Nanostructured surfaces

Water Droplet Spreading Behavior for ZnO columnar Films

C. W. Su[1], P. W. Chi[1], B. H. Jhuo[1], Y. D. Yao[2] and D. H. Wei[1]

1 Institute of Manufacturing Technology and Department of Mechanical Engineering, National Taipei University of Technology (TAIPEI TECH), Taipei 106, Taiwan
2 Institute of physics, Academia Sinica, Taipei 115, Taiwan
E-mail: D. H. Wei; dhwei@ntut.edu.tw

ZnO thin films with various grains size and density were deposited onto glass substrates at room temperature by radio-frequency (RF) magnetron sputtering under different sputtering powers. The microstructures and surface wettability of the ZnO thin films were investigated by scanning electron microscopy (SEM) and contact angle measurement. Recently, many reports [1] indicated that the surface wettability was affected by microstructure and surface morphology. As shown in SEM images of ZnO columnar films deposited under different sputtering powers, it can be seen that grain size of ZnO columnar films increased with increasing RF powers, this improvement could be attributed to ion bombardment of high Ar plasma energy that leading to the grain transformation. [2] The contact angle (CA) of ZnO columnar films deposited from 50, 100, to150 W is 71.3, 89.9, and 73.6 deg, respectively. The ZnO columnar films deposited at 100 W with the highest CA value is due to the aperture on ZnO columnar films surface provide an opportunity to form air pocket, therefore, when the water droplet on the surface with many air pockets, it is mostly in contact with air pockets rather than solid surface, thus leading to high contact angle. On the other hand, the ZnO columnar films deposited at 50 W and 100 W exhibited a poor water contact angle due to flat and rough surface, it is difficult to form air pockets on flat surface, and the air pockets are large that can't afford water droplet on the rough surface.[3] Fig. (e) and (f) show that the CA switching rate of the ZnO columnar film with rough and flat surface, both CA value obviously decreased with increasing the contact time. In several cases of the contact angle measurements, the water droplet gradually spread out after contacting ZnO films. At first, this phenomenon was observed unstable contact angle due to the attributed metastable liquid-air interface of ZnO films. When a water droplet contacted the films surface, it sank into the gaps and holes between the grains until stabilized. As the result, this research work demonstrates that the wettability of ZnO can be controlled by sputtering power, and it is a good choice for self-cleaning device.

1. *M. Laurenti, V. Cauda, R. Gazia, M. Fontana, V. F. Rivera, S. Bianco, G. Canavese* Wettability Control on ZnO Nanowires Driven by Seed Layer Properties // Eur. J. Inorg. Chem.-2013.-**2013.** -P. 2520-2527.
2. *Z. Y. Huang, M. Chen, S. R. Pan, D. H. Chen* Effect of surface microstructure and wettability on plasma protein adsorption to ZnO thin films prepared at different RF powers // Biomed. Mater.-2010.-**5.**-P. 054116
3. *H. C. Barshilia, K. R. S. Tej, L. M. Devi, K. S. Rajam* Nanometric multiscale rough Zn–ZnO superhydrophobic thin films: Self-diffusion of zinc and effect of UV irradiation // J. Appl. Phys.-2010.-**108**.-P. 074315

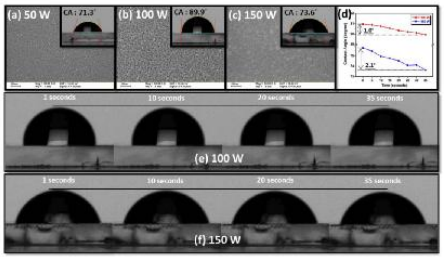

Fig. SEM images and photographs of water droplets are for different RF powers of (a) 50 W, (b) 100 W, and (c) 150 W. The change rate of water contact angle with different ZnO films are shown in (d). The water droplet spreading behavior for ZnO films is with different deposition powers of (e) 100 W and (f) 150 W, respectively.