

BIOMIMICKING HYDROPHOBICITY USING MICROSCALE STRUCTURES FOR BIOMEDICAL APPLICATIONS

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ABSTRACT

Hydrophobic surfaces provide special characteristics for biomedical applications ranging from tunable protein adsorption, cellular interactions, and hemocompatibility to antibacterial coatings. In this research, we biomimic the hair-like micro-whisker structures of magnolia leaf using a synthetic polymeric formulation. Optical and scanning electron microscopy images revealed the presence of micro-whiskers resulting in higher water contact angles. The top layer of the magnolia leaf had a contact angle of 50º as compared to the hydrophobic bottom layer at 98º. A synthetic polymeric formulation was coated on different materials to study its effect on hydrophobicity. The coating was replicated (n=3) on each of the materials used such as glass, polymer, fabric, wood, and stainless steel. A surface tensiometer was used to measure the transition from hydrophilic to hydrophobic interactions between water and the substrate materials. Contact angle measurements revealed an increase in hydrophobicity for all the materials from their original uncoated surface. Glass displayed the highest increase in contact angle from 37º to 90º. Phase analysis of the coated region was performed to characterize the surface exposure of glass substrate to the synthetic polymeric formulation. An increase in the coated region showed a significant increase in contact angle from 50º to 95º. This research lays the foundation to develop and understand hydrophobic coatings for several biomedical applications including non-fouling implant surfaces, lab-on-chip devices, and other diagnostic tools.

Keywords: Biomimicry, Hydrophobicity, Biomedical Applications, Nanotechnology, synthetic polymer, FTIR spectroscopy, micro-whiskers, Scanning Electron Microscopy (SEM)

INTRODUCTION

Hydrophobic surfaces serve a crucial role in the biomedical field, creating pathways for drug delivery and substrates for bacterial growth [1]. Nature possesses water-repelling surfaces on plants such as magnolia tree leaves, lotus leaves, and insect (cicada) wings [2], [3], [4]. Microscopic hair-like structures and a waxy coating on several plant leaves and structures seem to be responsible for the hydrophobic property. Magnolia leaves often use hydrophobicity as a self-cleaning mechanism [5]. Likewise, hydrophobic surfaces can be re-purposed for the development of self-cleaning photovoltaic cells [6], and more importantly, diagnostic, and surgical tools [7]. In particular, hydrophobic tools have been used to protect surgical instruments from fluid contamination [8]. Improvements in the level of hydrophobicity and the creation of superhydrophobic surfaces can aid in minimizing contamination in surgical settings [9]. Further, prior research has implemented hydrophobic surfaces to limit bacterial growth on implants such as knee or hip implants [10]. Other applications of hydrophobic surfaces include creating scaffolding surfaces for patterned cell growth and controlling drug delivery [11], [12], [13]. Hydrophobic surface

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