Department of Chemical Engineering Seminar Series

Electrokinetic Locomotion

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Lecture: 4:00-5:00 p.m.
BAGLEY 154
Reception at 3:15 p.m., Benson Lobby

Abstract

Locomotion of microorganisms is commonly observed in nature. Although microorganism locomotion is commonly attributed to mechanical deformation of solid appendages, Nobel Laureate Peter Mitchell (1956) proposed that an asymmetric ion flux on a bacterium's surface could generate electric fields that drive locomotion via self-electrophoresis. Recent advances in nanofabrication have enabled the engineering of synthetic analogues that swim due to asymmetric ion flux originally proposed by Mitchell. The development of these synthetic motors may represent a step towards the development of practical nanomachines, directed drug delivery, and autonomous microsystems.

We are investigating the fabrication, locomotion physics, and engineered functionality of bimetallic synthetic nanomotors that harvest chemical energy from their local environment and convert it to useful work, analogous to their biological counterparts. Bimetallic nanorods can autonomously propel themselves at a hundred body lengths per second through aqueous solutions through electrochemical decomposition of hydrogen peroxide. These swimming motors (i) can be controlled using magnetic and chemical fields; (ii) can load, transport, and release colloidal cargo; and (iii) exhibit chemokinesis, a collective dynamic behavior similar to biological chemotaxis. Scaling analyses and computational simulations show that locomotion results from electrical body forces, which are generated by a coupling of an asymmetric dipolar charge density distribution and the electric field it generates.

Speaker Biography

Dr. Jonathan D. Posner is the Bryan T. McMinn Endowed Associate Professor of Mechanical Engineering and Adjunct Professor of Chemical Engineering at University of Washington. Dr. Posner came to UW in 2011 from Arizona State University where he continues his role as an Affiliate in the Consortium for Science, Policy, & Outcomes (CSPO). Dr. Posner earned his Ph.D. (2001) degree in Mechanical Engineering at the University of California, Irvine. He spent 18 months as a fellow at the von Karman Institute for Fluid Mechanics in Rhode Saint Genèse, Belgium and two years as a postdoctoral fellow at the Stanford University. His interests include micro/nanofluidics, electrokinetics, colloids, electrochemistry, and the physics of nanoparticles at interfaces as it applies to applications in energy, health, and the environment. At CSPO, Posner has interest in the social implications of technology, role of science in policy and regulation, as well as ethics education. Dr. Posner was honored as a 2011 Washington State Strategically Targeted Academic Researcher and a 2008 NSF CAREER award. He has also been recognized for an ASU Mentor Award and for his Excellence in Experimental Research by the von Karman Institute for Fluid Dynamics.