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New concepts in molecular and energy transport within carbon nanotubes: thermopower waves and stochastically resonant ion channels

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Our laboratory has been interested in how carbon nanotubes can be utilized to illustrate new concepts in molecular and energy transfer. In the first example, we predict and demonstrate the concept of thermopower waves for energy generation [1]. 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 [2] 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.

[1] Choi W, Hong S, Abrahamson JT, Han JH, Song C, Nair N, Baik S, **Strano MS**: Chemically driven carbon-nanotube-guided thermopower waves. NATURE MATERIALS, 9 (2010) 423-429.

[2] Lee, CY, Choi W, Han, JH, **Strano MS**: Coherence Resonance in a Single-Walled Carbon Nanotube Ion Channel. SCIENCE, 239