Journal of Nanotechnology in Engineering and Medicine

Editorial

Special Section on Spectroscopy, Scattering, and Imaging Techniques for Nanostructured Materials

Nanotechnology has seen rapid progress in recent years, with the emergence of advanced capabilities to synthesize and characterize precisely engineered materials that point toward disruptive new performance regimes of relevance for diverse application areas. Understanding how the atomic, electronic, mechanical, and magnetic structures/properties of materials relate to their performance across multiple length-scales is, thus, of growing importance. This special topic titled "Spectroscopy, Scattering, and Imaging Techniques for Nanostructured Materials" focuses on understanding these fundamental processes, which occur within material systems in the atomic or nanoscopic regime, using advanced tools such as time-of-flight secondary ion mass spectrometry, scanning electron microscopy (SEM), X-ray diffraction (XRD), helium ion microscopy (HIM), atomic force microscopy, Raman thermometry, and in situ imaging techniques. This understanding is being leveraged by the scientific community to deliver new knowledge that has the potential to improve the performance of different material systems: lithium-ion battery materials, biological materials, nanostructured materials for energy applications, carbon nanofiber, nanoparticles, nanowires (NW), silicon microcantilevers, etc. The special topic brings together a wide variety of excellent contributions from the scientific community showcasing the depth and breadth in this vibrant topical area within nanotechnology. The collection of papers exemplifies how the current state-of-the-art of imaging and spectroscopic techniques provides new insights into these exciting nano and biological materials with unprecedented resolution.

Seven papers were submitted to this special section. Chiu Huang and colleagues at North Carolina State University investigate the origins of voltage fluctuations in high discharging current rate (C-rate) lithium-ion batteries by quantifying lithium-ion intensity and distribution via time-of-flight secondary ion mass spectrometry. Interestingly, it is observed that lithium-ion intensity and distribution are not C-rate dependent, suggesting that different lithium-ion insertion mechanisms might be solely responsible for the observed low-frequency voltage fluctuation at higher C-rates.

The paper from Palapati et al. at Virginia Commonwealth University investigates elastic modulus measurements on large diameter NW using a nano-assembled platform. The nanomechanical platform is constructed by assembling single NWs across pairs of gold nano-electrodes using dielectrophoresis and contains a short, suspended segment of the NW (in air) between the assembly electrodes. AFM force spectroscopy measurements are followed. The study demonstrates the measurement technique using lithium iron phosphate NW, which is a cathodic material of interest for battery applications, as a model system and presents a finite element model to extract the Young's modulus from nanomechanical data. This data is relevant for use within computational models that predict the stresses and cycle-life capabilities of battery nanomaterial systems.

Samykano et al. at the North Carolina A&T State University provide morphological and crystallographic characterization of nickel NW synthesized by template based electrodeposition method. The structure and morphology of the synthesized NW are studied using HIM and SEM methods. The crystallographic properties of the grown NW are also studied using XRD. The results clearly indicate that properties of synthesized nickel NW are strongly influenced by the applied magnetic field and current density intensity during the synthesis process.

Zhang and colleagues at Purdue University have utilized Raman thermometry to characterize bone materials and studied the influence of structural hierarchy on physical properties such as thermal conductivity and its correlation with mechanical stresses. The unique analytic-experimental approach provides stress-thermal conductivity correlation in bovine cortical bone as a function of nanomechanical compressive stress and temperature changes. It is observed that the thermal conductivity values increase and then decrease as a function of increase in compressive strain in bone tissues.

Goudarzi et al. at University of British Columbia characterize different lignin powders via XRD and study the variations in the XRD patterns during carbon nanofiber formation. The results indicate that the graphite peak for (101) plane is available in the grinded carbon nanofibers, and it is suggested that the available sulfate groups in lignins might facilitate graphite formation in carbon nanofiber production process.

Tomar's research group at Purdue University reports in situ creep properties of silicon microcantilevers in the temperature range of 25 °C to 100 °C under uni-axial compressive stress; as the silicon structures are commonly subject to this temperature range and the stress level of tens to hundreds of MPa in micro-electromechanical systems. The results reveal that in the stress range of 50–150 MPa, the strain rate of the silicon cantilever increases linearly as a function of applied stress, and the strain rate also increases as a function of increased temperature. Moreover, the sensitivity of the strain rate change with respect to change in temperature or stress is much lower comparing with the literature values. It is suggested the near-surface atoms of the microscale silicon exhibit a relaxed state signified by lower surface stress values than bulk, especially at high temperature.

Jingjie Zhang and Da-Ren Chen at Virginia Commonwealth University have provided a review article on differential mobility particle sizers for nanoparticle characterization. These instruments are used for characterizing gas-borne particles in submicrometer and nanometer diameter ranges. Specifically, aerosol chargers, differential mobility analyzers (DMA), and particle concentration detectors are discussed. This article gives an interesting overview of the state-of-art DMAs, which are particularly designed for sizing particles with the sizes down to sub-10 nm.

We would like to thank the authors for choosing to publish their work to this special section in the *ASME Journal of Nanotechnology in Engineering and Medicine*. The papers included in this special section gives an interesting snap shot of the current research topics in this emerging area of nanoscience and nano-engineering. We hope that this special section will stimulate future discussion and collaboration among physicists, engineers, and material scientists in this interdisciplinary research field and we hope you enjoy reading this special section.

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Guest Editors