Annotation

New approach for controllable bulk energy deposition and micromodification of transparent solids under two-color (seeding pulse 620nm, 150fs, E<1,1μJ + heating pulse 1240nm, 200fs, E<2,3 μJ) excitation by femtosecond tightly focused (NA=0.5) laser pulses was investigated experimentally and theoretically. This technique is promising replacement for one-pulse interaction. The use of the third harmonic generation technique in focused laser beams made it possible to perform diagnostics of both evolution of laser induced microplasma and subsequently created micromodification. It was observed experimentally that double pulse excitation, combined with the changes in polarization state of the heating laser pulse from linear to elliptical, leads to the enhancement in deposited energy density reaching the value of 6kJ/cm^3 in the bulk of fused silica, which demonstrates the dominant role of avalanche ionization in a two-color plasma production in the bulk of dielectric. In accordance with the numerical simulations, it is possible to enhance energy delivery into transparent dielectrics (sapphire) up to 14kJ/cm^3 under two-color excitation by attenuating heating pulse's wavelength up to 5μ. That provides extremely high up to 7×10^{16} W/cm^3 rates of energy deposition inside the dielectric.The morphology of laser-induced "tandem" defects makes it possible to estimate the pressure of a transparent medium in the microvolume up to 12 GPa, which corresponds to the estimate of deposited energy density. The minimal size of modification obtained by interaction with 620nm, 150fs, 0,24μJ and 1240nm, 200fs, 1,55 μJ pulses (focusing lens f=3.3mm, NA=0,4) in the bulk of fused silica amounts to 3μ.

Using the UV laser pulse for seed electrons generation and mid-IR laser pulse for ponderomotive heating is the most prospective way to increase the localization of the incoming energy giving the route to the sub-micrometer spatial resolution with high energy efficiency in forthcoming femtotechlogies and for investigating the extreme state of matter.