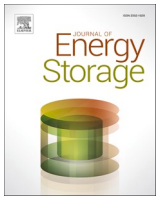
Journal of Energy Storage 68 (2023) 107821

Contents lists available at ScienceDirect

Journal of Energy Storage

journal homepage: www.elsevier.com/locate/est



Research Papers

Construction of high-capacitance carbonate-rich bimetallic layered (hydr) oxides onto ZIF-67–derived Co/CoO-N-carbon hybrid cubes for high-performance symmetric supercapacitors☆

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ARTICLE INFO

Keywords:
Bimetallic hydroxides
Energy storage
Hybrid catalyst
Supercapacitor
ZIF-76–derived N-carbon

ABSTRACT

Herein, we fabricated carbonate-rich bimetallic layered hydr(oxides) ($CoMnO_x$), which are primarily used as active materials for supercapacitors, using a simple hydrothermal method. $CoMnO_x$ was deposited onto cobalt oxide (CoO), which was produced by pyrolyzing ZIF-67 at 800 °C under N_2 atmosphere. The Co/CoO cubes synthesized using carbonized ZIF-67 (ZIFC) were covered with $CoMnO_x$ shells with high reduction efficiency and abundant Co active sites and surface O species. The effects of the carbonate species present between the $CoMnO_x$ layers and at the surface of the hybrid $CoMnO_x$@ZIFC materials were evaluated using PXRD and XPS. The peaks at the binding energies of 290 and 400 eV in the C 1s and N 1s XPS profiles of $CoMnO_x$@ZIFC, respectively, indicate the presence of carbonate species and coordination of CoO and Co with the N-rich carbon materials, respectively. The FE-SEM images of $CoMnO_x$@ZIFC revealed the partial decomposition of the cubic structure of ZIFC, which agreed with previously reported data. Moreover, the elemental composition of $CoMnO_x$@ZIFC was confirmed using EDS mapping and point analysis. The $CoMnO_x$@ZIFC electrodes exhibited a remarkable specific capacitance/capacitor of 963 F g^{-1}/588 C g^{-1} at 1 A g^{-1} and excellent cycling stability over 1000 cycles, which was superior to those of previously reported MOF-derived carbonate-based materials in alkaline electrolytes. The $CoMnO_x$@ZIFC||$CoMnO_x$@ZIFC symmetric supercapacitor exhibited an energy density of 60.75 W h kg^{-1} with a power density of 5947 W kg^{-1} and an exceptional cycling stability (>99.5 %) after 3000 cycles.

1. Introduction

Batteries and supercapacitors (SC) play critical roles in energy storage devices. Batteries are widely used because of their high capacity; however, they present sluggish kinetics owing to the slow ion transport between the electrode and electrolyte [1]. Moreover, batteries exhibit low rate capacities and short lifetimes. In contrast, SCs overcome the disadvantages of batteries by providing high cycling stability, excellent performance, and long cycling life of up to 10,000 charge–discharge cycles [2,3]. According to their mechanism, SCs can be divided into electrical double-layer capacitor (EDLC), pseudocapacitors (PC), and battery SCs, also known as hybrid SCs (HSCs), which are fabricated using materials comprising carbon, polymer composites, and metal-based oxides [4–6]. PC works by fast faradaic reactions and ion

☆ **Dedication**: This article is dedicated in memory of Prof. S. Abraham John, Department of Chemistry, The Gandhigram Rural Institute, Gandhigram, Tamil Nadu, India, for his outstanding contributions to the field of electrochemistry.

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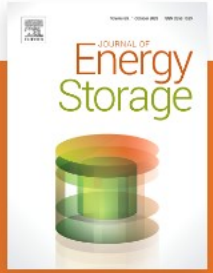
https://doi.org/10.1016/j.est.2023.107821
Received 7 February 2023; Received in revised form 2 May 2023; Accepted 21 May 2023
Available online 1 June 2023



Journal of Energy Storage

10.3
CiteScore

9.4
Impact Factor