Nanofluidic transport in individual carbon and boron nitride nanotubes

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Abstract:

Liquid transport in nanopores challenges the fundamental frontiers of fluid dynamics and nanoscience. Recently a number of reports highlighted exceptional water transport properties when confined in carbon-based nanopores, and carbon nanofluidics raised a lot of hopes for new avenues for desalination, nano-filtration and energy harvesting. However many of these results still remain debated and the fundamental reasons why carbon materials is so specific to fluidic transport still remains debated.

A major challenge to address the fundamental properties at the nanoscales lies in building distinct and well-controlled nanosystems, amenable to the systematic exploration of their properties. To this end, we have developed new methods based on the manipulation of nano-objects, displacing, cutting, and glueing these elementary building blocks. This allows us to fabricate original fluidic and mechanical systems involving single nanotubes.

I will first discuss ionic transport through single nanotubes, made of both carbon (CNT) and boron-nitride (BNNT) materials. These results show a contrasting interfacial behavior between the rather hydrophobic CNT and its crystallographic analogue, BNNT. In particular these experiments highlights strong adsorption of hydroxyle ions at the pristine carbon-water interface.

I will then discuss experiments of nanoscale water jets emerging from single nanotubes. The peculiar jet geometry allows for a passive and dye free probe of the mass flow across a nanotube with an unprecedented sensitivity. It reveals a diameter-dependent surface slippage for carbon nanotubes, leading to a giant flow enhancement for the smallest tubes. In contrast their boron-nitride analogues show no slippage. This highlights the subtle microscopic origin of water superlubricity at carbon interfaces.

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