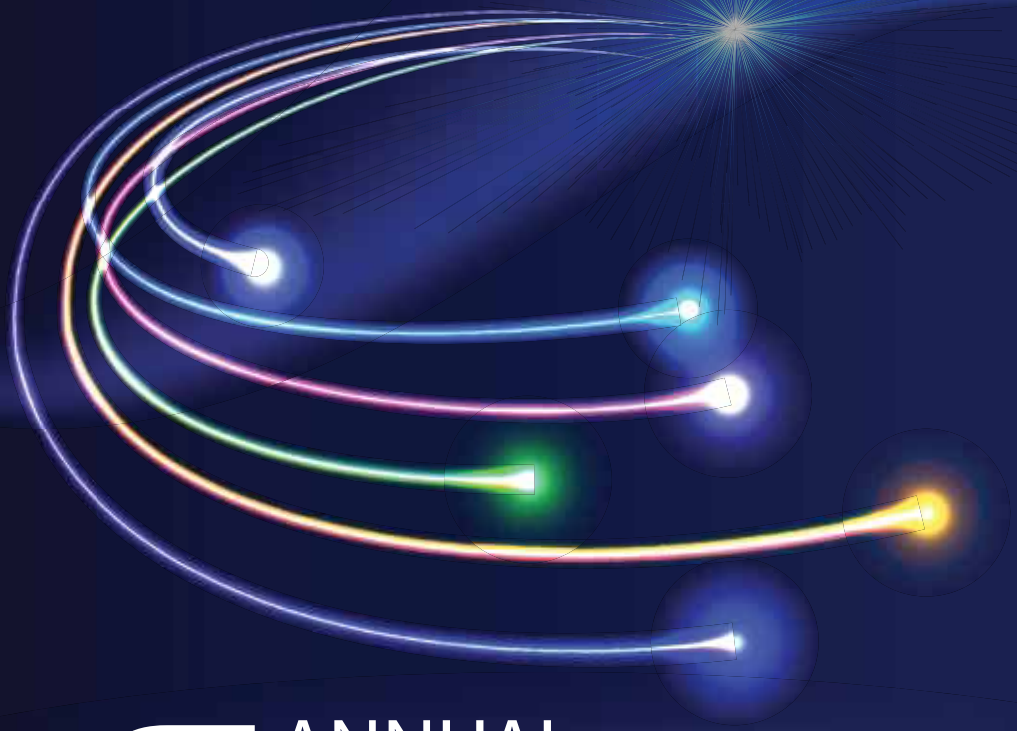
[call for papers Abstracts due May 24]



# 5th ANNUAL ENERGY HARVESTING SOCIETY MEETING (EHS 2022)

SEPTEMBER 7–9, 2022
Falls Church, Virginia USA
ceramics.org/ehs22

ORGANIZERS

The American Ceramic Society
www.ceramics.org

ENERGY HARVESTING SOCIETY

[call for papers Abstracts due **May 24**]

SEPTEMBER 7–9, 2022
Falls Church, Virginia USA
ceramics.org/ehs22

# 5th ANNUAL ENERGY HARVESTING SOCIETY MEETING (EHS 2022)

## WELCOME!

First and second Energy Harvesting Workshop (EHW) was held in Fort Worth, TX, in January 2006 and 2007 respectively. The workshop covered presentations on vibration, thermal, magnetic and light energy harvesting. Since then, this workshop has been highly successful in bringing the academic community from around the world together year after year. In these last few years, workshop has also been held in China and Germany. Energy harvesting has become the key to the future of wireless sensor and actuator networks for variety of applications including monitoring of temperature, strain, humidity, light, and location of person in the building, chemical/gas sensor, structural health monitoring, IoT, etc. In Year 2017, 12th Energy Harvesting Workshop (EHW) was held in conjunction with the 1st Annual Energy Harvesting Society Meeting (AEHSM) from Sept. 11-14 in Falls Church, Virginia, at hotel Westin Tysons Corner. This meeting brought together leading speakers from dozens of countries such as US, Australia, Germany, Japan, Korea, China, India, South Africa, and more. In Year 2018, at the Penn State Navy Yard meeting, it was decided to merge the EHW and AEHSM to provide higher value for attendees by providing access to larger amount of information at lower cost. In Year 2019, the 3rd meeting was held in Falls Church, Virginia featuring "Women in Science" with each Plenary lecture provided were given by respected female science within the field. In 2021, a virtual meeting was held in conjunction with Materials Challenges in Alternative and Renewable Energy (MCARE) due to the COVID-19 pandemic. This year we are excited to resume in person meetings in 2022. This 5th 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.)
- Materials for EH: multifunctional, SDG-compatible materials, Composites, thin film, 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, IoT, 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

PROGRAM CHAIRS:

**Shashank Priya**
Penn State University

**Jungho Ryu**
Yeungnam University, Korea

**Yang Bai**
University of Oulu, Finland

**Huiming Yin**
Columbia University

**Chris Rahn**
Penn State University

**Lei Zuo**
Virginia Tech University

# PROGRAMMING COMMITTEE:

**Grzegorz Litak** Lublin University of Technology, Poland
**David Arnold** University of Florida, USA
**Tim Button** University of Birmingham, UK
**Chris Bowen** University of Bath, UK
**Vikram Pakrashi** University College Dublin, Ireland
**Sebastian Bader** Mid Sweden University, Sweden
**Carlo Trigona** University of Catania, Italy
**Sahn Nahm** Korea University, Korea
**Shuxiang Dong** Peking University, China
**Seong-Ju Hwang** Ewha Womans University, Korea
**Ji-Won Choi** KIST, Korea
**Armin Feldhoff** Leibniz University Hannover, Germany
**Isaku Kanno** Kobe University, Japan
**Takeshi Morita** University of Tokyo, Japan
**Chong-Yun Kang** Korea Institute of Science and Technology, Korea
**DaeYong Jeong** Inha University, Korea
**Miso Kim** Sungkyunkwan University, Korea
**Mickaël Lallart** Laboratoire de Génie Electrique et de Ferroélectricité (LGEF) INSA Lyon, France
**Jens Twiefel** Leibniz University Hannover, Germany
**Joe Shapter** Flinders University, Australia
**Muhammad Hajj** Steven Institute of Technology, USA
**Li Zheng** Virginia Tech, USA
**Sang-Gook Kim** MIT, USA
**Kai Wang** Penn State, USA
**Bed Poudel** Penn State, USA
**Amin Nozariasbmarz** Penn State, USA
**Wenjie Li** Penn State, USA
**Fei Wang** SuSTech, Shenzen, China
**Fabien Giovanelli** University Tours, France
**Mari-Ann Einarsrud** NTNU Trondheim, Norway
**Luis Fonseca** Institute of Microelectronics of Barcelona, IMB-CNM (CSIC), Spain
**Zdeněk Hadaš** Brno University of Technology, Czech Republic
**Cristina Rusu** RISE Research Institute of Sweden AB, Sweden

## ABSTRACT SUBMISSION INSTRUCTIONS

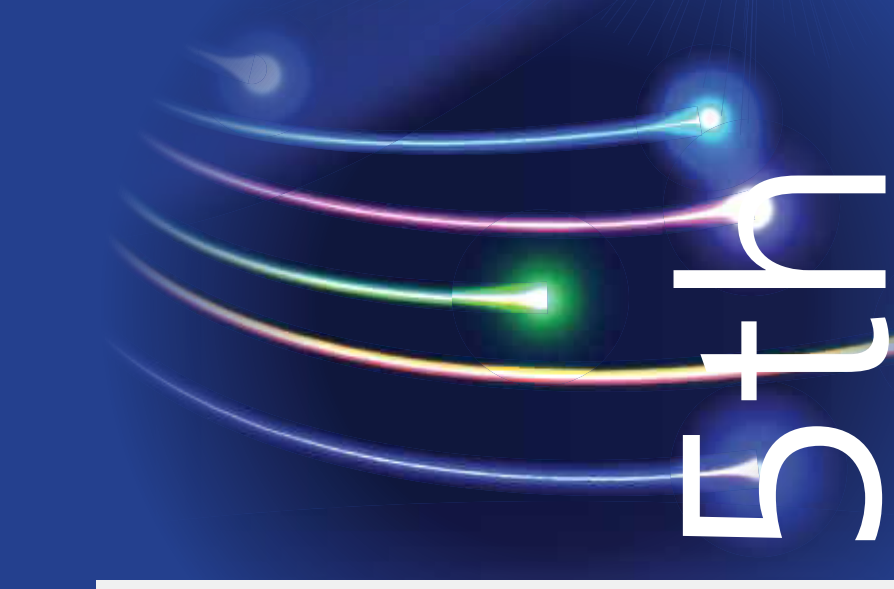
- Visit **ceramics.org/ehs22** to review session topics.
- Select "Submit Abstract" to be directed to the Abstract Central website. Abstract title plus text character limit (including spaces) is 1,500 characters.

If you have questions, please contact
**Marilyn Stoltz** at
**mstoltz@ceramics.org** or
+1 614-794-5868. Submit your abstracts at
**https://ceramics.org/ehs22.abstractcentral.com**

## FALLS CHURCH MARRIOTT FAIRVIEW PARK

3111 Fairview Park Dr.
Falls Church, Va. 22042-4550 USA
1-800-228-9290 (within U.S.)

RESERVATIONS **Cut-Off Date: August 8, 2022**
Single/Double/Triple/Quad/Student: $149 a night plus tax
Mention ACerS Energy Harvesting conference to get conference rate.



# 5th ANNUAL ENERGY HARVESTING SOCIETY MEETING (EHS 2022)

## S1: PIEZOELECTRIC AND MECHANO-MAGNETO-ELECTRIC ENERGY HARVESTING

Mechanical vibrations and low amplitude magnetic field are freely available in our surroundings on 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 magneto-mechano-electric (MME) generator have shown 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 magnetoelectric (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 SESSIONS

- Piezoelectric materials
- ME composite materials – Fundamentals, synthesis, and modeling
- MME generator design, modeling and implementation
- Hybrid frequency vibration energy harvesting structures
- ME composites-based energy harvester design and implementation

### SYMPOSIUM ORGANIZERS

– **Jungho Ryu**, Yeungnam University, Korea, jhryu@ynu.ac.kr
– **Shashank Priya**, Penn State University, USA, sup103@psu.edu
– **DaeYong Jeong**, Inha University, Korea, dyjeong@inha.ac.kr
– **Shuxiang Dong**, Peking University, China, sxdong@pku.edu.cn

## 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 SESSIONS

- 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

### SYMPOSIUM ORGANIZERS

– **Vikram Pakrashi**, University College Dublin, Ireland, vikram.pakrashi@ucd.ie
– **Sebastian Bader**, Mid Sweden University, Sweden, sebastian.bader@miun.se
– **Zdeněk Hadaš**, Brno University of Technology, Czech Republic, zdenek.hadas@vut.cz
– **Yang Bai**, University of Oulu, Finland, yang.bai@oulu.fi

SEPTEMBER 7–9, 2022 | Falls Church, Virginia USA

# [call for papers Abstracts due May 24]

## 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 behaviour 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 the 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

### SYMPOSIUM ORGANIZERS


– **Chris Bowen**, University of Bath, UK, c.r.bowen@bath.ac.uk

– **Tim W. Button**, University of Birmingham, UK, t.w.button@bham.ac.uk

– **Yang Bai**, University of Oulu, Finland, yang.bai@oulu.fi


## 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 the high peak and average ZT of materials deserves attention, the mechanical properties, thermal stability, 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 the overall device performance rather than the material performance is the key factor that motivates the investment, research input and leads to the real application for energy harvesting and cooling. For small footprint devices, exploring micro and nanotechnology approaches allow to address together micromodule fabrication and low-dimension materials integration. The overall intent of this symposium is to provide an opportunity for thermoelectric scientists and researchers to discuss critical issues and exchange their 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 idea in thermoelectric applications, waste-heat recovery and cooling

### SYMPOSIUM ORGANIZERS

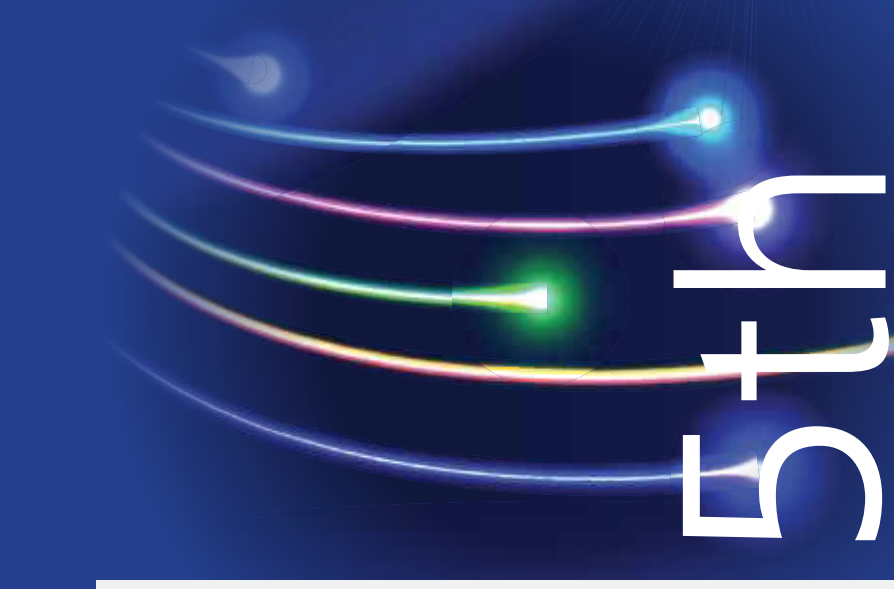

– **Bed Poudel**, Penn State University, USA, bup346@psu.edu

– **Amin Nozariasbmarz**, Penn State University, USA, aln192@psu.edu

– **Wenjie Li**, Penn State University, USA, wzl175@psu.edu

– **Luis Fonseca**, Institute of Microelectronics of Barcelona, IMB-CNM (CSIC), Spain, Luis.Fonseca@imb-cnm.csic.es


,



# 5TH ANNUAL ENERGY HARVESTING SOCIETY MEETING (EHS 2022)

## 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 innovating 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

### SYMPOSIUM ORGANIZERS


– **Miso Kim**, Sungkyunkwan University, Korea, smilekim@skku.edu

– **Sohini Kar-Narayan**, University of Cambridge, UK, sk568@cam.ac.uk

– **Wenzhuo Wu**, Purdue University, USA, wenzhuowu@purdue.edu

– **Rusen Yang**, Xidian University, China, rsyang@xidian.edu.cn


## S6: THIRD GENERATION PHOTOVOLTAIC TECHNOLOGIES WITH EMPHASIS ON PEROVSKITE SOLAR CELLS AND MODULES

Third-generation photovoltaic technologies comprising of dye sensitized solar cells, perovskite solar cells and organic solar cells, will have a great impact on the global deployment of renewable energy. Generally, these photovoltaic cells are layered-structure devices, consisting of nanostructured layers with multiple functionalities comprising of charge collection, extraction and photoconversion. Nanostructured layers including anode/cathode buffer layers, interfacial modification layers, and photon active layers are synthesized by various physical and chemical deposition techniques. Advanced nanotechnology fabrication approaches have accelerated the design and development of novel nanostructured materials, which is driving the advancements in solar cell performance. The nanomaterials and nanostructures critically impact the optical and electronic properties of the functional layers by modulating their morphology, microstructure, and surface states; thereby influencing the output voltage and conversion efficiency. In this session, we aim to have a detailed discussion on recent developments in nanostructured materials and learn about the the designs for their integration with "third-generation photovoltaic technologies".

### PROPOSED SESSIONS

- Fundamental physics of energy conversion in solar cells
- Synthesis, fabrication and characterization techniques for solar cells and modules
- Role of nanostructures, functionalities, and effectiveness of various nanomaterials in improving the performance of dye sensitized solar cells, perovskite solar cells and organic solar cells.
- Methods for improving the lifetime of solar cells
- Lead-free perovskite solar cells

### SYMPOSIUM ORGANIZER


– **Kai Wang**, Penn State University, USA, kqw5449@psu.edu

# [call for papers Abstracts due May 24]

## S7: SPECIAL SYMPOSIUM – WORKSHOP IN DEVICES, MATERIALS AND STRUCTURES FOR ENERGY HARVESTING AND STORAGE (By invitation only)

The Workshop in Devices, Materials and Structures for Energy Harvesting and Storage has been organized for 5 consecutive years in different locations of Europe. The 6th workshop was held jointly with the 3rd Annual Energy Harvesting Society Meeting. This symposium will include some invited review talks across different topics of activities in Europe and posters. There will also be an introduction presentation of the European energy harvesting network and collaboration opportunities. More detailed presentations of this session will be shown on associated posters.

### SYMPOSIUM ORGANIZERS


– **Grzegorz Litak**, Lublin University of Technology, Poland, g.litak@pollub.pl

– **Sebastian Bader**, Mid Sweden University, Sweden, sebastian.bader@miun.se

– **Carlo Trigona**, University of Catania, Italy, carlo.trigona@dieei.unict.it