

Micro/Nano Scale Elastohydrodynamics and Reactive Transport in Porous Media

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ABSTRACT

Elastohydrodynamics (EHD) is a crucial phenomenon in numerous micro/nanoscale physical systems where flow occurs through soft confinements. A prime example is soft microchannels, finding applications in a wide range of scenarios like particle filtration systems and vascular biomimetics. Avenues for exploiting the EHD towards extracting desired system behavior thus comprise cutting-edge technological development. Focusing on modulating the EHD response of the soft walls towards passively controlling microchannel shape under flow, two modes of modulation are explored – material and geometric, and appreciable promise is demonstrated using either of these approaches. The findings of these studies are expected to complement and present avenues of flow control in microchannels toward specialized applications like biomimetics and targeted drug delivery.

Beyond mechanical interactions, flows through micro/nano confinements are also hotbeds for reactive transport of dissolved solutes, which in turn plays a central role in a wide range of porous media systems and applications, e.g., chemotaxis in tumors, action of injected drugs, etc. Exploring the interplay of the different transport processes, the exclusive impact of hydrodynamic dispersion on radially-advected reaction fronts was delineated and the mechanism of reaction enhancements in extensional flow reaction fronts when subjected to transient flow was established. The findings of these studies are expected to be instrumental in designing and optimizing remediation of contaminated aquifers and diseased tissue matrices.

ABOUT THE SPEAKER

My educational background includes a dual-degree BTech and MTech (2010-2015) and then a PhD (2017-2022), each from Dept Mech Engg, IIT Kharagpur. Working on elastohydrodynamics in micro/nano scale physical systems for my PhD, I took a two-pronged approach and studied the fundamentals of the elastohydrodynamic interactions in scanning probe microscopy of fluid-inundated soft materials, whilst simultaneously exploiting wall elasticity to control the flow in soft microchannels. Post-PhD, I have worked for about a year as an Early-Career Fellow at IIT Gandhinagar (2021-2023), followed by posting as a CNRS Post-doctoral Fellow at Geosciences Rennes, France (since Mar 2023). For my post-doctoral assignments, I have studied reactive transport in porous media under different flow configurations, employing and honing the tools of mathematical modelling and fluorimetric/luminometric experimentation.



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