DOI: 10.4172/2325-9655-C3-025

21st International Conference on

Past and Present Research Systems on Green Chemistry

August 27-28, 2018 | Boston, USA

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Development of high-performance supercapacitors based on hybrid nanocomposite materials: A green approach for energy storage

Recently, electrochemical supercapacitors or ultracapacitors are developing eye-catching technology to the world that comes under the electrochemical energy storage and conversion class along with batteries and fuel cells. As an origin of clean and renewable energy, supercapacitor provides superiority in power density, less charging time, high electrochemical reversibility and longer cyclic life as compared to batteries and fuel cells. However, the only demerits of supercapacitors that limit their wide range of applications are insufficient energy density (<10 Wh.kg-1) and high production cost. The purpose of the present study is to develop a simple, cost-effective, environmental friendly yet facile method for the preparation of hybrid nanocomposites and their successful application for development of high-performance supercapacitors. In one of the approaches, Co-based metal-organic framework (CoBTC MOF) was synthesized by mechanochemical grinding and further its nanocomposite with graphene (GNS) was prepared by reduction of graphene oxide in presence of CoBTC MOF. The material was then characterized by surface analytical techniques as well as electrochemical methods. The combination of the pseudo-capacitive behavior of CoBTC MOF (faradaic + intercalation) and double layer capacitive behavior of GNS delivers high specific capacitance of 608.2 F.g-1 at the current density of 0.25 A.g-1 showing its great potential as an energy storage material. Further, symmetric supercapacitor was assembled for practical application of CoBTC MOF/GNS which delivered specific capacitance of 153.7 F.g-1 with a high energy density of 6.4 Wh.kg-1 and power density of 232.5 W.kg-1. It also manifests 92.1% retention of initial capacitance after 5000 charge-discharge cycles which prove its excellent cyclic stability. The combination of faradaic and non-faradaic charge storage mechanism is responsible for its improved charge storage capacity resulting into better performance. We believe that such encouraging results can open a new avenue to design and fabricate high-performance supercapacitors in the near future.

Biography

Ashwini K Srivastava is a professor of analytical chemistry at the department of chemistry, University of Mumbai, India. He obtained his Master's and PhD degrees from Banaras Hindu University, India. He has supervised a large number of Masters, Postdoctoral, and 26 PhD students. He has published 125 research papers in peer-reviewed journals with over 3100 citations and 29 h-index. His research activities have spanned diverse areas including electrochemical (bio) sensors, functional nanomaterials, energy storage, environmental pollution and chromatographic separations. His work is mainly focused on the development of sensors for trace level detection of biologically active molecules: vitamins, amino acids, and neurotransmitters; analgesics, cardiovascular and psychiatric drugs; environmental pollutants: pesticides and metals. His recent interest involves the synthesis of a variety of nanocomposite materials for fabrication of energy storage devices like high-performance supercapacitors.

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