Mode locking of fiber lasers using patterned graphene on SiN waveguides

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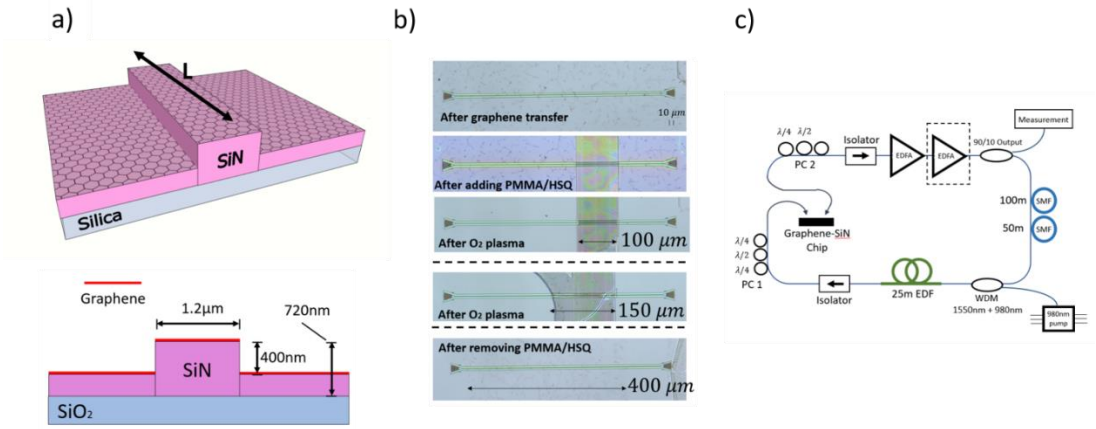

Figure 1 a) 3D scheme of a graphene covered SiN waveguide and 2D cross section of the waveguide. b) Optical microscope graphene pattern with patterning steps. c) Fiber laser cavity with patterned graphene SiN chip.

In this paper, we demonstrated the mode locking properties of fiber ring lasers with intra-cavity patterned graphene on SiN waveguides. The chip coupling loss was around 20~30 dB and was overcome by using EDFAs, while mode locking was achieved by changing the angle of the polarization controllers (PCs). Wong, et al, previously studied graphene covered silicon waveguides for mode locking [1], but that report doesn't discuss the impact of different lengths of graphene or non-linear polarization rotation (NPR) [2]. Focusing gratings used for fiber-chip coupling induce a polarizing effect and NPR but based on our previous work we conclude that the impact of NPR in high intra cavity loss cavities is limited [3].

We fabricated SiN waveguides, patterned graphene (Fig.1a) at 3 different lengths (100μm, 150μm and 400μm, shown in Fig.1b) and built a system (Fig.1c, cavity length around 240m) to test the mode-locking properties of the waveguides.

We observed 3rd and 5th harmonic pulses in 400μm length case and it is shown in Fig.2c including autocorrelation in Fig.2d. For 100μm and 150μm cases, the fundamental frequency pulse with optimized pump power is shown in Fig.2a&b.

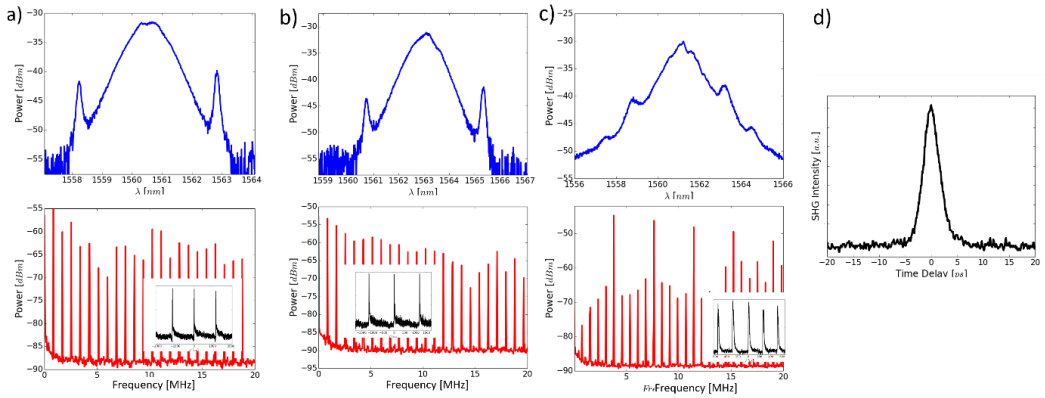

Figure 2 a) Mode locking results in the case of the 100μm graphene pattern under optimized pump power, showing a ps, fundamental frequency pulse (optical spectrum and RF spectrum with oscilloscope trace inset). b) 150μm. c) 400μm. d) Autocorrelation trace of the pulse obtained using 400μm graphene pattern

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[2] Nelson, L. E., et al. "Ultrashort-pulse fiber ring lasers." Applied Physics B: Lasers and Optics 65.2 (1997): 277-294.

[3] G. Kovacevic, et al, "Influence of Intra-Cavity Loss on Mode-Locking of Fiber Lasers," CLEO-PR, 2981236 (2018).