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Simultaneous B-doping and Reduction of Graphene Oxide by Optical Annealing toward Sensitive Chemiresistors

Since the discovery of graphene, many researches have been devoted for application of graphene to actual uses. Along with graphene, graphene oxide (GO) has been employed for the cost-effective and mass production of graphene based materials [1,2]. The essential step to synthesize graphene composites with GO is to reduce it and doping processes are achieved to obtain moderate electrical or chemical properties. In most cases, however, GO should be kept constrained under reduction atmosphere at elevated temperature for very long hours for reduction and doping processes, indicating that synthesis of doped rGO through a facile and low-cost process remains a big challenge [3-5]. In this contribution, attempts have been made to reduce and B-dope GO at the same time by optical sintering in ambient atmosphere through intensive pulsed light (IPL) within a very short time (<10 ms). With the experiment, the authors endeavored to suggest a facile and cost-effective way of doping and reduction of GO and investigate feasibility of B-doping by optical thermal treatment for the first time. First, boron doping source was added into GO dispersed D.I water and the mixture was ultra-sonicated. Then, it was drop-coated on glass substrates (Figure 1a). The subsequent IPL treatment was carried out for 10 ms, resuling in dramatic temperature increase up to 1000 °C by photothermal effects of graphene sheets (Figure 1b). As a result, ultrafast B doping and simultaneous reduction of graphene oxide sheets occurred at the same time even in ambient atmosphere, confirmed by XPS analysis (Figure 1c). Notably, photothermal treated samples feature much higher surface area and porosity mainly with mesopores (2-50 nm), compared to ones synthesized by conventional thermal processes. For further investigation on tunning in material properties, the NO_2 sensing characteristics of B doped and reduced GO (B@rGO) and rGO were compared to each other to identify effects of B-doping into rGO. As a result, the findings from NO_2 sensing test exhibit that B@rGO features notably higher response to NO_2 than rGO.

References

[1] Loh, K. P.; Bao, Q. L.; Eda, G.; Chhowalla, M., *Nat. Chem.*, 2 (2010) 1015.

[2] Zhu, Y. W.; Murali, S.; Cai, W. W.; Li, X. S.; Suk, J. W.; Potts, J. R.; Ruoff, R. S., *Adv. Mater.*, 22 (2010) 3906.

[3] Wang, Y.; Wang, C. Y.; Wang, Y. J.; Liu, H. K.; Huang, Z. G., *ACS Appl. Mater. Interfaces*, 8 (2016) 18860.

[4] Putri, L. K.; Ng, B. J.; Ong, W. J.; Lee, H. W.; Chang, W. S.; Chai, S. P., *ACS Appl. Mater. Interfaces*, 9 (2017) 4558.

[5] Li, S. B.; Wang, Z. F.; Jiang, H. M.; Zhang, L. M.; Ren, J. Z.; Zheng, M. T.; Dong, L. C.; Sun, L. Y., *Chem. Commun.*, 52 (2016) 10988.

Figures

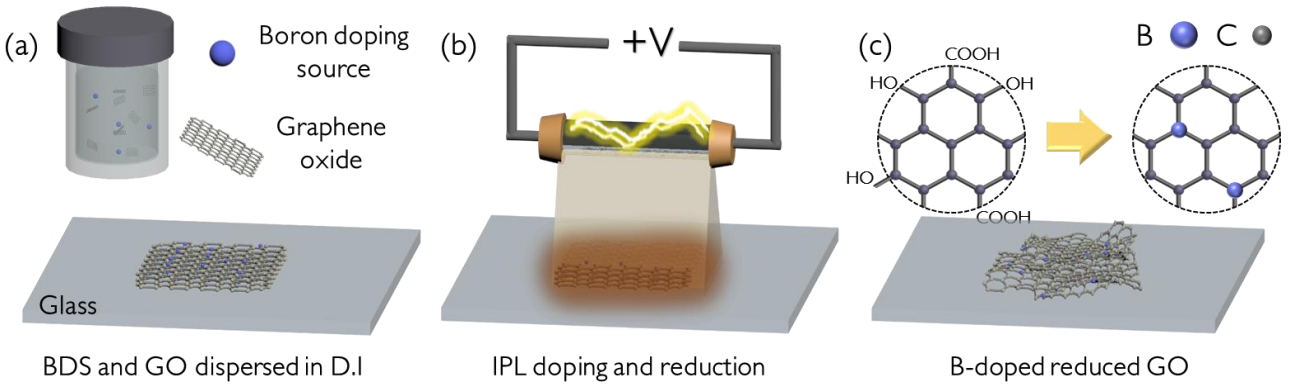

Figure 1: Schematic illustration of (a) drop-coating on the glass with graphene oxide dispersed D.I water having boric doping source, (b) IPL irradiation on the coated film in the short time, (c) B-doping reduced graphene oxide on the substrate.