LIPSS formation on soda-lime glass by femtosecond laser beam : effect of repetition rate with two different wavelengths (1030nm and 515 nm)

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ABSTRACT

In this work, we investigate the laser-induced periodic surface structures (LIPSS) formation on soda-lime glass using a femtosecond (fs) laser source, with two different wavelengths are λ= 1030 nm and λ= 515 nm. Due to the nonlinear absorption behavior of the fs-laser beam in soda-lime glass, we introduce a framework featuring a combined thin metal film of silver and chromium (Ag:100 nm + Cr:30 nm) deposited onto soda-lime glass by DC sputtering, taht helps to absorb the laser beem on the material surface. This substrate is employed under green and IR light irradiations to induce the formation of LIPSS. Four different repetition rates (f) such as 10 kHz, 50 kHz, 100 kHz, and 250 kHz were employed. The formation of LIPSS upon irradiation with linearly polarized fs-laser pulses (τ = 300 fs, E = 10 μJ) in the air environment is experimentally studied. In the case of 515 nm laser irradiation, the absence of LIPSS was observed at a low repetition rate of 10 kHz. Upon increasing the repetition rate to 50 kHz, high spatial frequency LIPSS ($HSFL_{\perp}$) were obtained, oriented parallel to the beam polarization (**E**), at the center of the laser spot (higher energy dose). Upon increasing the repetition rate to 100 kHz, same ($HSFL_{\perp}$) pattern was retained, with a slight increase in the spatial period size from 80 (±10) nm to 100 (±10) nm. At a high repetition rate of 250 kHz, the direction of the LIPSS transitioned from perpendicular (⊥) to parallel (//) with the polarization, **E**. In the other case of 1030 nm laser irradiation, LIPSS were observed at all four repetition rates, with (HSFL//) to the laser beam polarization, **E**. The observed periodicity ranges between 180 (±10) nm and 275 (±10) nm, showing a gradual increase versus the repetition rate.

Keywords: Soda-lime glass substrate; thin film; femtosecond laser irradiation; laser-induced periodic surface structures (LIPSS); HSFL.