

Fabrication and characterization of water stable multi-layer graphene oxide membranes by potassium ion crosslinking

W R N M Bandara¹, J A Liyanage^{1*}, A R Kumarasinghe²

¹*Department of Chemistry, University of Kelaniya, Sri Lanka.*

²*Department of Physics, University of Sri Jayewardenepura, Sri Lanka.*

**Email: janitha@kln.ac.lk*

Graphene Oxide (GO) was synthesized from vein graphite sourced from Bogala mine using Improved Hummer's method. GO nano sheets are the oxidative exfoliation products of graphite. GO contains oxygenated functional groups attached to their basal planes and edges. GO membranes readily disintegrate in water, because GO sheets become negatively charged on hydration, and the electrostatic repulsion between GO sheets overcome the van der Waals attraction and hydrogen bonding. This represents significant obstacles to water treatment applications. Oxygenated functional groups allow GO nano sheets to be cross-linked with cationic metal ions. This improves the mechanical properties of the resulting membrane. The aim of this experiment is to stabilize the GO membranes *via* cross-linking with cationic metal ions. It was achieved by potassium ion cross-linking. On hydration with mechanical agitation GO membranes disintegrate immediately compared to the GO membranes cross-linked with potassium ions. At a high pH GO nano sheets become negatively charged and the cations are removed from nano sheets destabilizing the cation crosslinked nanosheets. Then cations become unable to crosslink GO nano sheets. Therefore it can be stated that aqueous acidic dispersions of GO are cross-linked with the selected cation, K⁺ to enhance the mechanical strength and water stability of GO membrane. Energy Dispersive X ray (EDX) was used to investigate for the incorporation of metal ions into the GO membrane. Scanning Electron Microscopy (SEM) images of low magnification indicate that cross-linked GO membranes have a wrinkled surface morphology compared to unmodified GO membranes. On crosslinking, the amounts of freely available carbonyl and epoxy functional groups decrease. Hence intensity of carbonyl and epoxy peaks have been decreased and peak positions have been shifted to lower wave numbers in the FTIR-ATR spectrum of potassium cross-linked membrane compared to unmodified membrane. Increase of elastic modulus was identified from tensile testing analysis of the modified GO membranes due to enhancement of mechanical strength on crosslinking.

Here, elastic modulus has been increased by 147% on crosslinking with K⁺. This confirms the ability of potassium ions to cross-link the GO membrane in the in-plane direction. Work is ongoing to further characterize the cross-linking by XRD, to identify the variation in d spacing on cross-linking and to find whether potassium ion cross-linking has been taken place in the stacking direction of GO membrane.

Keywords

Graphene oxide, stability of GO in aqueous phase, cross-linked GO, mechanical strength, elastic modulus