Nanofluidics in Carbon Nanotube Porins

Aleksandr Noy
Lawrence Livermore National Laboratory, 7000 East Ave, Livermore, CA 94550, USA
noy1@llnl.gov

Abstract
Nanofluidic systems provide an opportunity to control ion and water transport on a molecular scale, which is important for applications ranging from precision separations to industrial water treatment. Living systems, which move ions and small molecules across biological membranes using protein pores, often rely on finely controlled nanoscale confinement effects to achieve efficient and exquisitely selective transport. I will show that carbon nanotube porins—pore channels formed by ultra-short carbon nanotubes assembled in a lipid membrane—can exploit similar physical principles to transport water [1], protons [2], and ions [3] with efficiency that rivals and sometimes exceeds that of biological channels. I will discuss how molecular confinement, slip flow, and the nature of the pore walls influence the mechanisms of ion diffusion, ion selectivity, electrophoretic transport, and electroosmotic coupling in these nanopores. Overall, carbon nanotube porins represent simple, versatile, and highly controlled biomimetic membrane pores that provide an ideal test bed for development of the next generation of separation technologies.

References

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Figures

Figure 1: Artist view of an ion-water cluster inside a carbon nanotube.