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Comparative study on the electrical conductivity of reduced graphene oxides

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Graphene due to its unique physical and chemical properties has attracted a lot of interest among the scientific community and the technologist. Aiming the large-scale production and tuneable properties, several synthesis methods of graphene have been developed since its discovery in 2004. Chemical oxidation of graphite to graphene oxide (GO) and subsequent reduction of GO to reduced graphene oxide (RGO) is a widely practised production technique. Different reduction methods including chemical, thermal, photo or their combinations were reported for the conversion of GO to RGO. This paper describes the influence of these reduction techniques on the electrical conductivity of RGO sheets. The samples were characterised by Raman and UV/Vis spectroscopy. I_{2D}/I_G area ratios of the 2D and G band of the respective Raman spectrum were calculated to assess the electrical conductivity (Table 1). The photo-reduced RGO (by sunlight) [sRGO] showed higher conductivity compared to RGO synthesised through hydrothermal [hyRGO] or UV reduction [uvRGO] techniques (Figure 1). However, the sRGO conductivity is comparable with that of chemically (hydrazine) reduced RGO [hRGO]. Results also reveal that sRGO has least structural defect followed by hRGO, uvRGO and hyRGO. This indicates the restoration of graphitic electronic structure (sp^2 carbon-network) with high conductivity. Based on our study, the sunlight mediated reduction method seems to be more attractive compared to its counterparts for application in transistor, photo-electronic devices, sensors and electrochemical energy storage devices. Besides enhanced conductivity, this method is also attractive due to low cost of production and environmental friendly nature.

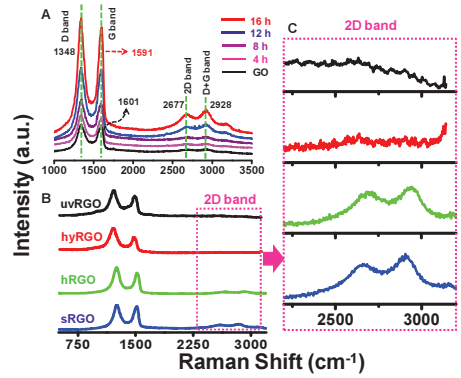

Figure 1: Raman spectrum showing the A) kinetics for the conversion of GO to RGO with respect to time, B) comparison of RGO synthesised by different methods and C) enlarged 2D regions of the RGO prepared by different protocols

Table 1: Raman characteristics of RGO reduced by four different reduction methods

RGO	I_D/I_G	I_{2D}/I_G
Sunlight (sRGO)	1.016	0.136
Hydrazine (hRGO)	1.194	0.069
UV irradiated (uvRGO)	1.238	0.060
Hydrothermal (hyRGO)	1.554	0.01

Keywords: chemical reduction, conductivity, reduced graphene oxide, Raman spectroscopy, sunlight