



Superamphiphobic Stainless Steel Surface Prepared by Femtosecond laser Texturing/Pulsed Plasma Polymerization

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Abstract

Superamphiphobic surfaces, being super-repellent either water or oil, show various applications in self-cleaning, antifouling, non-staining surfaces, spill-resistant, corrosion prevention, and liquid separation. By employing femtosecond laser texturing (FL) and pulsed plasma polymerization (P³), this study developed a dual-technique of surface modification to obtain superamphiphobic surfaces on the AISI 304 stainless steel substrates. Based on the surface observation results, a micro/nano complex structure was obtained on the stainless steel surface after FL process; moreover, P³ process can successfully deposited a low-surface-energy silicon oxide–fluorocarbon (SiO-CF) bilayer on such rough surface. The water and oil contact angle (WCA and OCA) for bare stainless steel were 65° and 18°, respectively. After dual-technique treatment, the WCA and OCA were 160° and 146°, respectively; namely, both hydrophobicity and oleophobicity were enhanced significantly. As a whole, the value-added superamphiphobic surface modification technique may have the potential in broadening application field on stainless steel.

Experimental

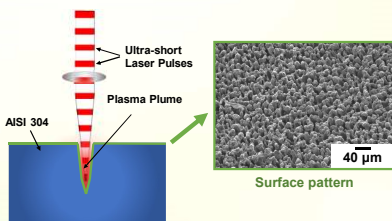


Fig. 1. Femtosecond laser texturing.

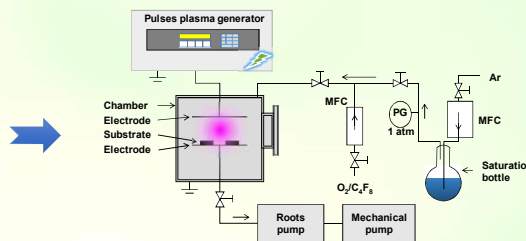


Fig. 2. Pulsed plasma polymerization system.

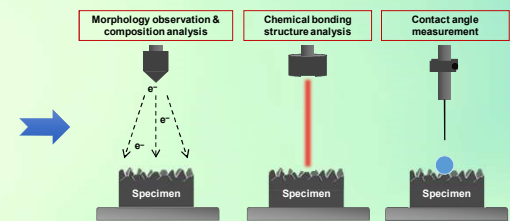


Fig. 3. Surface analysis.

Results & discussion

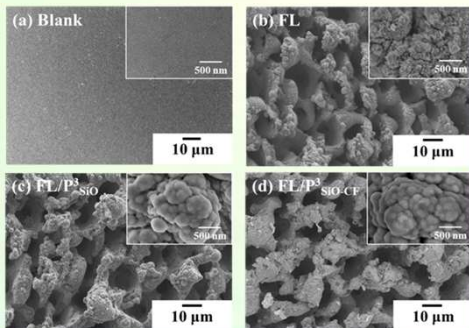


Fig. 4. Surface morphology of (a) blank stainless steel, and treated by (b) FL, (c) FL/P³_{SiO}, and (d) FL/P³_{SiO-CF} process.

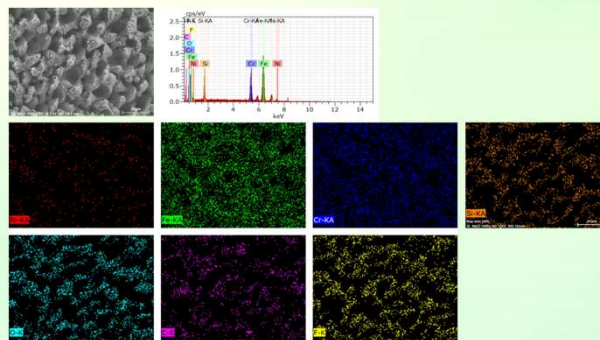


Fig. 5. Composition analysis of FL and P³_{SiO-CF} dual-technique treated stainless steel surface.

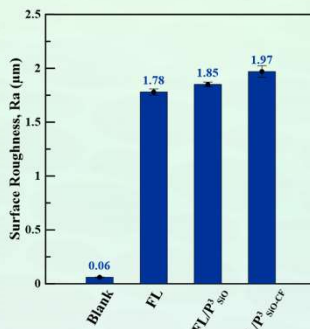


Fig. 7. Surface roughness of bare stainless steel, and treated by varied processes.

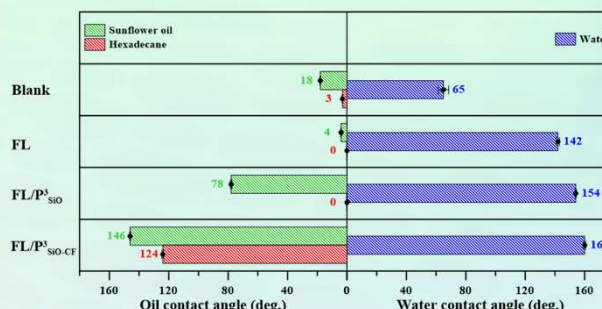


Fig. 8. WCA and OCA of bare stainless steel, and treated by varied processes.

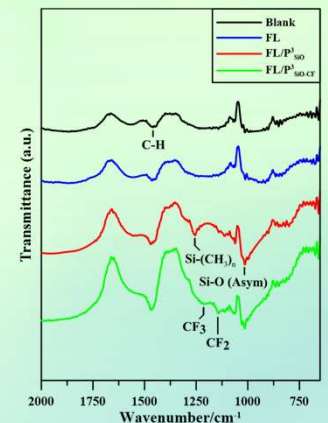


Fig. 6. FTIR spectra of stainless steel treated by (a) FL, (b) FL/P³_{SiO}, and (c) FL/P³_{SiO-CF} process.

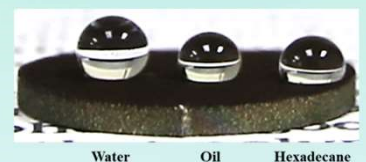


Fig. 9. Image of water, sunflower oil, and hexadecane droplets on FL and P³_{SiO-CF} dual-technique treated stainless steel surface.

Conclusions

- A superamphiphobic surface characteristics was successfully produced on stainless steel in this study. Such impressive result is ascribed to the synergistic effects of unique micro/nano complex structure prepared by FL process, and low-surface-energy in Si-CF bilayer deposited by P³ process.
- The value-added superamphiphobic surface modification technique on stainless steel may open a new era for various applications.