Graduate Student Research Seminar

Spring 2024

Study of Laser-induced Surface Wettability Variation on Stainless Steel

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3:00 pm (EST) – 132 Fluor Daniel Building

Abstract

Femtosecond lasers have emerged as a cutting-edge tool for manipulating surface wettability, a critical factor in industrial applications. Despite their vast potential, the stability of laser-induced wettability remains a challenge, particularly under varying storage/aging conditions. This study systematically investigates the dynamics of surface wettability variation on 304L stainless steel, a metallic material widely used in people's daily lives. (Super)hydrophilicity is initially achieved by fabricating surface structures at the micro-/nano-meter level with a femtosecond laser. Subsequent exposure of these laser-treated samples to different aging environments, specifically air and vacuum conditions, leads to a transition towards (super)hydrophobicity. This transformation is explored through an in-depth X-ray photoelectron spectroscopy (XPS) analysis. The results reveal that the adsorption of non-polar molecules from the external environment drives the shift from hydrophilicity to hydrophobicity. Furthermore, the study uncovers that the transition speed is significantly influenced by the created surface structures, suggesting a complex interplay mechanism between surface structures and surface chemistry. The findings from this work not only deepen the understanding of the mechanisms behind ultrafast laser-induced surface wettability but also provide valuable insights for the practical application of this technique. By elucidating the factors influencing the stability and transition of wettability states, this study offers a foundational guideline for optimizing femtosecond laser treatments in real-world applications, paving the way for enhanced performance and reliability in surface engineering.

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