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Electrodeposition of MWCNT-Co_3O_4 nanocomposite onto TiO_2 nanotubes for supercapacitor application.

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Abstract: Co_3O_4/MWCNT/TiO_2NTs/Ti electrodes with high surface area and good capacitive characteristics were prepared by Electrdeposition of Multe-Walled Carbon NanoTubes-Co_3O_4 nanocomposite onto previously formed TiO_2 nanotubes by anodizing of titanium. The structure and morphology of the obtained electrodes were characterized by X-ray diffraction, EDX analysis and scanning electron microscopy. Microstructure studies show that Co_3O_4/MWCNT having high surface area has been deposited onto the TiO_2NTs arrays. The electro chemical capacitive behaviors of the obtained electrodes were investigated by cyclic voltammetry (CV), galvanostatic charge-discharge studies, and electrochemical impedance spectroscopy (EIS) in 1 M KOH solution. The electrochemical data demonstrated that the electrodes displayed specific capacitance of 130 m F cm^{-2} at the current density of 0.5 mA cm^{-2}.

Keywords: Supercapacitors, Cobalt oxide, MWCNT, TiO_2 nanotubes, Capacitances.

1. INTRODUCTION

Supercapacitors can be classified into two types depending on the charge storage mechanism: electrical double layer capacitors (EDLCs) and redox supercapacitors. EDLCs store energy by accumulating positive and negative ionic charges from electrolytes on the surface of electrodes [1, 2]. The second group of supercapacitors, known as pseudocapacitors or redox supercapacitors, stores energy using fast and reversible charge transfer reactions. A pseudocapacitor typically exhibits higher capacitance than an EDLC, while the cycleability is not as high as in EDLC. Therefore, a combination of EDLC and pseudocapacitance is preferred [2, 3]. Co_3O_4 is considered as one of the most attractive pseudocapacitor material where MWCNT is consideted as EDLC material. The mesoporous properties of a substrate can significantly affect the deposition and microstructures of active materials, leading to high charge/discharge capacities and short diffusion paths for ion transport that are expected to improve the performance of electrochemical supercapacitors [4]. Among various substrates, TiO_2NTs (TiO_2 nanotubes) fabricated by anodizing titanium can be used as a suitable substrate for deposition of Co_3O_4/MWCNT composite because of its high surface area, thermal stability, controlled pore structure, and relatively low cost. The especially ordered structure seems to increase the dispersion of active materials and results in the enhancement of capacitance. In the present work, we report the synthesis of Co_3O_4/MWCNT/TiO_2NTs/Ti using electrodeposition of Co_3O_4/MWCNT on TiO_2 nanotubes fabricated by anodizing and study its potential use as a supercapacitor material.