ME Seminar

Unlocking the Power of Capillary-Driven Transport for Droplet Manipulation: From point-of-care diagnostics to sustainability solution

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ABSTRACT

With the advent of technology, there is a rapidly growing trend towards device miniaturization in every field of engineering, starting from wearable electronics to the field of biomedical diagnostics. A wide range of engineering applications, ranging from bioanalytical and biomedical devices to thermal management in electronics devices, is progressively seeking fluid transport at reduced length scale. Open microfluidics offers a new paradigm of droplet-based fluidic transport, where individual droplets, a train of droplets or an open jet of liquid is manipulated on a substrate, entailing certain operational advantages. However, achieving even the simplest microfluidic tasks in a controlled fashion on an open surfaces remains a challenge because of the absence of any flow conduits, pumps and valves. In general, a surface microfluidic platform for bioanalytical applications would warrant that the device is capable of directional transport, metered dispensing, mixing and splitting of the sample liquid without the need for any external power supply. Capillary-driven transport of liquid droplets and jets using spatial gradients and patterns in the underlying substrate-wettability has shown promise in achieving such transport. Liquid droplets on such wettability-engineered surfaces experience an unbalanced surface force in the direction of increasing wettability, leading to fluid mobilization on the substrate. In the first part of the talk, the underlying mechanism of such transport, and its use in the context of point-of-care (PoC) diagnostics will be discussed. A few relevant methods of surface fabrication will also be discussed which are facile, substrate independent, and hence can be realized on metal, silicon, glass, polymer or even paper. The second part of the talk will describe how such capillary-driven liquid transport on strategically wettability-patterned substrates can be leveraged to enhance atmospheric water capture via condensation, jet-impingement cooling, self-cleaning of solar photovoltaic panel covers, or even atmospheric and industrial fog harvesting.

ABOUT THE SPEAKER

Dr. Ranjan Ganguly is a Professor in the Power Engineering Department of Jadavpur University (JU) and has more than 28 years of teaching experience. He is also an adjunct professor at the Mechanical and Industrial Engineering Department of University of Illinois at Chicago (UIC). Dr. Ganguly completed BE in Power Plant Engineering (1995) and ME with Heat Power specialization (2000), both from JU. He received PhD from UIC (2005). He also had postdoctoral research stints at Universität Hannover, TU Darmstadt, Virginia Tech, and UIC. Dr. Ganguly has received several accolades, including the Alexander von Humboldt Fellowship (2008-09), the Indian National Academy of Engineering Young Engineer Award (2008), BRNS Young Scientist Research Award (2006), Dean's Scholar Award and Provosts Award for Graduate Research at UIC (2004), and University Medals at JU (1995 and 2000). He is also a fellow of the Indian National Academy of Engineering (FNAE) and West Bengal Academy of Science and Technology (FWAST). His primary research encompasses magnetic particles-based microfluidics, wettability engineering, heat transfer, and energy systems. Dr. Ganguly has more than a hundred international journal publications, eight book chapters, five patents and two invention disclosures to his credit. His work is widely cited in different fields of engineering research.

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