Amgen Seminar Series in Chemical Engineering

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Biopolymer-Carbon Nanotube Hybrids: From Fundamentals to Biomedical Applications

By

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The intrinsic band-gap photoluminescence (fluorescence) of single-walled carbon nanotubes (SWCNTs) exhibits exceptional photostability, narrow bandwidth, near-infrared (NIR) tissue-penetrating emission, and microenvironmental sensitivity, enabling their usage in a variety of biomedical imaging and sensing applications. Amphiphilic biopolymers, such as single-stranded DNA or peptides, are capable of singly-dispersing SWCNTs, facilitating photoluminescence in aqueous solutions, in addition to increasing the biocompatibility of the hybrid. A DNA sequence-dependent scheme for SWCNT species (chirality) separation has been observed that highly correlated with DNA-SWCNT binding strengths. Using all-atom replica exchange molecular dynamics simulations (REMD), equilibrium structures confirmed that a variety of novel DNA secondary structures form when confined to the exterior surface of the SWCNT in a DNA-sequence and SWCNT-chirality-dependent fashion.

In biological applications, DNA-encapsulated SWCNTs were found to enter primary mammalian endothelial cells by means of an energy-dependent endocytosis mechanism and remain in the endosomal pathway. A novel hyperspectral fluorescence imaging approach spatially resolved over a dozen chiralities of single SWCNTs within live cells. This technique was used to construct an endolysosomal lipid accumulation sensor for *in vitro* and *in vivo* applications. In a similar fluorescence spectroscopy approach, nanotubes reported the protein-mediated charge accumulation on the exterior surface of live cells. Finally, due to their unique shape and optical properties, we have shown that nanotubes can be used to penetrate multicellular tumor spheroids (MCTSs), potentiating their usage in drug discovery and delivery applications.

Bio-Sketch: Dr. Roxbury is currently an Assistant Professor of Chemical Engineering at the University of Rhode Island where he is an investigator for the Rhode Island IDeA Network for Excellence in Biomedical Research (RI-INBRE) and leads an interdisciplinary research team. Prof. Roxbury received his B.S. and Ph.D. degrees in chemical engineering from Lehigh University (Bethlehem, PA). Prior to attaining a faculty position, Prof. Roxbury conducted his postdoctoral work at Memorial Sloan Kettering Cancer Center (New York, NY), where he was externally funded through an American Cancer Society Postdoctoral Fellowship.

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