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Facile Preparation and Characterisation of Oxygen-rich Reduced Graphene Oxide for Improved Electrochemical Performance: A Preliminary Study

Mohamad Aliff Bin Ali Rahman[1], Soon Poh Lee[3,4], Kwok Feng Chong[3,4] and Ellie Yi Lih Teo[1,2*]

[1]Institute of Ecosystem Science Borneo, Universiti Putra Malaysia, 97008 Bintulu, Sarawak, Malaysia
[2]Department of Science & Technology, Faculty of Humanities, Management & Science, Universiti Putra Malaysia, 97008 Bintulu, Sarawak, Malaysia
[3]Faculty of Industrial Sciences & Technology, Universiti Malaysia Pahang Al-Sultan Abdullah, 26300 Gambang, Kuantan, Pahang Darul Makmur, Malaysia
[4]Centre for Advanced Intelligent Materials, Universiti Malaysia Pahang Al-Sultan Abdullah, 26300, Kuantan, Pahang Darul Makmur, Malaysia
*Corresponding author (e-mail: ellie_teo@upm.edu.my)

Graphene is an excellent candidate as an electrode material for supercapacitors due to its exceptional properties. Among the many synthesis routes, reduced graphene oxide (rGO) synthesised through modified Hummers' method followed by reduction has been the preferred route to obtain graphene due to its flexibility. Depending on the reaction condition, the degree of oxidation present on rGO will differ and affect its overall charge storage capability. But, the use of toxic reagents or harsh conditions will introduce environmental concerns. Herein, an environmental-friendly KCl was introduced to modify the degree of oxidation on rGO using a simple aggregation method. In this study, graphite oxide obtained through modified Hummers' method was modifiedwith KCl followed by reduction using ammonia to produce chemically-modified rGO (S-rGO).S-rGO obtained was then characterised using UV-Vis and FT-IR while its electrochemical behaviourwas studied with cyclic voltammetry. The UV-Vis and FT-IR analyses showed that the oxidationlevel of S-rGO increased linearly with the mass of KCl used. Specific capacitance calculated from the CV curves revealed that a 3.5 times enhancement was observed. The results revealed the possible modification on S-rGO using environmental-friendly KCl and its potential use as an electrode material for supercapacitors application.

Keywords: Surface modification; reduced graphene oxide; oxygen; aggregation; electrode

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Historically, the theory of nanotechnology was first conceived by Richard Feynman in the 1960s [1], which Norio Taniguchi later defined in 1974, the term nanotechnology as "…the processing of separation, consolidation, and deformation of materials by one atom or one molecule" [2]. In 2004, the successful extraction of 2-dimensional graphene layers via repeating micromechanical exfoliation revitalised and sparked a golden age of research and development for advanced nanomaterial with promising breakthroughs in various fields and applications [3], [4].

Graphene is a unique carbon allotrope with outstanding properties such as high electrical conductivity and optical transparency [5], attributed to its one-atom-thick layer and sp^2-hybridised hexagonal lattice arrangement. Research on graphene as an electrode material in electrical energy storage systems has been lively over the past two decades. However, the commercial implementation of graphene-based technology is almost non-existent due to several limitations such as; 1) impractical top-down synthesis pathways e.g., micromechanical exfoliation can only produce small amounts of graphene as well as, 2) expensive and complex bottom-up synthesis pathways via chemical vapour deposition (CVD) still hinder the upscale production of graphene [6].

Reduced graphene oxide (rGO) is a cost-effective substitute that shares similar physical, chemical and electrical traits with graphene. This material can be easily synthesised through the oxidation of bulk graphite material, forming GO precursor which can be reduced to minimise the presence of surface oxygen groups (hence the term reduced GO) [7]. Alternatively, recent findings on the use of rGO with varying degrees of oxidation as an active material for electrodes in electrical energy storage systems such as supercapacitors [8], redox flow batteries [9], [10], and lithium-ion batteries [11], showed improvements towards their electrochemical and capacitance performances.

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