Nanocarbon materials for short-pulse fiber lasers and photonic devices

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We review the optical properties of carbon nanotubes (CNTs) and graphene, and describe how those properties have been used for the implementation of various nonlinear fiber optic applications. Early studies on the optical properties of CNTs revealed that these materials exhibit high third order susceptibility and a broadband saturable absorption with a sub-picosecond response time. Recent discovery of similar nonlinear optical properties in graphene attracts much attention in this field. Such ultrafast, highly nonlinear optical response means that they can be employed for noise suppression and for the mode-locking of fiber lasers, and their high third order nonlinearity holds great promise for the implementation of various other nonlinear fiber optic devices such as wavelength converters based on four wave mixing. In addition, absorption in graphene is known to be controllable by the adjustment of its Fermi level, which can lead to the electrically controllable optical modulators.

In this talk, we will discuss the various methods that have been considered thus far for the integration of CNTs and graphene in optical systems and highlight the advantages and limitations of using the saturable absorption of CNTs and graphene for the passive mode-locking of fiber lasers, and the current status of CNT and graphene saturable absorbers in the state of art fiber laser technologies. We also introduce our works on nonlinear photonic devices and optical modulators using CNT and graphene.

References

[1] S. Yamashita, “A tutorial on nonlinear photonic applications of carbon nanotube and graphene (Invited Tutorial),” Journal of Lightwave Technology, vol.30, no.4, pp.427-447, Feb. 2012.
[2] A. Martinez, B. Xu and S. Yamashita, “Nanotube based nonlinear fiber devices for fiber lasers (Invited),” Journal of Selected Topics in Quantum Electronics, vol.20, no.5, pp.89-98, Sept. 2014.
[3] S. Yamashita, A. Martinez, and B. Xu, "Short pulse fiber lasers mode-locked by carbon nanotube and graphene (Invited)," Optical Fiber Technology, vol.20, no.6, pp.702-713, Dec. 2014.
[3] S. Yamashita, Y. Saito, and J. H. Choi (ed.), *Carbon nanotubes and graphene for photonic applications*, Woodhead Publishing, 2013.