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Fabrication of Hierarchical Nanostructures Using Vacuum Cluster System

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In this study, we fabricate a superhydrophobic surface made of hierarchical nanostructures that combine wax crystalline structure with moth-eye structure using vacuum cluster system and measure their hydrophobicity and durability. Since the lotus effect was found, much work has been done on studying self-cleaning surface for decades. The surface of lotus leaf consists of multi-level layers of micro scale papillose epidermal cells and epicuticular wax crystalloids [1].

This hierarchical structure has superhydrophobic property because the sufficiently rough surface allows air pockets to form easily below the liquid, the so-called Cassie state, so that the relatively small area of water/solid interface makes the energetic cost associated with corresponding water/air interfaces smaller than the energy gained [2]. Various nanostructures have been reported for fabricating the self-cleaning surface but in general, they have the problem of low durability. More than two nanostructures on a surface can be integrated together to increase hydrophobicity and durability of the surface as in the lotus leaf [3,5].

As one of the bio-inspired nanostructures, we introduce a hierarchical nanostructure fabricated with a high vacuum cluster system. A hierarchical nanostructure is a combination of moth-eye structure with an average pitch of 300 nm and height of 700 nm, and the wax crystalline structure with an average width and height of 200 nm. The moth-eye structure is fabricated with deep reactive ion etching (DRIE) process. SiO_2 layer is initially deposited on a glass substrate using PECVD in the cluster system. Then, Au seed layer is deposited for a few second using DC sputtering process to provide stochastic mask for etching the underlying SiO_2 layer with ICP-RIE so that moth-eye structure can be fabricated. Additionally, n-hexatriacontane paraffin wax ($C_{36}H_{74}$) is deposited on the moth-eye structure in a thermal evaporator and self-recrystallized at 40^{o}C for 4h [4]. All of steps are conducted utilizing vacuum cluster system to minimize the contamination. The water contact angles are measured by tensiometer. The morphology of the surface is characterized using SEM and AFM and the reflectance is measured by spectrophotometer.

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