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Covalent intercalation of hydrazine derived graphene oxide as an efficient 2D material for supercapacitor application

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ABSTRACT

Herein, we demonstrate a covalent modification of hydrazine functionalized graphene oxide (FGO-H) using a protected tert-butyl carbazate (t-boc) as an intercalating agent over the GO surface and investigated as electrode candidates for electrochemical supercapacitor applications. The resulting functionalized materials were examined by different physicochemical techniques to investigate the physical and structural features of the as-made functionalized GO materials. The favorable method for the surface modification of GO is achieved by treating the primary amine of t-boc with the epoxide groups on the surface of GO. The FGO-TBpa electrode materials lead to the covalent coordinating moieties in between the basal planes of GO by enlargement of interlayer spacing of 1.8 nm from 0.9 nm. More importantly, the functionalized FGO-H can encourage the diffusion of electrolyte ion and result in the enhanced supercapacitance features. Notably, the FGO-H electrode has revealed a comparatively higher specific capacitance of 305 F g^{-1} at 1 A g^{-1} and showed excellent capacitance retention of 90%. The functionalized GO-based energy materials will have incredible impending applications in the energy-related systems.

1. Introduction

The increasing worldwide crisis for clean energy sources and environmental pollution has attracted considerable attention since the last decade. To efficiently preserve these limited energy sources, cost-effective, environmentally friendly, dependable, and durable energy storage materials become urgently needed for storage systems [1,2]. During the past few decades, electrochemical supercapacitors have fascinated tremendous consideration due to its unique characteristics of rapid great specific power, shorter charging time, long-term cycling stability properties, flexible, light-weight, and eco-friendly, etc. [3]. Based on the mechanism, electrochemical supercapacitors can be split up mainly into two phases: the electrical double-layer capacitors (EDLC) and the pseudocapacitors (PC) (redox supercapacitors) and hybrid capacitors. EDLCs are based on store charges in a non-faradic process forming adsorption at the electrode-electrolyte interface, while PCs are built on faradic processes. For EDLCs, carbonaceous materials are the most appropriate materials; because of their excellent electron transport, fine wettability with the electrolyte, lower production cost, large specific surface area, admirable chemical, and electrochemical stability [4–9].

Among the carbonaceous materials, graphene oxide (GO) receives considerable attention for its distinctive electronic nature proceeding from the existence of both localized sp^3 and sp^2 carbon, subsequent guaranteed applications in the recent technologies [10–15]. Also, GO renders different options to design new-kinds of supported materials owing to its various existing kinds of oxygenated functional groups [16]. Further, the oxygenated functional moieties on the surface of graphite

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