UNIVERSITI TEKNOLOGI MARA

ELECTROCHEMICAL PERFORMANCE OF LAYERED $LiCo_{0.9}X_{0.1}O_2$ (X = Cr, Mn, Fe, Ni) CATHODE MATERIALS FOR LITHIUM-ION BATTERIES

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AUTHOR'S DECLARATION

I declare that the work in this thesis was carried out in accordance with the regulations of Universiti Teknologi MARA. It is original and is the results of my own work, unless otherwise indicated or acknowledged as referenced work. This thesis has not been submitted to any other academic institution or non-academic institution for any degree or qualification.

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ABSTRACT

$LiCoO_2$ is one of the main cathode materials used in commercial lithium-ion batteries due to the high rate capacity, high energy density and good life cycle. However, the $LiCoO_2$ cathode material is high cost and toxic. Besides, this cathode material also suffers from a few limitations such as low thermal stability and structural degradation when charging at a higher voltage. Therefore, the search for better cathode material is needed to be developed to improve the performance of existing $LiCoO_2$. One of the approaches is the substitution of $LiCoO_2$ with transition metal which is cheaper and non-toxic that can enhance the structural stability and electrochemical properties. In this work, $LiCo_{0.9}X_{0.1}O_2$ (X = Cr, Mn, Fe, Ni) prepared by self-propagating combustion (SPC) method using citric acid as a combustion agent were investigated. The precursors of $LiCo_{0.9}X_{0.1}O_2$ were annealed at a temperature of 800 °C for 24 h. The materials were characterized using Simultaneous Thermogravimetric Analysis (STA), X-Ray Diffraction (XRD), Field Emission Scanning Electron Microcopy (FESEM), and Energy Dispersive X-Ray Spectroscopy (EDX). All the cathode materials found to be single and pure phase with no impurity peaks detected with the surface morphology of roughly polyhedral-type crystal with some spherical-type Finally, the electrochemical performance of the materials was studied using discharge cycling in the voltage range of 2.5 V to 4.2 V. Based on the results, the Mn substituted cathode material exhibited a better initial specific discharge capacity of 136.60 mAh/g. Different stoichiometries of $LiCo_{1-x}Mn_xO_2$ (x = 0.1, 0.2, 0.3, 0.4, 0.5) cathode materials has been further investigated. The initial discharge capacities of all the materials are 136.60 mAh/g, 112.66 mAh/g, 93.75 mAh/g, 66.98 mAh/g, 52.32 mAh/g, respectively. Therefore, only small amount of a Mn content is preferable to enhance the electrochemical performance of $LiCoO_2$ layered cathode material.

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