Nonlinear Optical Thin Film Devices using Saturable Absorption of Single Wall Carbon Nanotubes for Optical Telecommunication

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Carbon nanotubes (CNTs) are unique nanostructures with fascinating electrical, mechanical, and chemical functions. However, so far, little promising optical functions attracting extended attentions have been known. Here we present detailed properties of saturable absorption of single wall carbon nanotubes (SWNTs) that function effectively at optical telecommunication wavelength (~1550 nm) [1].

Diameter-selective SWNTs with a mean diameter at ~1.1 nm were grown by laser ablation method. The SWNTs were sprayed onto the surface of a 1mm thick quartz substrate forming a thin film of SWNTs (~1 μm). The film had a strong exciton absorption band ranging from 1400 nm to 2000 nm with a peak at 1680 nm. Saturable absorption properties were investigated, using a mode-locked fiber laser operating at 1550 nm with 1ps pulses [2], by the z-scan method [3] and by observing the spectral variation of the transmitted pulses. The z-scan experiments clearly showed an increase in the transmitted laser power when the CNT-film was placed at around the focal point, where the laser intensity was at its maximum. This phenomenon clearly showed occurrence of saturation of the excitonic absorption. High-resolution spectral transmission measurements were also carried out, showing a reduction in absorption over the spectral region of the pulse source, with a double-hump absorption feature. This result indicates that the sample has an inhomogeneously broadened absorption, which can respond to pulses on a timescale of 1ps. Based on these results, we will discuss the potentials of SWNT thin films for implementing optical telecommunication devices such as an ASE noise suppresser for EDFA and an optical switch.

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