Surface Functionalization of Graphene Materials and Their Applications

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Despite their remarkable properties, many challenges must be overcome to achieve practical applications of graphene-based materials. The primary obstacle lies in establishing a cost-effective method for producing high-quality graphene materials on a large scale, while ensuring good reproducibility. A trade-off relation exists between cost and properties, necessitating the selection of an optimal preparation method depending on the intended application.

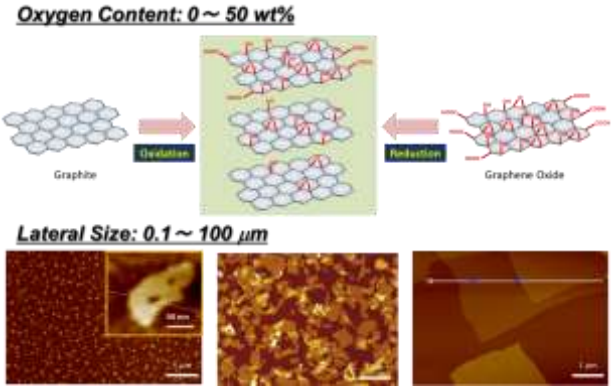

Figure 1. Strucuture control of GO.

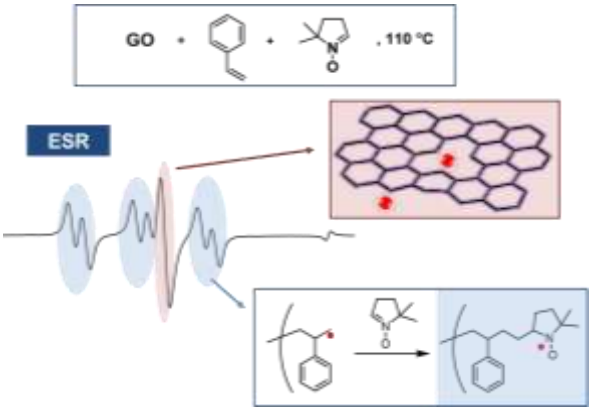

Figure 2. Polymer grafting on GO by radical.

During this presentation, we will explore the introduction of graphene oxide (GO) as an illustrative example, which is obtained through the oxidation and exfoliation of graphite. Through an optimized oxidation process utilizing $KMnO_4$ in H_2SO_4, we have successfully achieved the laboratory-scale production of 500 g of GO, and a prototype plant-scale production of 10 kg. The large-scale productions were possible by conducting mechanistic studies of the oxidation process using in situ analyses such as XRD and XANES. Our refined GO production processes controlled the size, degree of oxidation, and distribution of functional groups on GO (Figure 1).
By tailoring our GO, we have accomplished the grafting of polymers onto it via a radical pathway. The grafting mechanism was elucidated through in situ ESR measurements employing a spin trap reagent. During thermal treatment (Figure 2), the radicals were generated by cleaving C-O bonds of GO. In addition, redox-active molecules and polymers were grafted onto GO and utilized for supercapacitor applications.

References

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