Single-stage Electrochemical Exfoliation and Functionalisation of Graphene

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Electrochemical exfoliation of graphite is considered to be a fast, scalable and eco-friendly way to produce graphene.[1,2] Cathodic exfoliation in organic electrolyte, unlike anodic exfoliation, produces high quality graphene as it avoids the formation of oxygen containing functional groups.2 However, development of applications of graphene is currently hampered by its poor dispersion in common, low-boiling point, solvents.

In this contribution, we describe the single step simultaneous electrochemical exfoliation and functionalisation of graphene using diazonium compounds.[3] Using caesium salt (dissolved in dimethyl sulfoxide) the intercalating ions, functionalisation was achieved in combination with diazonium salt (either 4-nitrobenzenediazoniumtetrafluoroborate, 4 bromobenzenediazonium tetrafluoroborate or anthraquinone-1-diazonium chloride) as functionalisation moieties. We found that the presence of diazonium compounds in solution not only acts to functionalise the graphene but also aids the exfoliation through the generation of N_2 gas which assists the separation of the functionalised graphene layers. The functionalisation also enhanced the dispersibility of graphene in aqueous solution by two orders of magnitude and increased the charge storage capacity of graphene by three times because of the introduction of surface active redox reactions (Figure 1). Finally, we will introduce a simple electrochemical route for the synthesis of metallic phase trilayer MoS2 nanosheets.

References

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[2] A. J. Cooper, N. R. Wilson, I. A. Kinloch and R. A. W. Dryfe, Carbon, 2014, 66, 340-350
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Figures

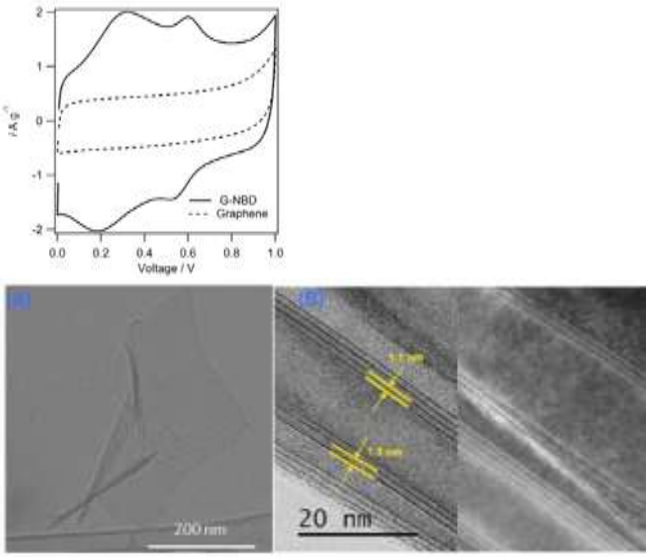

Figure 1: Figure 1: Cyclic voltammograms recorded at 100 mV s^{-1} in 6.0 M KOH (aq) using symmetrical coin cells constructed from electrochemical exfoliated restacked graphene and graphene functionalised insitu with 4-nitrobenzenediazoniumtetrafluoroborate (G-NBD) and high resolution TEM image of electrochemically exfoliated MoS_2 (A and B)