Direct laser writing with a sub-nanosecond burst of femtosecond pulses exploiting excitation of deformation wave

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It is well known, the the laser micromachining gets different types of benefits with temporary shaping of a single or a train of ultra short pulses. It exploits material dependent electronic relaxation processes on a sub-picosecond time scale, and heat accumulation on a sub-microsecond time scale. Meantime until now there was no developed method for pulse shaping on a sub-nanosecond time scale, and clear evidence of benefits for micromachining with such pulses.

We developed a simple method for generating a sub-nanosecond burst of femtosecond pulses and found a new regime of efficient laser modification of transparent materials based on the simultaneous actions of rarefaction and electronic excitation [1]. The scenario of the regime is following: a deformation wave is developed on a sub-nanosecond scale as a result of production of local excessive pressure by a tightly focused bullet of femtosecond laser pulse. Second and following pulses of the burst interact with the stretched material, and this condition translates to inscription of increased refractive index change in silica glass and sapphire.

The innovative burst produces an enhanced refractive index change in fused silica and sapphire and a thermally stable birefringent structure in fused silica even with a single laser shot.

[1] A. Okhrimchuk, S. Fedotov, I. Glebov, V. Sigaev and P. Kazansky, "Single shot laser writing with sub-nanosecond and nanosecond bursts of femtosecond pulses", Scientific Reports, 7, 16563 (2017).

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