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Facile Synthesis of Advanced Nanostructured Conducting Polymer-Reduced Graphene Oxide Hybrid Composites for Energy Storage Devices

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Extended Abstract

The surge in supercapacitor exploration is driven by rising demand for their advanced energy storage devices. Supercapacitive materials offer high-power density, long charge/discharge rates, and extended cyclic stability. Yet, innovation in electrode materials is crucial for further performance enhancement. Nanostructures integrating graphene-based conducting polymers emerge as promising contenders, combining the unique attributes of both materials [1]. Despite their advantages, limitations like low performance, cyclic stability and material depletion persist in conducting polymers [2]. Refining their microstructure and morphology shows potential to boost efficiency. Doping polymers with various carbon materials minimizes stability issues during charge-discharge cycles. Additionally, pioneering electrolytes with broader electrochemical thresholds can reduce material depletion [3]. Among carbon materials, graphene stands out for its properties [4]. Further improvements in manufacturing techniques, such as controlling doping concentrations and optimizing weight ratios, enhance mechanical stability and increase electrode capacitance and cyclic stability [5]. In the present study we synthesized the composite materials incorporating reduced graphene oxide and conducting polymers (polyaniline and polypyrrole) via an in-situ chemical polymerization method, meticulously varying polymer to reduced graphene weight ratios. In this endeavour, reduced graphene oxide was synthesized via a modified Hummer's method [6]. Thorough characterization of these fabricated samples ensued, employing a comprehensive suite of analytical techniques such as Fourier transform infra- red (FTIR) spectroscopy, Raman spectroscopy, Transmission electron microscopy (TEM), X-ray photoelectron spectroscopy (XPS), X- ray diffraction (XRD) and cyclic voltammetry. These analyses unveiled profound insights into the structural and electrochemical properties of these hybrid nanostructures, underscoring their immense potential in reshaping energy storage devices and driving strides towards sustainable energy solutions.

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