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Electroosmotic Flow Hysteresis and Effect of Nanostructure Orientation in a Microfluidic Channel

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Host: Dr Deepak Choudhury

Seminar Abstract

Electroosmotic flow (EOF) has been exploited in a wide range of microfluidic applications, with fluids which are inhomogeneous either in concentration or conductivity, or both. There is an anomaly in that the flow behavior of two fluids (with either different concentrations or ion species) is direction-dependent and is termed as “EOF hysteresis” in this investigation. This EOF hysteresis was found to originate from the accumulation/depletion of ion species as a result of the imbalanced electric-field-induced flux at the two-fluid interface, which subsequently widened and spread during the displacement flow. The resultant ion distributions (thus difference in average zeta potentials) led to the direction-dependency of the EOF flow rate. As such, an in-depth understanding of EOF hysteresis is required for precise manipulation of fluids and analyte transports in microfluidic applications, where the fluids involved are typically inhomogeneous.

Nanoscale structures are usually incorporated within a microchannel for various applications. Despite of the numerous investigations of nanostructures on EOF reduction, a proper study on the orientation effect of nanostructures on EOF is yet to be conducted. This investigation discovered that the perpendicular nanolines significantly reduced the EOF velocity due to the local electric field distortion at the nanostructured surface. In contrast, the parallel nanolines had no effect on the EOF as they did not result in distortion of the electric field. The outcomes of this investigation enhance the fundamental understanding of the effect of nanostructures on EOF behavior. These have implications on the precise EOF control in devices utilizing nanostructured surfaces for chemical and biological analyses.

About the Speaker

I received Ph.D. in Mechanical Engineering from Nanyang Technological University in 2018. During my Ph.D. education (in 2015), I had also participated in an Overseas Research Attachment Programme with Department of Micro-/Nanotechnology, Technical University of Denmark, to equip myself with micro-/nanofabrication capabilities. I join Biomanufacturing Devices Group (BMD) in BTI to contribute my expertise in research with translational and industrial value.

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