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Review of Supercapacitive Performance of Metal Oxide Thin Film Synthesized by Chemical Route

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Abstract-Objective of this paper is synthesis of metal-oxide supported on conducting substrate by electrochemical deposition. According to this study analysis of metal oxide thin film were done for physico-chemical properties like pH, current density, specific capacitance Vs voltage, surface area, cycle stability and coulombic efficiency. In order to get efficient metal-oxide thin film for various metal-oxide. Finally, higher energy density materials with better stability in an actual operating condition can be obtained by chemical route.

Key words: - metal-oxide, thin film, chemical route and electrochemical deposition

1. Introduction:-

The development of electrochemical supercapacitors has been attracting a pivotal role in micro power source for medical instruments, back-up power source for computer memories, portable electronic systems, digital communication devices and electric vehicles due to their high power density and long cycle life compared with batteries.[1-3] Along with that the supercapacitors possesses high energy density compared to conventional capacitors, which leads to greater advantages in near future for energy storage devices (Figure 1).[1-3] To achieve the highest power and energy density to have greater stable and possessing intrinsic higher energy density materials like metal oxides.[4] Viewing to the literature, the metal oxides has been synthesized by many chemical and thermal treatments, including, chemical oxidation, reduction, chemical vapor deposition, calcinations, annealing, plus laser deposition, and arc discharge, etc.[1-4] Many of these techniques have their own advantages like high quality and quantity, easy-work up process and mainly have good control on size, shape and pore size.[1-4,5-7] However, recently, the Ashvini et al[5] has reported the synthesis of iron-oxide by chemical method, which as shown capacitance of ~400 F/g. But, due to the metal decoration on carbon substrate is a tedious task; it has low stability compared to the other reported metal oxide based systems.

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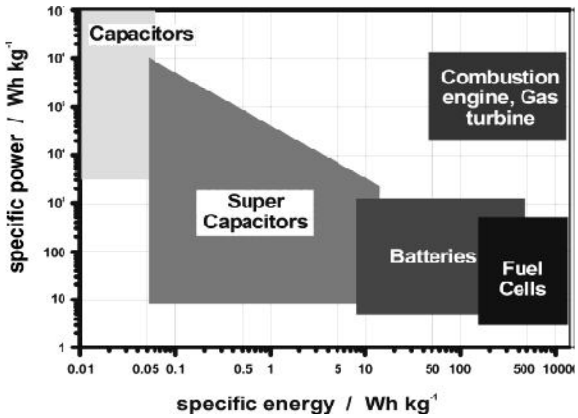

Figure 1: Simplified Ragone plot of the energy storage domains for the various electrochemical energy conversion systems compared to an internal combustion engine and turbines and conventional capacitors.

In last few decades, researcher are focused on the electrochemical deposition technique, which possess intimate contact between the metal-oxide and support substrate, eventually leads to better activity and stability during actual operating conditions. Looking closely to the literature, very recently, Bihag et al[4] has reported the electrochemical deposition of MnO_2 on carbon paper by using manganese acetate and highlighted the higher electronic and ionic mobility within the single system. Moreover, the formed nanowall forests have given specific capacitance of 1149 F/g with better stability in a sodium sulfate solution. Therefore, coupling the electronic and ionic material could be an elegant solution to achieve the desired activity in real application devices.

Taking the advantage of the recent articles, herein we propose the idea to generate the active and stable metal-oxide based systems by electrochemical deposition method, which can be directly grown on the conducting substrate, to achieve dual characteristic system. This system could leads to resolve existing problems related to the conductivity and activity of the solar system. Therefore, modulating the properties of the materials in connection with the conducting substrate possessing wide range pore size and higher surface area could leads efficient charge storage systems for future niche applications.

2 Literature Review

2.1 Literature Review on Metal-Oxide Thin Film:-

Recently, the Kim et al[1] has reported the synthesis of Mn-Ni oxide films were electrodeposited on graphite sheets in a bath consisting of Mn-acetate and Ni-Chloride, and physico-chemical properties of these films were investigated. The electrochemical deposited Mn-Ni oxides films were formed as nano-fiberous porous structures and shown specific capacitance of 424 F/g in sodium sulfate (Figure 2).

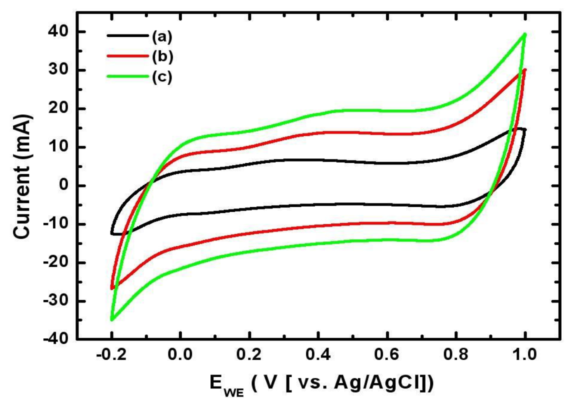

Figure 2a: Cyclic voltammograms of the electrodeposited Mn-Ni oxide electrode in 0.5 M sodium sulfate at scan rate of (a) 20; (b) 60; (c) 100 mV/s.

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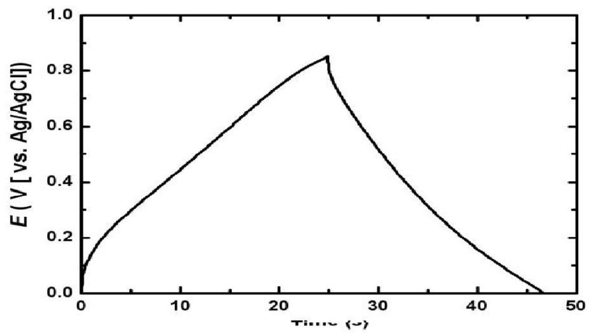

Figure 2b. Charge-discharge curve of the electrodeposited Mn-Ni oxide electrode in 0.5 M sodium sulfate.

Bihag et al[4] has reported the electrochemical deposition method for the Mn-oxide nanowall on the carbon fibers of carbon papers, using Mn-acetate in a sodium sulfate (Figure 3). The formed Mn-oxide nanowalls (Mn-CP) have shown specific capacitance of ~1149 F/g at higher current density of 100 mA/cm^2 (Figure 4).

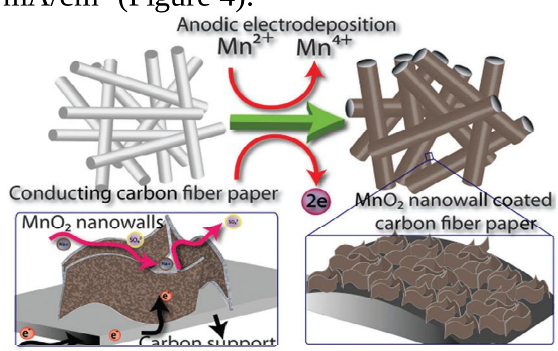

Figure 3: Schematic illustration of the MnO_2 nanowall preparation by electrochemical deposition technique.

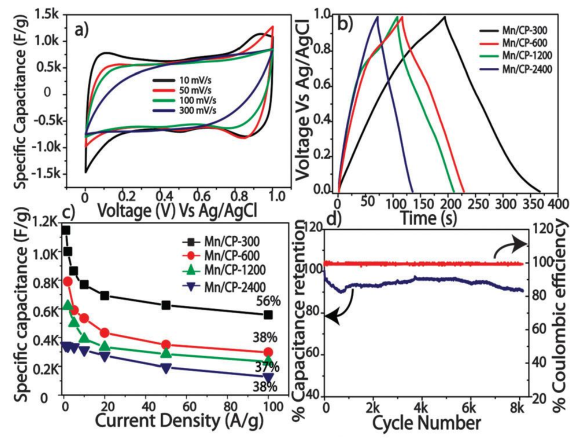

Figure 4:(a) Cyclic voltammograms of Mn/CP-300 at various scan rates, (b) charge–discharge profiles at 5 A/g current density, (c) specific capacitance for various depositions at varied current densities and (d) cycle stability and coulombic efficiency at 5 A/g current density.

3. Conclusion:

Optimization of synthesis of metal-oxide supported carbon strip to achieve better adhesion and thickness with controlled surface and porosity by easy available metal sources of Fe, Co, Ni, and Mn, etc. in an aqueous electrolyte. This study mainly deals with real super capacitor testing in a two electrode system. The deposition and thickness were controlled by changing the time of deposition.

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