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New concepts in molecular and energy transport within carbon nanotubes and graphene: Optical sensors, resonant ion channels and thermo power waves

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Our laboratory has been interested in how 1D electronic material such as carbon nanotubes can be utilized to illustrate new concepts in molecular transport and energy transfer. In the first example, we predict and demonstrate the concept of thermo power waves for energy generation. Coupling an exothermic chemical reaction with a thermally conductive CNT creates a self-propagating reactive wave driven along its length. We realize such waves in MWNT and show that they produce concomitant electrical pulses of high specific power >7 kW/kg. Such waves of high power density may find uses as unique energy sources. In the second system, we fabricate and study SWNT ion channels for the first time and show that the longest, highest aspect ratio and smallest diameter synthetic nanopore examined to date, a 500 μm SWNT demonstrates oscillations in electro-osmotic current at specific ranges of electric field that are the signatures of coherence resonance yielding self-generated rhythmic and frequency locked transport. The observed oscillations in the current occur due to a coupling between stochastic pore blocking and a diffusion limitation that develops at the pore mouth during proton transport. Lastly, our laboratory has been interested in how semiconducting single walled carbon nanotubes (SWNT) can be modified such that their fluorescent emission is modulated in response to specific molecules, hence creating a new class of sensor. Such sensors have important advantages including enhanced optical penetration of tissues in the near infrared, reduced auto-fluorescence, infinite resistance to photo bleaching and most recently, single molecule analyte sensitivity. This presentation will review our recent efforts in this space including new platforms for label free protein detection, nitric oxide, H2O2 and the interfacing of sensor arrays to living cells.

Biography

Michael S Strano is currently the Carbon P Dubbs Professor of Chemical Engineering at the Massachusetts Institute of Technology. He received his BS from Polytechnic University in Brooklyn, NY and PhD from the University of Delaware both in Chemical Engineering. He was a Postdoctoral Research Fellow at Rice University in the Departments of Chemistry and Physics under the guidance of Nobel Laureate Richard E Smalley. From 2003 to 2007, he was an Assistant Professor in the Department of Chemical and Biomolecular Engineering at the University of Illinois at Urbana-Champaign before moving to MIT. His research focuses on biomolecule/nanoparticle interactions and the surface chemistry of low dimensional systems, nano-electronics, nanoparticle separations and applications of vibrational spectroscopy to nanotechnology. He is the Recipient of numerous awards for his work from 2005 to the present.

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