UNIVERSITI TEKNOLOGI MARA

SYNTHESIS OF REDUCED GRAPHENE OXIDE FROM SUB-BITUMINOUS COAL USING ONE STEP PROCESSING AND MICROWAVE HEATING SYSTEM

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AUTHOR'S DECLARATION

I declare that the work in this thesis was carried out in accordance with the regulations of Universiti Teknologi MARA. It is original and is the results of my own work, unless otherwise indicated or acknowledged as referenced work. This thesis has not been submitted to any other academic institution or non-academic institution for any degree or qualification.

I, hereby, acknowledge that I have been supplied with the Academic Rules and Regulations for Post Graduate, Universiti Teknologi MARA, regulating the conduct of my study and research.

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ABSTRACT

Reduced graphene oxide (rGO) was produced from sub-bituminous coal by using graphitization-activation process alongside with microwave heating system as a heating media in order to reduce the production time. The process was carried out by using $FeCl_3$ and ZnCl as graphitizing and activating agents, respectively. There are two parameters of microwave power levels and irradiation times were setup in order to study its effects on the production process. The power levels and irradiation times were setup in range of 600 to 1000 W and 10 to 30 minutes, respectively. The surface functional group and crystal structure were analyzed by using Fourier Transform Infrared (FTIR) and X-Ray Diffraction (XRD) spectroscopies, respectively. Meanwhile, Raman spectroscopy was used in order to analyse the defects, ordered and dis-ordered carbon of rGO produced. Further, the surface area and surface morphology of rGO produced were analyzed by using Bruneur Emmet Teller (BET) analysis, Scanning Electron Microscope (SEM) and Transition Electron Microscope (TEM), respectively. Specific capacitance value was determined by using Automatic Battery Cycler. G930 is rGO produced at power level and irradiation time of 900 W and 30 minutes, respectively was chosen as the most optimum product based on the results of FTIR, XRD and Raman spectroscopies, as well as product yield. G930 has two peaks at wavelength of 1083 and 1580 cm^{-1} of FTIR spectra assigned to C−O−H of stretching epoxy groups and C=C of skeletal vibration of graphene layers, respectively. XRD pattern of G930 has (002) peak at around $2\theta = 26^{o}$ which corresponding to the interlayer spacing of 0.35 nm. Based on Raman, the G930 has three band of D, G and 2D band at 1345, 1592 and 2800 cm^{-1}, respectively with I_D/I_G ratio of 1.31. It was found that the rGO produced has high BET surface area and specific capacitance value of 1463.103 m^2g^{-1} and 253.42 Fg^{-1}, respectively with 48 % of product yield. SEM and TEM analyses shows that the rGO produced has a very good porous structure consists of multilayer graphene. Thus, it can be concluded that the graphitization-activation method has successfully produced a good quality of rGO from coal in a single step process, as well as reduced the production time. The rGO produced also was found to have a good potential to become as an electrode material for supercapacitor due to its high specific capacitance value.

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