Elastic properties of laser-affected glass probed by grid nano-indentation

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Ultrafast lasers have been shown to be useful to locally tailor the physical properties of materials [1]. Thanks to the high-peak power delivered by these lasers, one can trigger non-linear absorption processes, enabling the ability of modifying transparent materials in three dimensions. Among these physical properties, local elastic properties play an essential role at the micro-scale. We thus investigate how ultrafast lasers can be used for locally tailoring local mechanical properties [2], such as Young modulus, and to distribute it in a controlled manner, in three dimensions. Applications are foreseen in integrated optical polarization devices as well as for fine contact-less positioning of micro-objects [3].

Grid nano-indentation has been applied to characterize the elastic stiffness field in fused silica after it has been exposed to a femto-second laser irradiation. Because of the very small size of the laser-affected zone (LAZ), the necessary spatial resolution is achieved by adapting a previously proposed deconvolution procedure [4] to the LAZ geometry. This ends up in minimizing a projection residual, and an elastic description of the modified glass is thus sequentially constructed, driven by the minimization of the global projection residual. This reveals a very significant and very heterogeneous Young's modulus modification compared to the pristine material.

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