MRS® ENERGY & SUSTAINABILITY

science & technology & socio-economics & policy

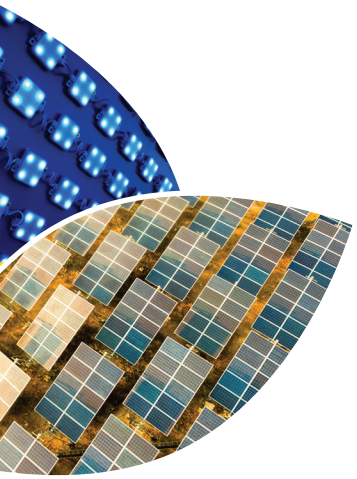
CALL FOR PROPOSALS

NEW! Original Research in Energy & Sustainability

***MRS Energy & Sustainability* will now publish original research articles** highlighting recent breakthroughs in energy and sustainability research that emphasize materials science developments integrated with objective economic, sociological, and policy factors. This research will span a wide range of topics including energy generation, storage, and distribution; carbon capture; life-cycle analysis of energy and non-energy materials; technologies for optimizing water resources, and more.

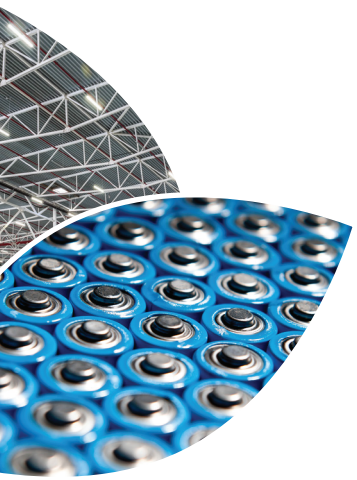
Within the scientific and technological communities, global sustainability challenges cannot be addressed without also considering the integration of broader societal, economic, and policy issues framing the adoption of innovative technologies. Putting materials, energy, and environment in the framework of sustainability is a primary focus of *MRS Energy & Sustainability,* defining the context for this field and leading its scientific development. The journal's intended readership is a broad spectrum of scientists, academics, policymakers, and industry professionals.

Originally a review-only journal, the addition of original research to the reviews, commentaries, and perspectives delivered by the journal will inform and educate on the scientific, technological, socio-economic, and policy complexities for energy and sustainability, establishing the unique character and scope of the journal in serving numerous communities of researchers.



Proposals for original research papers are solicited in the following areas, including but not limited to:

- Energy generation (solar, wind, and nuclear)
- Energy storage (batteries, biofuels, solar fuels, supercapacitors)
- New forms of energy distribution and usage enabled by these new materials (such as future electronics, neuromorphic devices, sensors, etc.)
- Electrocatalysis and photocatalysis
- Materials for carbon capture and storage
- Life-cycle analysis (LCA) of new energy materials and systems
- Life-cycle analysis for applications other than energy (electronics, plastics)
- Reducing or making substitution for use of rare or toxic materials
- Designing materials properties for long life or transience
- Use of plastics in the environment
- Artificial intelligence to speed research for sustainability solutions
- Synthetic biology for materials development
- Technologies for water purification or conversion



Submission of Proposals

To be considered, proposals outlining new but complete and previously unpublished results significant to the development of this field should be submitted via the *MRS Energy & Sustainability* electronic submission system. The proposal form and author instructions may be found at **mrs.org/energy-sustainability-proposal-form**.

Editor-in-Chief

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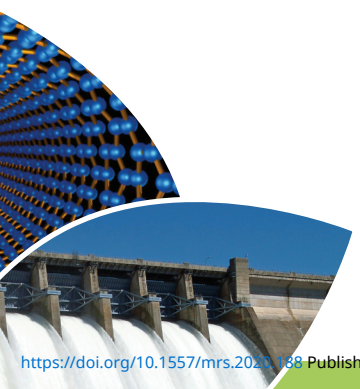

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PROSPECTIVES

N-dimensional optics with natural materials

Giulia Guidetti, **Fiorenzo G. Omenetto**, Tufts University, USA

Natural systems displaying optical properties have long been an inspiration for new classes of optical constructs. Using the same families of materials employed by nature in combination with their directed assembly allows access to *n*-dimensions of control to, ultimately, generate optical systems with multiple coexisting functions. The authors provide an overview of laboratory-made optical systems made of protein and polysaccharide-derived materials found in naturally occurring optical systems. Recent advances in optical biomimicry and bioinspired, polyfunctional optical structures are presented, addressing attributes such as sensing, edible devices, biological activity, and resorbable optical formats. doi.org/10.1557/mrc.2020.23

Emerging soluble organic redox materials for next-generation grid energy-storage applications

Xiaowen Zhan, Pacific Northwest National Laboratory, USA; **Xiaochuan Lu**, North Carolina A&T State University, USA; **David M. Reed**, **Vincent L. Sprenkle**, **Guosheng Li**, Pacific Northwest National Laboratory, USA

Because of their structural versatility, fast redox reactivity, high storage capacity, sustainability, and environmental friendliness, soluble organic redox molecules have emerged as materials that have potential for use in energy-storage systems. Considering these advantages, the authors review recent progress in implementing such materials in aqueous soluble organic redox flow batteries and organic alkali metal/air batteries. They identify and discuss major challenges associated with molecular structures, cell configurations, and electrochemical parameters. Hopefully, they provide a general guidance for the future development of soluble organic redox materials for emerging energy-storage devices used in the electricity grid. doi.org/10.1557/mrc.2020.27

Strain mediated magnetoelectric interactions in hexagonal ferrite and ferroelectric coaxial nanofibers

Y. Liu, **P. Zhou**, Oakland University, USA, and Hubei University, China; **J. Fu**, Oakland University, USA, and Hangzhou Dianzi University, China; **M. Iyengar**, Oakland University, USA; **N. Liu**, **P. Du**, Hubei University, China; **Y. Xiong**, Argonne National Laboratory, USA; **V. Moiseienko**, **W. Zhang**, Oakland University, USA; **J. Zhang**, Zhengzhou University of Light Industry, China; **Z. Ma**, **Y. Qi**, Hubei University, China; **V. Novosad**, Argonne National Laboratory, USA; **T. Zhou**, Hangzhou Dianzi University, China; **D. Filippov**, Novgorod State University, Russia; **T. Zhang**, Hubei University, China; **M.E. Page**, Air Force Research Laboratory, USA; **G. Srinivasan**, Oakland University, USA

The authors report on the synthesis by electrospinning of multiferroic core–shell nanofibers of strontium hexaferrite and lead zirconate titanate or barium titanate and studies on magnetoelectric (ME) coupling. Fibers with well-defined core–shell structures showed the order parameters in agreement with values for nanostructures. The strength of ME coupling measured by the magnetic field-induced polarization showed the fractional change in the remnant polarization as high as 21%. The ME voltage coefficient in H-assembled films showed the strong ME response for the zero magnetic bias field. Follow-up studies and potential avenues for enhancing the strength of ME coupling in the core–shell nanofibers are discussed. doi.org/10.1557/mrc.2020.30

RESEARCH LETTERS

Molecular beam epitaxy growth of nonmagnetic Weyl semimetal LaAlGe thin film

Niraj Bhattarai, **Andrew W. Forbes**, The Catholic University of America, USA; **Rajendra P. Dulal**, Chapman University, USA; **Ian L. Pegg**, **John Philip**, The Catholic University of America, USA

The authors report a detailed method of growing LaAlGe, a nonmagnetic Weyl semimetal, thin film on silicon(100) substrates by molecular beam epitaxy and their structural and electrical characterizations. About 50-nm-thick LaAlGe films were deposited and annealed for 16 h *in situ* at a temperature of 793 K. As-grown high-quality films showed uniform surface topography and near ideal stoichiometry with a body-centered-tetragonal crystal structure. Temperature-dependent longitudinal resistivity can be understood with dominant interband s–d electron–phonon scattering in the temperature range of 5–40 K. Hall measurements confirmed the semimetallic nature of the films with an electron-dominated charge-carrier density of ~7.15×10^{21} cm^{-3} at 5 K. doi.org/10.1557/mrc.2020.28

Molecular Au(I) complexes in the photosensitized photocatalytic CO_2 reduction reaction

Shakeyia Davis, **Dinesh Nugegoda**, The University of Mississippi, USA; **Joshua Tropp**, **Jason D. Azoulay**, The University of Southern Mississippi, USA; **Jared H. Delcamp**, The University of Mississippi, USA

Five Au complexes are evaluated for the reduction reaction of CO_2 via cyclic voltammetry and in a photocatalytic system. Electrochemically, the complexes were all evaluated for pre-association with CO_2 prior to electrochemical reduction and for thermodynamic favorability for CO_2 reduction in photocatalytic systems. The complexes were evaluated in photocatalytic reactions using an Ir-based photosensitizer and a sacrificial electron donor for the conversion of CO_2 to CO. Au-complex counterion effects on the photocatalytic reaction were analyzed by varying weakly coordinating counterions with significant performance changes noted. At low Au-complex concentrations, a high TON value of 700 was observed. doi.org/10.1557/mrc.2020.21

Phonon-scattering mechanism in thermoelectric materials revised via resonant x-ray dynamical diffraction

Adriana Valério, **Rafaela F.S. Penacchio**, **Maurício B. Estradiote**, **Marli R. Cantarino**, **Fernando A. Garcia**, **Sérgio L. Morelhão**, Universidade de São Paulo, Brazil; **Niamh Rafter**, **Stefan W. Kycia**, University of Guelph, Canada; **Guilherme A. Calligaris**, Brazilian Synchrotron Light Laboratory, Brazil; **Cláudio M.R. Remédios**, Universidade Federal do Pará, Brazil

Engineering of thermoelectric materials requires an understanding of thermal conduction by lattice and electronic degrees of freedom. Filled skutterudites denote a large family of materials suitable for thermoelectric applications where reduced lattice thermal conduction attributed to localized low-frequency vibrations (rattling) of filler cations inside large cages of the structure. In this work, a multiwavelength method of exploiting x-ray dynamical diffraction in single crystals of $CeFe_4P_{12}$ is presented and applied to resolve the atomic amplitudes of vibrations. The results suggest that the vibrational dynamics of the whole filler-cage system is the actual active mechanism behind the optimization of thermoelectric properties. doi.org/10.1557/mrc.2020.37

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Monolithic quartz platform for cellular contact guidance

Michael C. Robitaille, **Joseph A. Christodoulides**, **Jinny L. Liu**, U.S. Naval Research Laboratory, USA; **Wonmo Kang**, Arizona State University, USA; **Jeff M. Byers**, **Katarina Doctor**, **Dmitry Kozak**, **Marc P. Raphael**, U.S. Naval Research Laboratory, USA

Contact guidance is vital to many physiological processes, yet it is still poorly understood. This is partly due to the variability of experimental platforms, making comparisons difficult. To combat this, a multiplexed approach was used to fabricate topographical cues on single quartz coverslips for high-throughput screening. Furthermore, this method offers control of surface roughness and protein adsorption characterization, two critical aspects to the *in vitro* environment often overlooked in contact guidance platforms. The quartz surface can be regenerated, is compatible with versatile microscopy modes, and can scale up for manufacturing offering a novel platform that could serve as a potential standard assay. doi.org/10.1557/mrc.2020.15

Interstitial versus substitutional metal insertion in V_2O_5 as post-lithium ion battery cathode: A comparative GGA/GGA+*U* study with localized bases

Daniel Koch, National University of Singapore, Singapore; **Sergei Manzhos**, Institut National de la Recherche Scientifique, Canada

The generalized gradient approximation (GGA) often fails to correctly describe the electronic structure and thermochemistry of transition-metal oxides and is commonly improved using an inexpensive correction term with a scaling parameter *U*. The authors tune *U* to reproduce experimental vanadium oxide redox energetics with a localized basis and a GGA functional. The value for *U* is found to be significantly lower than what is generally reported with plane-wave bases, with the uncorrected GGA results being already in reasonable agreement with experiments. This computational setup is used to calculate interstitial and substitutional insertion energies of main group metals in vanadium pentoxide, and interstitial doping is found to be thermodynamically favored. doi.org/10.1557/mrc.2020.36

Detection of plasmonic behavior in colloidal indium tin oxide films by impedance spectroscopy

Salil M. Joshi, **Ning Xia**, **Yolande Berta**, **Yong Ding**, **Rosario A. Gerhardt**, Georgia Institute of Technology, USA; **Kenneth C. Littrell**, Oak Ridge National Laboratory, USA; **Eric Woods**, **Mengkun Tian**, Georgia Institute of Technology, USA

Impedance spectroscopy was conducted on colloidal indium tin oxide (ITO) thin films that had been subjected to alternating oxygen and argon plasma treatments, followed by air annealing from 150 to 750°C. An equivalent circuit consisting of an RC element nested within another RC element, featuring a negative resistance and a negative capacitance, fitted the data well. These results are interpreted as being due to surface plasmons that are a function of the presence of nanoporous ITO-rich regions surrounded by isolated ITO nanoparticles coated with an amorphous polymer that intertwines with the ITO-rich regions as a function of annealing treatment. doi.org/10.1557/mrc.2020.22

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