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Influence of selected laser parameters on the densification of picosecond pulsed laser structured objects

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The modification of glasses with picosecond or even femtosecond lasers is a relatively young research field and offers powerful opportunities to form micro-structured modifications in the glass network due to the formation of plasma in the laser focal spot. For the laser-glass interaction, the absorption conditions depend on the glass composition while the structural modification is based on the energy deposition conditions, which are mainly controlled by the laser parameters (e.g. pulse energy, pulse length, repetition rate, and focalization).
Microstructured modifications are inscribed into silica glass using a 10 ps laser at diverse pulse energies and repetition rates. Additionally, the energy input per volume is controlled with an alteration of the feeding speed of the sample. The thermal quenching effects of the laser-modified zones on the silicate network are characterized using a coupled Raman and Brillouin spectrometer (ARABICA) to identify structural changes with respect to the varying laser parameters and feeding speeds.
The variation of the fictive temperature related to structural rearrangements and residual stress due to the change of volume of the modified zones is monitored by studying shifts of the main band as well as the ratio of the intensities of the D_1 and D_2 bands of the Raman spectra. In addition, the observation of longitudinal acoustic modes of the modified zones provides an idea of the elastic properties as well as the change of refractive index with a spatial resolution within one modification and between all modifications of different parameters.
The spatial and thermodynamic analysis of the modifications proposes the formulation of a densification model based on the energy deposition conditions for the laser-glass interaction.

References

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