Rectified Ion Transport Through Concentration Gradient in Homogeneous Nanochannels

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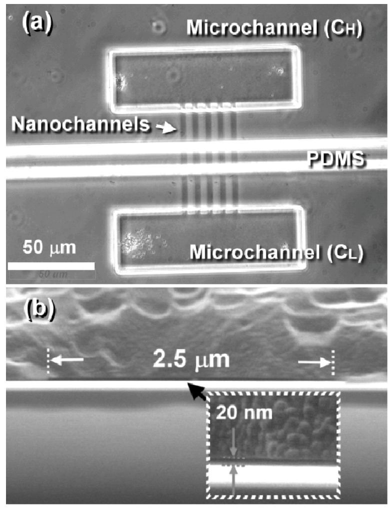
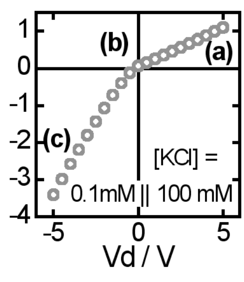
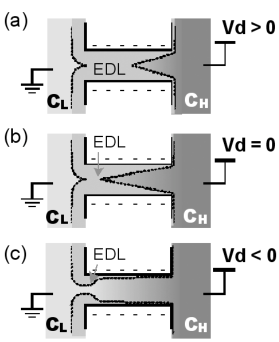
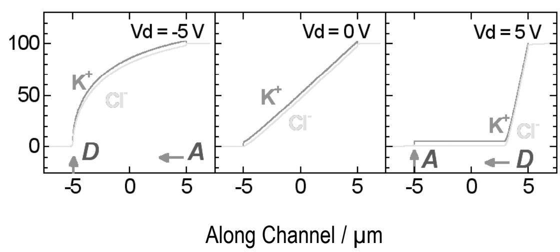
Nanofluidic devices are potentially useful for attoliter-scale chemical delivery. In this project, rectified ion transport was investigated in sub-20nm-thick homogeneous nanochannels. The rectification effect was observed at certain ionic concentrations such that the electric double-layer overlap occurs at only one end of the channel. The calculation based on Poisson-Nernst-Planck theory and a proposed model suggests that the effects are the result of the accumulation and depletion of both cations and anions in the nanochannels under bias of different polarities. The model also elucidates that the basis of the rectifying effects in the nanofluidic devices reported to date is due to the asymmetric cation/anion ratios or equivalently the build-in potentials on the two ends of the nanochannels. This project is supported by a Riethmiller Fellowship.



Phase-contrast microscopic image (a) and cross-section SEM image, (b) of a 20nm-thick nanofluidic channel connecting between two PDMS microfluidic channels.







Rectifying effect due to the disparate ion distribution along a negatively charged nanochannel under different polarities of applied potential.