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SYNTHESIS OF POROUS GRAPHENE MATERIALS FOR SUPERCAPACITORS IN THE PRESENCE OF PHOSPHORUS-BASED ADDITIVES

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The worldwide energy crisis has led to the development of green and high-performing energy storage devices. Supercapacitors' high power density and miniaturization have made them a vital device for energy storage. Graphene is a perfect electrode material for supercapacitors. However, graphene synthesised through less sophisticated approaches like electrochemical exfoliation tends to restack because of the strong van der Waals interactions between graphene layers. This results in hindrances to the intrinsic characteristics, electron mobility rate, and penetrating power of the electrolyte. The majority of high-quality graphene manufacturing techniques are complex, costly, and require hazardous oxidizing chemicals. Therefore, the main objective of this study was to produce high-quality porous graphene (PG) with reduced restacking through a sustainable, innovative electrochemical approach. Porous graphene materials (PG-PA, PG-EA) were separately synthesised via electrochemical exfoliation with phytic acid (PA) and etidronic acid monohydrate (EA), respectively, as the additives. Synthesised PGs were characterised structurally and electrochemically. The absorbance band of ~ 270 nm in UV-Vis data verified the formation of graphene. Scanning electron microscopy confirmed the formation of a porous morphology. The synthesis of porous graphene was further confirmed by Raman spectroscopic analysis, resulting in an ID/IG ratio of 0.67 for PG-PA. The FT-IR spectra verified that the phosphorus atoms are not incorporated into the PG structure. The rectangular shape with a wider range potential window exploited in the cyclic voltammetry performed over the 5-100 mV/s range, demonstrating the electric double-layer capacitive behaviour, and electrochemical impedance spectroscopy, galvanostatic charge-discharge confirmed the improved capacitive behaviour of the synthesised PG. The specific capacitances of PG-PA and PG-EA are 21.1 F/g and 19.2 F/g, respectively, at a scan rate of 5 mV/s, and this enhancement can be considered as 42.2% and 29%, respectively, compared with the graphene sample. These characterization results validate the successful synthesis of PG with enhanced electrochemical performance in a more economical and environmentally friendly approach.

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