# Concentration Polarization and Electroconvection in Heterogeneous Permselective Systems

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The passage of an electric current through a permselective medium (membranes or nanochannels) under an applied electric field is characterized by the formation of ionic concentration gradients which result in regions of depleted and enriched ionic concentration at opposite ends of the medium, i.e. concentration polarization (CP). Understanding the effects of 3D geometric field focusing effects on CP in realistic three dimensional and three layers system (i.e. microchannel-permselective medium-microchannel device) is of much importance in the growing field of electrokinetics and nanofluidics. In our previous works [1,2], under the assumption of local-electroneutrality and negligible convection, we derived analytical solutions for the ionic concentrations and electric potential distributions for an electrolyte undergoing CP in one and three layers systems. In particular, we studied the effect of system heterogeneity (i.e. 2D and 3D cases, in contrast to the 1D, characterized by a non-equal permselective medium and microchamber cross-sections) on the current-voltage curves and the concentration profiles. The current study waives our previous assumptions and account for the effects of space-charge formation and electroconvection through numerical simulations. In addition, we shall experimentally verify these theoretical predictions by studying a system made of a nanoslot array (Fig.1).

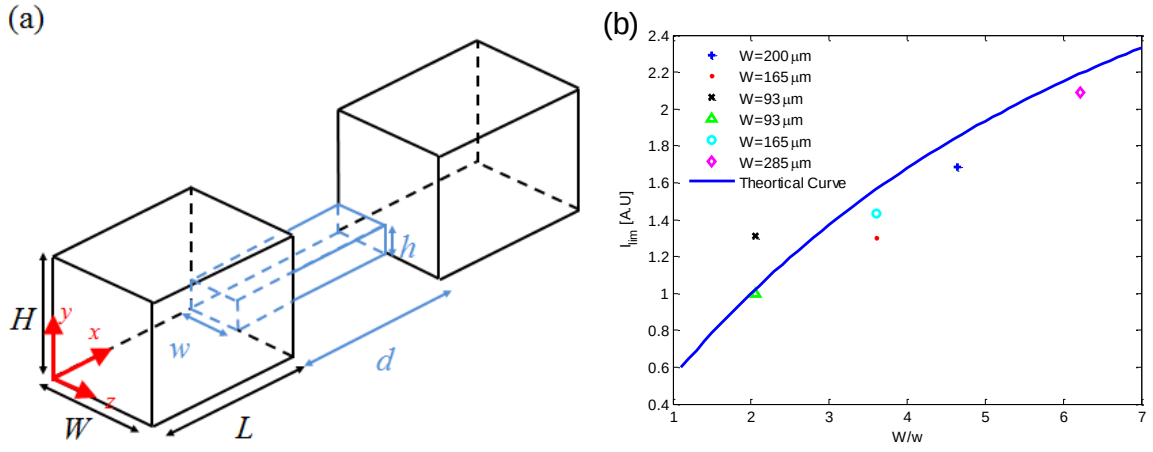



Fig.1: (a) Schematics describing half a single 3D unit periodic cell consisting of a straight permselective medium connecting two opposite symmetric microchambers. (b) Normalized measured limiting currents compared to theory as a function of the heterogeneity $W / w$.

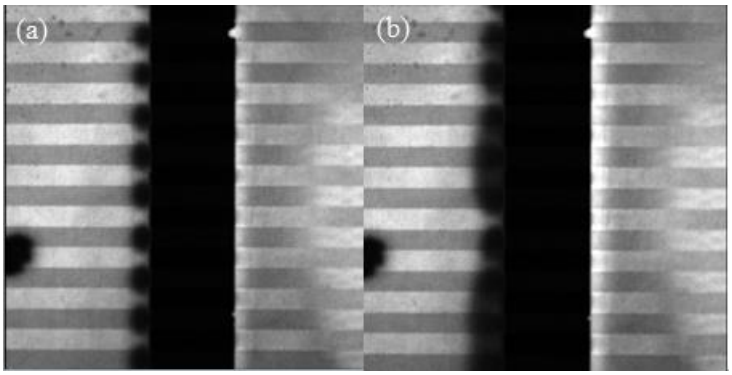



Fig.2 : Evolution of the vortices in a channel of width $W = 93\mu m$ at 50V at a (a) early time and at a (b) later time. Initially the vortices are isolated until the merge to have form similar to that shown for the electro-diffusion investigated in Ref. [1].

## References

[1] Y. Green and G. Yossifon, Phys. Rev. E **89**, 013024 (2014).
[2] Y. Green, S. Shloush, and G. Yossifon, Phys. Rev. E **89**, 043015 (2014).