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Femtosecond direct laser writing and micromachining

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We explore the capabilities of femtosecond lasers in direct laser writing (DLW) applications, emphasizing their advantages and the impact of various parameters on the micromachining process. Femtosecond lasers, with their ultrashort pulse durations and high peak powers, offer high precision and minimal heat-affected zones eliminating thermal effects during micromachining. These attributes make them ideal for intricate micromachining tasks and the generation of a variety of structures at the micro- and nanoscale. Our investigation focuses on the significance of process parameters such as pulse energy, focusing depth, and repetition rate, all of which influence the feature size, shape, and quality of the laser-modified materials. In this work, we present micromachining results in a range of various material platforms such as Silica, Silicon, and polymers materials. Additionally, we examine various distinct applications such as silica on silicon optical circuits for quantum applications [1, 2], laser-patterned silicon substrates explored for cancer cell culture [3], surface modifications in polymer Intraocular Lenses (IOLs) for personalized vision correction, polymer films for aiding cytological screening, and also PMMA thin films and polymer optical fibers, for information storage or sensing applications. Through these experiments, we aim to confirm surface modifications and identify the optimal irradiation parameters for precise laser ablation by eliminating thermal effects accumulation during laser processing.

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