CONTROL OF THE STAINLESS STEEL WETTABILITY VIA FEMTOSECOND LASER-INDUCED PERIODIC STRUCTURES AND DEPOSITION OF AMORPHOUS DIAMOND LIKE CARBON THIN FILMS

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Next generation digital flowmeter devices employ ultrasound methods for precise gauging of liquid flow. Stainless steel mirrors that reflect the ultrasound waves ensure corrosion resistance but the permanent contact with domestic water with a high mineral content leads to biofouling which inevitably changes the performance of such smart devices. Processing of solids near their ablation threshold by high intensity polarized laser irradiation may lead to the development of regular nanoscale structures known as Laser-induced Periodic Surface Structures (LIPSS). Applying LIPSS to a surface can lead to numerous applications of surface functionalization such as improved wetting performance [1] and anti-bacterial activity [2]. On top of that, it can be additionally controlled by employing hydrophobic amorphous diamond like carbon (DLC) films, which could also aid to preserve the laser induced nanostructures under constant water flow in the long term.

In this work, the fundamental harmonic (1030 nm) of a linearly polarized Yb:KGW femtosecond laser beam was scanned over the surface of a stainless steel mirror while varying the pulse energy and laser spot overlap. Amorphous DLC films were deposited on virgin and laser treated stainless steel surfaces by employing the direct ion beam synthesis from a hexamethyldisiloxane precursor. Wettability of the surfaces was evaluated using sessile drop method where 1 µl volume droplets of water were dispensed on the pristine and differently treated surfaces. Optical microscope images of the laser treated and later on DLC coated samples are depicted in Fig. 1.

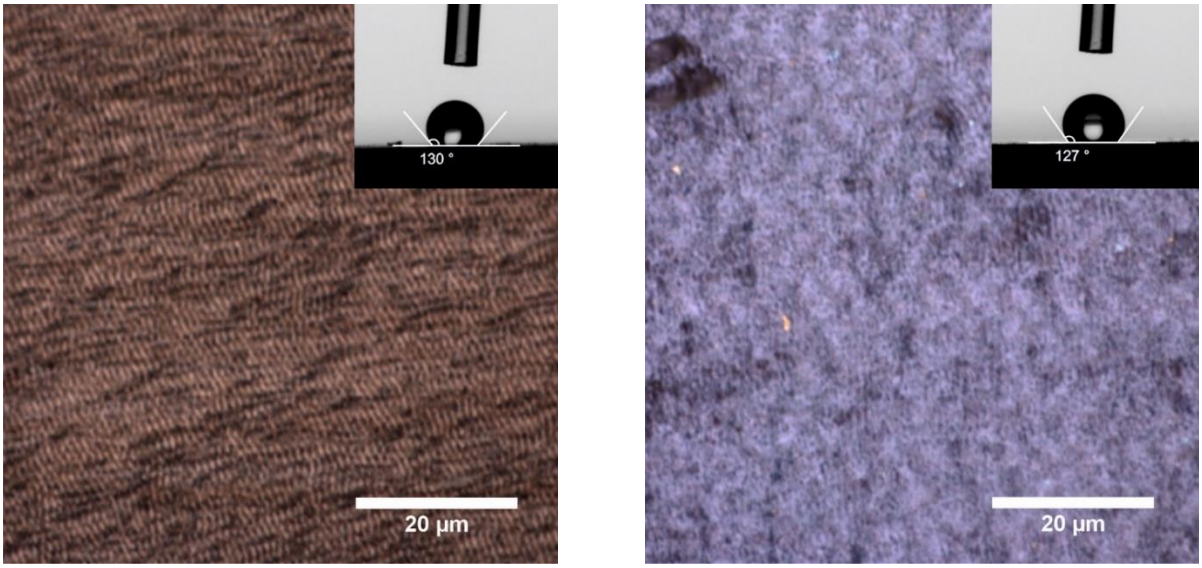

Fig. 1. Stainless steel surface micrographs after (a) laser treatment and (b) application of the DLC thin film. The inset depicts the water contact angles.

The laser treatment conditions that ensured a contact angle of 130° for deionized water close to the laser ablation threshold were obtained. Amorphous DLC films increased the water contact angle of pristine stainless steel surface by 40° while in the case of laser treated surface it remained constant. The anti-biofouling properties of treated surfaces were investigated in a custom-built setup that simulates tap water flow in a domestic system.

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