Chemical Surface Modification of Graphene Oxide (GO) by Femtosecond Laser Pulse Irradiation

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Graphene oxide (GO) is two-dimensional (2D) material covered with oxygen groups, and one of low-cost precursors of graphene based materials, which has many practical applications such as energy storage, optoelectronic and sensing devices, catalysts and membranes. Reduction of GO (or formation of rGO) is a key process because it has a strong effect on the properties of final products. Reduction of GO by laser irradiation is a versatile method because it is one step process to eliminate oxygen functional groups and is applicable either in colloidal solution or in film form [1, 2]. Several advantages using femtosecond laser are promising instead of CW and nanosecond lasers for reduction of GO. In general, lower thermal effect on targeted material is expected in femtosecond laser process [3]. Then, it becomes possible to remove oxygen groups on GO through electronically-induced excitation without further damage [4]. In this study, photo-reduction of GO using femtosecond laser pulses with different irradiation conditions was conducted.

GO colloidal solution was kept in a glass vial with the volume of 9 mL and used as a precursor. Femtosecond laser pulses (λ: 800 nm, pulse width: 100 fs, repetition rate: 300 Hz) were shone vertically to the surface of the solution through a focusing lens with the local length of 35 cm. Different laser fluence and irradiation time were examined to obtain highly reduced GO. Figure 1(a) shows a set of UV-vis. absorption spectra of GO and rGO solution for different laser fluence for 1 hour irradiation. The absorption peak at 230 nm in the spectrum of the GO solution indicates the strong π-π* interaction, which is correlated to the carbon double bond in benzene ring. The peak position shifted to 261 nm after 1 hour irradiation with different laser fluences, and reached to 275 nm after 2 hours irradiation with 80 mJ/cm^2 of laser fluence indicating the effective reduction of GO. In addition, Raman spectroscopy of rGO shows that intensity ratio of D and G bands decreased up to 0.81 indicating the enhancement of graphitic region or reduction of defect area. This result is different from that by conventional chemical or thermal method and indicates that the proposed method can minimize disorder or damage on the graphene basal structure during the reduction.

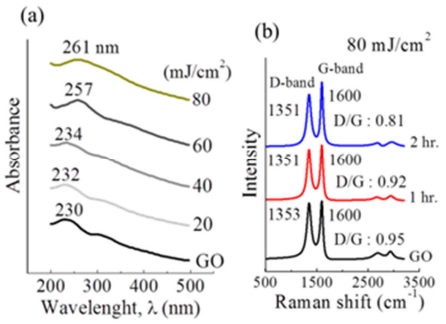

Fig. 1. (a) UV-vis spectra of rGO with different laser fluence, (b) Raman spectroscopy profiles of rGO with different irradiation time

References

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