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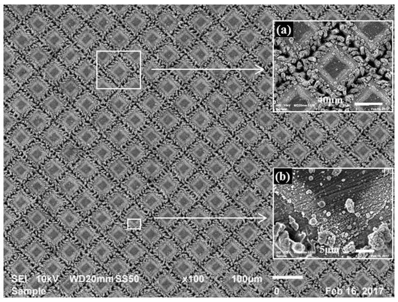
Realization of laser textured brass surface via temperature tuning for surface wettability transition

Huangping Yan[1], Mohamed Raiz B Abdul Rashid[2], Si Ying Khew[2], Fengping Li[3] and Minghui Hong[2]*

[1]School of Aerospace Engineering, Xiamen University, Xiamen 361005, China;
[2]Department of Electrical and Computer Engineering, National University of Singapore, 4 Engineering Drive 3, 117576, Singapore; [3]School of Mechanical and Electrical Engineering, Wenzhou University, Wenzhou 325035, China



SEM images of the laser textured brass surface.

Abstract: Superhydrophobic surfaces have attracted extensive interest and research into their fundamentals and potential applications, including self-cleaning, anti-icing, anti-corrosion, reduction of drag, oil/water separation, biomedical devices and microfluidic manipulation. Laser texturing provides a facile and promising method to make superhydrophobic metallic surfaces. However, immediately after laser texturing, the metallic surface becomes hydrophilic or superhydrophilic. It takes several weeks to months to achieve wettability transition from superhydrophilicity to superhydrophobicity under ambient conditions. This poses a barrier to mass production and industrial applications. Therefore, external stimuli have been applied to change the surface composition and/or the surface morphology to influence wettability transition. Among these methods, temperature tuning has attracted special attention due to its advantage of being a simple and controllable process.

A nanosecond pulsed fiber laser is employed to fabricate the micro/nanostructures on the as-prepared brass sample surfaces. The surface morphology of the laser textured samples is then characterized by a field-emission scanning electron microscope. A uniform distribution of periodic micro-scale grid patterns on the brass substrate can be clearly observed in Fig. 1, which is beneficial to uniform superhydrophobic properties in all directions with trapped air.

After the laser ablation, a post-processing by temperature tuning is carried out to investigate the influence of temperature on wettability behavior of the laser textured brass surfaces. After temperature tuning, the evolution from superhydrophilic to hydrophobic or superhydrophobic state of laser textured surfaces is evaluated by measuring static contact angle (CA) with a CA analyzer using the sessile drop technique. Time taken to reach the CA of 135 ° is 14, 18, 9, 9, 24, 17 and 17 days for temperature tuning at -16 ℃, 25 ℃, 100 ℃, 150 ℃, 200 ℃, 250 ℃ and 300 ℃, respectively. By low-temperature heating (100 ℃~150 ℃), partial deoxidation of the top CuO layer occurs faster, resulting in the formation of hydrophobic Cu_2O. It demonstrates that applying low-temperature heating could greatly speed up the rate of wettability transition of brass surfaces subjected to the laser texturing. After 100 ℃ temperature heating, the sample surface achieves superhydrophobicity with the CA of 150.2 ° after 18 days. Furthermore, for the laser textured brass surface after 100 ℃ temperature heating, a contacting experiment is carried out. The experimental results indicate the superhydrophobic performance of the laser textured surface and the low adhesive force between the droplet and the surface.

Keywords: wettability transition; temperature tuning; laser texturing; superhydrophobic surface; contact angle

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