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Picosecond laser microfabrication of infrared antireflective functional surface on As_2Se_3 glass

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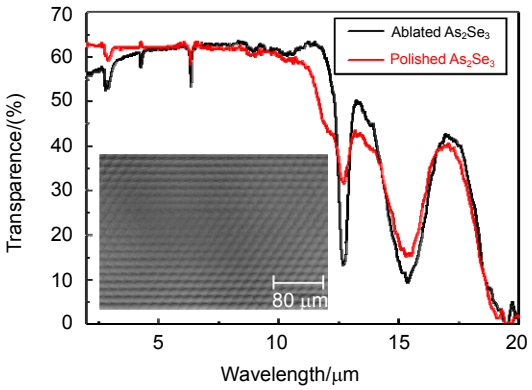

The morphology of large area surface micro-structure and transmission rate of As_2Se_3 glass.

Abstract: Chalcogenide glasses are formed of chalcogen of S, Se, Te with doping of a certain of other metal elements. Due to the lower refractive index, temperature coefficient and good infrared transmittance, it has been recognized as the ideal materials for a new generation temperature non-refrigerated infrared optical system. In order to decrease the large reflection losses, researches on multi-layer thin-film coatings for anti-reflection (AR) with good performance were performed. However, disadvantages of the method are needed to be overcome, such as high costs and short life-times. Recently, surface micro-structures have been shown to be a good alternative potential to multi-layer thin-film AR coatings in many infrared and visible-band applications.

Large-scale periodic dot matrix anti-reflective microstructures were fabricated on the surface by using UV picosecond laser with rapid line scanning to improve the infrared transmittance of As_2Se_3 glass. In the study, the laser ablation threshold of As_2Se_3 glass was concluded and the optimal line scanning method was designed. The transmittance of the fabricated chalcogenide glass increased about 10.0 % and 5.2 % in wavelength ranged from 11.0 μm~12.4 μm and 13.0 μm~14.2 μm, respectively. In addition, the static contact angles of the treated samples were increased from 71° to 84° of the untreated ones, which means there was no significant change in the wettability. The processing was carried out in air condition showing low cost, high controllability and high efficiency. Since the ultra-short pulse laser duty ratio is very small, the laser rapid scanning can be used to achieve single-pulse point by point processing on the sample surface. It only took 3.65 s to finish the fabrication of 8 mm×8 mm surface structures. Both the size and space of the surface microstructure unit can be controlled according to the application requirement. The morphology of the surface microstructure is controllable by changing the laser parameters (single pulse energy, defocus, etc.) and interval depends on the laser scanning speed, laser pulse frequency and scanning path. The removal of the chalcogenide glass induced by laser was mainly based on "cold fabrication" in which no obvious thermal effects inducing the element change on the surface were observed. Higher laser energy could induce obvious thermal effect resulting in melting of the ablation points and bump of the crater edges. The results can be provided as a guide for the laser rapid fabrication of anti-reflection micro-structure, which is suitable for the applications in infrared optical material and other optical materials in a low-cost and controllable way.

Keywords: picosecond laser; As_2Se_3 chalcogenide glass; surface micro-structure; antireflection; contact angle

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