Abstract Submitted
for the MAR06 Meeting of
The American Physical Society

Rocking and Flashing Ratchet Mechanisms of Ion Current Rectification in Asymmetric Nanopores in the Presence of Calcium ZUZANNA SIWY, MATTHEW POWELL, ERIC KALMAN, Univ. of California, Irvine, BOB EISENBERG, Rush University Medical Center, Chicago — We have investigated an engineered system of a single nanopore in a plastic membrane that shows rectification depending on the chemical composition of the surrounding solutions. No lipid bilayer is involved so the system is simple and robust with >10 gigohm leak resistance. The single nanopores are tapered cones with openings of diameter $\sim$ 600 nm and $\sim$ 5 nm. The single nanopores were prepared by the track-etching technique. The walls of the pores have carboxylate groups with surface density $\approx$1.5 (e/[nm]^2). Transport properties of these nanopores were studied by recording current-voltage curves in a variety of solutions. In KCl solutions these single asymmetric nanopores are cation selective and rectify with a ratio of limiting conductances $\approx$ 4-10. The K ions flow with lower resistance from the smaller to larger opening. Adding millimolar Ca to both sides reverses the direction of rectification and produces a negative incremental resistance; i.e., larger magnitudes of voltage produce smaller magnitudes of ion current. The rectifying properties of these asymmetric nanopores are described by rocking and flashing ratchet models of directional motion. It will be interesting to compare permeation, selectivity, and gating properties of the polymer nanopores and biological voltage-gated calcium channels.

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Date submitted: 07 Dec 2005 Electronic form version 1.4