Reliability Study of Hydrophobic Films for Superhydrophobic Applications

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Abstract:

Hydrophobic coatings are highly water repellent and have successfully been used in many industrial and technological fields including microelectronics, adhesion, biomaterials, and composites. The desired hydrophobic surface properties are typically obtained by coating a substrate with fluorine based polymer or self-assembled monolayers (SAMs) of perfluorinated hydrocarbons.

In the last decade researchers have focussed much attention on hydrophobic coatings for microfluidic applications. However, in spite of all the research, very few products were launched using water repellent surfaces. This is mainly due to the aging of these hydrophobic surfaces, which are generally fragile. Consequently, their use in devices requiring both chemical stability and mechanical strength, such as e.g. microchannels has been limited. Since these coatings are used in applications where they are subjected to harsh chemical environments the hydrophobic coatings have to survive long-term exposure to water. In most cases, it remains a challenge to build a strong hydrophobic surface, which is able to resist the different environmental conditions that they are exposed to.

The long term stability of any coating is crucial to its practical application. However, the robustness of the coatings is controlled by its processing methods, conditions, and their molecular structure. Upon immersion in water, the coatings are seen to lose their hydrophobicity with time. There are two possible failure mechanisms that could occur in these coatings a) the delamination of the films b) degradation of the surface/bulk properties of the coating.

The main goals of the work that is reported here are;

- To realise a coating that doesn't degrade when subjected to a variety of aging conditions
- To understand why these coatings fail under the influence of water
- To investigate the formation of hydrophobic coatings using three deposition techniques:
    - Plasma Polymerised Fluorocarbons (FC),
    - Self-Assembled Monolayer (SAM) and
    - SuperCritical Fluid (SCF) deposition of monolayers
- To identify the optimum deposition technique, processing conditions and treatment method.
- To assess the reliability of the range of coatings produced by the three deposition techniques,
- To develop an understanding of and explanation for, the possible failure mechanisms of the coatings using physical and chemical characterisation tools
- To apply the optimised coating on a micro-pillar surface to compare its stability.