Optical sensing of ion flux through biomimetic carbon nanotube channels

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Increasing demands for cheaper and more efficient water treatment methods have never been higher, as shortages of fresh water have become a growing pain in many regions worldwide. In both experiments and theory, carbon nanotubes have shown a potential in water treatment, desalination and energy conversion with high ion selectivity and enhanced water transport. In this research, we present an approach to investigate fluid transport across each single carbon nanotube channel by visualize the ion and water flux under a Total Internal Reflection Fluorescence Microscopy (TIRF). Using a droplet interface bilayer (DIB) technique, we place an aqueous droplet (~ 200 nanoliter) on an oil-agarose hydrogel interface, which brings together the lipid monolayers on the droplet and the interface to form a bilayer that mimics a cell membrane. We then incorporate the carbon nanotube channels in this bilayer. The ion and mass fluxes in each channel were characterized through the optical image of ion-sensitive fluorescence, which made it available to trace the flux through a large number of nanoscale channels individually instead of averaging them. The evanescent wave from TIRF also made it possible by eliminating the noise in the background and confining the illuminated region. we envision that novel methods for water treatment can thus emerge via a better understanding of fundamental transport properties through biomimetic carbon nanotube porins.