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Designing biomimetic superhydrophobic surfaces by femtosecond laser pulses and the effect of laser fluence

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Superhydrophobic surfaces are found extensively in nature as a wide variety of plants present superhydrophobic properties. These surfaces have attracted attention over the past years due to their wide range of potential industrial applications including the prevention of biofilm development, corrosion and even ice formation. In this study, femtosecond laser texturing of stainless steel 316L with no post chemical treatment was found to be efficient in rendering surfaces with contact angles as high as 135°. Contact angle hysteresis was also measured to study the anchorage of the droplet on the surface. Laser fluence was varied to study its influence on wetting.

Keywords: femtosecond laser, surface texturing, superhydrophobicity, hysteresis, biomimetics.

1. Introduction

Superhydrophobic surfaces are under growing interest especially when achieved with a femtosecond laser [1] which has the particularity of having such fast pulses that it has little, if not, effect on the material itself [2]. That makes this technique very interesting for applications in which a coating or any added chemical could be prohibited. Therefore, this study aims to develop superhydrophobic surfaces with no post chemical treatment, by texturing a reproducible geometry with a femtosecond laser.

2. Methods

Multi-scaled micrometric squares were textured on stainless steel 316L with a femtosecond laser (Figure 1). This design was inspired by *Euphorbia* leaves. Different fluences were used to study the effect of fluence on wetting, topography and more specifically the formation of multi-scaled structures. Using a 3D goniometer, contact angles (CA) and contact angle hysteresis (CAH) were measured.

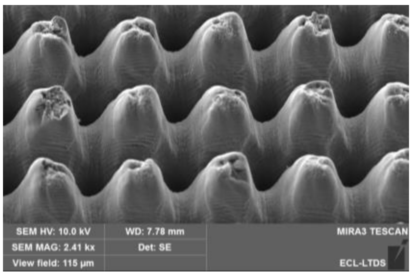

Figure 1: SEM image of the texture generated on stainless steel 316L by a femtosecond laser with SE detector using a voltage of 10.0 kV. Surface tilted by 35°.

3. Results and discussion

Texturing micrometric squares on stainless steel 316L was found to generate contact angles up to 135°. Figure 2 shows that, in the first few days after laser texturing, the surface exhibits hydrophilic properties but the CA increases sharply. The surface enters hydrophobic regime after 20 days and CA keeps increasing at a slower pace.

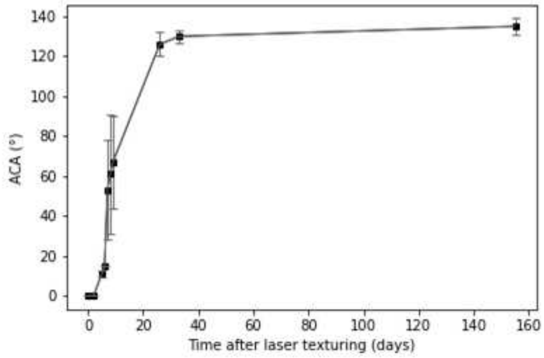

Figure 2: Average contact angle (ACA) measured after laser texturing of stainless steel 316L.

These surfaces were also exhibiting high contact angle hysteresis (Figure 3). This is typical of the rose petal effect. The smooth areas that can be seen on Figure 1 could explain this behavior. Laser surfacing might solve this problem by turning these surfaces into the well-known lotus effect, which is what is required to have a superhydrophobic surface. The results for this study are under progress.

Figure 3: Image of a water droplet on the stainless steel 316L surface presenting micrometric squares as a texture as shown in Figure 1. The surface is tilted by 90° in the direction of the arrow on the picture. For better visualization of the reader, the image in the red box represents how the surface is during the experiment.

4. References

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