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Nanotube Films and Their Application For Mode-Locked Lasers

ALEX G. ROZHIN, A.C. FERRAR, University of Cambridge — Carbon nanotubes (CNTs) exhibit strong saturable absorption, i.e. they become transparent under sufficiently intense light. This has great potential for applications in photonics. By tuning the nanotube diameter it is easy to tune the saturable absorption in a broad optical range of interest for telecommunications, medicine and military applications. The performance of CNTs based saturable absorbers depends on concentration, bundle size, and transparency of the matrix where CNTs are dispersed. CNT saturable absorbers can be produced by cheap wet chemistry and can be easily integrated into polymer photonic systems. Here, we review the fabrication and characterization of saturable absorber based on CNT-polymer optical composites [1,2,3]. We use strong ultrasonication to obtain CNT solutions. Such solutions with different nanotube bundle sizes are then studied by photoluminescence excitation spectroscopy [4]. We find that exciton energy transfer between semiconducting CNTs is an efficient carrier relaxation channel in the bundles [4]. This fingerprints and quantifies the presence of small bundles and allows us to optimize the solutions used for composites preparation. We demonstrate picosecond pulse generation in a nanotube mode-locked waveguide laser [5], as well as 125 fs generation in an erbium doped fiber laser. We also report a novel SWNT- polycarbonate polymer composite, with a absorption maximum at 1550 nm and a bandwidth of about 300 nm [6]. This has strong saturable absorption with saturation intensity of 7 MW/cm^2. We demonstrate the first SWNT-mode-locked widely tunable fibre ring laser [7]. This is achieved through the control of amplification at the specific transitions of the Er^{3+} gain medium by placing a band-pass filter in a laser cavity [7]. [1] A. G. Rozhin et al. Phys. Stat. Sol. (b) **243**, 3551 (2006). [2] V. Scardaci et al. Physica E **37**, 115 (2007) [3] T. Hasan et al. J. Phys. Chem C **111**, 12549 (2007) [4] P. H. Tan et al. Phys. Rev. Lett. **99**, 137402 (2007) [5] G. Della Valle et al., Appl. Phys. Lett. **89**, 231115 (2006) [6] V. Scardaci et. al. Adv. Mat. **20**, 4040 (2008 [7] F. Wang et. al. Nature Nano. Nov (2008).

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