



Review of Metal Oxide Thin Film Based Supercapacitors

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Abstract- Metal oxide thin films based supercapacitors known for several decades and are those used as for storing the potential energy. Presently research had done on energy storage methods namely redox electrochemical capacitors, the electrochemical double layer capacitor, metal oxides and conducting polymers. Recently, many chemically deposited metal oxide thin film electrodes including MnO_2 , Co_3O_4 , NiO , Fe_3O_4 etc. have been tested in supercapacitors. From this review data of metal oxide thin films proposed to play a major role in supercapacitor technology.

Key words: - Metal oxide, thin film, supercapacitors and electrochemical depositions.

1. Introduction:-

Survey through literature of supercapacitors shows that, different types of metal oxide thin films have been studied. Namely, thinfilms of MnO_2 , NiO , Co_3O_4 , Fe_3O_4 , Bi_2O_3 , NiFe_2O_4 , BiFeO_3 etc

Electrochemical capacitors are attracting significant interest in power storage of electric and fuel cell vehicles. Electrochemical capacitors classified namely electric double layer capacitor and redox supercapacitor. Redox supercapacitors make use of a reversible redox reaction in rechargeable battery more than a traditional capacitor. In the case of redox supercapacitors, various noble and transition metal oxides (e.g., RuO_2 , CoO_x , NiO_x , MnO_2 , etc.) and conducting polymers have been employed as electrode materials. Among these materials, ruthenium oxide has been found to be a successful redox supercapacitor exhibiting a specific capacitance up to 720 F/g. However, cost is

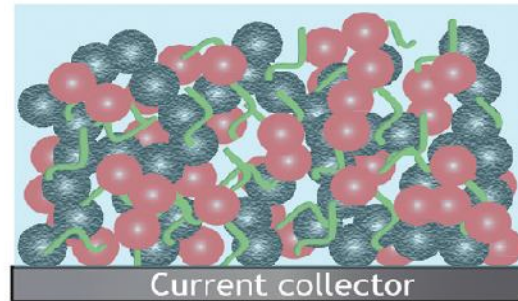
high in the large-scale commercial production of ruthenium oxide as a redox supercapacitor.

Several methods including hydrothermal synthesis, chemical bath deposition, sol-gel method, and co-precipitation, have been used to produce electrodes for electrochemical capacitors.

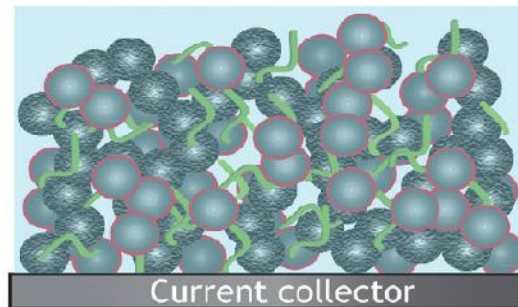
A more effective method to prepare metal oxide electrodes for electrochemical capacitor applications is electrodeposition because it leads to a direct deposition of oxide films on an electrode. There are also several reports that binary metal oxides such as manganese-nickel oxide and manganese-cobalt oxide enhance the electrochemical capacitive performance of manganese oxides and have better electrochemical properties than single metal oxide. Electrodeposition has been proven to be an effective method to prepare a Nanocomposite film, which has potential for real application as a supercapacitor electrode material, which

contributes to the cycling capability and stability of the Nano composite.

Composite electrode: 1st generation



Composite electrode: 2nd generation



Nanoarchitected electrode

metal oxide-coated carbon architecture

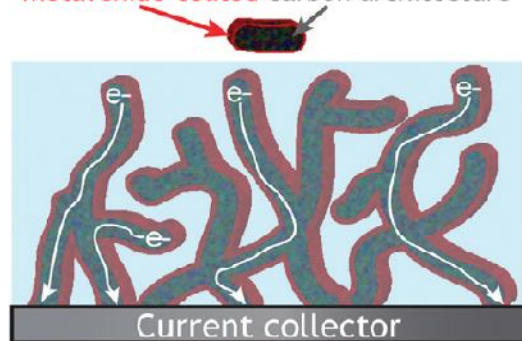


Figure1: Schematic of electrolyte-infiltrated electrode structures incorporating electron paths, active, and inactive materials, using

composites, versus a nano architecture incorporating electron paths wired to the active material.

2 Literature Review

2.1 Nanostructured materials deposition:

Nanostructured materials have been extensively studied during the last decade due to their interesting electronic, magnetic, electrochemical and optical properties and potential use as catalytic- and electrode materials in various devices. Nanocrystalline metals and alloys have been achieved using pulses of high current density, while the effect of organic additives on Nanocrystalline copper has been specifically studied. Nanocrystalline metal oxides have been prepared using oxidizing conditions in a non-aqueous medium.

2.2 Deposition of metal oxides:-

The deposition of metal oxides from aqueous solutions is mainly alkaline solutions containing metal complexes. Electrochemical deposition of metal oxides can be carried out under oxidizing conditions as well as reducing conditions from alkaline solutions. In both cases, the metal ion dissociates from the complex and precipitates on the electrode as the oxide. What controls the ability to deposit an oxide is the stability of that oxide under the experimental conditions, i.e. the potential, temperature and pH.

2.3 Formation Mechanism of the Electrodeposited Mn-Ni Oxide Films:-

The electrodeposition of Mn-Ni oxide films for use as an electrochemical capacitor electrode was carried out in a bath

containing manganese acetate and nickel chloride. SEM studies showed that the Mn-Ni oxide film was well covered with numerous nanofibers in a three-dimensional network. Porous spaces were also observed between the nanofibers, which are required for electrochemical capacitor applications.

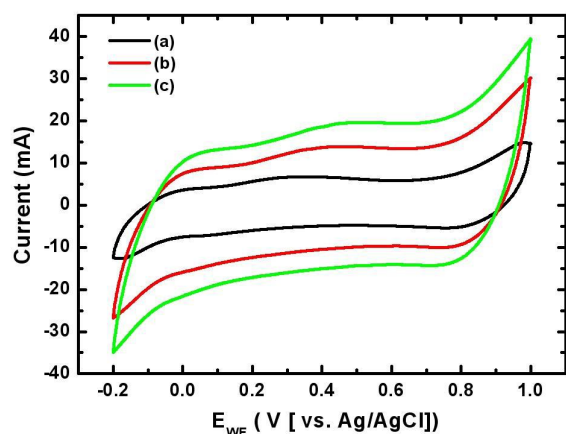


Figure 2: Cyclic voltammograms of the electrodeposited Mn-Ni oxide electrode in 0.5 M Na₂SO₄ at scan rates of (a) 20; (b) 60; and (c) 100 mV/s.

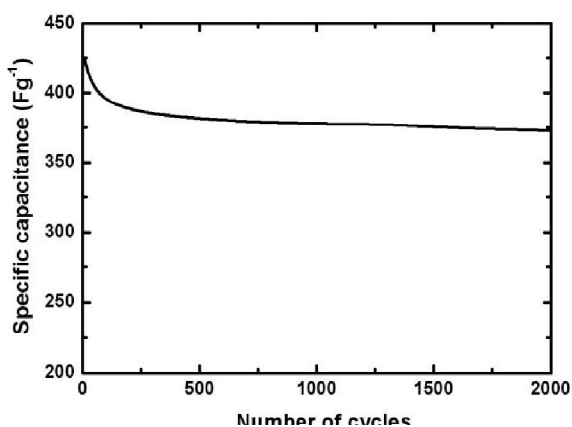


Figure 3: Specific capacitance of the electrodeposited Mn-Ni oxide electrode in 0.5 M Na₂SO₄.

The stability test of the film exhibited good cycling stability in that the

electrodeposited Mn-Ni oxide electrode maintained 86% of its initial specific capacitance over 2000 cycles of the charge-discharge operation. Therefore, electrodeposition is a simple and promising method to fabricate Mn-Ni oxide films for electrochemical capacitor applications.

3. Conclusion:

Porous spaces detected in nanofibers, which are required for electrochemical capacitor applications. Ultimately, electrochemical deposition carried out in alkaline condition whose porosity depends upon various parameters viz pH, potential, temperature. This study mainly deals with supercapacitor testing materials. These materials treated as nanomaterial.

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