INDIAN INSTITUTE OF TECHNOLOGY GUWAHATI
SHORT ABSTRACT OF THESIS

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SHORT ABSTRACT

In the past, lotus leaf-inspired superhydrophobicity and fish-scale-inspired underwater superoleophobicity were successfully extended for developing various functional materials. A number of top-down and bottom-up approaches have been introduced to fabricate the artificial bio-inspired superwetting interfaces. However, reports of durable and bio-inspired wettabilities that can perform in practically relevant severe settings are rare in the literature. Designing of bio-inspired interfaces that can sustain physical deformations and abrasions are highly challenging. In the last decades, two dimensional and flexible nano-sheets (e.g. graphene and graphene oxide etc.) have been utilized to tailor/improve the mechanical property in various materials. In this synopsis report, I have introduced approaches to covalently integrated amino graphene oxide (AGO) and chemically reactive nanocomplex (CRNC) to achieve physically deformable and abrasion tolerant superhydrophobicity and underwater superoleophobicity, where a facile and catalyst-free 1,4-conjugate addition reaction between the amine and acrylate groups played an important role. The entire synopsis report entitled "**Graphene Oxide-Based Functional Interfaces that Embedded with Tolerant Super-Liquids (Oil/Water)-Wettability**" is divided into six chapters. The ***Chapter 1***, includes a) the introduction to the fundamentals of both the lotus leaf and fish-scale inspired liquid wettabilities and b) a brief discussion on durability related challenges of conventional artificial anti wetting interfaces. The bio-inspired interfaces that sustained diverse and various practically relevant exposures are highly important for prospective and outdoor applications. In the past, some complex and tedious approaches had been introduced to heal the damaged topography and chemistry on application of appropriate stimuli. However, the healing of compromised topography in the damaged bio-inspired interfaces—without external intervention is rare in the literature. All these important aspects are illustrated in Chapter 1. The ***Chapter 2,*** introduces the design of a highly flexible and compressible superhydrophobic monolith through strategic use of two distinct nanomaterials—a) reduced amino graphene oxide (AGO) and b) chemically reactive nano-complexes that were derived from branched polyethylenimine (BPEI) and dipentaerythritol penta-acrylate (5Acl). The appropriately selected reaction mixture provided chemically reactive and compressible polymeric materials. Further, the post covalent modification of the material with decylamine through 1,4 conjugate addition reaction yielded a highly tolerant superhydrophobic interface that remained efficient to withstand various kinds of physical insults (sand drop test, adhesive tape peeling test, knife scratching test, sand paper abrasion test), prolong chemical exposure (pH 1, pH 12, contaminated river water and artificial seawater) and various physical manipulations (bending, creasing, rolling and twisting) without compromising its super water repellence. Furthermore, this approach was extended to develop a self-healable and abrasion tolerant superhydrophobic coating on planar substrates. On application of high (188 kPa) external pressure, the polymeric coating flattened the non-adhesive superhydrophobic interface and became highly adhesive superhydrophobic. However, the physically crushed interface remained efficient to self-restore both the physical damage and water wettability without demanding any external stimuli. The content of AGO in the polymeric coating played an important role in controlling the rate of recovery process. This self-healing ability was further successfully extended for the selective immobilization of hydrophilic molecules on the superhydrophobic interface—directly from water medium. The same principle used to demonstrate rewritable pattern. ***Chapter 3,*** accounts for highly stretchable and durable superhydrophobic and underwater superoleophobic interfaces. The layer-by-layer deposition of AGO and CRNC provided a chemically reactive multilayer coating that loaded with residual acrylate groups. The appropriate post covalent modifications of this single multilayer coating allowed to achieve two distinct and durable bio-inspired interfaces. The synthesized bio-inspired interfaces remained efficient to tolerate large and repetitive tensile deformations—even after incurring severe physical deformation. Next, in ***Chapter 4***, the same multilayer coatings of AGO/CRNC were extended to fibrous substrate for developing abrasion-tolerant and selective oil or water (underwater superoleophobic) filtrating membranes. The integration of superhydrophobic and underwater superoleophobic coatings onto the fibrous substrate provided a facile basis for achieving gravity-driven selective filtration of oil and water phase respectively. Furthermore, the synthesized bio-inspired membranes were successfully applied for simultaneous collection of selectively separated oil and water phases from the oil-water mixtures under various practically relevant harsh conditions. However, such membranes are inappropriate to separate oil/water emulsions. In ***Chapter 5,*** I developed magnetically active and chemically reactive two-dimensional (2D) nanomaterials, where the reduced amino graphene oxide sheets were decorated with both magnetic Fe_3O_4 nanoparticles and CRNC. The post covalent modification of such chemically reactive material with octadecylamine allowed to achieve a magnetically active and superhydrophobic 2D nanomaterial for separating both 'oil-in-water' and 'water-in-oil' emulsion under practically relevant challenging conditions. In the ***Chapter 6***, I have introduced a distinct and unique approach to associate different oil-wttability with superhydrophobicity. A reaction mixture of small molecules and its strategic dilution prior to achieve three different superhydrophobicity that separately associated with superoleophilicity, oleophobicity and superoleophobicity. In ***Chapter 7***, a brief overview of the thesis work has been presented and the possible future applications of graphene-based super wetting interfaces have been proposed.