Wilson	Michigan State University, USA
Richard Wilson	Argonne National Laboratory, USA
Tsuyoshi Yaita	SPring-8, Japan

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Symposium SF03: Ion Insertion—Fundamental Processes and Applications to Switching

Ion insertion is a process of inserting ions into materials to control materials properties, which has recently emerged as a viable approach for tuning functional properties, including electrical, mechanical, optical, magnetic, and catalytic properties. One notable example of ion-insertion is ion intercalation in layered materials, which has transformed our lives via the invention of Li-ion batteries. This interdisciplinary MRS symposium will, for the first time, bring together researchers working on fundamental ion insertion processes with those utilizing ion insertion on different functional devices, many of whom are primarily affiliated with different communities despite the central unifying theme of ion insertion. This symposium will focus on both experimental and theoretical efforts to understand and use ion insertion in bulk and low-dimensional materials, as well as applications to various functional materials and devices. The symposium will bring together an interdisciplinary and diverse group of researchers on these topics to discuss the diverse facets of the field and pave a way for future discoveries and engineering of new tools.

Topics will include emerging theories on ion insertion dynamics, method developments in both intercalation platforms and characterization, and applications of ion insertion with respect to diverse fields including sensing, catalysis, and computing.

Topics will include:

- Method develop in ion insertion platform and characterization
- Theory of ion insertion dynamics
- Synthesis of layered bulk and low-dimensional materials suitable for intercalation
- Chemical and electrochemical methods for ion insertion
- *In situ/operando* characterization of ion insertion
- Effects of ion insertion on electronic, mechanical, thermal, optical, and magnetic properties
- Applications of ion insertion for digital, analog, neuromorphic, and/or quantum computing
- Electrochemical devices for sensing, photonics, and memristive devices
- Opportunities for biointerfacing

Invited speakers include:

Kwabena Bediako	University of California, Berkeley, USA	**Diana Qiu**	Yale University, USA
David Cahill	University of Illinois at Urbana-Champaign, USA	**John Rozen**	IBM Corporation, USA
William Chueh	Stanford University, USA	**Aditya Sood**	Princeton University, USA
Regina Dittmann	Forschungszentrum Jülich GmbH, Germany	**Alec Talin**	Sandia National Laboratories, USA
Yu Huang	University of California, Los Angeles, USA	**Kazuya Terabe**	National Institute for Materials Science, Japan
Kristie Koski	University of California, Davis, USA	**Ilia Valov**	Forschungszentrum Jülich GmbH, Germany
Mario Lanza	King Abdullah University of Science and Technology, Saudi Arabia	**Yoeri van de Burgt**	Technische Universiteit Eindhoven, Netherlands
Aaron Lindenberg	Stanford University, USA	**Bilge Yildiz**	Massachusetts Institute of Technology, USA

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