In Situ Synthesized Graphene for Mode-locked Femtosecond Fiber Lasers

Pulak Chandra Debnath
Yong-Won Song

Center for Opto-Electronic Materials and Devices, Korea Institute of Science and Technology (KIST), Hwarangno 14-gil 5, Seongbuk-gu Seoul 02792, Korea

ysong@kist.re.kr

Abstract

Graphene, with its significant optical nonlinearity and dispersionless nonlinear optical response over a broad wavelength range, has been investigated widely to implement optical devices such as fiber laser, broadband optical modulator, photodetector, polarizer, and optical switches.[1-3] Conventionally synthesized graphene relying on high temperature approach and vacuum equipment mostly requires deleterious transfer steps to implement devices that degrade the graphene crystal quality, thereby affecting the efficiency of nonlinear optical operation and lacking the customized patterning with minimized footprint as well as missing the facilitated fabrication process.[2,3] Here, we present a laser induced *in situ* synthesis of multilayered graphene directly onto the optical fiber in ambient condition to generate mode-locked femtosecond fiber laser. An amplified continuous wave (CW) laser, propagating through the waveguide, provides activation energy for carbon atoms to diffuse through the nickel catalyst and to grow graphene directly on the waveguide (see Figure 1). The *in situ* grown graphene shows nonlinear optical absorption property with the modulation depth of 4.4 % and acts as saturable absorber (SA) in the fiber laser ring cavity to generate ultrafast optical pulses in the femtosecond regime, (see Figure 2) thus ensuring the passive mode-locking of fiber laser operating with the pulse duration of ~910 fs.[4]

References

[1] F. Bonaccorso *et al.* Nat. Photonics, 4 (2010) 611.
[2] Z. P. Sun *et al.* ACS Nano, 4 (2010) 803.
[3] Y. W. Song, *et al.* Appl. Phys. Lett. 96 (2010) 051122.
[4] P.C. Debnath *et al.* Adv. Opt. Mat. 3 (2015) 1264.

Figures

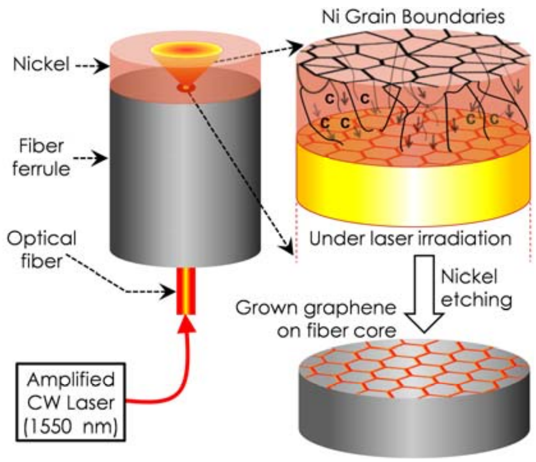

Figure 1: *In situ* synthesis of graphene on optical fiber end facet.

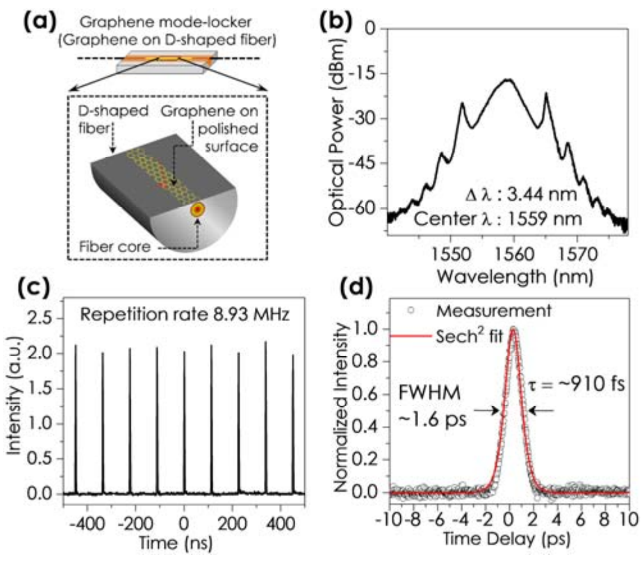

Figure 2: Mode-locked femtosecond fiber laser with *in situ* grown graphene on D-shaped fiber