Digest Journal of Nanomaterials and Biostructures Vol. 11, No. 4, October-December 2016, p. 1029-1033

HIGH PERFORMANCE SUPERHYDROPHOBIC THIN FILMS BASED ON ARRAY TYPE OF NANOSTRUCTURED 3D FLOWER-LIKE ZINC OXIDE

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This paper reports that the high performance superhydrophobic thin films are fabricated by spraying 3D ZnO nanoparticles and polyester mixtures on host materials. The superhydrophobic thin films can achieve the better hydrophobic effect by spraying the 3D flower-like zinc oxide to the array arrangement , exhibit self-cleaning properties with a water contact angle of 153^o and a sliding angle of 2^o, and show the good corrosion resistance and the high adhesive force. The superhydrophobic films are widely used in the outer membrane, building, textile, clothing and so on.

(Received July 19, 2016; Accepted October 3, 2016)

Keywords: Superhydrophobic thin film; Flower-like ZnO; High adhesive force.

1. Introduction

Superhydrophobic characteristics are of great importance in various fields, such as the self-cleaning power of cars, buildings and clothings. Many type of advanced superhydrophobic surfaces have been developed. Recently, flexible superhydrophobic films have received significant attention, owing to its better potential for applications and advantages than rigid substrates. We have fabricated high performance flexible superhydrophobic films based on 3D flower-like zinc oxide on polyimide or polyester substrates. Various superhydrophobic films have shown excellent potential and comparable performance compared with those on rigid substrate.

3D flower-like zinc oxide has several advantages over other nanostructured ZnO materials because of the spatial distribution of the legs of the polypody . One of the advantages of the polypody is that it gets automatically oriented on the substrate with one of its arms directed normal to the substrate surface. In addition, 3D flower-like zinc oxide is arranged array so as to obtain better hydrophobic property, A variety of polyester mixed solution as binder and stronger adhesion performance. In sum, it shows great flexibity and reliability for commercial applications.

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2. Experimental

2.1 The array type of nanostructured 3D flower-like zinc oxide preparation

The micro/nano ZnO particles were prepared by hydrothermal synthesis method, and the specific process were as follows. Initially, 2mmol zinc acetate dihydrate and 0.12g polyvinylpyrrolidone were added together to the polytetrafiuoroethylene equipment liner(PTFE). Moreover, 5ml H2O2 and 20ml NaOH were added sequentially wherein. Eventually, 71ml deiorized water were added into PTFE. Then they would be placed into the constant temperature oven with 140^{o}C for 4 hours until the hydrothermal synthcsis reactor was compeletely sealed. After that, the reator should be cooled to room temperature. In order to remove the residue and get the pure product 3D flower-like zinc oxide, the surface of the particles needed to be repeatedly washed with deionized water and ethanol.

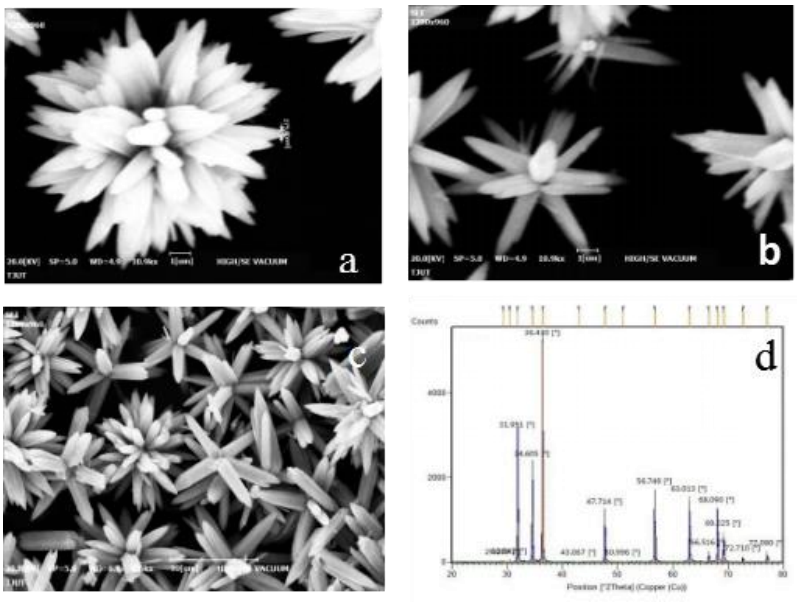

Fig. 1. Scanning electron microscope (SEM) images of (a)(b)single flower-like zinc oxide[3] and (c)3-D network/array of interconnected flower-like zinc oxide [4] and (d) X-ray diffraction (XRD) of ZnO.

2.2 Fabricate superhydrophobic films

The high performance superhydrophobic ZnO particles were synthesized by stearic acid modification. In order to obtain superhydrophobized zinc oxide(Fig.2), the ZnO nanoparticles and stearic acid should be added in 2:3 ratio and stirred magnetically with ethanol for 2 hours ..

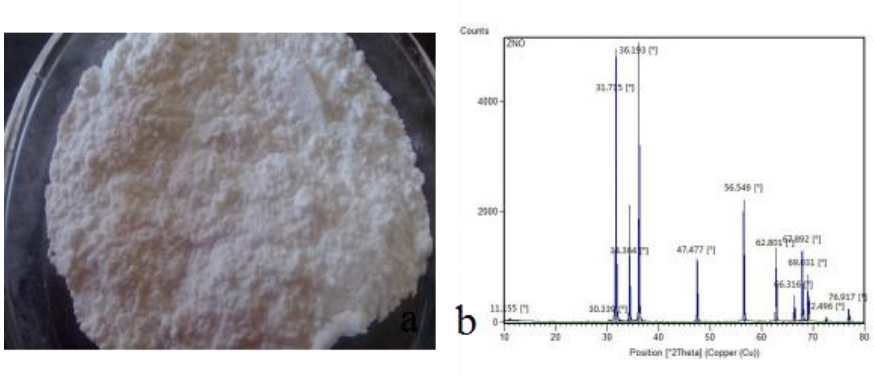

Fig..2. The images of (a) white zinc oxide power and
(b) X-ray diffraction(XRD) of modifized 3D ZnO.

2.3 Superhydrophobic thin films based on array type of nanostructured 3D flower-like zinc oxide

The array of 3D ZnO nanotetrapods were synthesized via a simple spraying method: the superhydrophobic capability of 3D flower-like zinc oxide and homemade sol various alcohols were mixed (5%:1) and stirred magnetically for at least 1h to gain a homogeneous suspension. The suspension was then sprayed onto the PI with 0.2MPa compressed air gas by a spray gun. Finally, the ZnO-PI nanocomposite coating was dried at ambient temperature for 1h. In this way, the superhydrophobic thin films based on array type of nanostructured 3D flower-like zinc oxide were prepared completely.

3. Results and discussion

In this report, we selected 3D flower-like zinc oxides for the fabrication of superhydrophobic surface, as this material is inexpensive and simplely prepared and stearing acid modifized zinc oxide shows remarkable superhydrophobicity. The mixed solution of polyurethane waterproof paint and ethyl acetate were added in order to increase the adhesive force between the ZnO NPs and substrate. Fig.2 the contact angle and roll angle measuring instrument images of the original PI polyester film(PI film) and the one coated with 3D flower-like zinc oxides.

As shown in Fig.3(a and b), the contrast between the ordinary surface and the modified surface, we can seen that either water(a) or mixed aqueous solution on the surface such as ink(b), after modification of hydrophobic material surface has obvious hydrophobic effect.The imagine of Fig.3c shown that the effect of hydrophobic material spraying on yarn net. In addition,the film adhesion test of superhydrophobic image of Fig.3d reveals that according to ISO standard grade, the level of the hydrophobic film for 4B.

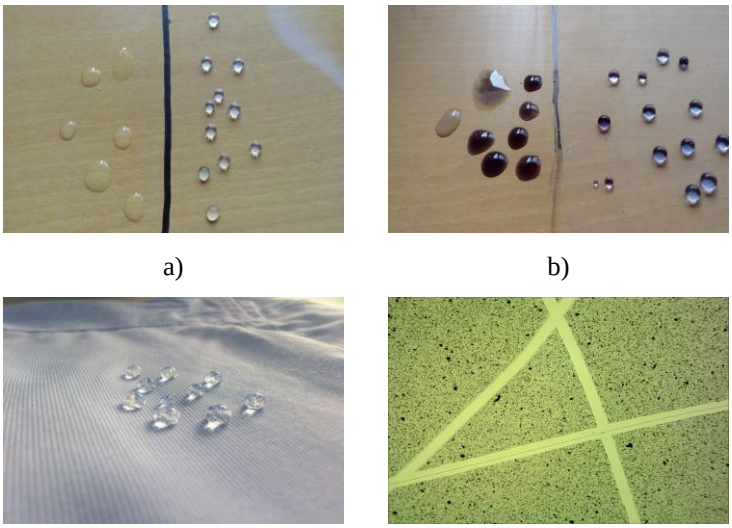

Fig..2. The images of (a)(b)(c) hydrophobic effect and the adhesion test.

4. Conclusion

In summary, an optimized 3D ZnO-coated PI film was prepared by simple method. Superhydrophobic film has excellent self-cleaning action, super liquidity and adhesion power. Owing to the super liquidity and high adhesion power, superhydrophobic films could be applied in various fields more for a long time, such as building facades and glass, bathroom glass, automotive and other fields. We believe that a large number of superhydrophobic film will be market-oriented in the near future.

Acknowledgement

This work has been supported by The Recruitment Program of Global Experts and Advanced Materials and Printed Electronics Center.

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