NANOPROCESSING WITH PICOJOULE EXTREME ULTRAFAST 12 FEMTOSECOND LASER PULSES

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ABSTRACT

KEY WORDS: femtosecond laser, nanoprocessing, nanolithography, targeted transfection, sub-100 nm

An ultra-broadband femtosecond laser scanning microscope with 12 femtoseconds pulse width at the focal plane of a 40x NA1.3 objective has been employed in material nanoprocessing. The laser works at 85 MHz and possesses an M-shaped emission spectrum (maxima 770/827 nm). Different motorized setups based on the introduction of chirped mirrors, flint glass wedges, and glass blocks have been realized to vary the *in situ* pulse length from 12 fs up to 3 ps. Nanoprocessing was performed in silica, photoresists, glass, polymers, and biological structures. Mean powers as low as 2 mW were sufficient to realize plasma-mediated cutting effects in human chromosomes with sub-80 nm cut width. Using a mean power of 7 mW, transient nanoholes were "drilled" in the cellular membrane for targeted transfection of stem cells and the introduction of μRNA probes. Region of interest (ROI) scanning have been used for optical cleaning of human adult stem cell populations and blood cell suspensions. 3D two-photon nanolithography based on the ultrabroad excitation band was realized with the photoresist SU-8. Multiphoton sub-20fs microscopes may become novel non-invasive 3D tools for highly precise nanoprocessing.