International Conference on Micro Nano Fluidics

(ICOM 2025)

October 31 – November 2, 2025, IIT Guwahati

Speaker/affiliation: Prof. Marco Marengo, University of Pavia, Italy

Tentative topic of the invited talk

Spreading Behavior of Core-Shell Droplets upon Impact on Solid Surfaces

Abstract of the invited talk

Compound droplets composed of immiscible core-shell structures have garnered considerable interest due to their applications in areas such as pharmaceuticals, food processing, and inkjet printing. However, the interplay between the geometrical and rheological properties of such droplets and their impact dynamics remains insufficiently understood. This study experimentally investigates the influence of core size and viscosity contrasts on the maximum spreading behavior of compound droplets upon impact on a solid substrate. Using water and silicone oils of various viscosities, a wide range of core-to-total volume ratios and viscosity combinations were tested to construct a representative dataset. High-speed imaging was employed to capture the spreading and recoiling dynamics of the droplets after free fall. The analysis revealed that the shell layer viscosity plays a dominant role in dictating the maximum spreading factor, while the core viscosity has a notably weaker influence. Nevertheless, droplets with highly viscous cores exhibited a suppressed rebound behavior, reducing the upward motion of the core after impact. This suggests that while the shell controls the overall extent of spreading, the core affects the internal fluid motion during retraction. Dimensionless scaling was applied to correlate the maximum spreading factor with the Weber number and Ohnesorge number, accounting for the compound nature of the droplets. The results indicate that conventional models for single-phase droplets require modification to predict the dynamics of compound systems accurately. This study contributes to a deeper understanding of compound droplet impact behavior, highlighting the separate roles of core and shell properties. The findings offer valuable insights for optimizing droplet-based processes where control of spreading and rebound is critical, and lay the groundwork for improved predictive models in multiphase impact dynamics.