Highly efficient restoration of graphene by photochemical reduction *via* hydrohalic acid as trigger reagent

Ching-Yuan Su
Wei-Han Chen

Graduate Institute of Energy Engineering, National Central University, Tao-Yuan 32001, Taiwan
Contact: cysu@ncu.edu.tw

Abstract

In this study, we investigate the mechanism and applications of the restoration on reduced graphene oxide(rGO). Here, graphene oxide(GO) paper was prepared via our previous works [1-3], followed by chemical reduction by using Hydroiodic acid(HI) for preliminary reduction. Then, the photoreduction was carried out to further restore graphene by using light-focusing Xenon flash lamp. The optimized conditions for photoreduction were obtained by controlling temperature and flash shot. The resultant rGO shows high C/O ratio(36.2) and high crystalline(Raman D/G ratio=0.24; 2D/G ratio=0.43). Due to the high efficient deoxygenation and restoration by photoreduction. The study suggests that the comprising of HI chemical treatment and Xenon flash facilitate the photolysis reaction of iodic molecular, leading to a high efficient break of the epoxy bond (higher C/O ratio). Meanwhile, the exothermic heat during GO reduction process a chain reaction, where heat was found to propagate over the whole material, thus further restore graphene defects.
To evaluate the performance and particle application, the as-prepared rGO paper with various reduction conditions were employed as electrodes in a symmetric type supercapacitors. The rGO treated by comprising of HI and Xenon flash (rGO-HI-Xe) shows higher specific capacitance of 28 F/g, which was 233% increased when compare to that (12 F/g) of rGO treated by HI(rGO-HI). This was attributed to the high specific surface area and diffusion path created from porosity and fluffy structured rGO-HI-Xe samples, thus promoting ion transport capability. In addition, the rGO paper can be utilized as a thermal pad. The rGO-HI samples show a thermal diffusivity and thermal conductivity of 439.18 mm2/s and 1056 W/m . K, respectively. This work provides a facile(within few second) and high-efficiency method for graphene restoration, which was potential for high-quality graphene production and its related applications.

References

[1] C. Y. Su, et al, Chemistry of Materials, 21 (2009), 5674.
[2] C. Y. Su, et al, ACS Nano, 5 (2011) 2332.
[3] C. H. Chen et al, Nanoscale, 7 (2015), 15362.

Figures

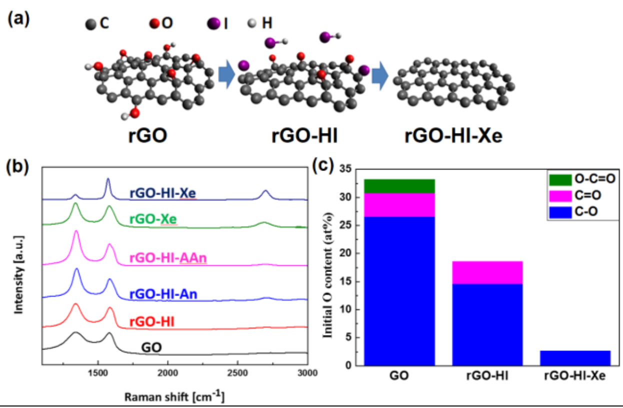

Figure 1: (a)Evolution of graphene restoration. (b) Raman spectra and (c) XPS for various reduced graphene.