2012-2013

Graduate Seminar Series

The Department of
Mechanical Engineering – Engineering Mechanics

Proudly Presents

Professor Alexander L. Yarin
Department of Mechanical and Industrial Engineering
University of Illinois at Chicago
and
Center for Smart Interfaces
Technische Universität Darmstadt

Professor Alexander L. Yarin received his PhD in 1980, his DSc (Habilitation) in 1989. He was a Senior Research Associate at The Academy of Sciences of the USSR, Moscow from (1977-1990). In 1990 he became a Professor at the Technion-Israel Institute of Technology and is currently with the University of Illinois at Chicago. Since 2008, Dr. Yarin has been a Fellow of the Center for Smart Interfaces at the Technical University of Darmstadt, Germany.

Professor Yarin is the author of 2 books, 10 book chapters, approximately 210 research papers, and 5 patents. He is one of the three co-Editors of “Springer Handbook of Experimental Fluid Mechanics” (2007) and an Associate Editor of the journal “Experiments in Fluids”.

Thursday, Oct. 11, 2012 | 4:00 – 5:00 p.m. | Room 112, ME-EM Bldg.

FROM ELECTROSPINNING TO THERMAL MANAGEMENT IN MICROELECTRONICS, FROM CO-ELECTROSPINNING TO NANOFLUIDICS

In the first part, a novel method of enhancement of drop and spray cooling for microelectronic, optical and radiological elements and server rooms, which require extremely high heat fluxes, is discussed. The key idea of the method is to cover the heat transfer surfaces with electrospun nonwoven polymer or metal-plated “thorny devil” nanofiber mats. The experiments revealed that drop impacts on nanotextured surfaces of nanofiber mats produce spreading similar to that on the impermeable surfaces. However, at the end of the spreading stage the contact line is pinned and drop receding is prevented. All the mats appeared to be dynamically permeable for coolant drops. The enhanced efficiency of drop cooling in the presence of nanofiber mats observed experimentally results from full elimination of receding and bouncing of the drops, characteristic of the current spray cooling technology. Therefore, the drops evaporate completely, and the large cooling potential associated with the latent heat of evaporation is more fully exploited. This is paradoxical: the best cooling can be provided by a "furry overcoat"! Using this approach very high cooling rates of about 1 kW/cm^2 were achieved and the anti-Leidenfrost effect was discovered.

In the second part, carbon nanotubes are synthesized and self-assembled via co-electrospinning, emulsion electrospinning, or template electrospinning and subsequent carbonization. Then, controlled flows through macroscopically long (~1cm) carbon nanotubes are demonstrated. It is shown that a higher flow rate of liquid in a bi-layer gas-liquid system 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. This quasi-giant-slip phenomenon occurs in relatively large nanotubes (of the order of 500 nm dia.) where the no-slip condition holds with sufficient accuracy. This phenomenon can be beneficial in reverse osmosis systems. In addition, parallel bundles of these carbon nanotubes are used as nanoreactors to polymerize sufficiently monodisperse thermo-responsive nanoparticles of the order of 400 nm dia. at the rate of 10^7 particles per sec. Nanoparticles of this size are therapeutically beneficial and can be used as drug carriers. Controlled release from them modulated by temperature variation was demonstrated.

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