Design of Graphene-Based Nanomaterials for Energy and Environmental Applications

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Abstract

Graphene-based materials are poised to revolutionize the energy and environmental sectors due to their versatile nature, unique properties, and tunability, which make them strong candidates for a myriad of energy storage and environmental remediation applications. The doping and functionalization of graphene-based materials can also modify their electronic properties to enhance the utility of electrochemistry. Here, we present four different graphene-based nanomaterials: graphene oxide (GO), fluorine-doped graphene oxide (F-GO), interconnected reduced graphene oxide (ICrGO) and nitrogen-doped interconnected reduced graphene oxide (N-ICrGO) [1-5]. All were synthesized from high-purity graphite produced from the Albany graphite deposit, which is owned and currently under development by ZEN Graphene Solutions Ltd. GO and F-GO have a two-dimensional sheet morphology whereas ICrGO and N-ICrGO exhibit a three-dimensional interconnected morphology. The fabricated GO showed efficient dye adsorption properties due to the abundance of the C=O and O-H functional groups. The synthesized F-GO exhibitedhigh-performance for the simultaneous determination of ultra-low concentrations of multiple heavy metal ions such as Cd, Pb, Cu, and Hg. The novel ICrGO possessed a large specific capacitance for energy storage, while the N-ICrGO exhibited high catalytic activity for the oxygen reduction reaction. The effect of the morphology, modification and functionalization of these graphene-based nanomaterials on the environmental, sensing and energy applications are discussed.

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FIGURES

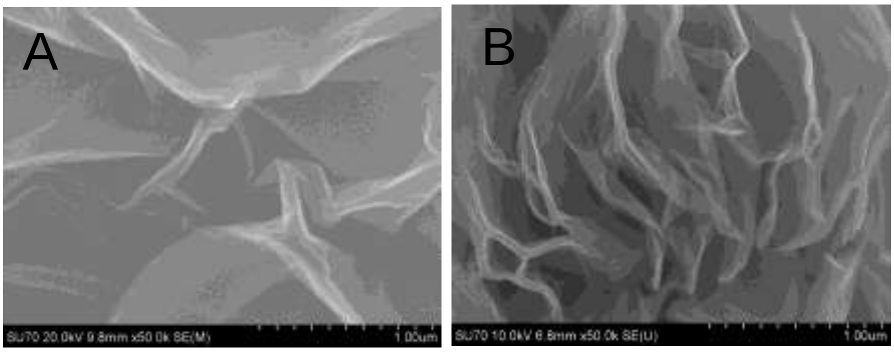

Figure 1: Scanning electron microscopic images of (A) F-GO and (B) N-ICrGO.

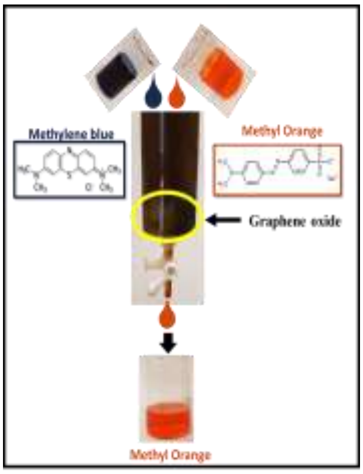

Figure 2: Schematic diagram of the use of GO for separation of different dyes.