Ratchet based ion pumps for selective ion separation

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Abstract

Even though highly selective ion pumps can be found in every cell membrane, artificial, membrane-based ion selective separation is an unmet challenge in science and engineering. The development of a membrane-based ion separation technology can drive a dramatic progress in a wide range of applications such as: water treatment, bio-medical devices, extraction of precious metals from sea water, chemical sensors, solar fuels and more. In this talk I will discuss our theoretical and experimental demonstration of ion pumps based on an electronic flashing ratchet mechanism.

Ratchet-based ion pumps (RBIPs) were fabricated by coating the two surfaces of nano-porous alumina wafers with gold forming nano-porous capacitor-like devices. The electric field within the nano-pores is modulated by oscillating the capacitors voltage. When immersed in solution, ions within the pores experience a modulating electric field resulting in ratchet-based ion pumping. RBIPs were shown to drive ionic current densities of several $\mu A/cm^2$ even when opposed by an electrostatic force. A significant ratchet action was observed with amplitudes as low as 0.1V thus demonstrating that RBIPs can drive an ionic current with no associated redox reactions. Simulations show that frequency dependent flux inversions in ratchet systems may pave the way towards ion selective RBIPs.

Short Biography

Gideon Segev is a faculty member in the School of Electrical Engineering at the Tel Aviv University. Gideon did his graduate studies at the Tel Aviv University solar energy lab. In 2016 Gideon joined the Joint Center of Artificial Photosynthesis at the Lawrence Berkeley National Lab, where he worked on advanced semiconductor devices for solar fuels generation and advanced characterization of photoelectrochemical cells. In 2019 Gideon joined the School of Electrical Engineering at the Tel Aviv University. His research focuses on electronic devices for solar energy conversion, solar water splitting, water desalination and selective ion separation.