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Ion current fluctuations in abiotic mimics of voltage-gated biochannels

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We have been investigating voltage-gating properties of single abiotic nanopores in polymer films. The pores have a shape of a tapered cone with the opening diameter of the tip as small as several nanometers. We have designed two nanotube systems, which exhibit ion current rectification through two distinct mechanisms (i) electrostatic interactions, based on asymmetric shape of electrostatic potential inside the pore, and (ii) electro-mechanical gate placed at the entrance of the conical pore, responsive to the external field applied across the membrane. We have also shown that transient transport properties of nanotubes can be modulated by change of chemistry of the pore walls. We have designed nanotubes, which produce voltage-dependent ion current fluctuations with the kinetics of openings and closings similar to voltage-gated ion channels in biological membranes. An abiotic equivalent of calcium-gated potassium channel will be discussed as well. I will also describe application of voltage-gating nanopores as platforms in biosensing. Recognition sites were incorporated into the pore walls, introducing selectivity for a given analyte. Sensors can be developed from these modified pores based on current-voltage characteristics or on the stochastic detection of analyte molecules as they translocate the membrane.