

AC Electro-Kinetics, Bipolar Current and Concentration-Polarization in a Microchannel-Nafion Membrane System

Authors : Sinwook Park, Gilad Yossifon

Abstract : The presence of a floating electrode array located within the depletion layer formed due to concentration-polarization (CP) across a microchannel-membrane device, produces not only induced-charge electro-osmosis (ICEO) vortex and but also a bipolar current resulting from faradaic reactions. It has been shown that there exists an optimal SiO₂ layer thickness of ~50nm which is sufficient to suppress bipolar currents (at least up to 5V applied voltage) but still enables ICEO vortices that stir the depletion layer, thereby affecting its I-V response. This effect is pronounced beyond the limiting current where the existence of the depletion layer results in increased local electric field due to decreased solution conductivity. This comprehensive study of the interaction of embedded electrodes with the induced CP in microchannel-perm selective medium systems, allows one to choose the thickness of the thin dielectric coating to either enhance the mixing as a means to control the diffuse layer, or suppress it, for example, in the case where electrodes are intended for local measurements of the solution conductivity with minimal invasion. In addition, the use of alternating-current electro-osmosis by activating electrodes results in further enhancement of the fluid stirring and opens new routes for on-demand spatiotemporal control of the CP length. In addition, the use of embedded heaters within the depletion layer generates electro-thermal vortices that in turn also control the CP length.

Keywords : AC electrokinetics, microchannel, concentration-polarization, bipolar current

Conference Title : ICMN 2016 : International Conference on Microfluidics and Nanofluidics

Conference Location : Prague, Czechia

Conference Dates : July 07-08, 2016