Theoretical insights of electrolyte transport in nanopores

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Fundamental understanding of ionic transport at the nanoscale is essential for developing biosensors based on nanopore technology and new generation high-performance nanofiltration membranes for separation and purification applications.

After a general introduction on the theoretical modeling of ionic transport in nanopores, we present a mesoscopic theoretical approach for the electrolyte conductivity inside nanopores. The model considers explicitly ion advection by electro-osmotic flow, possible flow slip at the pore surface (when the pore is hydrophobic) [1], dielectric exclusion of the ions [2], hard core repulsion between ions [3], and surface charge regulation [4]. Various regimes where the conductivity has a relatively simple analytical expression are identified.

The theory is then compared to experimental measurements of ionic transport through single putatively neutral hydrophobic nanopores and with a well controlled cylindrical geometry [1] and through single wall carbon nanotubes [5]. We focus on the dependence of the nanopore conductance with the reservoir ionic concentration, showing various behaviours depending on the experimental conditions.

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