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Fabrication of 2D Nanostructured Hybrid Material-Based Devices for High-Performance Supercapacitor Energy Storage

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Abstract : Supercapacitors have emerged as a leading energy storage technology, gaining popularity in applications like digital telecommunications, memory backup, and hybrid electric vehicles. Their appeal lies in a long cycle life, high power density, and rapid recharge capabilities. These exceptional traits attract researchers aiming to develop advanced, cost-effective, and high-energy-density electrode materials for next-generation energy storage solutions. Two-dimensional (2D) nanostructures are highly attractive for fabricating nanodevices due to their high surface-to-volume ratio and good compatibility with device design. In the current study, a composite was synthesized by combining MoS2 with reduced graphene oxide (rGO) under optimal conditions and characterized using various techniques, including XRD, FTIR, SEM and XPS. The electrochemical properties of the composite material were assessed through cyclic voltammetry, galvanostatic charging-discharging and electrochemical impedance spectroscopy. The supercapacitor device demonstrated a specific capacitance of 153 F g-1 at a current density of 1 Ag-1, achieving an excellent energy density of 30.5 Wh kg-1 and a power density of 600 W kg-1. Additionally, it maintained excellent cyclic stability over 5000 cycles, establishing it as a promising candidate for efficient and durable energy storage solutions. These findings highlight the dynamic relationship between electrode materials and offer valuable insights for the development and enhancement of high-performance symmetric devices.

Keywords : 2D material, energy density, galvanostatic charge-discharge, hydrothermal reactor, specific capacitance
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