MnO₂ AS A ELECTRODE MATERIAL FOR ELECTROCHEMICAL CAPACITORS

Ravinder N Reddy * and Ramana G. Reddy **

* Graduate student, ** ACIPCO Professor
Department of Metallurgical & Materials Engineering
The University of Alabama, Tuscaloosa, AL 35487-0202

Abstract

Electrochemical capacitors are of high interest in hybrid electric vehicle in conjection with batteries and fuel cells and as backup memory application in many electronic devices due to its high cycle life and short term pulse.[1-3]. Electrochemical capacitors can be classified into two types, electrochemical double layer capacitors (EDLC’s) and capacitors based on pseudocapacitance. RuO₂ xH₂O has been found to be an ideal material in the pseudo capacitance category. However, hydrous ruthenium oxide is very expensive. Therefore efforts are being made to replace ruthenium oxide by other oxides such as MnO₂. This study essentially deals with the use of MnO₂ as a potential electrode material for electrochemical capacitors. MnO₂ was synthesized in our laboratory by heating of K₂MnO₄ and Na₂MnO₄ at 300°C in air [4]. The resulting product was washed with distilled water in which water soluble potassium manganate was separated and the resulting MnO₂ had a non-stoichiometric amount of potassium and sodium respectively. Cyclic Voltametry (CV) experiments were carried out using the three electrode system, saturated calomel electrode as reference electrode, platinum mesh as a counter electrode, and MnO₂ composite material mounted in a platinum mesh as a working electrode. Two kinds of composite working electrode materials were used, one was mixture of MnO₂ and 25 wt% acetylene black and the other was MnO₂, 25 wt% acetylene black and 25 wt% carbon. All the experiments were carried out at 25°C. A maximum capacitance of 130 F/g was observed at the scan rate of 2 mV/sec in 1 M KCl for composite electrode containing MnO₂ with non stoichiometric potassium made with carbon. 107 F/g was observed at the scan rate of 2 mV/sec in 1 M NaCl for composite electrode containing MnO₂ with non stoichiometric sodium made with carbon.

References:


Fig. 1. CV curve of 7.5 mg of layered MnO₂ with non stoichiometric potassium with carbon at 2 mV/sec scan rate in 1M KCl.

Fig. 2. CV curve of 10 mg of composite electrode containing layered MnO₂ with non stoichiometric potassium with carbon at 2 mV/sec scan rate in 1M KCl.

Fig. 3. CV curve of 9.1 mg of composite electrode containing layered MnO₂ with non stoichiometric sodium with carbon at 2 mV/sec scan rate in 1M NaCl.