Materials Today: Proceedings 41 (2021) 717–722

Contents lists available at ScienceDirect

Materials Today: Proceedings

journal homepage: www.elsevier.com/locate/matpr

Recent advances on regiocentric homo-epitaxial approaches in bio-mimetically derived artificial non-wettable surfaces

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ARTICLE INFO

Article history:
Received 9 May 2020
Accepted 17 May 2020
Available online 7 July 2020

Keywords:
Zinc oxide
Hydrophobic
Non-wettable
Water repellent
Thin-film
Coatings

ABSTRACT

Natural biosurfaces shows water repellence mainly because of its unique surface roughness and peculiar chemical compositions. Herein, we have mimicked the properties of the natural, non-wettable surfaces and created artificial water repellent surfaces using perpendicularly aligned zinc oxide (ZnO) nanostructured coatings having rough surface texture. These non-wettable surfaces were prepared through simple seed assisted hydrothermal methods. In the present method, a seed layer of nano regime zinc oxide was initially prepared on clean glass slides by coating and calcination methods. The as-synthesized seed layer was utilized for the hydrothermal growth of vertically oriented nanostructures. The structural and functional features of the resultant samples were studied using XRD, FTIR, UV-Vis. spectrophotometer and Contact angle analyzer. The homo-epitaxial growth and the crystallinity of ZnO nano particles were assessed using XRD. The structural studies were performed using FTIR and the optical transparency studies of the samples were carried out using UV–Vis. spectrophotometer. Along with the photographic image analyses, the water contact angle analyses were performed to predict the non-wettable character of the resultant coatings. At low nutrient solution concentrations (10 mM) and at low seed solution concentrations (1–10 mM), hydrophobic nanomaterials surfaces with high water contact angle, >130°, were successfully prepared through the present hydrothermal methods that extends many practical applications in biomedical, defense and industrial sectors.

Selection and peer-review under responsibility of the scientific committee of the International Conference on Energy and Environment.

1. Introduction

Hydrophobic, non-wettable surfaces have aroused worldwide attention among the scientific community over the last few decades and it geared up since the beginning of the 21st century due to the early developments in the sophisticated surface analysis tools in nanoscience. Even though, the Lotus leaves were referred as the symbol of purity in Asian religions, the mechanism that left behind the rolling of water droplets on these biosurfaces, were unknown to the common man for quite a lot time. But, later, the self-cleaning the self-cleaning property of the natural biosurfaces were successfully described by scientists with the help of modern characterization tools in materials science [1]. Researchers recently identified that the surface of the lotus leaves are microscopically rough, even though it seems macroscopically smooth. The unique combination of surface roughness and the material composition produces a non-wettable state on the leaves [2]. Building from these ideas and experiences, biologically inspired design adaptation and derivation from nature gave rise to a new branch in nanotechnology, called 'biomimetics' [3,4]. Researchers have proved that, by having a detailed investigation on special wettability, water repellence and controlled adhesion, one can biomimetic the surface of lotus leaves and can produce non-wettable surfaces [5,6]. The properties of these surfaces are attractive for many commercial and biological applications such as anti-biofouling paints, anti-snow sticking surfaces, anti sticking antennas and windows, self-cleaning wind shields for automobiles, microfluidics, textiles, lab-on-a chip devices, metal refining, stain resistant textiles, anti-soiling architectural coatings, dust free coatings, thin film technology, photocatalysis and antibacterial applications [7–17].

Nanostructures with well designed architectures can provide unique interface/surface properties, such as hydrophobic or non-wettable character. It has been recently reported that hierarchically oriented nanostructured metal oxide surfaces can exhibit superior water repellent properties [18–19]. Currently, the

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https://doi.org/10.1016/j.matpr.2020.05.771
2214-7853/
Selection and peer-review under responsibility of the scientific committee of the International Conference on Energy and Environment.