

OPTIMAL PULSE COMPRESSION USING PHOTONIC CRYSTAL FIBER AND ITS APPLICATION ON TWO-PHOTON FLUORESCENCE MICROSCOPY

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The 2P absorption probability is inversely proportional to pulse width[1]. Pulse compression using photonic crystal fibers (PCFs) has great advantages: the high nonlinearity of PCFs supports wider spectral bandwidth and pulse can be compressed much shorter[2]; the liberty of fiber dispersion control can promote the quality of compressed pulse[3]. A numerical model is used to predict the evolution of pulse propagation in the highly nonlinear PCF[4], which includes dispersion, self phase modulation, self-steepening and linear Raman response of fiber. The experiment and simulation results show that pulse width varies with the central wavelength of the laser beam, fiber transmitted power, and group-delay dispersion (GDD) compensated by the grating pair. The 790 nm, 94 fs, 80 MHz pulses from a Ti:Sapphire laser can be compressed to 21.5 fs (fiber transmitted power: 200 mW; compensated GDD: -988 fs²). While delivering to the Olympus Fluoview 1000 system, a pulse width of approximately 44 fs is achievable on the sample. By using the compressed pulses, the two-photon fluorescence imaging depth of cerebellum slices from GFP transgenic mouse can be enhanced up to 170 μm and the signal of fluorescence increases approximately 3.2 times compared with the uncompressed pulse. We also demonstrate that the intensity of autofluorescence from NAD(P)H in Nasopharyngeal Carcinoma increases 5.3 times at 740 nm and 3.5 times at 800 nm in the case of the compressed pulse. As the wide spectral band excites NAD(P)H more effectively than the narrow band, the wide spectrum of the compressed pulse also enhances the signal of the autofluorescence. Higher order dispersion is the main limit for pulse compression, which can be further improved by designing PCFs with relatively flat dispersion property over a wide wavelength range.

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