**Abstract No: MO-07**

# Electrochemical conversion of graphite to graphene oxide and electrophoretic deposition of graphene oxide

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Graphene and graphene oxide (GO) have gained huge importance in multiple fields, including chemistry and physics due to the desirable and incomparable properties which they possess. Practical applications of graphene and graphene related materials (GRM) such as graphene and GO is a progressive topic in the research world. Various methods are available for the synthesis of graphene and GO. Conventional chemical methods have the drawbacks of the evolution of toxic gases, which are highly expensive and environmentally unfriendly. Current approaches targeted on increasing the yield of GO synthesis with minimal environmental effects using vein graphite obtained from Bogalapathala, Sri Lanka. The electrochemical methods are much more favoured since they are scalable, high yielding, cost effective and less time consuming. In this work, an electrochemical synthesis method was followed in the production of GO by oxidizing graphite and subsequently, its electrophoretic deposition was carried out on various substrates. During the first part of the research, electrochemical exfoliation of graphite to GO was carried out using $(NH_4)_2SO_4$ solution as the electrolyte. Initially, a cylindrical graphite pellet was made using graphite powder and was covered with a cellulose bag. Electrolysis was carried out by using the prepared graphite pellet as the anode and carbon electrode as the cathode. Various experimental conditions were tested to find out the optimum conditions which give rise to an efficient electrolysis with a maximum production yield of GO. Concentration of $(NH_4)_2SO_4$ was varied from 0.5 M to 1.0 M, electrochemical exfoliation time was varied from 1 to 8 hours, applied voltage was varied as 5 V, 10 V and 15 V, the temperature was varied from 30 °C to 50 °C and mechanical stirring speed was varied from 100 rpm to 300 rpm. The second part of the research is based on the electrophoretic deposition of GO. This was carried out by using Pt as one terminal and glass-FTO or the stainless steel substrate as the counter terminal. The process was carried out using a mixture of N,N- DMF and $MgCl_2.6H_2O$ as the dispersion medium. The GO coatings were annealed at 350 °C under $N_2$ atmosphere as the post electrophoretic deposition treatments. The experiments resulted in a maximum yield of 59.25% of GO. The UV-Visible, the FTIR spectra and XRD diffractograms obtained confirmed the formation of GO. The two main factors which cause the exfoliation of graphite are; intercalation of ions between the adjacent layers of graphite and the expansion of graphite induced by the evolution of gases at the electrodes. This research revealed that the GO can be effectively synthesized using a $(NH_4)_2SO_4$ electrolyte (1 M) under an applied voltage of 15 V, at a temperature of 50 °C with mechanical stirring (300 rpm) for 8 hours. Moreover, a uniform coating of GO was deposited on the glass-FTO and stainless steel substrates in both organic and inorganic suspension media of N,N- DMF and $MgCl_2.6H_2O$, respectively. This communication brings a viable method of synthesizing GO from vein graphite, using an environmentally benign and less costly method, into the spotlight.

**Keywords:** Ammonium sulphate, Electrophoretic deposition, Exfoliation, Graphene oxide, Vein graphite.

**Acknowledgement:** Bogala Graphite Lanka Ltd., Sri Lanka, for providing Vein graphite for the research.