ScienceDirect

Materials Today: Proceedings

Volume 67, Part 8, 2022, Pages 1001-1004

Synthesis of nickel ferrite for supercapacitor application

Rajiv Kumar [a], Rahul Kumar [b], Prasanta Kumar Sahoo [c], Mamraj Singh [a], Ankur Soam [c]

[a] Department of Physics, University of Rajasthan, Jaipur 302004, India
[b] Department of Energy Science and Engineering, IIT Delhi, New Delhi 110016, India
[c] Department of Mechanical Engineering, Siksha 'O' Anusandhan University, Bhubaneswar 751030, Odisha, India

Available online 6 June 2022, Version of Record 21 October 2022.

https://doi.org/10.1016/j.matpr.2022.05.433

Get rights and content

Abstract

In this study, nickel ferrite ($NiFe_2O_4$) nanoparticles synthesized by a solution based approach have been investigated for supercapacitor application. To prepare the electrode of supercapacitor, $NiFe_2O_4$ nanoparticles were deposited on a stainless steel substrate by drop casting method. The structural and morphological properties of the synthesized $NiFe_2O_4$ nanoparticles were investigated by XRD and SEM techniques. The electrochemical performance was investigated in an aqueous electrolyte and in two electrodes configuration. A specific capacitance of ~ 120F/g has been obtained from $NiFe_2O_4$ nanoparticles. Electrochemical properties suggest that $NiFe_2O_4$ can be utilized as effective electrode for supercapacitor.

Introduction

Supercapacitors are being considered as efficient charge storage devices [1], [2], [3]. Supercapacitor can be charged completely in few seconds and therefore it is suitable to be used with a battery to minimize the load on the battery [4], [5], [6], [7], [8]. The charge storage capacity of supercapacitor depends on the electrode properties hence several electrode materials such as carbon, metal oxides, ferrites etc have been investigated as electrodes [9], [10], [11], [12], [13]. Ferrites with the structural formula MFe_2O_4 are the most attracting class of materials because of their many technical applications such as in photoelectric devices, catalysis, sensor, nano devices, and microwave devices. They have very interesting and important properties such as low saturation magnetic moment and magnetic transition temperature. With large surface area and high chemical stability in aqueous electrolyte, ferrite nanostructures have recently been considered as efficient candidate for supercapacitor [12], [13]. Moreover their mixed oxidation states can enhance charge storage property of the electrode. Supercapacitors are divided into two categories based on the charge storage mechanism, 1) Electric double layer capacitor (EDLC) where the energy is stored physically at the electrode surface and 2) pseudocapacitor which involves redox reaction between the electrode and electrolyte to store the charge. A large capacitance of MFe_2O_4 as electrodes is due to the redox reactions whereas they exhibit almost negligible EDL capacitance. Among the ferrites, $NiFe_2O_4$ has been considered a potential candidate as electrode in supercapacitor [12], [14], [15]. The electrochemical properties of $NiFe_2O_4$ are governed by its structure and morphology which can be easily controlled by the synthesis parameters. S. Anwar et al. [16] have studied the electrochemical behavior of $NiFe_2O_4$ prepared by different process. $NiFe_2O_4$ synthesized by sol–gel method showed the highest specific capacitance of 97.5 F/g. A. Ghasemi et al. [17] have synthesized $NiFe_2O_4$ nanospheres via a novel synthesis process to be used in supercapacitor. A maximum specific capacity of 137.2 F/g at 4 A/g could be achieved from the nanospheres. The mesoporous $NiFe_2O_4$ nanoparticles exhibited a very high value of specific capacitance of 1040 F/g and good cycling stability [18]. This high value of the capacitance results from the high surface area and fast electron and ion transport on the electrode surface. It is clear that optimizing the morphology of