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Facial growth of $Co(OH)_2$ nanoflakes on stainless steel for supercapacitors: effect of deposition potential

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Abstract

In this work, the nanoflakes of $Co(OH)_2$ have been grown successfully on a stainless steel (SS) substrate at an ambient temperature. The novel architecture, binder free synthesis and considerable capacitance of $Co(OH)_2$ nanoflakes render them as a potential candidate to be used as an electrode material for supercapacitor application. It is observed that the different cathodic potentials have a dramatic impact on the growth mechanism of $Co(OH)_2$ nanoflakes. The prepared thin films were subjected for their structural and morphological study using X-ray diffraction, field emission scanning electron microscope, energy dispersive X-ray spectroscopy, etc. The supercapacitive properties of $Co(OH)_2$ nanoflakes have been studied using cyclic voltammetry, galvanostatic charge–discharge and electrochemical impedance spectroscopy techniques. The $Co(OH)_2$ nanoflakes evaluated a maximum specific capacitance of 275 F g^{-1} for 5 mV s^{-1} in 1 M KOH.

1 Introduction

The supercapacitors are promising energy storage devices for renewable energy sources such as geothermal energy, solar energy, wind energy, etc. [1, 2]. In supercapacitor, a variety of attempts have been made to combine the power density of capacitors with the energy density of batteries [3]. Due to that, the much attention has been focused on synthesis of efficient electrode materials for supercapcitor application. There are two types of energy storage and electrochemical conversion involve in electrode materials. These electrochemical conversion includes double layer conversion and pseudocapacitive conversion. The most of electrodes are comprised of carbon based materials such as graphite, carbon cloth, activated carbon, and carbon aerogels, etc. which are promising materials for double layer storage. On the other side, most commonly used pseudocapacitive materials involves conducting polymers, metal oxides and hydroxides including RuO_2, NiO, MnO_2, Co_3O_4, $Ni(OH)_2$, $Co(OH)_2$, etc. [1–8]. Among these, $Co(OH)_2$ can be regarded as a promising electrode material due to its low cost, high theoretical capacitance, high redox activity, and reversibility [9–11]. Also, $Co(OH)_2$ is considered as attractive materials for wide applications such as glucose sensors [12], lithium storage performance [13], photoelectrochemical water reduction [14], super-hydrophobic [15], inflammatory and antioxidative [16], solar hydrogen production [17], photodegradation [18], etc., Due to its large surface area, cyclic stability, high reactive area, large interior space, and environmentally friendly characteristics [19].

Recently, for supercapacitor application Suksomboon et al. reported Ag doped $Co(OH)_2$ coated graphene [20], Li et al. reported RuO_2 nanoparticles coated on $Co(OH)_2$ nanoflakes [21], Dong et al. reported $Co(OH)_2$-activated carbon composite [22], Weng et al. synthesized $Co(OH)_2$-graphene oxide nanocomposite [23], Zang et al. and Kong et al. reported precipitation method for $Co(OH)_2$ nanoplatelets and nano-flakes [24, 25]. There are several methods available for the synthesis of $Co(OH)_2$, such as hydrothermal [26], chemical bath deposition [27], microwave assisted [28] electrodeposition [19] etc. Among these methods and reports, the electrodeposition is binder free, facial, single step, economical, convenient, and attractive

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