NANOTUBE AND GRAPHENE-BASED POLYMER OPTOELECTRONICS

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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 in spectroscopy, photochemistry, biomedical research and telecommunications. The performance of CNT-based saturable absorbers strongly depends on the CNT concentration, bundle size, and transparency of the matrix where CNTs are dispersed.

Here, we review the fabrication and characterization of saturable absorber based on CNT-polymer composites [1,2]. We use ultrasonication to obtain CNT solutions. These are then studied by photoluminescence excitation spectroscopy [3]. We find that exciton energy transfer between semiconducting CNTs is an efficient carrier relaxation channel in the bundles [3]. This fingerprints and quantifies the presence of bundles and allows us to optimize the solutions [1-3]. The composites are successfully used to mode-lock lasers in a broad spectral range [4-6]. We focus on two recent advances. The first is the realisation of a mode-locked tuneable fiber laser [6]. This is achieved through the control of amplification at the transitions of an Er^{3+} gain medium by placing a band pass filter in the cavity. The laser generates 2.4 ps pulses continuously tuneable between 1518 and 1558 nm, the widest to date [6]. The second is a stretched-pulse fibre laser generating ~120 fs pulses. This allows us to realise a laser with high power (0.63W) [7], orders of magnitude higher than previous nanotube-based fibre lasers.

We then consider graphene. Single and few layer graphene have as well strong nonlinear optical properties with ultrafast response over a broad spectral range. Here, we report the linear and nonlinear optical characterization of graphene-polymer composites prepared using wet chemistry techniques [8,9]. The composites are then integrated in a fiber laser cavity, to generate ultrafast pulses. We obtain pulse duration of ~800fs [3, 4] at 1557nm with a 3.2nm spectral bandwidth [10, 11]. The time-bandwidth product is 0.317, close to the theoretical value of 0.314 for Fourier-transform limited $sech^2$ pulses, indicating that the pulse is as short as allowed by the spectral bandwidth. These composites are expected to mode-lock from visible to IR due to the broad absorption range of graphene, with the potential to overcome the wide tenability offered by nanotubes [6]

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