Photo-reduced Graphene Oxide with Tunable Properties by Femtosecond Laser Irradiation

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Graphene oxide (GO) has been recently used as an alternative precursor for low-cost and large-scale graphene production because it has the same basic structure with graphene and can be easily dispersed in water without any dispersants. Moreover, one can control not only the optical properties but also the conductivity of GO by reducing the oxygen group on it. However, the reduction of GO is still elusive and remains a challenge to be conquered. Several methods have been introduced to get reduced graphene oxide (rGO). Although chemical and/or thermal methods are becoming effective routes because of high C/O ratio of rGO, those methods usually inquire special treatment and strong reducing agents, which sometimes lead to environmental issues. Photo-reduction of graphene oxide is one of promising methods because it is simple, fast and eco-friendly. Flash lamp[1], visible light[2] and laser[3] have been employed as a light source. In regarding to the laser irradiation method, reduction of GO can be easily controlled by changing the parameters i.e. laser fluence, pulse duration and irradiation time.

In this work, photo-reduction of GO by femtosecond laser pulses in different irradiation conditions was studied. First, different laser fluence from 10 to 80 mJ/cm^2 was applied to 9 mL of GO solution for 1 hour with the repetition rate of 300 Hz to find the optimum laser fluence for making highly reduced GO. Then, GO solution was irradiated for different irradiation times with a fixed optimum laser fluence to know the reduction process in detail. Figure 1(a) shows a set of UV-vis. absorption spectra of rGO formed by different laser fluences. The absorption peak indicates the strong π-π* interaction correlated to the restoration of carbon double bond in a benzene ring due to the reduction process, and shifted to higher wavelength region with increasing the laser fluence of irradiated laser. It was shown that 60 mJ/cm^2 was the optimum laser fluence for the effective reduction of GO because of the largest shift of the absorption peak to longer wavelength (260 nm) compared to the others. XRD profiles of rGO fabricated by different irradiation times with 60 mJ/cm^2 laser fluence was shown in Fig. 1(b). It is clear that the diffraction peak around 10° corresponding to GO was gradually decreased while rGO peak around 22° was increased indicating the reduction of GO in connection with the irradiation time.

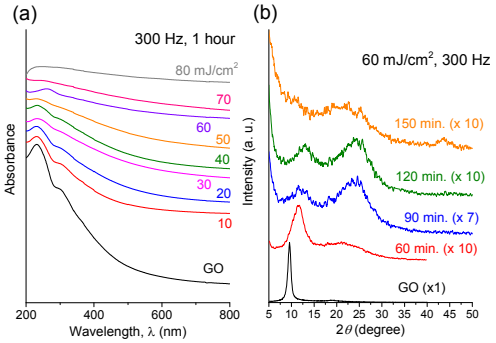

Figure 1. (a) UV-vis spectra of rGO with different laser fluences, (b) XRD profiles of rGO with different irradiation times.

1. *L. J. Cote et al., J. Am. Chem. Soc.,* ***13****, 111027 (2009).*

2. *Y. H. Ng et al., J. Phys. Chem. Lett.,* ***1****, 2607 (2010).*

3. *G. Compagnini et al., Nanotechnology,* ***23****, 505601 (2010).*