Research Article

Synthesis of mesoporous carbon-polymeric hybrid material for energy storage application

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Abstract

The overarching goal of this study is fabrication and evaluation of mesoporous carbon-polymeric hybrid electrode materials derived by in situ polymerization of aniline on mesoporous carbon. The mesoporous carbon (CMK-3) was prepared using mesoporous silica SBA-15 as a hard template. The characteristics and functional groups of synthesized mesoporous carbon-polyaniline composite confirmed by Fourier-transform infrared spectroscopy, Raman spectroscopy, Thermo gravimetric analysis, X-ray powder diffraction, and BET surface area analysis. The electrochemical performance of carbon-polyaniline composite was evaluated through its supercapacitor behavior in the electrolyte Potassium bicarbonate ($KHCO_3$). Synthesized carbon-polyaniline was used as the working electrode after modification with Nafion solution on glassy carbon electrode. The hybrid material reveals high current density with increased storage efficiency due to uniform confinement of polyaniline into the pore structure of CMK-3. The high specific capacitance of 487 F/g was observed on carbon-polyaniline electrode at 0.2 A/g in $KHCO_3$, and also reveals better stability, retained 90% efficiency after 1000 charge–discharge cycles. Thus, the prepared carbon-polyaniline composite exhibit as a good candidate in supercapacitor application.

Keywords Mesoporous carbon · Polyaniline · Cyclic voltammetry · Supercapacitor · Energy storage

1 Introduction

Recent days, there exist greatest challenges in the developing energy storage system that could efficiently harness energy produced from various renewable energy sources influenced by the location and time. Thus, it is highly desirable to develop energy storage system with high efficiency, high energy storage capacity and low cost so that the stored energy can be used for portable electronic devices and hybrid electric vehicles [1, 2]. Among various energy storage system, batteries and supercapacitors are considered as excellent candidates. As far as batteries are concern can accommodate large energy with poor cycle life [3], whereas, supercapacitors can provide large power density and long cycle life with better charge–discharge properties [4]. The supercapacitors are performed based on the interaction between the active electrode materials [5] and electrolyte. Hence, the supercapacitor studies provide an opening to explore new possibilities of electrode materials as well as electrolyte. Previous reports demonstrate that the transition metal oxides and conducting polymers are successful electrodes materials for supercapacitors due to their predominantly fast and reversible surface for charge storage [1, 5–9]. Also, conducting polymers like polypyrrole and polyaniline (PANi) have been well-established as electrode material in supercapacitor applications, in terms of flexibility, high conductivity, and synthetic process [10–13]. Especially, polyaniline has attracted great interests in energy storage, sensors, and electrochromic devices because of the simple synthesis route [14] and doping/de-doping chemistry [15], low cost, high conductivity, and excellent

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SN Applied Sciences (2019) 1:509 | https://doi.org/10.1007/s42452-019-0509-1

Received: 7 March 2019 / Accepted: 17 April 2019

Published online: 02 May 2019