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Lab talk

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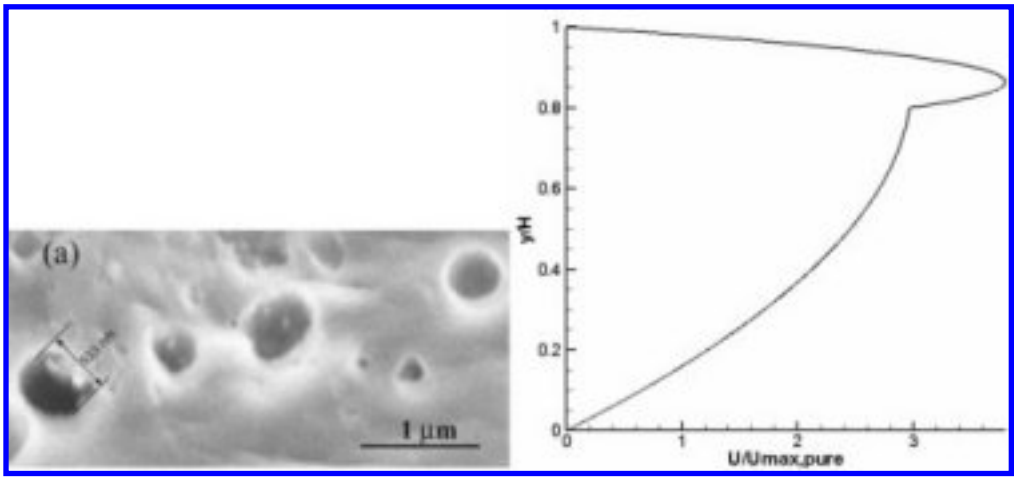
Giant quasi-slip in flows in 500 nm carbon nanotubes

Researchers at the University of Illinois at Chicago are studying laminar pressure-driven flows in carbon nanotubes produced via electrospinning of polymer nanofibers.



Nanotube exits and velocity profile

They demonstrated that bi-layer flows of liquid and gas can result in an over-limiting regime. Namely, a regime in which a higher flow rate of liquid can be achieved as compared to the case when the same liquid flows through the same tube subjected to the same pressure drop and occupies the whole bore. This means that it is possible to release more liquid than predicted by the Poiseuille law, even though in the bi-layer flow liquid does not occupy the whole cross-section.

This paradoxical result is related to the fact, that the less viscous gas layer can flow much faster than the underlying liquid layer and entrain the latter via a significant shear stress. The present results show that the over-limiting liquid flows through nanotubes, seemingly resembling a deviation from the no-slip condition, in reality

are entrained by a rapidly moving gas layer in bi-layer liquid/gas flows. This quasi-slip phenomenon happens in relatively large nanotubes (of the order of 500 nm) where the no-slip condition holds with sufficient accuracy. This phenomenon can be beneficial in micro- and nanofluidics, nanoreactors and drug delivery systems, which are the current goals of this team.

About the author

Suman Sinha Ray is a PhD student at UIC. Paul Chando is an undergraduate REU visitor from RPI whose visit was supported through Grant NSF-EEC 0755115 from National Science Foundation and Department of Defense. Alexander L. Yarin is a Professor of the Mechanical and Industrial Department and a co-director of Micro/Nanoscale Fluid Transport Laboratory at the University of Illinois at Chicago, USA (ayarin@uic.edu; http://www.mie.uic.edu/faculty/yarin.htm; http://www.uic.edu/labs/MNFTL). He is also a Fellow at the Center for Smart Interfaces at the Technical University of Darmstadt, Germany. This work was partially supported by National Science Foundation through Grant NIRT CBET-0609062.