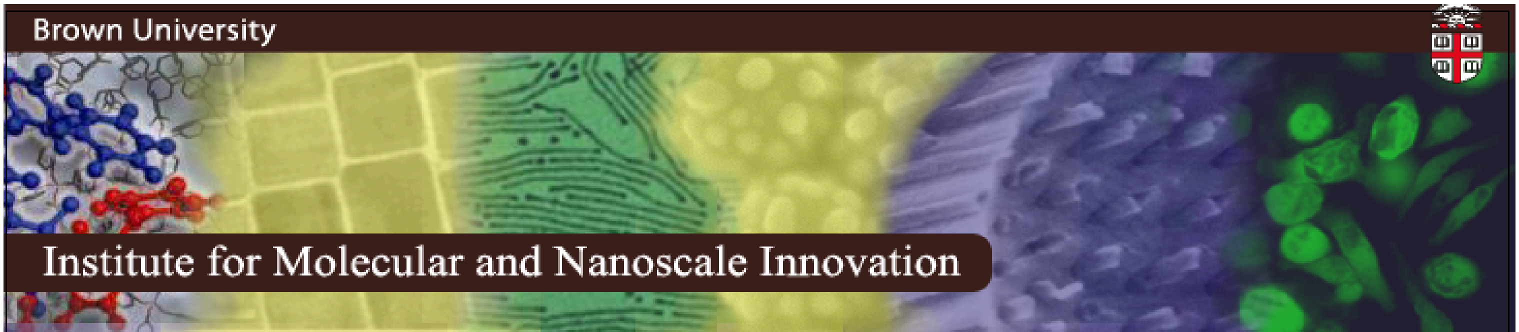

"Energy Harvesting in Nanofluidic Structures Using Electrokinetics and Hydrodynamic Slip"

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Abstract

Electrokinetic effects in fluidic channels reflect the coupled mechanical motion of the liquid with the electrical motion of dissolved ions. The microscopic picture behind this is that the charged inner surface of a fluidic channel attracts a neutralizing layer of mobile counterions, called the double layer, whose motion is coupled to that of the fluid by viscosity. The electrokinetic phenomena known as streaming currents and streaming potentials arise when a pressure-driven fluid flow transports ions in the double layer by advection. It has long been recognized that these effects can be used to drive an external load, and therefore represent a mechanism for converting mechanical work into electrical power. However, this is usually a very inefficient proposition because the counterion density is concentrated at the channel walls, where the no-slip boundary condition tells us that the fluid is stationary.

Recent experimental and numerical studies (including important contributions from the Breuer group here at Brown) have demonstrated the breakdown of the fluidic no-slip boundary conditions at nanometer scales, and the strong dependence of the slip length on the properties of the solid-liquid interface. Furthermore, work in our group suggests that the presence of slip should significantly enhance electrokinetic phenomena, such as streaming currents. The implications of these results will be explored in an IMNI seed project that is underway between the Stein and Breuer groups. In this talk, I will describe how our fundamental studies of slip's influence on electrokinetic transport in nanochannels may pave the way to an efficient harvester of mechanical energy.

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