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Synthesis and Characterization of Nanomaterials in Energy Harvesting and Storage Application

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Structured Abstract

Background: In an era defined by the urgent need for sustainable energy solutions, nanomaterials have emerged as game-changers in energy harvesting and storage technologies. One example of nanomaterials are graphene, a two-dimensional nanomaterial composed of layer of carbon atoms. Their extraordinary properties such as high electrical and thermal conductivity, a huge surface area and mechanical strength makes graphene a good candidate for advancing in photovoltaics, batteries and supercapacitors for sustainable energy system. This study employs graphene as the main nanomaterial used to propagate its potential in supercapacitors. The purpose of this study is to investigate the performance of graphene nanomaterials in charge-discharge and storage applications in supercapacitors.

Methods: The graphene is synthesize using electrochemical exfoliation. In this process, a graphite electrode is immersed in an aqueous electrolyte, which is a dilute H_2SO_4 and a potential of 5V to 10V is applied using a power supply for 30 minutes. This causes an intercalation of electrolyte ions into the graphite layers. The van der Waals force holding the graphite layers together will be weaken causing the exfoliation of graphene sheets. The graphene sheets were then collected and washed to remove residuals ions with a deionized water and dried in the oven in 60°C for 4 hours.

Results: This study shows that graphene was successfully synthesise from graphite, which produces a graphene sheet. The result in cyclic voltammetry of graphene-$BaTiO_3$ shows that it exhibits a quasi-rectangular CV curve with characteristic of double-layer capacitance behaviour which is ideal for supercapacitor applications. The results obtained also confirm that the $BaTiO_3$ improves charge storage capacity by enhancing the dielectric properties of graphene. Other than that, the result of cyclic voltammetry of graphene-MnO shows that it exhibits elliptical shape showing a pseudocapacitive behaviour from MnO. It shows that the CV curve serve a good charge-discharge reversibility in electrochemical performance.

Conclusion: In conclusion, the findings of this indicates that graphene-$BaTiO_3$ and graphene-MnO exhibit promising charge storage properties with graphene-$BaTiO_3$ offers high stability and good reversibility while graphene-MnO has the higher potential for high energy storage capacity. This study highlights the potential of graphene-based nanocomposites in energy harvesting and storage applications, particularly in supercapacitors.

Keywords: Graphite, Electrochemical exfoliation, cyclic voltammetry, charge storage capacity, charge-discharge performance

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