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Concentration polarization and desalination in nanochannels: Effect of surface charge dynamics MATHIAS B. ANDERSEN, HENRIK BRUUS, Technical University of Denmark, ALI MANI, MARTIN Z. BAZANT, MIT — Mani, Zangle, and Santiago (*Langmuir*, 25, 3898–3916) have shown that at microchannel-nanochannel junctions the coupled effect of concentration polarization and surface conduction can lead to long range propagation of bulk ion-depletion shocks. Essential for this phenomena is the surface charge which for many materials depends on both the concentration and the pH of the local bulk electrolyte. Standard models predict that the surface charge decreases with decreasing concentration leading to the contradictory expectation that there is little or no surface charge in the depleted region and hence no mechanism to sustain long range propagation of desalination shocks. We show that this simple prediction fails to take into account axial transport terms. As such, we couple a surface charge model with the Poisson–Nernst–Planck equations for electric potential and ionic species combined with the Navier–Stokes and continuity equations for fluid velocity. Motivated by experimental work we consider steady-state solutions at the dead end of a nanochannel against a membrane, a scenario where especially space charge and electroosmotic flow are important. Our results suggest that the surface charge density remains finite and does not vanish, and even grows, as the depletion front propagates through the channel.

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