Nanotube and Graphene Based Polymer Optoelectronics

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Carbon nanotubes (CNTs) are excellent saturable absorbers, 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 cover a broad optical range of interest for telecommunications, medicine and military applications. The performance of CNTs based saturable absorbers strongly depends on their concentration, bundle size, and transparency of the polymer matrix. 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 absorbers based on CNT-polymer composites [1-3]. These are successfully used to mode-lock lasers in a broad spectral range [4-6]. We report 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. This gives 2.4 ps pulses continuously tuneable between 1518 and 1558 nm, the widest to date [6]. We also present a stretched-pulse fibre laser generating ~120 fs pulses. This allows us achieve high power outputs, exceeding 1.6 W [7], orders of magnitude higher than previous nanotube-based fibre lasers. We will then extend our investigation to graphene. Single and few layer graphene also have strong nonlinear optical properties with ultrafast response over a broad spectral range. We will 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 at 1557nm with a 3.2nm spectral bandwidth [10, 11]. 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 of nanotubes. Finally, I will discuss how to induce significant photoluminescence in graphene [12]. The latter examples show the viability of graphene for optoelectronics.

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