Abstract Submitted
for the DFD13 Meeting of
The American Physical Society

Characterization of electrochemical response of a hybrid micro-nanochannel system using computational impedance spectroscopy (CIS)[1]

VISHAL NANDIGANA, NARAYAN ALURU, Department of Mechanical Science and Engineering, Beckman Institute for Advanced Science and Technology, University of Illinois at Urbana Champaign — Single molecule/particle sensing using micro/nanochannel integrated systems has attracted tremendous interest in recent years. The molecule in an aqueous ionic solution is translocated from the source microchannel towards the drain microchannel across a nanochannel under the influence of an external electric field. The translocated molecules are characterized from the electrical response of the system. In order to develop an efficient design for accurate characterization of single molecules, it is important to first understand the ion-transport dynamics in these integrated systems. To this end, we develop a computationally efficient area-averaged multi-ion transport model (AAM), considering an ion-selective nanochannel integrated with a microchannel on either side. Further, we study the ion transport dynamics both under equilibrium and non-equilibrium regimes. In each regime, the base state is perturbed with an external harmonic electrical disturbance over a wide range of frequency spectrum and the electrochemical impedance response is computed. We correlate each characteristic frequency present in the system to its corresponding physical phenomena and also characterize the microscopic diffusion boundary layer lengths (DBL) observed in the microchannel.

[1]This work was supported by the National Science Foundation (NSF) under Grants 0328162 (nano-CEMMS, UIUC), 0852657 and 0915718.

Vishal Nandigana
Department of Mechanical Science and Engineering,
Beckman Institute for Advanced Science and Technology,
University of Illinois at Urbana Champaign

Date submitted: 01 Aug 2013 Electronic form version 1.4