

Ultrafast and High-energy Pulsed Lasers With Graphene Mode-Lockers

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The conventional technology for generating ultrashort pulses relies on soliton-like operation based mode-locking. In this regime, the pulse duration is limited by nonlinear optical effects[1]. One method to mitigate these effects is to alternate segments of normal and anomalous group velocity dispersion (GVD) fiber[1]. This configuration is known as dispersion-managed soliton design. It decreases the nonlinear optical effects and reduces the pulse duration[1].

Here we present a dispersion-managed fiber laser with the GVD map formed by erbium doped fiber (EDF) and single mode fiber (SMF) respectively (Fig.1a)[2]. The EDF is pumped by a 980 nm diode laser (LD) via a wavelength division multiplexer (WDM). An isolator (ISO) is placed after the gain fiber to ensure unidirectional operation. A polarization controller (PC) optimizes mode-locking, obtained using a graphene-based saturable absorber (GSA). Graphene is an interesting material to be used as SA, especially due to its inherent broadband operation [3-8], when compared to nanotubes[3,9-11] or SESAMs[12]. Graphite flakes are exfoliated by mild ultrasonication[4,7,13] and then mixed with polyvinylalcohol (PVA) to give a $\sim 50\mu\text{m}$ composite[3,4,7]. This is then placed between two fiber connectors to form the SA device. The autocorrelation trace (Fig.1b) of the output pulses has FWHM $\sim 268\text{fs}$. Considering a sech^2 temporal profile, a $\sim 174\text{fs}$ pulse width is obtained [2].

We also demonstrate a tuneable graphene Q-switched fibre laser[14]. The broadband absorption of graphene enables Q-switching between 1522 and 1555nm (Fig.1c)[14]. The tuning range is limited only by the tunable filter we use in our setup. The laser generates $2\mu\text{s}$ pulses (Fig.1d). The pulse energy is $\sim 40\text{nJ}$.

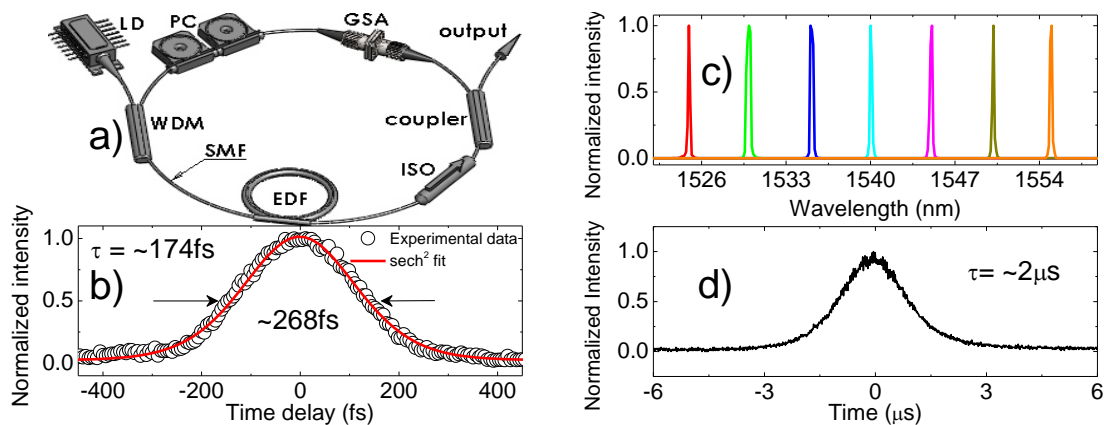


Fig. 1 a) Laser setup. b) Autocorrelation trace with sech^2 fit. c) Tunable output spectrum. d) Pulse envelope.

In conclusion, we demonstrated graphene as SA for generation of ultrashort and high-energy optical pulses. The flexibility offered by the fiber laser design, along with the easy SA preparation, can lead to simple, low-cost, ultrafast light sources.

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