C A L L F O R P A P E R S

Materials Challenges in Alternative and Renewable Energy 2019

MCARE 2019

August 19-23, 2019

LOTTE Hotel, Jeju Island, Korea

On behalf of the organizing committee of Materials Challenges in Alternative and Renewable Energy 2019 (MCARE 2019), we cordially invite you to participate in this exciting, interdisciplinary conference. MCARE 2019 organized by the Korean Institute of Chemical Engineers (KIChE) and American Ceramic Society (ACerS) will be held in Jeju, Korea for the period of August 19-23, 2019.

Building sustainable energy systems represents one of the mega-challenges of our times that have triggered a quest for alternative energy solutions both in academia and industry. This top-of-the-line conference will feature plenary, keynote and invited lectures, thematically focused technical sessions and poster presentations enabling the delegates to network and exchange ideas with their professional peers and acclaimed experts.

MCARE 2019 plans to shoot for 500+ presentations in Solar fuel production, Perovskite and next generation solar cells, Batteries and energy storage systems, Thermal-to-energy conversion, Self-powered generators, Critical and spectral energy conversion, Materials for ultra-low energy and emission vehicles, Advanced materials for fuel cells and High temperature electrolysis, Materials and nanodevices for sustainable and eco-friendly applications. In addition, special activities for young professionals and interested participants are planned to enhance the awareness on materials challenges in alternative and renewable energy sources.

Please make plans to attend this unique conference. We look forward to seeing you in beautiful Jeju island, Korea.

Plenary Speakers

- Dr. Dileep Singh, Argonne National Laboratory, USA
- Prof. Rodney S. Ruoff, IBS Center on the UNIST, Korea
- Prof. Fritz B. Prinz, Stanford University, USA
- Prof. Kyung Byung Yoon, Korea Center for Artificial Photosynthesis, Sogang University, Korea

Hosted by:
Korean Institute of Chemical Engineers

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The Korean Institute of Chemical Engineers

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Abstract Submission Due: March 31, 2019

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MCARE 2019

Materials Challenges in Alternative and Renewable Energy

August 19-23, 2019 LOTTE Hotel, Jeju Island, Korea

MCARE 2019 will address a variety of materials and technologies that are critically needed for development of state-of-art technologies of alternative and renewable energy. The technical program features plenary, keynote and invited talks, contributed oral and poster presentations for thematically-focused technical symposiums. MCARE 2019 consists of 11 symposia

Symposium 1. Symposium on Materials for Solar Fuel Production and Applications

Symposium 2. Advanced Materials for Energy Storage

Symposium 3. Challenges in Thermal-to-Electrical Energy Conversion Technology for Innovative Novel Applications

Symposium 4. Advanced Materials for Perovskite and Next Generation Solar Cells

Symposium 5. Spectral Conversion Materials for Energy Applications

Symposium 6. Materials for Nanogenerators and Self-powered Electronics

Symposium 7. Materials for Super Ultra Low Energy and Emission Vehicles

Symposium 8. Critical Materials for Energy Applications

Symposium 9. Advanced Materials for Fuel Cells and High Temperature Electrolysis

Symposium 10. Symposium on Advanced Materials and Nanodevices for Sustainable and Eco-Friendly Applications

Symposium 11. Young Scientists Forum on Future Energy Materials and Devices

Abstract Submission Due: March 31, 2019

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[Symposium 1] Symposium on Materials for Solar Fuel Production and Applications

- Brief description and scope of symposium

Recently, 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 the Symposium 1 will be the recent progress and scientific challenges of integrating the light absorbers and catalysts into subsystems, with the goal of achieving closed photo(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 PV-electrolysis method and etc.
This special session will bring experts together from the 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 or PV-electrolysis for solar fuel production
  - New catalysts for solar fuel generation

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[Symposium 2] Advanced Materials for Energy Storage

- Brief description and scope of symposium

Batteries are devices that convert chemical energy into electrical energy. There are many types of batteries available, representing a multi-billion dollar industry. The 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. Battery technology seeks new concepts in materials design to overcome the current limitations of performance and lifetime. More critical insight is required to both in terms of material structures as well as interfacial reactions to produce next-generation electrode materials and battery cells enabling higher energy densities, high power densities and longer cycling abilities. This symposium will explore novel energy storage materials and technologies that are critical in making the current energy storage systems more effective in the future. In addition, we also strongly welcome abstracts on supercapacitors and flexible batteries for self-powering small electronics.

Session topics

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

- Lithium ion batteries
- Sodium ion batteries
- Magnesium ion batteries
- Lithium metal batteries
- Lithium-air batteries
- Lithium-sulfur Batteries
- Redox Flow Batteries
- All-solid-state Batteries
- High Temperature Batteries
- Flexible Batteries
- Supercapacitors

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[Symposium 3] Challenges in Thermal-to-Electrical Energy Conversion Technology for Innovative Novel Applications

- Brief description and scope of symposium

The aim of the symposium is to introduce the state-of-the-art thermoelectric materials as well as devices and system applications for thermoelectric power generation and cooling. This symposium also assembles experts from different research fields to promote co-operations on thermoelectric materials and applications development. The measurement technology for thermoelectric materials and devices is also one of the important subjects of this symposium. New era of thermoelectric materials and applications is opening with significant improvement of thermoelectric properties, which is from nano-structures embedded bulk materials, novel fabrication processing, and discovering a new physical phenomenon. From the thermoelectric conversion of body heat, industry waste heat, geothermal, or solar as a heat energy source is an attractive and environmentally clean way to generate electrical power.

In addition, new functionality such as flexibility added to thermoelectric devices so that applications and markets for thermoelectric modules are expanding.

This symposium invites papers reporting new thermoelectric materials, enhanced thermoelectric properties, novel devices and new applications for power generation and cooling. The study on the methodology for thermoelectric materials and devices evaluation is also welcome. Leading experts and opinion leaders from universities, institutes, and industries will convene to exchange knowledge and ideas related to all thermoelectric technologies.

- Session topics
  - Novel thermoelectric materials
  - Waste heat recovery
  - Nano materials and nanocomposites
  - Thermoelectric modules
  - Thermoelectric power generation
  - Thermoelectric cooling
  - Thermoelectric thin films
  - Thermoelectric oxides
  - Hybrid thermoelectric system with photovoltaic and so on.
  - Energy harvesting system
  - Processing and engineering of materials
  - Thermoelectric materials and devices measurements

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[Symposium 4] Advanced Materials for Perovskite and Next Generation Solar Cells

- Brief description and scope of symposium

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 23.3%. 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, vapour-vapour, vapour-solid, co-solution, solid-solution phases into high quality crystalline powder or thin films at near-ambient conditions. Despite the high efficiency and excellent opt-electronic 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
  - - Large area module technology
  - - Device stability issues
  - Materials and technologies for quantum-dot solar cells
  - Materials and technologies for organic and hybrid solar cells
  - Materials and technologies for inorganic solar cells

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[Symposium 5] Spectral Conversion Materials for Energy Applications

● Brief description and scope of symposium

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, solar fuels and artificial photosynthesis, where usually large parts of the solar spectrum do not contribute to the harvesting scheme. 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. 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, QDs, organic dyes, carbon-based structures and photonic concepts.

It is the scope of this symposium to provide a 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. It is the particular aim to foster the exchange between experts from different fields, such as materials design and chemical materials synthesis (e.g., nanostructures, QDs), synthesis of optical micro- and macromaterials, spectral characterization, and device development in order to communicate knowledge and demands between the different communities. Moreover, taking advantage from interdisciplinary approaches and multifunctional materials, experts in synthesis and characterization of spectral conversion materials from related research areas (such as bioprobe, phosphor or laser design) are greatly welcome.

Topics will focus on, but not been limited to, spectral conversion materials with emphasis on materials design and synthesis, characterization and optimization, assembly of hybrid structures, clarification of mechanisms, device fabrication, and applications in energy (and beyond) technologies.

● Session topics

- Materials for upconversion, downconversion / quantum cutting and luminescent downshifting
- Lanthanides, dyes and quantum confined nanomaterials (quantum dots, wires, plates, etc.) for photovoltaic applications
- Spectral conversion for photo-catalytic and water-splitting applications
- Triplet–triplet annihilation photon-upconversion
- Development of novel optical materials: From nano to macro - Achievements and challenges in the design and synthesis of innovative nano-, micro- and macrostructures including lanthanide-doped materials, QDs, carbon-based materials etc.
- Smart assemblies: Combining lanthanide-doped nanoparticles, QDs, carbon-based nanostructures, dyes etc. to enhance spectral conversion efficiency.
- Novel device design: Towards module-scale solar-chemical energy harvesting by implementing e. g., 3D-printed solar concentrators, external light traps, etc.
- Plasmonic / photonic manipulation of conversion processes

- Novel sustainable and green synthesis approaches for energy conversion materials
- Deeper understanding and prediction of more efficient energy converters: Theoretical approaches and modeling
- Application-oriented approaches in spectral conversion
- Multifunctional spectral conversion materials: Applications beyond the energy sector (e.g., novel phosphor materials, bioprobes, etc.)

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[Symposium 6] Materials for Nanogenerators and Self-powered Electronics

- Brief description and scope of symposium

This symposium will aim at fundamental understandings and practical development of the mechanical energy-harvesting strategies, micro/nanometer-scale piezoelectric/ triboelectric/thermoelectric effect, and the coupling between piezoelectric/triboelectric potential and semiconductor behavior and functionalities. In addition, we also strongly welcome studies on future energy storage devices and systems including supercapacitors and batteries with a flexible, stretchable platform for self-powering small electronics. Abstracts on the theoretical and experimental study of piezoelectric, ferroelectric, triboelectric nanomaterial development; nanomaterials for flexible, stretchable supercapacitors and batteries; systematic design and optimization of nanogenerators for self-powered electronics; and coupling effect between piezoelectric or ferroelectric polarization and semiconducting properties including electronic band structure, optoelectronics, photovoltaics, thermoelectrics, catalysts, photoelectrochemistry, etc are greatly welcome.

- Session topics
  - Materials and devices for piezoelectric, triboelectric, hybrid nanogenerators
  - Piezoelectric and ferroelectric nanomaterial synthesis, characterization, and integration
  - Flexible, stretchable supercapacitors, batteries, and other energy storage devices
  - Nanomaterials for flexible, stretchable energy storage devices
  - Theoretical and experimental study on nanoscale mechanical-to-electric energy conversion process
  - Fundamental study on band-structure engineering based on piezoelectric or ferroelectric polarization
  - Hybrid energy-harvesting techniques (mechanical, thermal, solar, etc.)
  - Power management systems for self-powering small electronics

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[Symposium 7] Materials for super ultra low energy and emission vehicle

- Brief description and scope of symposium

This symposium will aim at fundamental understandings and practical development of the exhaust gas purification system for the Super Ultra Low Energy & 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 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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[Symposium 8] Critical Materials for Energy Applications

● Brief description and scope of symposium

Focus of this symposium is critical materials for energy applications. Critical materials constitute rare metals and rare earth elements. Known as the "Vitamins of industry", critical materials are increasingly becoming critical resource since global demand for advanced and compact electronic instruments, defense equipment, magnets, and pollution control catalysts is increasing every day. In these days, critical materials become a hot issue due to its core role to the main element as well as its rarity. Since the rarity is not only determined by its existence in nature, but also the balance between demand and supply; assurance has been propelled in various manners such as exploration, recycling, substitution etc. This symposium will bring experts together to exchange ideas, and experiences on critical materials, which will foster the scientific exchange.

● Session topics

Topics will include critical materials and rare earths for energy applications:

- Rare earth elements
- Critical materials strategies and industry
- Exploration and mining
- Extraction, refining and materialization technologies
- Recycling and substitution technology
- Optical, photonic, electronic, magnetic and energy application.

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[Symposium 9] Advanced Materials for Fuel Cells and High Temperature Electrolysis

● Brief description and scope of symposium

Fuel cells and high temperature electrolysis are devices that convert chemical energy into electrical energy or vice versa. There are many types of such devices available, corresponding to a multi-billion dollar industry. However, the cutting edge technologies about fuel cell and high temperature electrolysis systems do not fully satisfy the requirements for effective utilization in transportation, grid and commercial technologies, although the systems keep pursuing new concepts in materials design to overcome the current limitations of performance and lifetime. In this regard, Efforts for addressing such crucial limitations are needed and the development of new and advanced material structures including interfacial reactions to produce next-generation electrode and membrane materials is required, while new solutions on fuel cells and high temperature electrolysis enabling high power densities and longer stabilities should be suggested. This symposium will explore novel energy convergence materials and technologies that are critical in making the current fuel cell and high temperature electrolysis systems more effective in the future. In addition, we also strongly welcome abstracts on other fuel cell and high temperature electrolysis related materials, systems, applications and computational evaluations.

● Session topics

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

- Polymer electrolyte membrane fuel cell (PEMFC)
- High temperature fuel cells (SOFC and MCFC)
- Direct carbon fuel cell (DCFC)
- Direct liquid fuel cells (DMFC and DFAFC)
- Biofuel cells (Enzymatic and microbial)
- Alkaline fuel cell (AFC)
- Phosphoric acid fuel cell (PAFC)
- High temperature electrolysis (HTE)
- Flexible fuel cells
- Catalysts for fuel cell systems
- Membranes for fuel cell systems

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[Symposium 10] Advanced Materials and Nanodevices for Sustainable and Eco-Friendly Applications

- Brief description and scope of symposium

Recently, IoT and the fourth industrial revolution is marked by emerging technology and in the near future. This symposium will focus on the development of novel advanced materials and nanoscale devices required to these research trends, especially for sustainable and environmentally friendly applications. Hybrid organic-inorganic, polymers, nanostructured materials, and biomimetic or bioinspired materials will be of particular interest. Based on these advanced materials, the organizers also welcome studies related to the sustainable system, and integrated device platforms suitable for health and eco-friendly monitoring. Both theoretical and experimental studies are welcome for this symposium.

- Session topics
  - Advanced materials for renewable and sustainable energy
  - Advanced materials for eco-friendly applications
  - Biomimetic and bioinspired materials
  - Electronic devices using advanced materials
  - Chemical and biological sensors for environmental and health monitoring.
  - Wearable and stretchable electronics for health applications
  - Theoretical and experimental study on the interface phenomena
  - Integrated systems for IoT technology platforms

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[Symposium 11] Young Scientists Forum on Future Energy Materials and Devices

- Brief description and scope of symposium

The energy materials and devices research area addresses one of the most pressing challenges of our time: securing a stable base for energy supply. These challenges can be met by materials development approaches from various angles: no single approach is likely to suffice and an effective solution will require creative integration of several approaches including photovoltaics, photocatalysis, and hydrogen, as well as energy storage. Young scientists across the world are at the forefront of these activities and have potential to be leaders in their fields in the future. This symposium highlights significant contributions from early-career scholars and scientists on the problem of energy materials and devices.

- Session topics

Contributed papers and presentations on the following topics will be primarily considered:

- High efficiency energy harvesting devices
- High efficiency optoelectronic devices

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