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Materials Challenges in Alternative and Renewable Energy

April 17 - 21, 2016

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Introduction

Materials Challenges in Alternative Renewable Energy (MCARE 2016), organized by The American Ceramic Society, is a premier forum to address opportunities of emerging material technologies that support sustainability of a global society. MCARE 2016 is organized to bring 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.

This cutting edge international conference features plenary and invited talks, thematically-focused technical sessions, and poster presentations, enabling delegates to network and exchange ideas with professional peers and acclaimed experts. MCARE 2016 should be of interest to academic, industrial, and government scientists and engineers working toward sustainable energy solutions that support a global society. The conference atmosphere is developed to engage and promote participation of students and early stage researchers. MCARE 2016's scientific and technical scope is to discuss, exchange ideas, and learn about new advances and research results in materials, energy, and environmental technologies.

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.

Abstract Submission Instructions

Visit **www.ceramics.org/mcare2016** 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.

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SYMPOSIUM 1

Functional Materials for Photoelectrochemical and Electrocatalytic Hydrogen Production

The scale of the solar energy challenge not only calls for efficient solar photovoltaic and photoelectrochemical devices, but also abundant, inexpensive, and stable photoactive materials that can enable efficient light harvesting, charge separation and collection, and chemical transformation. Many earth-abundant materials are promising for solar energy applications, but significant challenges have prevented them from becoming as efficient as conventional and other recently commercialized thin film or single-crystalline solar materials. To maintain sustainable development and deployment of solar technologies, there has been increasing interest in further developing these earth-abundant materials to overcome scientific and technological barriers to enable applications in solar energy conversion.

Fabrication of new devices with better performance and improved stability—achieved by nanoscale materials design and control using unique phenomena, such as quantum confinement effects—is the key to success. This symposium will bring together an interdisciplinary group of researchers in materials science, physics, chemistry, and device engineering to propel a dialogue on innovative and sustainable applications of new and earth-abundant materials in solar energy conversion.

Proposed topics:

- Electrocatalytic reactions for fuel generation
- Bioinspired molecular and nanocatalysts for hydrogen production
- Tandem devices for integrated hydrogen production
- Solar-powered hydrogen production and utilization
- Functional nanostructures and nanocomposites for sustainable hydrogen production
- Device concepts for cost-effective water purification and desalinisation
- Ecological and energy-efficient processing of advanced functional nanostructures
- Nanotechnology for sustainable generation of renewable fuels
- Nanomaterials for energy efficient buildings and green architecture
- Industrial production, implementation, and commercialization of hydrogen production systems
- Societal, educational, environmental, and economic aspects of sustainable energy technologies

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SYMPOSIUM 2

Spectral Conversion Materials for Energy Applications

More efficient energy conversion technologies are an essential challenge facing the increasing demand for energy supply. Spectral conversion luminescent materials are potential candidates to increase the efficiency of solar cells as well as other environmentally relevant technologies, such as photocatalysis. Even the most efficient single-junction solar cells present energy losses of ~30% due to thermalization of high-energy photons and ~20% due to transparency of sub-bandgap photons. Downconversion or quantum cutting, luminescent downshifting, and upconversion are alternatives to diminish these losses by manipulating the solar spectrum. Thus, rational design of suitable optical materials is crucial, with approaches reaching from novel host materials and dopant optimization for upconversion and downconversion materials to hybrid materials for energy conversion enhancement.

This symposium will bring together different yet complimentary approaches for development and application of spectral conversion materials for the energy sector. Topics will focus on spectral conversion materials, with emphasis on materials design, characterization, hybrid structures, mechanisms, device fabrication, and innovative approaches and applications.

Proposed topics:

- Upconversion, downconversion, and luminescent downshifting for solar cells
- Lanthanides, dyes, and quantum dots for photovoltaic applications
- Spectral conversion for photocatalytic and water-splitting applications
- Triplet–triplet annihilation photon-upconversion
- Plasmonic and photonic manipulation of conversion processes
- Novel upconversion and downconversion materials—including sustainable and green synthesis approaches—such as nanoparticles, macro- and micro-sized structures, composites, and antenna for NIR harvesting
- Application-oriented approaches in spectral conversion

Organizers:

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SYMPOSIUM 3

Ferroelectrics and Multiferroics for Energy Applications

Ferroelectric or piezoelectric materials have the ability to transform mechanical strain energy into electric current or voltage. Converting available energy from the environment allows a self-sufficient energy supply for small electric loads, such as sensors, handheld devices, and radio transmitters. Magnetoelectric multiferroics show coupling between piezoelectric and magnetic orders that opens up possible applications in novel sensors and mechanical-vibration or magnetic energy harvesting. This symposium will address properties and functionalities of ferroelectrics and their relation to energy applications. Topics include ferroelectrics, antiferroelectrics, pyroelectrics, piezoelectrics, and nonlinear dielectrics for energy-related applications, such as energy storage and harvesting and related competitive alternatives. The symposium will particularly focus on cost-effective synthesis and device fabrication using piezoelectric or multiferroic bulk, thin films, and nanocomposites. This symposium is intended to serve as a platform to facilitate exchange of novel ideas and results and to establish collaborations among material chemists, physicists, and device engineers in the field of alternative and renewable energies.

Proposed topics:

- Synthesis and processing of ferroelectrics and multiferroics
- Electromechanical phenomena of piezoelectric composites, actuators, sensors, and motors
- Lead-free ferroelectrics and piezoelectrics
- Nanoscale phenomena in ferroelectric and piezoelectric materials
- Multiferroic oxides, heterostructures, and thin films
- Ferroelectric photovoltaics
- Photovoltaic, photocatalytic, and electrochemical effects
- Pyroelectric, electrocaloric, and thermoelectric properties
- Modeling and simulations
- Energy applications of ferroelectrics and multiferroics

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SYMPOSIUM 4

Material Challenges in Nuclear Energy

Nuclear energy has the potential to become an 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 reactor concepts, core structures, and fuels that enable innovative nuclear power. With the advent of new reactor concepts, there is a significant challenge to develop advanced materials to meet stringent requirements. Thus, a systematic approach of modeling, processing, characterization, and in-service performance testing is required to bring new materials in use.

Proposed topics:

- Modeling and simulation of 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 for radioactive waste containment and disposal

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SYMPOSIUM 5

Materials Challenges in Fuel Cells

Fuel cell technologies have attracted attention for mobile applications, stationary power generation, and combined heat and power. Various kinds of fuel cells are produced and sold commercially for a wide range of applications. However, continued fundamental and applied research is essential to reduce production costs and increase durability. 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 fuel cell technologies. Topics will focus on proton exchange membrane fuel cells, solid

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oxide fuel cells, solid oxide electrolysis cells, molten carbonate fuel cells, and direct methanol fuel cells.

Proposed topics:

- Materials development and microstructure engineering
- Processing of cell components
- Transport phenomena and degradation
- Modeling and design of stacks

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SYMPOSIUM 6

Critical Materials for Energy

Critical materials, or rare materials, are important components of electronic devices, instruments, defense equipment, magnets, and pollution control catalysts. Because application areas and material demands are continuously expanding, the science and engineering community needs to discuss assurance of critical materials. Reduction or substitution of critical element consumption is one current solution beyond new mining. This interdisciplinary symposium will bring together experts to exchange ideas and experiences on critical materials.

Proposed topics:

- Optical, photonic, electronic, magnetic, structural, and energy applications
- Recycling, reduction, and substitution technology
- Separation, refining, and materialization technology
- Rare-earth elements
- Exploration and mining
- Environmental and human health issues
- Critical material strategies and industry overview

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SYMPOSIUM 7

Emerging Materials for Next Generation Photovoltaics

Economically viable, high-performance photovoltaic systems with long-term stability are a promising renewable energy solution to replace fossil fuels. Various next-generation solar cells have been exploited to facilitate photovoltaic systems by using novel device architectures and cost-effective materials and processes. This symposium will address recent material developments in next-generation solar cells, such as perovskite, dye-sensitized, organic photovoltaic, quantum dot, and other emerging solar cells. Topics will bring together interdisciplinary experts on state-of-art technologies of photovoltaic devices by focusing on fundamentals and applications from materials to devices.

Proposed topics:

- Synthesis, functionalization, processing, and self-assembly of nanomaterials for next-generation solar cells
- Solution process for fabrication of hybrid solar cells
- Emerging materials for perovskite, dye-sensitized, organic, and quantum dot solar cells
- Strategies for realizing environmentally friendly and long-term stable next-generation solar cells
- Other photovoltaic technologies and applications

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SYMPOSIUM 8

Self-Power Generators

This symposium will focus on fundamental understanding and practical development of mechanical and thermal energy-harvesting strategies. Topics will include theoretical and experimental studies of piezoelectric, ferroelectric, triboelectric, and thermoelectric nanomaterial development; nanomaterials for flexible, stretchable

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supercapacitors and batteries; systematic design and optimization of nanogenerators for self-powered electronics; and coupling effects between piezoelectric or ferroelectric polarization and semiconducting properties, including electronic band structure, optoelectronics, photovoltaics, thermoelectrics, catalysts, and photoelectrochemistry.

Proposed topics:

- Materials and devices for piezoelectric, triboelectric, thermoelectric power generators
- Piezoelectric and ferroelectric nanomaterial synthesis, characterization, and integration
- Flexible and stretchable supercapacitors and batteries
- Nanomaterials for flexible, stretchable energy storage devices
- Theoretical and experimental studies of nanoscale mechanical- and thermal-to-electric energy conversion processes
- Fundamental studies of band-structure engineering based on piezoelectric or ferroelectric polarization
- Hybrid energy-harvesting techniques, including mechanical, thermal, and solar
- Power management systems for self-powering small electronics

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SYMPOSIUM 9

Direct Thermal-to-Electrical Energy Conversion Materials and Applications

Significant advances in direct thermal-to-electrical energy conversion materials have pushed these materials into new applications for solid-state energy harvesting or cooling. 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-electric energy conversion. The symposium will focus specifically 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 material and device design innovations that lead to higher efficiency thermal-to-electric energy conversion technologies.

The symposium will include 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, and nanostructured materials, including recent advances in thermoelectric nanocomposites (nanomaterials or inherent nanostructures in bulk thermoelectric material matrices). It will also highlight advances in the use of spark plasma sintering to develop high performance thermoelectric materials. New developments in material property and device performance measurements and metrology will also be presented.

Proposed topics:

- Oxides and other materials with strong electron correlation
- Theoretical guidance to high-efficiency thermoelectric energy conversion
- New and emerging technologies for thermoelectric power conversion
- High-efficiency bulk thermoelectric materials
- Nanoscale thermoelectric materials
- Thermoelectrics for harvesting solar energy
- Thermionics and other related topics
- Synthetic strategies for preparing novel materials and compounds
- Role of spark plasma sintering techniques for thermoelectric materials
- Thermoelectric nanocomposite materials
- Processing of bulk and thin-film nanostructured materials
- Materials property measurement and new metrology techniques
- Design, performance testing, fabrication, and processing of energy conversion devices
- Device performance requirements for future applications
- Applications and new directions in thermal energy conversion

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SYMPOSIUM 10

Batteries and Energy Storage

Batteries convert chemical energy into electrical energy. The many types of available batteries represent a multi-billion-dollar industry, yet state-of-the-art electrical energy storage systems cannot meet requirements for use in transportation, grid, and commercial technologies. Battery technology seeks new concepts in materials design to overcome current limitations of performance and lifetime. More critical insight is required to overcome both limitations in terms of material structures as well as interfacial reactions to produce

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next-generation electrode materials and battery cells with higher energy densities, higher power densities, and longer cycling abilities. This symposium will explore novel energy storage materials and technologies that are critical to make current energy storage systems more effective in the future.

Proposed topics:
Fundamentals, modeling, mechanisms, materials design, screening, electrode architectures, diagnostics, materials characterization, and electrode/electrolyte interface characterization of the following systems:

- Lithium batteries
- Sodium batteries
- Magnesium batteries
- Lithium–air batteries
- Lithium–sulfur batteries
- Redox flow batteries
- All-solid-state batteries
- High-temperature batteries
- Supercapacitors

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SYMPOSIUM 11

Hydrogen Materials and Economy

Hydrogen is a key fuel for use in a wide range of energy conversion technologies. Hydrogen can be produced from a variety of domestic sources, including fossil fuels, as well as from renewable resources and can be stored in gas, liquid, or solid form. Because hydrogen can produce significant energy through environmentally friendly chemical reactions, there is considerable work in progress to develop the infrastructure, materials, and systems for efficient, effective, and safe hydrogen storage and transfer. This symposium focuses on materials for developing the infrastructure for hydrogen energy conversion technologies.

Proposed topics:
- Separation
- Absorption, catalysis, and methods for enhancing interactions
- Interactions with and effects on materials for storage and transfer
- Storage and transfer materials and methods
- Analytic methods for characterization of storage and transfer systems

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SYMPOSIUM 12

Global Young Scientist Forum: Nanomaterials for Energy

Although many newly investigated materials and processes for energy generation, storage, and conversion provide significant advantages over existing technologies, few bridge the gap from laboratory demonstrations over prototype devices to commercial products. In particular, large volume production, handling, and integration of nanostructured materials for existing technology platforms is a challenging task when ensuring high device reproducibility at low cost. This symposium will elaborate how industrial uptake of new material technologies can be accomplished, identify current hurdles that prevent economic impact, and elucidate how research, industry, and policy support implementation of new nanomaterials for improved energy generation, storage, and conversion devices.

Proposed topics:
- Photovoltaics: Potential and prospects of a post-silicon era (organic, CIGS, perovskite, and beyond)
- Batteries: Post lithium-ion concept application potential and hybrid storage media
- Hydrogen economy: Nanomaterials for hydrogen production, storage, and utilization
- Carbon nanotubes, fullerene, graphene, and diamond: Integration and commercialization potential of carbon-based functional materials for energy applications
- Large-scale integration of nanostructured materials for energy applications
- Sustainable production of nanostructured materials (low-energy fabrication, atom economic materials synthesis, replacement of critical materials, etc.)
- Virtual materials: Calculations and simulations for reduced innovation cycles
- Economic and policy aspects of nanomaterial integration and commercialization

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