Biomimetic, Micro-Structured and Hydrophobic Surfaces for Blood-Repellent Medical Devices

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Blood clots compromise the efficacy of blood-contacting medical implants as well as the health of the patients whose lives they sustain. Commonly used antithrombotic drugs or coatings can cause severe bleeding and wear off over time. Without the use of drugs, hydrophobic surfaces exhibit blood-repellence. In this work, micro-structured biological surfaces are mimicked and investigated to provide sufficient hydrophobicity for reducing blood clots in implanted biomedical devices. Butterfly, beetle, and cicada wings, as well as the lotus-like Nasturtium leaf, were first imprinted into a negative mold using polydimethylsiloxane elastomer. Then positive surface replications were made of Carnauba Wax and SU-8 epoxy-based photoresist. Evaluations of water and blood repellency were conducted by contact angle and sliding angle tests over 5 trials. For all material types, the trichome-covered, ground-facing side of the leaf showed the greatest static hydrophobicity, with some trials measuring a contact angle greater than 150°, classified as super-hydrophobic. The SU-8 imprints were the most accurate leaf replications, exhibiting around 100% of the original contact angle. The results were compared to a commercial hydrophobic coating, which not only performed over 30% worse, but is not biocompatible. This study succeeded in replicating the hydrophobicity of natural surface structures, showing promise for blood-repellent materials inhibiting thrombus formation. Future research should utilize more advanced materials and replication methods to achieve super-hydrophobicity that can be tested against the surface adhesion of real blood. These findings pave the way for bioinspired, micro/nanostructured surfaces to make a life-saving impact in the medical field.