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PROSPECTIVES

Towards biomimetic electronics that emulate cells

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Bioelectronics aims to design electronic devices that can be fully integrated within tissues to monitor or stimulate specific cell functions. The main challenge is the engineering of the cell–chip interface and diverse materials, and devices have been developed to recapitulate biological architectures and functionalities. The authors give an overview on how the bioelectronics community has exploited biomimetic approaches to emulate cell morphologies, interactions, and functions to design optimal electrical platforms to be coupled to living cells. doi.org/10.1557/mrc.2020.56

Additive manufacturing for COVID-19: Devices, materials, prospects, and challenges

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The current COVID-19 pandemic has caused the shortage of personal protective equipment (PPE) where improvised manufacturing, in particular three-dimensional (3D) printing has addressed many needs. The authors discuss the current global crisis, then follow the wide interest in addressing the shortage of medical devices and PPE used for treatment and protection against pathogens. An overview of the 3D printing process with polymer materials is given followed by the different 3D printing projects of PPE and medical devices that emerged for the pandemic (including validation/testing). The potential for rapid prototyping with different polymer materials and eventual high throughput production is emphasized. doi.org/10.1557/mrc.2020.57

Architected mechanical designs in tissue engineering

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The deeper comprehension of biological phenomena has led to the pursuit of designing and architecting complex biological systems. This has been incorporated through the advances in bioprinting of artificial organs and implants even at microscale. In addition, tissue modeling has been employed to understand and prevent malfunctional and detrimental mechanisms that lead to fatal diseases. Furthermore, the endeavor to convey the mechanical properties of both scaffolds and cells has enabled the unveiling of disease modeling and regenerative medicine. The authors aim to provide a brief review on the design, modeling, and characterization of conventional and architected structures employed in bioengineering. doi.org/10.1557/mrc.2020.60

Toward bioimplantable and biocompatible flexible energy harvesters using piezoelectric ceramic materials

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The author presents a comprehensive overview of currently available research on bioimplantable energy harvesters, with a specific focus on their fabrication and issue of biocompatibility. Both the achievements and limitations of the field are pointed out from the standpoint of materials science and engineering as directions for future research. Particular attention is paid to the controversy over the use of lead-based or lead-free piezoelectric ceramics in biomedical applications, which is closely related to different temporalities of research on biological conditions. This report is intended to serve as a reference guide for developing the next generation of piezoelectric biomedical devices. doi.org/10.1557/mrc.2020.48

RESEARCH LETTERS

Water flow enhancement in amorphous silica nanochannels coated with monolayer graphene

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Inspired by the recently reported translucency of monolayer graphene (GE) to wetting, atomistic simulations are employed to evaluate water flow enhancement induced by GE deposited on the inner surfaces of hydrophilic nanochannels. The flow in the coated channels exhibits a slip length of approximately 3.0 nm. Moreover, by contrasting the flow rates in channels with coated walls against flow rates in the corresponding uncoated channels, an "effective" flow enhancement from 3.2 to 3.7 is computed. The probability-density function of the water dipole orientation indicates that the flow enhancement is related to a thinner structured water layer at the solid–liquid interface. The authors provide quantitative evidence that GE employed as a coating reduces substantially hydraulic losses in hydrophilic nanoconfinement. doi.org/10.1557/mrc.2020.53

Investigation of thermal transport properties in pillared-graphene structure using nonequilibrium molecular dynamics simulations

Khaled Almahmoud, **Thiruvillamalai Mahadevan**, **Nastaran Barhemmati-Rajab**, **Jincheng Du**, **Huseyin Bostanci**, **Weihuan Zhao**, University of North Texas, USA

The authors focus on calculating the thermal conductivity of pillared-graphene structures (PGS). PGS consists of graphene and carbon nanotubes (CNTs). These two materials have great potential to manage heat generated by nano- and microelectronic devices because of their superior thermal conductivities. However, the high anisotropy limits their performance when it comes to three-dimensional heat transfer. Nonequilibrium molecular dynamics simulations were conducted to study thermal transport of PGS. The simulation results suggest that the thermal conductivity along the graphene plane can reach up to 284 W/m K depending on PGS parameters, while along the CNT direction, the thermal conductivity can reach 20 W/m K. doi.org/10.1557/mrc.2020.58

Nature-inspired spherical silicon solar cell for three-dimensional light harvesting, improved dust, and thermal management

Nazek El-Atab, **Nadeem Qaiser**, **Wedyan Babatain**, King Abdullah University of Science and Technology, Saudia Arabia; **Rabab Bahabry**, University of Jeddah, Saudi Arabia; **Rana Shamsuddin**, King Abdulaziz University, Saudi Arabia; **Muhammad Mustafa Hussain**, University of California, Berkeley, USA

Unconventional techniques to benefit from the low-cost and high-efficiency monocrystalline silicon solar cells can lead to new device capabilities and engineering prospects. Here, a nature-inspired spherical solar cell is demonstrated, which is capable of capturing light three-dimensionally. The proposed cell architecture is based on monocrystalline silicon and is fabricated using a corrugation technique. The spherical cell shows an increase in power output by up to 101% with respect to a traditional flat cell with the same projection area using different reflective materials. Finally, the spherical cell shows advantages in terms of enhanced heat dissipation and reduced dust accumulation over conventional cells. doi.org/10.1557/mrc.2020.44

Synthesis of self-assembled siloxane–polyindole–gold nanoparticle polymeric nanofluid for biomedical membranes

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The Lewis base character of 3-aminopropyltrimethoxysilane (3-APTMS), an imine derivative of siloxane and an indole monomer, were shown to enable the reduction of gold cations in acetone. The Lewis acid–base adduct of indole monomers and gold formed a polyindole–gold nanoparticle sol. Similarly, the Lewis acid–base adduct of 3-APTMS and gold enabled the formation of gold nanoparticles in the presence of acetone. The polyindole–gold nanoparticle sol and siloxane–gold nanoparticles underwent self-assembly into a polymeric nanofluid that was suitable for casting membranes. The use of these membranes as a potentiometric ion sensor for both cations and anions was considered; a common nonspecific ion exchange molecule, sodium tetraphenylborate, and the polymeric nanofluid were used to prepare an anion sensor and a cation sensor. doi.org/10.1557/mrc.2020.50

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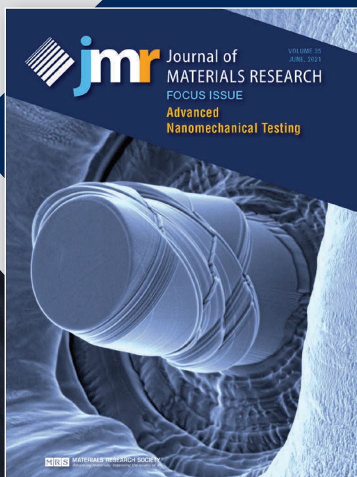

CALL FOR PAPERS

Advanced Nanomechanical Testing

Small-scale mechanical characterization is essential for ensuring the service performance and lifetime of small components, such as thin films and coatings, electronic sensors, and MEMS. The first mechanical measurements on the submicrometer scale were enabled by the development of nanoindentation in the 1980s. *JMR* has long been the flagship journal for this field. In addition to countless contributed articles, previous Focus Issues published over the past two decades have disseminated the latest in method developments and trends in the field.

In addition to providing a long-expected update, this Focus Issue will expand the scope of nanomechanical testing methods beyond classical nanoindentation. Recent years have seen numerous attempts to access specific materials parameters and to better account for the typical operational conditions of the sample of interest. We therefore welcome contributions related to, but not limited to, focused ion beam (FIB) enabled methods, complex loading conditions, *in situ* testing, and testing in extreme environments. Application of nanomechanical testing methods to new types of materials are also encouraged. This Focus Issue is a unique opportunity to highlight and share recent significant developments and achievements with the greater nanomechanics community.

Contributing papers are solicited in the following areas:

- Nanoindentation, micromechanical, and nanomechanical testing
- New developments, e.g., for the acquisition of the full stress–strain response
- Application to new types of materials
- Complex loading conditions (cyclic fatigue, fracture testing)
- Extreme testing environments (high and low temperatures, irradiation, high strain rates)
- *In situ* testing (in scanning electron microscope, transmission electron microscope, or synchrotron)

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To be considered for this issue, new and previously unpublished results or review articles significant to the development of this field should be presented. The manuscripts must be submitted via the *JMR* electronic submission system by November 16, 2020. Manuscripts submitted after this deadline will not be considered for the issue due to time constraints on the review process. Please select *"Advanced Nanomechanical Testing"* as the Focus Issue designation. **Note our manuscript submission minimum length of 3250 words, excluding figures, captions, and references, with at least 6 and no more than 10 figures and tables combined. Review articles may be longer but must be pre-approved by proposal to the Guest Editors via jmr@mrs.org. The proposal form and author instructions may be found at mrs.org/jmr-instructions.** All manuscripts will be reviewed in a normal but expedited fashion. Papers submitted by the deadline and subsequently accepted will be published in the Focus Issue. Other manuscripts that are acceptable but cannot be included in the issue will be scheduled for publication in a subsequent issue of *JMR*.

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