Superhydrophobic surfaces of 316L austenitic stainless steel processed by femtosecond laser texturing

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Inspired by nature's superhydrophobic surfaces found in lotus leaves, rose petals, duck feathers, and butterfly wings, the development of artificial superhydrophobic surfaces has garnered significant attention due to their potential applications in self-cleaning, drag reduction, and corrosion protection. Among various fabrication methods, femtosecond laser treatment has emerged as a precise, controllable, and environmentally friendly approach for creating micro- and nanostructures and enhancing hydrophobic or hydrophilic properties. This study utilizes femtosecond laser (TruMicro 5070 Femto Edition) treatment on three types of 316L austenitic stainless steel, which are fabricated via conventional manufacturing (CM: hot rolling method), binder jet printing (BJP), and BJP followed by hot isostatic pressing (HIP), respectively. The femtosecond laser treatment was applied using alternating horizontal and vertical scanning patterns, with total scanning cycles of 200, 400, and 800. As a result, a micro-protrusion array structure covered with nanoparticles of varying depths was fabricated on the samples. Laser microscope measurements revealed that both roughness and depth increased linearly with the number of laser scanning times. Additionally, the contact angle of untreated samples was 105 degrees and increased to over 150 degrees through the femtosecond laser treatment, resulting in surfaces considered superhydrophobic. With the rapid and continuous development of bionic theory and technology, this superhydrophobic surface fabricated by femtosecond laser treatment is expected to provide a new and effective approach for metal corrosion protection.