Journal of Nanotechnology in Engineering and Medicine

Guest Editorial

Special Section on Nanoscale Materials, Devices, and Systems for Biosensing, Biomanipulation, and Biofabrication

This special section of *ASME Journal of Nanotechnology in Engineering and Medicine* focuses on reporting state-of-the-art nanoscale materials, devices, and systems for advanced biosensing, biomanipulation, and biofabrication. Such nanoscale materials, devices, and systems can be organic, inorganic, and hybrid, and their applications for advanced biosensing, biomanipulation, and biofabrication have generated significant impact for important biology and biomedical applications. Nanotechnology has seen rapid progress in recent years, with advanced capabilities to generate and manipulate precisely engineered nanoscale organic and inorganic materials and their assemblies pointing toward the emergence of disruptive functionalities for diverse biological and biomedical applications. Furthermore, nanofabricated devices and systems such as nanofluidics, nanoelectromechanical systems, and nanophotonic structures with critical dimensions comparable to the molecular scale open up new possibilities for direct observation, manipulation, and analysis of biomolecules, thus providing a novel basis for ultrasensitive and high-resolution sensors and diagnostic systems. Nanoscale surface patterning tools for precisely controlling biomolecule- and cell-surface interactions and nanotools such as atomic force microscopy and optical and magnetic tweezers are also extremely powerful for controlling cell fate and function and studying molecular and cellular biomechanics.

The following small but diverse selection of articles from different nanotechnology research areas describes current important topics of nanobiotechnology that we believe to be interesting, informative, and educational for the reader.

An ongoing important research direction using nanotechnology is the sorting, enrichment, and informative analysis of rare cells from bodily fluids including circulating tumor cells (CTCs), antigen-specific T-cells, and hematopoietic stem *cells*. High-sensitivity sorting, detection, and analysis of such extremely rare cells can provide critical information for disease diagnosis and prognosis and advancing fundamental cellular understanding of physiological and pathological conditions. Qian et al. provide a concise review of the recent advance of using functional nanotopographic biomaterials for isolation of CTCs from blood specimens and their related nanofabrication methods. Qian et al. further discuss putative cellular mechanisms involving cell adhesion underlying the intrinsic nanotopography sensitive responses of CTCs. Another review contributed by Lee et al. provides a concise review of recent advances in micro/nanotechnology to improve the method of micropipette aspiration for applications in molecular and cellular biomechanics.

Another emerging research area of nanotechnology is to develop synthetic nanostructured materials and surfaces for engineering control of cell-surface interactions and cell fate. In this issue, Han et al. report a method of generating single-crystalline nanoporous gallium nitride (GaN) thin films with tunable pore sizes ranging from 20 to 100 nm. Surface nanotopographies with critical size dimensions comparable to cell adhesion structures can influence cell adhesion and more importantly downstream intracellular adhesion-mediated signaling that is important for cell survival, proliferation, and differentiation. Importantly, Han et al. report that human mesenchymal stem cells demonstrate the maximum osteogenic differentiation when seeded on GaN nanoporous substrates with a mean pore size of 30 nm, which is correlated with their optimal cell spreading, strongly supporting that cell adhesion, spreading, and stem cell differentiation are interconnected.

In this issue, Yi and Zhao provide an interesting study to examine the effect of nanoparticles on subzero biotransport phenomena of living cells, which is of significant importance for the application of nanotechnology in the field of cryobiology. In another paper, Goldberg et al. describe the development of a novel nanoparticle-embedded chitosan sponge for topical and local administration of chemotherapeutic agents. Such nanoscale material-based drug delivery tools can have great advantages in reducing systemic toxicity while increasing treatment efficacy.

In the perspective of the application of nanotechnology for biosensing, relevant to cell signaling and biomarker detection, surface enhance Raman scattering (SERS) spectroscopy has attracted intensive interest owing to its significant advantages in label free, multiplex, and ultrasensitive molecule detection. Liu et al. report SERS biosensing applications using nanocapsule structures with densely distributed Ag nanoparticles on the surfaces. Applications of electric fields on microelectrodes in a microfluidic chamber result in the nanocapsules to be aligned into ordered arrays while simultaneously concentrating molecules and enhancing SERS sensitivity. This work demonstrates an interesting approach to achieve local deterministic and ultrasensitive biochemical detections in a highly controllable and efficient manner.

This themed section of *ASME Journal of Nanotechnology in Engineering and Medicine* focusing on nanotechnology for biology and biomedical applications presents a collection of manuscripts selected in the spirit of demonstrating the power of interdisciplinary nanotechnology research enabling advanced biosensing and engineered control of cell–biomaterial interactions. Sincerely, we hope that you will enjoy reading this themed section.

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