CNST collaboration tunes viscous drag on superhydrophobic surfaces

December 1 2011

(PhysOrg.com) -- By measuring the motion of a vibrating, porous membrane separating water and air, researchers from the NIST Center for Nanoscale Science and Technology, the NIST Physical Measurement Laboratory, the University of Maryland, and Boston University have revealed a new regime of fluid behavior near solid surfaces that has not been previously observed.

The research team studied the behavior of a 200 nm-thick silicon nitride membrane containing a mesh of 10 µm-diameter pores. The surfaces of the membrane were chemically modified to repel water (superhydrophobic), and each membrane was fabricated in a device enabling it to have water on one side and air on the other. Using this novel system, the researchers observed that the friction force, or drag, on the water side is reduced dramatically when the spacing between the pores is reduced.

The researchers attribute the observed drag reduction along with an observed decrease in the mass of the water that moves along with the membrane to the formation of a stable layer of air a few tens of nanometers thick between the water and the pores. The layer forms because the large pores in the thin membrane allow air to enter freely, and the layer then decouples the membrane from the liquid.

Despite this airflow, the membrane remains a barrier to liquid water because of its hydrophobic coating. This surprising result may help explain various puzzling biofluidic phenomena and lead to better control of viscous drag in practical systems ranging from water pipes, to vehicles, to atomic force microscope sensors.

More information: Porous superhydrophobic membranes: hydrodynamic anomaly in oscillating flows, S. Rajauria, O. Ozsun, J. Lawall, V. Yakhot, and K. L. Ekinci, *Physical Review Letters* 107, 174501 (2011).