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Friction Reduction in Carbon Nanotubes

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Researchers have predicted and verified nearly frictionless water flows inside carbon nanotubes (CNT). It is a pioneering prediction by Hummer and colleagues (1) that water can enter hydrophobic conduits of carbon nanotubes despite contradiction against the Kelvin's equations, later explained by more degenerated hydrogen bonding for sub-1-nm diameter CNT. Once filling the tiny space of a CNT, water can flow very fast approaching the speeds in biological channels.

Holt, Park *et al.* (2) later confirmed this prediction by experiments. Membranes whose pores are made out of CNT provided a myriad of parallel channels that enabled the flow measurement in an ensemble averaged manner. What we found out is rapid water transport in a sub-2-nm-wide CNT, exceeding Hagen-Poiseuille formalism by three-to-four orders of magnitude. The potential of their CNT membranes have been touted for novel energy-efficient nanoscale filtration for gases, liquids and ions (3).

A combination of hydrophobicity and atomic-level smoothness can explain these nearly frictionless flow phenomena at nanoscales (4). This nanoscale fluid mechanics should incorporate slip flow boundary condition, molecular interaction models, and a new angle of molecular fluid dynamic approach. However, a complete picture to explain this phenomena and mechanisms behind still remains elusive. An absence of theoretical and experimental understandings of these phenomena is opening up grand research opportunities in the emerging field of so called Carbon Nanofluidics.

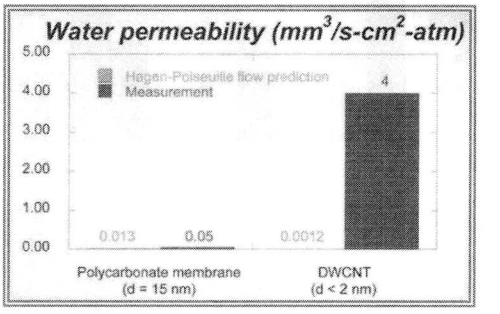

Fig. 1 Measured water permeability through membranes made out of carbon nanotubes of 1.6±0.3 nanometers, in comparison with Hagen-Poiseuille flows extrapolated to these length scales. Unlike polymer pores, 15 nanometers in diameter, CNT channels can enhance water flows enormously.

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참고문헌

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