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Optimising the fabrication of 3D binder-free graphene electrode for electrochemical energy storage application

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Highlights

â€¢ 3D binder-free graphene electrode exhibits excellent properties.
â€¢ Rapid and cost-effective fabricating of binder-free electrode
â€¢ Remarkable electrochemical performance (specific capacitance of 62.07Â F/g)
â€¢ Potential electrode candidate for enhanced electrochemical performance

Abstract

Herein, a one-step fabrication of three-dimensional (3D) binder-free graphene-nickel foam (G-Ni) electrode via atmospheric pressure chemical vapour deposition (APCVD) is reported. Graphene thin films were deposited on nickel foam under isobaric conditions in an inert environment. The process parameters such as temperature, time, and the gas flow rate were statistically optimised using design of experiment (DOE) to maximise the yield of graphene. The structural and morphological properties of the fabricated graphene electrode were investigated through X-ray diffraction (XRD), Raman spectroscopy, field emission scanning electron microscopy (FESEM), and energy dispersive X-ray spectroscopy (EDS). The electrochemical investigations were conducted through cyclic voltammetry (CV) and

electrochemical impedance spectroscopy (EIS) measurements. The results confirmed few-layered graphene with good surface morphology, high purity, and crystallinity of a binder-free electrode. The statistical analysis revealed that the optimal graphene electrode fabrication conditions were 900Â Â°C, 10Â min, and 100 sccm, respectively. Moreover, the regressed model and experimental results for the graphene growth were determined to be 3.93Â mg/cm^2, and 4.01Â mg/cm^2, respectively. Electrochemically, a specific capacitance value of 62.07Â F/g was recorded at a scan rate of 3Â mV/s showing an excellent performance of the fabricated 3D graphene electrode for energy storage applications.

Keywords

Graphene, ; Binder-free electrode, ; Energy storage, ; Metal oxides, ; Electrodeposition, ; Supercapacitors, ;

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