CALL FOR PAPERS
Abstract submission deadline: March 25, 2020

MATERIALS CHALLENGES IN ALTERNATIVE AND RENEWABLE ENERGY 2020 (MCARE 2020)

4TH ANNUAL ENERGY HARVESTING SOCIETY MEETING (EHS 2020)

August 16 - 21, 2020
Hyatt Regency Bellevue | Bellevue, WA USA | ceramics.org/mcare2020
MATERIALS CHALLENGES IN ALTERNATIVE AND RENEWABLE ENERGY (MCARE 2020), organized by The American Ceramic Society and its new Energy Materials and Systems Division, is a premier forum to address opportunities of emerging material technologies that support sustainability of a global society. MCARE 2020 brings together leading global experts from universities, industry, research and development laboratories, and government agencies to collaboratively interact and communicate material technologies that address development of affordable, sustainable, environmentally-friendly, and renewable energy conversion technologies. If your research seeks sustainable energy solutions on a global scale, you should attend this conference.

This cutting-edge international conference features plenary and invited talks, thematically-focused technical sessions, and poster presentations, enabling participants to network and exchange ideas with professional peers and acclaimed experts. The conference atmosphere engages and promotes the participation of scientists and engineers of all ages to include students and early-stage researchers.

Abstracts are solicited from interested and committed individuals from academia, national laboratories, industries, and start-up companies in the technology symposia listed in this Call for Papers.

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ABSTRACT SUBMISSION INSTRUCTIONS

Visit www.ceramics.org/mcare2020 to submit your 200-word abstract. Select “Submit Abstract” to be directed to the Abstract Central website. Please contact Marilyn Stoltz at mstoltz@ceramics.org or 614-794-5868 with questions.
ANNUAL ENERGY HARVESTING SOCIETY MEETING (EHS 2020) Since its inception, the EHS workshop has been highly successful in bringing the academic community from around the world together to openly discuss and to exchange ideas about energy harvesting. Those researching energy harvesting know it has become the key to the future of wireless sensor and actuator networks for a variety of applications, including monitoring of temperature, humidity, light, and location of individuals in a building, chemical/gas sensor, structural health monitoring, and more. Join us to share your research in this area and to freely discuss and network with colleagues from around the globe interested in energy harvesting solutions.

This 4th annual meeting will feature plenary lectures, invited talks, and contributed talks within the following topical areas:

- Energy harvesting (piezoelectric, inductive, photovoltaic, thermoelectric, electrostatic, dielectric, radioactive, electrets, etc.)
- Energy storage (supercapacitors, batteries, fuel cells, microbial cells, etc.)
- Applications (structural and industrial health monitoring, human body network, wireless sensor nodes, telemetry, personal power, etc.)
- Emerging energy harvesting technologies (perovskite solar cells, shape memory engines, CNT textiles, thermomagnetics, bio-based processes, etc.)
- Energy management, transmission, and distribution; energy-efficient electronics for energy harvesters and distribution
- Fluid-flow energy harvesting
- Solar–thermal converters
- Multi-junction energy harvesting systems
- Wireless power transfer

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S1: Materials for Solar Fuel Production and Applications

Solar fuel production in an artificial system offers an opportunity for generating renewable transportation fuels to replace fossil resources. Sunlight is used to split water into hydrogen and oxygen, or produce carbon-based fuels from carbon dioxide and water. A central theme of this symposium is the recent progress and scientific challenges of integrating the light absorbers and catalysts into subsystems, with the goal of achieving closed hoto (electro)chemical cycles, CO2 reduction (or proton reduction) and H2O oxidation in the single integrated system. A solar fuel can be produced when and where sunlight is available, and stored and transported for later usage. Various systems made of engineered materials have been developed to reduce proton to hydrogen or carbon dioxide to carbon-based fuels, including photoelectrochemical (PEC) cell, photocatalytic system, solar cell based method, etc. This special session will bring experts together from different fields of state-of-art technologies of solar fuel production, which will foster the scientific exchange.

Session topics
- Photoelectrochemical (PEC) system for solar fuel production
- Photocatalytic water splitting
- Photocatalytic carbon dioxide reduction
- Solar cell-PEC hybrid system for solar fuel production
- New catalysts for solar fuel generation

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S2: Advanced Materials for Energy Storage

Batteries are devices that convert chemical energy into electrical energy. There are many types of batteries available, representing a multi-billion dollar industry. State-of-the-art electrical energy storage systems are not able to meet the requirements for energy-efficient use in transportation, grid, and commercial technologies. New concepts in materials design for battery technology are sought to overcome the current limitations of performance and lifetime. More critical insight is required to produce next-generation electrode materials and battery cells enabling higher energy densities, high power densities and longer cycling abilities, in terms of material structures as well as interfacial reactions. This symposium explores novel energy storage materials and technologies that are critical to making the current energy storage systems more effective. In addition, abstracts are sought on supercapacitors and flexible batteries for self-powering small electronics. Abstracts are sought in fundamentals, modeling, mechanisms, materials design, screening, electrode architectures, diagnostics, materials characterization, and electrode/electrolyte interface characterization in the topics below:

Session topics
- Lithium batteries
- Sodium batteries
- Magnesium batteries
- Lithium-air batteries
- Lithium-sulfur batteries
- Redox flow batteries
- All solid-state batteries
- High temperature batteries
- Flexible batteries
- Supercapacitors

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S3: Challenges in Thermal-to-Electrical Energy Conversion Technology for Innovative Novel Applications

Since heat is the absolute final form of any kind of energy, harnessing thermal energy is one of the ultimate goals in science and technology in modern society. Challenges in materials design and synthesis have always been a key to exploiting heat by direct thermal-to-electrical energy conversion and related technologies. Moreover, recent advances in nanotechnology have elicited unconventional thermal transport across nanostructured materials and nano-interfaces, opening a new direction to harnessing thermal energy. This symposium will highlight a combination of new ideas, new materials, and device concepts by focusing on novel processing and synthesis methods, materials, technologies, and applications related to direct thermal-to-electrical energy conversion and thermal energy harnessing. The symposium will focus on thermoelectrics and thermionics and emphasize thermal, electrical, and mechanical properties of new materials, and processing of those materials into device structures. It also will highlight theoretical insight and materials innovations in unconventional heat transfer that enable novel approaches toward higher efficiency in thermal energy harvesting and heat management.

The symposium includes theoretical studies of material transport properties, band structure, crystal chemistry, thermodynamic analysis, and energy transfer. Experimental efforts will include new capabilities in solid-state synthesis, bulk materials, thin films, superlattices, nano-interfaces, and nanostructured materials, including recent advances in nanocomposites (nanomaterials or inherent nanostructures in bulk thermoelectric material matrices). It will also highlight advances in phonon engineering, phase transformation, thermal conductivity switching, and defect engineering in inorganic and organic solids. New developments in material property and device performance measurements and metrology will also be presented.

Session topics
- High-efficiency bulk thermoelectric materials
- Nanoscale thermoelectric materials
- Theoretical guidance to high-efficiency thermoelectric energy conversion
- Oxides and other materials with strong electron correlation
- New and emerging technologies for thermoelectric power conversion
- Thermoelectrics for harvesting solar and unused waste heat energy
- Thermionics and other related topics
- Synthetic strategies for preparing novel materials and compounds
- Thermoelectric nanocomposite materials
- Processing of bulk and thin-film nanostructured materials
- New ideas, new materials, and device concepts for thermal energy harnessing
- Phonon engineering and emerging thermal transport technologies
- Phonon transmission and scattering across nano-interfaces
- Materials property measurement and new metrology techniques
- Design, performance testing, fabrication, and processing of energy conversion devices
- Device performance requirements for future applications

Organizer
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S4: Advanced Materials for Perovskite and Next Generation Solar Cells

Recently, advanced materials and technologies for perovskite and next-generation solar cells have been exploited to develop economically viable, high-performance solar cells. Organo-metal trihalide perovskites have revolutionized the field of thin film solar cells due to their meteoric rise of power conversion efficiency (PCE) of a record value 22.1%. These materials exhibit salient properties such as strong light absorption from the visible into the near-infrared spectral region, long carrier diffusion length, and tailorable optoelectronic properties through compositional engineering of halides and cations. These properties are subservient to the formation and nature of the crystals, morphology, and growth. One of the most fantastic features of organo-metal trihalide perovskite is its ability to self-assemble between precursors of solid-solid, vapor-vapor, vapor-solid, co-solution, solid-solution phases into high quality crystalline powder or thin films at near ambient conditions. Despite the high efficiency and excellent optoelectronic properties, the biggest problem of organo-metal trihalide perovskite is stability under heat and light soaking conditions. This symposium will focus on the key issues and phenomena that are at the frontier of understanding and materials development in perovskite solar cells and next generation solar cells, addressing the following topics but not limited to them.

Session topics
- Materials and issues for perovskite solar cells
- Fundamental understanding of the materials properties using theory and experiments
- Role of interface interactions
- Design of alternate stable perovskite
- Novel charge transporting materials
- Crystal growth kinetics
- Device stability issues
- Materials and technologies for quantum-dot sensitized solar cells
- Materials and technologies for organic and bulk heterojunction solar cells
- Materials and technologies for ferroelectric solar cells
- Materials and technologies for CIGS solar cells

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S5: Spectral Conversion Materials for Energy Applications

Spectral conversion luminescent materials are potential candidates to increase the efficiency of solar cells as well as other environmentally relevant technologies, such as photocatalysis, solar fuels, and artificial photosynthesis, where usually large parts of the solar spectrum do not contribute to the harvesting scheme and are lost for energy conversion. Downconversion or quantum cutting, luminescent downshifting, and upconversion are approaches to diminish the losses. Yet, while cutting-edge research conducted around the globe led to promising achievements, remaining challenges (such as low quantum efficiency in nanomaterials, weak and/or narrow absorption, and broadband illumination under real sun conditions) have to be addressed in order to take full advantage of spectral conversion materials. In this context, the rational design of suitable optical materials is crucial for energy conversion enhancement, and approaches reach from novel host materials and dopant optimization for upconversion and downconversion materials to innovative hybrid materials, e.g. combing lanthanide-doped materials, quantum dots, organic dyes, carbon-based structures, and photonic concepts. It is the scope of this symposium to provide an interdisciplinary platform for the presentation and discussion of recent achievements, developments and remaining challenges regarding the design, synthesis, and characterization of spectral conversion materials as well as their assembly to more efficient devices. Session topics will focus on, but not be limited to:

Session topics
• Materials for upconversion, downconversion/quantum cutting, luminescent downshifting
• Lanthanides, dyes and quantum confined nanomaterials for photovoltaic applications
• Spectral conversion for photo-catalytic and water-splitting applications
• Triplet-triplet annihilation photon-upconversion
• Development and synthesis of novel optical materials
• Smart assemblies and novel device design: combining lanthanide-doped nanoparticles, QDs, carbon-based nanostructures, dyes, etc. to enhance spectral conversion efficiency
• Plasmonic/photonic manipulation of conversion processes
• Theoretical approaches and modeling
• Application-oriented approaches in spectral conversion
• Multifunctional spectral conversion materials: applications beyond the energy sector

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S6: Materials for Nanogenerators and Self-powered Electronics

Smart materials such as piezoelectrics, multiferroics, magnetoelectrics, triboelectrics, thermoelectrics, pyroelectrics, and photovoltaics transduce energy from one form to another. Energy harvesting technology using such smart materials promotes the development of self-powered electronics systems through an effective conversion of otherwise wasted ambient energy in the environment into useful electrical energy. This symposium will address up-to-date developments in smart materials and practical applications with special emphasis on energy generation and storage for self-powered electronics. In particular, the symposium addresses current challenges and strategies in developing prospective energy generation and storage materials and systems. This symposium will serve as a platform, not only to share novel ideas and recent research experiences, but to establish fruitful potential collaborations among material scientists and device engineers in various fields of smart materials and energy technologies. Topics include the following, but not limited to:

Session topics
• Materials and devices for piezoelectric, ferroelectric, multiferroic, magnetoelectric, triboelectric, thermoelectric, and photovoltaic power generators/energy harvesters
• Fundamental physics of energy conversion and harvesting through modeling, simulations, theoretical, and experimental study
• Synthesis, fabrication, and characterization techniques of energy materials and devices
• Multi-dimensional nanomaterials and nanostructures for energy harvesting: nanowires, nanotubes, nanofibers, and composite nanomaterials
• Flexible, stretchable batteries, super capacitors, and other energy storage systems
• Power management systems for self-powered electronics

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**S7: Advanced Materials & Nanodevices for Sustainable and Eco-Friendly Applications**

This symposium will focus on the development of new advanced materials, combinations of hybrid nano-materials, low dimensional materials, and nano-scale devices that focus on utilizing these designer materials in the development of a sustainable future in an environmentally-friendly manner. Studies on the physical properties of advanced materials such as hybrid organic-inorganics, nanostructures of inorganic perovskites, composites incorporating novel organic and inorganic systems, polymers, and nano-structured materials will be of particular interest. The organizers welcome both theoretical and experimental studies carried out on such materials and device platforms. Under nanoscale devices, studies related to energy harvesting in areas such as photovoltaics, piezoelectricity, triboelectricity, and thermoelectricity as well as studies on nanobio devices are welcome. The organizers also welcome studies related to energy storage and sensing, including integrated system platforms suitable for the field of Internet of Things (IoT), including autonomous sensing.

**Session topics**
- Fundamental studies on advanced nanoscale materials for energy harvesting and storage
- Nanoscale triboelectric, piezoelectric, and thermoelectric energy harvesting devices
- Organic and hybrid materials systems for photovoltaics
- Photovoltaics based on hybrid and inorganic perovskite materials
- Novel materials and nanoscale sensor devices for wearable healthcare applications.
- Energy storage: new materials and devices
- Metal oxides: fundamental studies and applications
- Integrated systems and IoT platforms: incorporation of new technologies into existing technologies and studies on combined sensors, energy harvesting, and storage systems

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**S8: Advanced Materials for Fuel Cells and High Temperature Electrolysis**

Fuel cell technologies have attracted attention as a highly efficient power generation method. Among various types of fuel cells, solid oxide fuel cells have particularly high efficiency and flexibility in fuel. However, fundamental and applied research is essential to increase their performance and durability. Since similar materials are used, high temperature electrolysis cells have also attracted attention for efficient electrolysis cells, in particular, hydrogen production. This symposium will bring together leading researchers and technologists working in critical areas such as new materials, degradation processes, and systems engineering, to discuss state-of-the-art developments in solid oxide fuel cells and high temperature electrolysis.

**Session topics**
- Oxide proton conducting oxide fuel cells
- Electrolysis cells

**Organizer**
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**S9: CRITICAL MATERIALS FOR ENERGY**

Materials with strategic importance to clean and alternative energy that may have potential issues in their supply are deemed critical. Examples abound, including rare earth elements in wind turbines and electric vehicles, indium, tellurium, and gallium in photovoltaics, and lithium, cobalt, and graphite in batteries. Competing sectors like electronics, defense, and healthcare create increasing demand for these scarce resources and lead to significant price volatility that may impact manufacturers and consumers in the clean energy sector. This symposium invites research focusing on tackling critical material issues for clean and alternative energy.

**Session topics**
- Criticality assessment and case studies
- Exploration and resource estimation
- Extraction, refining, and processing techniques
- Recycling technology development and assessment
- Substitution research and development

**Organizers**
- Nobuhito Imanaka, Osaka University, Japan
- Taek-Soo Kim, Korea Institute of Industrial Technology, Korea

**S10: LIFECYCLE IMPACTS OF CLEAN ENERGY MATERIALS**

The goal of clean energy development and adoption is to reduce the environmental impacts associated with fossil fuel extraction, production, and consumption. However, sustainability aspects of clean energy technologies must also be studied and quantified to ensure new problems are not being introduced. This symposium invites broader system-level research looking at environmental impacts of clean energy systems, energy payback times, and recycling technology development and assessment. Addressing sustainability challenges requires work that spans social and economic issues, and therefore topics such as economic feasibility, integration and grid issues, and adoption and penetration challenges are also invited.

**Session topics**
- Life-cycle assessment
- Energy/emissions payback analysis
- Economic feasibility
- Integration, grid issues
- Adoption/penetration challenges
- Recycling and end-of-life technology and infrastructure development and assessment

**Organizers**
- Gabrielle Gaustad, Alfred University, U.S.A.
- Hanjiro Ambrose, University of California, Davis, U.S.A.
**S11: Materials for Super Ultra-Low Energy and Emission Vehicles**

This symposium will aim at fundamental understandings and practical development of the exhaust gas purification system for the Super Ultra Low Emission Vehicle. Due to the modification of engine driving condition to achieve high fuel efficiency and low emission at the same time, the temperature of the exhaust gas decreases undesirably, which results in the decline of the performance of the existing purification system. This symposium will deal with the upgraded catalysts and adsorbents to exhibit higher performance at the low temperature, and the mechanism of the sintering and the poisoning of the catalysts for preventing the deactivation of the catalysts and commercializing the purification system.

**Session topics**
- Catalysts for oxidation of CO, hydrocarbon, and NO
- Selective catalytic reduction (SCR) of NO using urea
- Catalyst for combustion of Particulate Matters (PM)
- Diesel particulate filter (DPF)
- Adsorbents of NOx, hydrocarbon
- Mechanism of catalyst sintering and poisoning
- Reduction or replacement of precious metals in automobile catalyst
- Establishment of control model

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**S12: Materials and Process Challenges for Sustainable Nuclear Energy**

Nuclear energy has the potential to become a sustainable innovative energy source when novel solutions can overcome accident potential and waste issues for the current fleet power plants. This symposium will focus on improved and advanced materials for alternative next generation reactor concepts, for structure components, and fuels that enable innovative nuclear power. With the advent of new reactor concepts, there is significant challenge to develop advanced materials to meet stringent requirements, i.e., high temperature and corrosive environments. Thus, a systematic approach of modeling, processing, characterization, and in-service performance testing is required to bring new materials in use.

**Session topics**
- Modeling and simulation of radiation effects on structural materials
- High-temperature metals and alloys
- Advanced ceramics and composites
- Material performance in radiation environments
- Degradation mechanisms and lifetime predictions of material components
- Material behavior in accident environments
- Characterization of materials and nondestructive evaluations
- Heat transfer materials and coolants
- Materials and processes for radioactive waste containment and disposal
- Design and testing of waste forms
- Advanced fuels design and concept

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S13: Theory and Experiment Meeting in Energy Materials Research

Green energy technology is regarded as an urgent subject for human sustainability and is receiving tremendous interest. However, the developments of energy conversion and storage materials currently have critical problems that hinder their complete substitutions for fossil fuels. The problems mainly lie in the high production costs, low stabilities, and low efficiencies. Since new energy materials discovery or processing optimization works require a huge amount of time and cost, it is now becoming necessary to combine theoretical predictions and analyses in energy materials research. For accelerated problem-solving and discovery of new energy material, computational methods (first-principles, molecular dynamics, and finite element methods, etc.) have been successfully combined with experiments to make effective materials developments based on better understanding. It seems to be a good time to review accomplishments of theory-experiments combined with research in the energy materials field. This symposium intends to explore various theory-experiments and computation-experiments combined with works in energy materials research, and welcomes both computation-aided analyses on experiments and theory-guided discovery of new materials in the renewable energy materials field.

Session topics
- Solar cells
- Electrocatalysts
- Photocatalysts
- Supercapacitors
- Li-air battery
- Li-ion battery

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S14: Chemical and Biological Sensors: Materials, Devices and Systems

This symposium will address all aspects of chemical and biological sensors. Chemical and biological sensors find extensive application in environmental monitoring, health care, food security and industrial quality assurance, safety, and process control, to name a few. These ubiquitous sensors are becoming an integral part of Internet of Things (IoT) applications, and progress in this domain can be seen each month. The promise is that everyone and everything will be connected via wireless data collection, and services like healthcare will be brought to everyone, everywhere, anytime, for virtually any need. With recent advances in novel and smart materials, big data analytics, low cost manufacturing, point of care screening, and wearable platforms, sensors will play an instrumental role in improving the quality of life and enable end-users to make meaningful and informed decisions. This meeting intends to bring together a range of interdisciplinary topics and covers all materials aspects of sensors and systems, sensor fabrication, sensor testing, field studies, and prototypes.

Session topics
- Materials synthesis, characterization, and their sensing prospects;
- Novel sensor concepts, design, modeling, verification, and system integration
- Low-cost sensor implementation using inkjet printing, aerosol printing, etc. on flexible platforms
- Wearable and point of care sensors
- Sensors and systems for IoT, food quality, environmental monitoring, smart agriculture, and flexible tags

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**S15: Young Scientists Forum on Future Energy Materials and Devices**

The ability to secure a long-term sustainable source of energy is arguably one of the most important challenges that humankind faces. Due to their immense potential societal value, research activity in the field of energy materials and devices has accelerated rapidly in recent years, with a number of highly disruptive breakthroughs occurring in the last decade alone. The problems this community seeks to tackle are decidedly multi-dimensional and interdisciplinary, requiring a broad set of strategies and collaboration to succeed. While progress in performance metrics of certain relevant technologies has been impressive, reproducibility, stability, and incomplete theoretical descriptions still inhibit commercial viability in many cases.

Young scientists are well-placed to play a significant role in leading these endeavors and have demonstrated notable contributions in recent years. This forum aims to highlight the important contributions made by early-career researchers in energy materials and devices. To facilitate a comprehensive debate, this forum will span various topics, both experimental and theoretical, ranging from basic science to questions on scalability and commercialization.

**Proposed topics**
- Advances in fundamental science of emerging photovoltaic materials (e.g. OPV, CdTe, CIGS, perovskites, DSSC, quantum dots)
- Developments in efficiency, stability, and scalability of photovoltaic devices
- Electrochemical materials and devices for energy production and storage
- From vision to reality: scientific collaborations by young scientists on the topic of energy materials and devices leading to industry and commercial applications

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Frontiers of Solar Energy Harvesting: New Materials for Photovoltaics and Solar Fuels—International symposium in honor of Prof. Yoon-Bong Hahn, Chonbuk National University

Functional nanomaterials with intrinsically new and tailored properties are key elements for developing sustainable solutions for energy harvesting. This symposium will focus on new energy technologies such as the emerging class of inorganic-organic hybrid perovskites, next-generation photocatalysts, and solar hydrogen production devices. Specifically, this symposium will focus on the multifunctional materials and techniques that offer advanced processing, improved properties, and cost and energy-efficient synthesis, with a strong focus on the recent innovation in nanotechnological approaches and the assessment of their industrial impact.

Perovskite solar cell (PSC) materials with general formula ABX$_3$ manifest disruptive materials innovation in the field of energy harvesting due to their promising photonic properties, low cost, and easy solution processability. In view of their excellent semiconductor properties, especially tunable band energies, long diffusion length of charge carriers and high absorption coefficients, halide perovskites have been extensively studied in both hybrid (e.g., CH$_3$NH$_3$PbI$_3$) and all-inorganic (e.g., CsPbI$_3$) compositions. However, progress in device efficiency, long-term environmental stability, as well as lead-free technologies are essential for the commercial uptake and deployment of the perovskite solar cell. Photoelectrochemical (PEC) water splitting has emerged as a competitive technology being capable of converting solar energy directly into chemical energy using stable and efficient photocatalysts for solar hydrogen production. Recent developments based on novel system designs have led to significant advances in the fundamental understanding of light-induced charge dynamics and related interfacial chemical reactions and efficiencies as well as long-term performance and stability of such new systems.

This event will provide an international forum for presenting technological advances in functional materials for energy harvesting to meet the challenges of sustainable energy and environment technologies. Interested individuals from academia, national laboratories, and industries are invited to contribute by submitting their abstracts along the following topics.

**Session topics**

**Innovative processing of nano- and heterostructured functional materials**
- Understanding of interface-driven functionalities and multi-material heterostructures
- Synthesis, functionalization, and assembly of nanomaterials and nanocomposites
- Scaled-up production of nanomaterials and integration into energy harvesting devices

**Functional metal oxide nano- and heterostructures for photocatalysis and solar fuels**
- Inorganic nanomaterials for artificial photosynthesis
- Molecular and semiconductor catalytic materials and systems for CO$_2$ reduction
- Nanostructured oxide and nanocomposites for excitonic solar cells

**Advanced materials for next generation photovoltaic devices**
- Frontiers of organic, inorganic, and hybrid perovskite solar cells
- Solar cell architectures and materials requirements
- Next generation electron and hole transport materials
- Hybrid interfaces and nanocrystalline junctions
- Charge generation, trapping, and transport
- Optoelectronic devices based on nanoparticle, nanowires, and composites

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- Gunnar Westin, Uppsala University, Sweden
- Yoshitake Masuda, AIST, Japan
S1: Mechano-Magneto-Electric Energy Harvesting

Mechanical vibrations and low amplitude magnetic fields are freely available in our surroundings on a variety of platforms. Conversion of these mechanical and magnetic fields into electricity with high efficiency can provide ubiquitous energy sources. For example, we are surrounded with 50/60 Hz parasitic magnetic noise arising from power delivery infrastructure. Recent investigations on a magneto-mechano-electric (MME) generator have shown a possibility to capture this magnetic field with high power density. This MME generator can be a ubiquitous power source for wireless sensor networks, low power electric devices, and wireless charging systems. Multiferroic magnetoellectric (ME) composites are attractive materials for design of MME generators and dual-phase harvesters. This symposium will review the fundamental physics, fabrication processes, modeling methods, and device design for ME composite material systems with respect to MME generator application.

Proposed topics
- ME composite materials—fundamentals, synthesis, and modeling
- MME generator design, modeling, and implementation
- Low frequency vibration energy harvesting structures
- ME composites-based energy harvester design and implementation

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- DaeYong Jeong, Inha University, Korea
- Shuxiang Dong, Peking University, China

S2: Integrated Energy Harvesting and Storage Systems for Wearables and IoT

Currently, applications utilizing Internet of Things (IoT) along with wearable electronics are the most important venues for the More than Moore technologies. Particular interests are wireless and autonomous devices. Each active device requires electrical power for sensing, transduction, data processing and transmission, and actuation. Green energy technologies, including both harvesting and storage, will be inevitable parts of the IoT hardware in the future. For a successful and practical integration, energy harvesters, energy storage components, interface and power management circuits, sensors, wireless data transmission components, etc. are usually needed. This symposium will review recent research and technologies in the above-mentioned individual components as well as the entire system design, integration, and assessment.

Proposed topics
- Feasibility assessment of energy harvester-powered systems
- Energy storage and harvesting/storage hybrid components for energy harvester-powered systems
- Electronics and circuitry for energy harvesting applications
- Energy harvester-powered system design and implementation

Organizers
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- Zdeněk Hadaš, Brno University of Technology, Czech Republic
- Yang Bai, University of Oulu, Finland
S3: Multi-functional Energy Conversion Materials and Devices for Energy Harvesting and/or Sensing

Energy conversion materials serve as one of the most important parts of an energy harvester and relevant systems. The functionality of such materials determines the input energy sources and largely affects the efficiencies of energy harvesters. Materials exhibiting piezoelectric, photovoltaic, pyroelectric, thermoelectric, electromagnetic, magnetostrictive, or electrocaloric behavior are conventionally used in energy harvesting research. They are also widely used for sensing. Using a harvester as a sensor simultaneously provides a viable option for multi-functional integrations. Meanwhile, in order to increase the number of input energy sources and overall capability/effectiveness of energy harvesting processes, hybrid energy harvesters made from different materials/structures are under intensive investigation. Furthermore, multi-functional features, e.g., piezoelectric and pyroelectric, and piezoelectric and photovoltaic, can be realized in monolithic and composite materials. These hybrid and multi-functional materials and devices are also promising alternatives for harvester-sensor integration. This symposium will review emerging and advanced hybrid energy conversion materials and devices with multi-source harvesting or harvesting-sensing multi-functionalities.

Proposed sessions
- Multi-functional materials—ceramics, polymers, films, composites, etc.
- Multi-functional hybrid structures and devices

Organizers
- Chris Bowen, University of Bath, U.K., c.r.bowen@bath.ac.uk
- Tim W. Button, University of Birmingham, U.K., t.w.button@bham.ac.uk
- Yang Bai, University of Oulu, Finland

S4: Thermoelectric Energy Harvesting

Thermoelectric modules are solid state devices that can directly convert heat to electricity and vice versa. This symposium will broadly cover a diverse range of topics including all types of thermoelectric materials, generators and coolers, and their applications. Rapid progress has been recently made in discovery, fundamental understanding, and applications of thermoelectric materials and devices. In thermoelectric materials, not only do the high peak and average ZT of materials deserve attention, the mechanical properties, thermal stability, and oxidation resistance should be taken into consideration as well. Moreover, the thermoelectric society requires more efforts on thermoelectric module/device design, joint and brazing materials, and fabrication processes because overall device performance, rather than material performance, is the key factor that motivates the investment and research input and leads to real applications for energy harvesting and cooling. For small footprint devices, exploring micro and nanotechnology approaches allows us to address together micromodule fabrication and low-dimension materials integration. The overall intent of this symposium is to provide an opportunity for thermolectric scientists and researchers to discuss critical issues and exchange opinions in thermoelectric materials and device development, commercial application, and thermoelectric future.

Proposed sessions
- Fundamentals of thermoelectric: theoretical design of materials and device modelling
- Thermoelectric materials: synthesis and characterization of thermoelectric materials (bulk, thin film, heterostructures, and nanocomposites)
- Thermoelectric devices: device fabrication, novel design for thermoelectric modules, thermal, and mechanical stability
- Applications: new ideas in thermoelectric applications, waste-heat recovery, and cooling

Organizers
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- Amin Nozari, Pennsylvania State University, U.S.A.
- Wenjie Li, Pennsylvania State University, U.S.A.
- Luis Fonseca, Autonomous University of Barcelona, Spain

S5: Piezoelectric and Triboelectric Energy Harvesting Using Low-Dimensional Materials

Low-dimensional materials including nanowires, nanotubes, fibers, and nanomaterials have received growing interest in various research fields, including piezoelectric and triboelectric energy harvesting. Low-dimensional materials exhibit a wide range of unique mechanical, electrical, and electromechanical properties that are hardly observable at macro-scales, offering substantial capability for applications in energy harvesting. For example, two-dimensional materials with a non-centerosymmetric structure have been experimentally confirmed or theoretically predicted as piezoelectric or triboelectric. This symposium will provide a great opportunity where recent research knowledge and innovative ideas on low-dimensional materials, devices, and related technology for energy harvesting are actively shared and discussed.

Proposed sessions
- Fundamental physics of energy conversion and harvesting at the nano- and micro-scale
- Synthesis, fabrication, and characterization techniques of low-dimensional materials and devices
- Two-dimensional materials and devices for piezoelectric and triboelectric energy harvesting
- Nanomaterials and nanostructures for piezoelectric and triboelectric energy harvesting: nanowires, nanotubes, nanofibers, and composite nanomaterials
**S6: Special Symposium—The European Energy Harvesting Workshop** (Invitation only)

The Workshop in Devices, Materials, and Structures for Energy Harvesting and Storage has been organized for five consecutive years in different locations of Europe. The 6th workshop is held jointly with the 3rd Annual Energy Harvesting Society Meeting.

This symposium will include invited review talks and posters across different topics of activities in Europe. There will also be an introductory presentation of the European energy harvesting network and collaboration opportunities. Detailed presentations of this session will be shown on associated posters.

**Organizers**
- Grzegorz Litak, Lublin University of Technology, Poland
- Sebastian Bader, Mid Sweden University, Sweden
- Carlo Trigona, University of Catania, Italy

**EHS 2020 Programming Committee**

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- Chong-Yun Kang, Korea Institute of Science and Technology, Korea
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- Mickael Lallart, Laboratoire de Genie Electrique et de Ferroelectrice (LGEF) INSA Lyon, France
- Jens Twiefel, Leibniz University Hannover, Germany
- Joe Shapter, Flinders University, Australia
- Lei Zuo, Virginia Polytechnic Institute and State University, U.S.A.
- Muhammad Hajj, Stevens Institute of Technology, U.S.A.
- Li Zheng, Virginia Polytechnic Institute and State University, U.S.A.
- Chris Rahn, The Pennsylvania State University, U.S.A.
- Sang-Gook Kim, Massachusetts Institute of Technology, U.S.A.
- Congcong Wu, The Pennsylvania State University, U.S.A.
- Kai Wang, The Pennsylvania State University, U.S.A.
- Dong Yang, The Pennsylvania State University, U.S.A.
- Bed Poudel, The Pennsylvania State University, U.S.A.
- Wenjie Li, The Pennsylvania State University, U.S.A.
- Fei Wang, SuSTech, China
- Fabien Giovanelli, University Tours, France
- Mari-Ann Einarsrud, NTNU Trondheim, Norway
- Luis Fonseca, Institute of Microelectronics of Barcelona, Spain
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- Cristina Rusu, RISE Research Institute of Sweden AB, Sweden
MATERIALS CHALLENGES IN ALTERNATIVE AND RENEWABLE ENERGY 2020 (MCARE 2020)

4TH ANNUAL ENERGY HARVESTING SOCIETY MEETING (EHS 2020)

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