Electrokinetic transport in a microfluidic channel with polyelectrolyte-grafted surfaces aiming enhanced energy conversion

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pH responsive polyelectrolyte(PE)-grafted micro/nano-channels have shown great promise for applications such as ion-transport related sensing and selection, current rectification. We develop a two-dimensional mathematical model to simulate pressure driven flows in a rectangular microchannel considering ion transport through the pH dependent swelling surfaces. A PE-grafted layer is represented as a fixed charge layer and electrolyte ions can be presented both inside and outside of the layer. The Poisson-Nernst-Planck equations are numerically solved, which is well describing the Donnan potential at the soft channel. The coupled hydrodynamic equations are fully considering both electro-viscous effects of the charged solution and a Brinkman type friction inside the brushed layer. This presentation reports new results including a strong enhancement in the conversion efficiency at the higher pH condition for negatively charged PE brushes, such as an immobilized poly(acrylic acid) layer. Such ion transport in the soft channel will be significant in a useful basis for micro/nanofluidics design and potential applications to the enhanced energy conversion.