Abstract

Obtaining no-maintenance, self-healing and long-lasting surface finish is a panache for surface engineering, not only because of aesthetics, but also to meet the desirable functionalities of the concerned products. Circumventing several constraints of structured superhydrophobic interfaces that rely on the action of a metastable gas-gap between the topographical elements on the substrate and the incipient liquid, the proposition of liquid infused slippery surfaces (LISS) having stable lubricated film layers has been advanced in recent times. However, despite such rapid emergence, several unaddressed facets regarding their functionalities under extreme conditions remained to be prohibitive against their use in real-life industrial applications.

The aim of the present dissertation, accordingly, has been to advance controlling the fundamental stabilization dynamics of liquid infused slippery interfaces and apply the same to polymeric, metallic and paper-based substrates. Within the broad purview of fabricating functional liquid induced slippery interfaces having favourable stability under practical deployment, following specific aspects have been explored: (i) the effect of sticky hierarchical surface morphology on the stability of a non-spreading liquid film; (ii) the modes of thermal degradation of the lubricating liquid layer fabricated on a metallic substrate; (iii) the effect of lubricating layer viscosity on droplet impingement equilibration on the LISS; (iv) facile fabrication of LISS on a filter paper towards the proposition of an economical, biodegradable, and flexible alternate to the traditional LISS base materials.

In chapter 2 of the thesis, it is shown that a liquid with a negative spreading coefficient on a solid surface that otherwise dewets spontaneously can be stabilized to form a LISS film by harnessing rose-petal mimicking microstructrues that are interspersed with nano-wrinkles having a very strong anchoring with the oil layer and thus arresting in retracting motion of oil on a cross-linked solid PDMS (poldimethylsiloxane) surface. In *chapter 3,* LISS is fabricated on a metallic surface, with an aim of probing any possible mechanism of thermal denaturation of the lubricating layer at elevated temperatures. It is found that the LISS can repel low surface tension liquids even at high temperature. However, two major modes of thermal are deciphered. One is due to thermal oxidation and another is due to gradual deposition of soot particles on the lubricating layer when exposed to repeated heating and cooling cycles. While the samples that have undergone oxidative reduction are not restorable, the samples that had lost slipperiness due to repeated exposure to high temperatures are shown to be restored by replenishing the silicone oil layer. In *chapter 4,* drop impact on LISS is investigated. The overall equilibration time for the droplet post impingement is shown to be critically dependent on the lubricating oil layer. The consequent dynamical events are shown to behave like an underdamped oscillator, with a dissipation characteristic that follows from the counteracting contributions of the droplet phase and lubricant phase on the contact line as well as the rheological phenomena. In *chapter 5,* a liquid infused slippery interface on cellulose filter paper is fabricated and standardized. The filter paper is first functionalized with a silane monolayer coating, and subsequently infused with silicone oil. These interfaces are then successfully tested for durability under water as well as resistance to ice-formation and removal cycles. The paper strips, thus fabricated, are thus premised to serve as a readymade platform for various fundamental phenomena and be disposed of without leaving any impact on the environment. The results are also imperative in advancing self-propelled dynamics of soft biological moieties in the paradigm of paper based microfluidics and medical diagnostics.

Keywords: *Liquid Infused Slippery Surfaces, Biomimetics, Surface Engineering, Wettability, Wettability Alteration, Hydrophobization, Silanization, Contact Angle Hysteresis, Sliding Angle, Droplet motion, Drop Impingement, Cellulose Paper, Soft Lithography, Thermal Degradation.*