Ultrafast laser processing of narrow bandgap semiconductors

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Ultrashort pulse laser processing has become a powerful tool for direct inscription of optical functionalities like waveguides, Bragg structures or artificial birefringence in various glasses and crystals. In addition, cutting and welding of different glasses has been demonstrated with ultrashort pulses. All these processes rely on a well-controlled nonlinear energy deposition inside the transparent material.

This technique has until now no equivalent for narrow bandgap semiconductors, especially for silicon [1], which is the backbone of today's semiconductor industry. The reason is the different transparency range, the high refractive index leading to severe beam distortions and mainly the significantly higher nonlinearities, hindering a precisely localized energy deposition inside the material.

In this presentation, we will report on the analysis of the nonlinear interaction of intense ultrashort laser pulses in the infrared spectral region with silicon. Based on these investigations the inscription of waveguides in the longitudinal [2-3] as well as transversal regime [4-5] will be demonstrated. The potential to transfer this technology to other narrow bandgap semiconductors will be discussed.

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