Special

PHYSICAL MATHEMATICS SEMINAR

TOWARDS AN IMPROVED UNDERSTANDING OF SURFACE EFFECTS IN MICROSCALE LIQUID FLOWS

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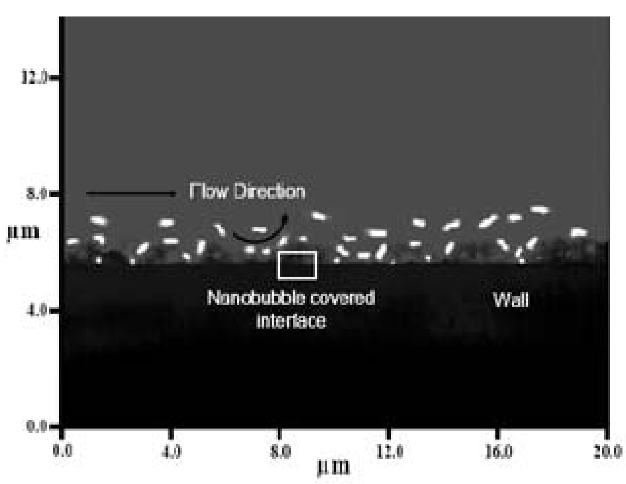
ABSTRACT:

Surface effects in microfluidics are of many-fold, encompassing the interesting and interconnected aspects of capillarity, electrostatics and electrokinetics, multi-phase thermo-physical transport, and the surface reactive kinetics. The underlying physical issues are truly diverse and multi-scale in nature, many of which are yet to be fundamentally well resolved. Developing an improved understanding in this regard becomes important for more efficient design and control of microfluidic devices and systems in a wide range of applications, ranging from the chip cooling and inkjet printing to the analysis of biological macromolecules and cellular transport.

The first part of the lecture is intended to briefly introduce the various research activities at the Microfluidics Laboratory at IIT Kharagpur, which is being headed by the speaker. The subsequent part of the lecture elaborates a novel physical and theoretical model that has recently been postulated (***S. Chakraborty, Applied Physics Letters, vol. 90, pp. 034108(1-3), 2007***) to capture the influences of microfabrication characteristics on the frictional behavior of pressure-driven liquid microflows, through a detailed analysis of the underlined surface effects that effectively link-up these two strongly-correlated aspects. For theoretical analysis, a continuum based generalized formalism is developed for critically assessing the competing aspects of the stick-slip influences of the surface roughness elements, the randomness related to the spontaneous production, size distribution and coverage of the nanobubble layers and the consequent apparent slip mechanisms due to hydrophobic interactions. Uncertainties pertaining to surface texture are accounted for by employing a stochastic version of the Navier-Stokes equation. The theoretical formulation is simultaneously validated with the data obtained from indigenous experiments and other benchmark studies reported in the literature, and excellent quantitative trends are obtained in this regard.



TUESDAY, JUNE 26, 2007
4:00 PM
Building 2, Room 105

Reception at 3:30 PM in Building 2, Room 349
(Applied Math Common Room)

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