INDIAN INSTITUTE OF TECHNOLOGY GUWAHATI
SHORT ABSTRACT OF THESIS

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Thesis Title: **Chemically Reactive Polymeric Dip/Spray-Coatings for Developing Durable and Functional Bio-inspired Interfaces**

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SHORT ABSTRACT

Over the last few years, both the lotus leaf-inspired superhydrophobic surface and Nepenthe's pitcher plant-inspired slippery liquid-infused porous surfaces (SLIPS) have been emerged as a prospective avenue to design different functional materials that are useful for various relevant applications—including remediation of oil-spillages, self-cleaning, anti-biofouling, anti-corrosion, water harvesting, etc. In the past, various approaches were introduced for developing smart interfaces embedded with desired bio-inspired wettability; however, the lack of a simple and scalable fabrication process and the poor durability of the reported bio-inspired interfaces appeared as major obstacles in their practical applications. In my thesis, I have introduced simple and scalable fabrication methods (dip coating and spray coating) for preparing an abrasion tolerant superhydrophobic and a chemically reactive SLIPS through the strategic use of a porous and chemically reactive coating, which is derived following the 1,4-conjugate addition reaction. While a stable dispersion of chemically reactive polymeric nanocomplex (CRPNC) allowed achieving chemically reactive coating on large and porous objects, the accelerated growth of the same CRPNC provided a facile basis for developing a substrate independent, porous, thick, and chemically reactive coating. Abrasion tolerant, and chemically reactive coatings were successfully prepared and further extended for developing durable and functional bio-inspired coatings for remediation of oil spillage, self-cleaning and efficient water harvesting. The thesis entitled **"Chemically Reactive Polymeric Dip/Spray-Coatings for Developing Durable and Functional Bio-inspired Interfaces"** has been presented with six chapters. ***Chapter 1*** introduced the fundamentals of lotus leaf and nepenthes pitcher plant-inspired liquid wettability.

A brief overview of the different synthesis processes has been included. The examples of existing synthetic methodologies and the practical limitations of such techniques are discussed in chapter 1. ***Chapter 2*** introduced a simple dilution process to stabilize such CRPNC in ethanol. Simple and single dip-coating of a commercially available and highly deformable spongy substrate, i.e., melamine sponge (MS) in the ethanolic solution of CRPNC allowed to develop a chemically reactive polymeric coating on the MS. Further, the post-covalent modification of the chemically reactive coating with octadecylamine yielded the superhydrophobic sponge with a water contact angle of 159°. The highly deformable and robust superhydrophobic MS selectively absorbed oil/oily phase with the capacity of 70 gg^{-1}, was extended for separating oil-spillages from an aqueous phase. ***Chapter 3*** accounted for a simple spray deposition of CPRNC for preparing a thick (254 ± 10 μm), porous, and chemically reactive polymeric coating on various substrates. A simple alteration of the reaction medium (from ethanol to pentanol) for the same reactant composition of BPEI/5Acl accelerated the sol-gel transition. A rapidly growing and turbid solution of CRPNC in pentanol was spray deposited onto a glass substrate to yield a thick, three-dimensionally (3D) chemically reactive and porous polymeric coating—which was found to be inherently hydrophilic. However, the appropriate post covalent modification through 1,4-conjugate addition reaction allowed to tailor the fraction of contact area between the beaded water droplet and the porous polymeric coating. In ***chapter 4,*** the same hydrophilic and chemically reactive porous coating that was loaded with residual acrylate groups as described in chapter 3 was directly lubricated with silicone oil; and the post covalent modification of the polymeric coating was not incurred. Interestingly, the hydrophilic and chemically reactive porous coating displayed the slippery property, where the beaded water droplet (WCA of 83.7°) slipped away on the tilted (2.1°) interface. The residual acrylate groups in the chemically reactive coating played a crucial role in achieving essential chemical compatibility to attain the slippery property. Further, such a slippery interface remained chemically reactive towards amine-containing small molecules. In ***chapter 5,*** this dual chemically reactive polymeric coating was strategically utilized to achieve different types of bio-inspired liquid wettability. Further, the water harvesting performance of all the interfaces was examined under the identical experimental conditions. An array of hydrophilic spots on a physically confined hydrophilic-SLIPS yielded the most efficient water harvesting SLIPS with an unprecedented efficiency of 4400 ± 190 mg cm^{-2} h^{-1}. Finally, in ***chapter 6,*** the summary of my thesis work has been described, and the prospects of the current design have also been accounted.