INDIAN INSTITUTE OF TECHNOLOGY GUWAHATI
SHORT ABSTRACT OF THESIS

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SHORT ABSTRACT

The manipulation of a discrete liquid droplet or a group of droplets with or without the deformation of the liquid-vapour interface in the presence of an externally stimulating field is an integral part of *Lab-On-Chip* devices, which in turn determines the performance of target applications. A detailed appraisal of the underlying rich physics associated with the deformation and/or disruption of the continuous two-phase interface and the behaviour of the contact line during the actuation of a droplet over an open surface or inside a closed channel, engendered in the presence of an external force, apparently contribute towards enhancing the efficacy of numerous microfluidics applications. In this regard, a plethora of complex hydrodynamic features during actuation, mixing, merging, or splitting of discrete droplets have been unfurled by the scientific community over the past years. However, owing to the growing demand for microfluidics platforms in a host of cutting-edge engineering and biomedical applications, it has become necessary to assess the existing or novel droplet-based physical systems more comprehensively. Thanks to the advancement of high-speed visualization tools and computational techniques, the latter task has become easier nowadays. The present thesis work draws enormous motivation from the aforementioned observations and makes an honest attempt to uncover the rich physics associated with the behaviour of single liquid droplets in the presence of external potentials, such as electric field, magnetic field, imposed inertia, etc., in a few interesting and unexplored physical systems. The problems addressed within the scope of the present thesis include the growth dynamics of a droplet from a yarn, softness mediated magnetowetting of sessile ferrofluid droplets, electric-discharge-mediated atomization of a conducting sessile droplet, and impact dynamics of viscous droplets on a superhydrophobic surface. Overall, the focus has been laid on experimentally characterizing the temporal evolution of the shape and contact line(s) during the growth/deformation phase of a droplet and the subsequent atomization dynamics of the primary droplet. Apart from the externally applied field, the effect of thermophysical properties of the liquid and properties of the substrate in contact have also been characterized during the systematic experimental investigation of the aforementioned systems. High-speed imaging/videography techniques are used primarily to analyze the intricate physical details of the systems under consideration. Also, the experimental results are strengthened by scaling analysis and numerical simulations. The comprehensive experimental analysis of each system unveils several interesting hydrodynamic features, such as liquid jet formation, crown formation, bursting ejecta sheet, lamella ejection, capillary pinch-off, high-speed hair-like jets emanating from a parent droplet exposed to different external stimulations. The aforementioned flow morphologies contribute enormously towards the effective atomization of the parent droplet, desirable for many microfluidics applications. The contributions from this thesis work are expected to pave the way for several new research avenues in microfluidics.