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Wettability of laser micro-circle-dimpled SiC surfaces

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ABSTRACT

Surface wettability on laser micro-circle-dimpled SiC surfaces was discussed. The morphology on the substrate was measured by the white-light interfering 3D profile meter, and the chemical composition of the substrate was tested by the Energy Dispersive Spectrometer (EDS). Water contact angles measured on the dimpled SiC surfaces and the correlation between the dimple parameters and the contact angles were analyzed. The results show that the circle-dimpled texture enhances hydrophobicity of the SiC surfaces, and the diameter of the circle dimples has more obvious influence on the contact angles than other dimple parameters.

1. Introduction

Surface wettability plays an important role in fluid lubrication due to its influence on lubricant absorption at solid surfaces [1]. Laser processing method has been proved to be an effective method to improve surface wettability by texturing morphology on the substrates [2–5]. Recently, the published literature has reported that the protuberant morphology can enhance both the hydrophobicity and the hydrophilicity by controlling the surface morphology [6,7]. The wettability on the textured micro-square-convexes SiC surfaces can be hydrophobic and hydrophilic [8–11]. In addition, the surface wettability presents anisotropy on micro-grooved SiC surfaces [12–14].

The concave morphology such as circular dimples, as another typical surface texture, has been widely applied in surfaces to improve lubrication properties [15–17] and wettability [18–20]. Tseng et al. [18] found that the droplet could spread very fast and disappear in almost 0.1567 s on laser circle dimpled Si surface which showed a superhydrophilic phenomenon. Besides, Qin et al. [19] found that the contact angle of circle dimpled alloy surface was the most stable, sliding time of the friction pair reaching steady state stage was shortest and coefficient of friction was minimum among three regular layout shapes of dimples during the tribological tests. However, the surface presents hydrophobic by processing the micro-dimple arrays on a smectic liquid crystal material [20]. This means that the micro-dimpled surface can lead to different wettability on distinct materials, but it is still not clear on the SiC surface.

In this paper, wettability of laser micro-circle-dimpled SiC surfaces was studied. The micro-circle-dimpled SiC surfaces were prepared by fiber laser marking machine. The morphology of the textured surfaces was measured by the white-light interfering 3D profile meter, and the wettability on the textured surfaces has been discussed by the measurement of the contact angles.

2. Experiment

The schematic view of the textured surface is shown as Fig. 1. The diameter of the circle micro-dimple was set as value *d*, and the center distance between the two micro-dimples was defined as *c* and the depth of the pore as *h*. The marking velocity was 100 mm/s and the output power was 0.3 W with different marking numbers according to the depth value during the processing. Besides, the detailed information was listed in Table 1.

The specturms of the untextured and circle-dimpled surfaces measured by the Energy Dispersive Spectrometer (EDS) are shown in Fig. 2 since the chemical composition has obvious influence on the wettability [9,10,21]. The chemical composition has been changed accordingly after laser processing, especially the element O and B, increased from 1.32% to 2.17% and 3.02% to 4.1%, respectively.

In order to study the influence of the micro-dimple parameters on the wettability, diameter parameters were set as 50 μm, 100 μm, 150 μm. Similarly, the depths were set as 10 μm, 20 μm, 30 μm. The 3D profiles of the untextured surface and textured surfaces are measured by the white-light interfering 3D profile meter and the 3D profiles of surface R4, R5, R7 are presented in Fig. 3. The

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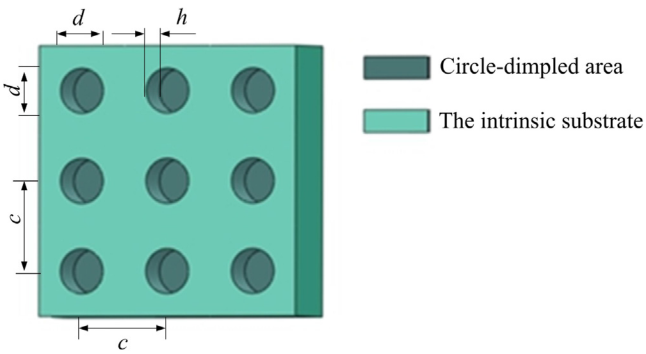

Fig. 1. The schematic view of the textured surface.

Table 1
Data of the laser micro-dimpled surfaces.

Type	d (μm)	c (μm)	h (μm)	p/d	Area ratio
R1	50	150	10	3	9.01
R2	50	200	10	4	4.91
R3	100	200	10	2	19.63
R4	150	200	10	1.33	44.18
R5	50	100	10	2	19.63
R6	150	300	10	2	19.63
R7	100	200	20	2	19.63
R8	100	200	30	2	19.63

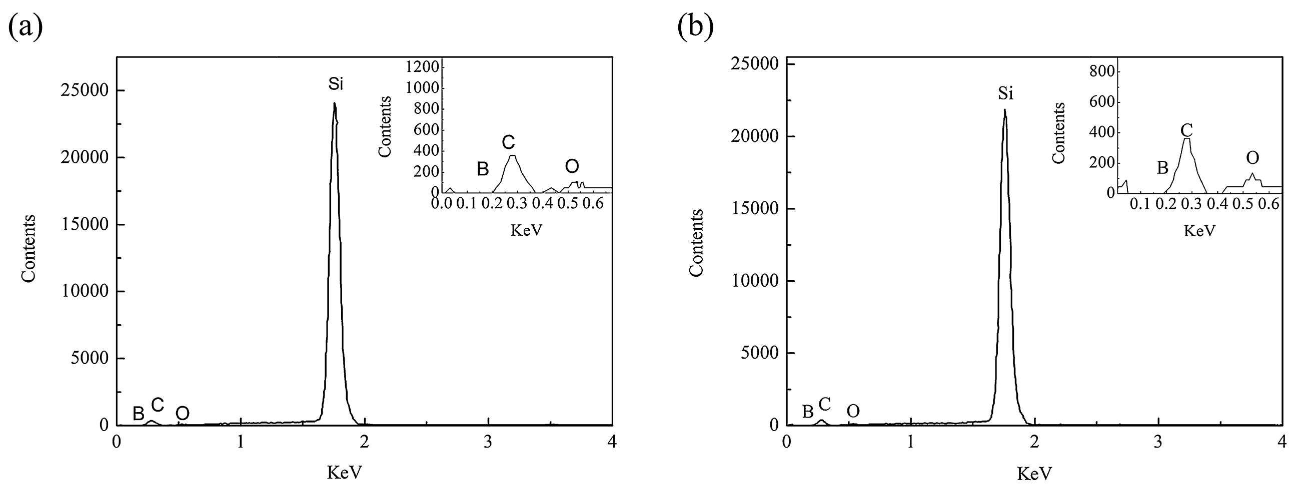

Fig. 2. The specturm of the SiC surfaces (a) untextured surface; (b) textured surface.

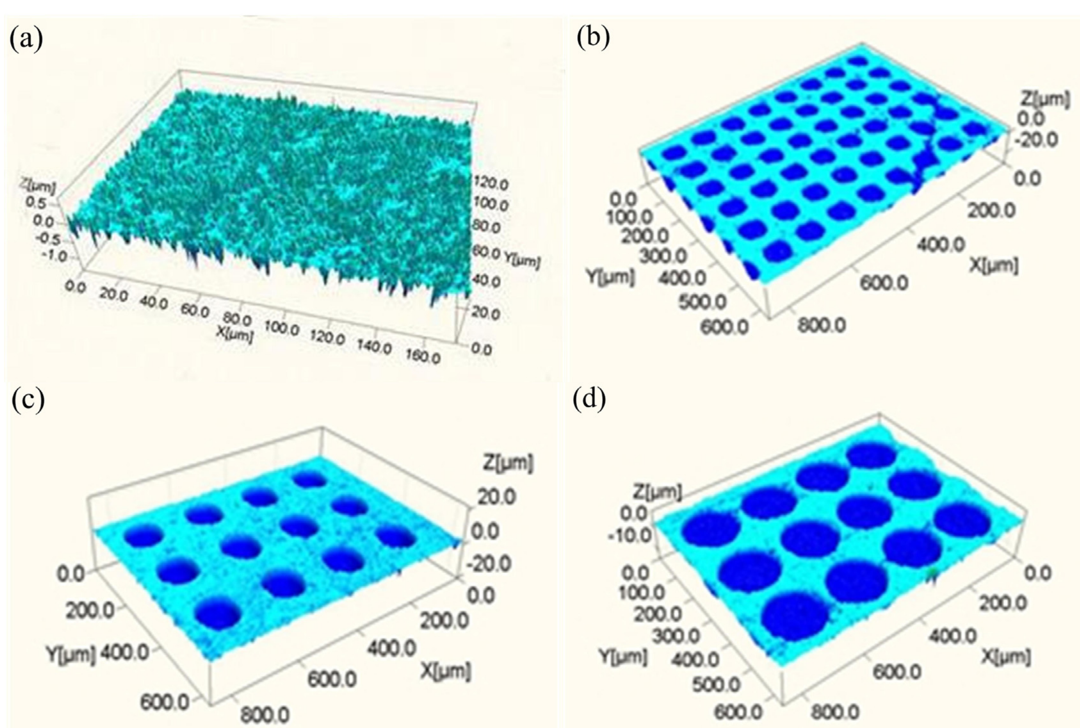

Fig. 3. The 3D profiles of different surfaces (a) untextured surface; (b) textured surface R5; (c) textured surface R7; (d) textured surface R4.