FMRC Fluid Mechanics Research Seminar Series

Electrohydrodynamic Instabilities in Microchannels

Kerem Uğuz
Bogaziçi University, Department of Chemical Engineering, İstanbul

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Abstract: Flow in microchannels is laminar due to the small dimensions involved. Consequently, rapidly mixing two miscible liquids or generating droplets of one phase in another one requires either employing complex geometries or creating an interfacial instability. It has been shown that using an electric field is an efficient active method to mix miscible liquids or generate droplets in microchannels.

In this presentation, both theoretical/numerical and experimental results will be discussed. Theoretically, the liquids, subjected to Poiseuille flow, are assumed to be immiscible and leaky dielectric, and the direction of the electric field is taken to be either parallel or normal to the flat, unperturbed interface. The effect of the electric field on the dispersion curves is presented for various physical parameters and a detailed study is performed to compare the influence of the normal versus parallel electric field. The theory employs both linear stability analysis and lubrication method.

Experimentally, two immiscible liquids are injected into a Y-shape rectangular cross section microchannel using a syringe pump. We investigate the effect of various parameters, including the types of liquids hence their physical properties, the flow rates of liquids, the channel dimensions, and the direction of the electric field, i.e. parallel or normal to the flat interface, on the critical voltage at which the interface starts deflecting.

Biography: Assoc. Prof. Kerem Uğuz received his B.S. and M.S. degrees in chemical engineering from Boğaziçi University, and his Ph.D. degree in chemical engineering from University of Florida, Gainesville, FL, USA, in 2006. He then worked in the department of mechanical engineering at Carnegie Mellon University, Pittsburgh, PA, USA as a postdoctoral fellow. He has been a faculty member at Boğaziçi University since 2008. His work is focused on the experimental and numerical aspects of microfluidics, electrohydrodynamics, non-Newtonian flows, and spectral methods.