Broadband Ultraviolet-to-Mid-Infrared Anti-Reflective Substrates Developed by Femtosecond Laser Ablation in Organic Solvents

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Abstract

Femtosecond (fs) laser ablation provides a powerful tool to develop functional substrates, among which anti-reflective substrates have been widely prepared and evaluated, especially in the ultraviolet (UV) to near-infrared (NIR) range. Literatures have shown that the minimum reflectance of the laser-ablated metallic Ti substrates can be lower than 0.29 %[1]. In comparison, the ablated substrates are seldom studied for their anti-reflective properties in the middle-infrared (MIR) range[2], which can be used for infrared imaging, sensors, thermoelectrics, stealth and artificial blackbody. To explore the possibility to enhance anti-reflection in MIR range by laser ablation and to quantitatively evaluate enhancement of anti-reflection, in this work, we performed fs laser ablation of ten metals including Fe, Mo, Ni, Ti, V, Cu, Nb, W, Ta and CuZn in acetone and tested their NIR-to-MIR anti-reflectance with wavelengths of 1.2 ~ 25 μm along with their anti-reflectance in UV-to-NIR range with wavelengths of 200 ~ 1800 nm. For NIR-to-MIR anti-reflectance studies, the unablated substrates were used as a control sample to determine the relative anti-reflectance ratios. The results showed that the anti-reflectance enhancement in the NIR-to-MIR range depended on the kinds of metals. The possible mechanism was analyzed and discussed. Regarding UV-to-NIR anti-reflectance performances, considering different reflectance for different raw metals, a total reflection mirror was used as a common reference to study the anti-reflection performance of the ablated metals using a UV-vis spectrometer. It was found that the reflectance of the ablated metallic substrates was significantly reduced below 1%, irrespective of the original reflectance of the metal substrates. This work demonstrated the possibility to enhance MIR absorption by laser ablation in organic solvents and shed lights on the underlying mechanisms for anti-reflectance enhancement.

Reference

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