UNIVERSITI TEKNOLOGI MARA

SYNTHESIS AND CHARACTERIZATION OF ALUMINIUM DOPED $LiNi_{0.6}Co_{0.3}Ti_{0.1}O_2$ CATHODE MATERIAL FOR LITHIUM-ION BATTERY

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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.

I, hereby, acknowledge that I have been supplied with the Academic Rules and Regulations for Post Graduate, Universiti Teknologi MARA, regulating the conduct of my study and research.

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ABSTRACT

In order to satisfy the energy demands of the electromobility market, further improvements in cathode materials are receiving much attention, aiming high energy density cathode materials for Li-ion batteries (LIBs) application. In this work, the self-propagating combustion (SPC) method is used to synthesise undoped $LiNi_{0.6}Co_{0.3}Ti_{0.1}O_2$ (LNCT), novel nano-size Al-doped into cobalt site of $LiNi_{0.6}Co_{0.3-x}Al_xTi_{0.1}O_2$ (x=0.01, 0.02, 0.03, 0.04, 0.05 denoted as LCA1, LCA2, LCA3, LCA4, LCA5 respectively) and novel nano-size Al-doped into nickel site of $LiNi_{0.6-x}Co_{0.3}Al_xTi_{0.1}O_2$ (x=0.01, 0.02, 0.03, 0.04, 0.05 denoted as LNA1, LNA2, LNA3, LNA4, LNA5 respectively) cathode materials. LNCT and Al-doped materials are annealed at 700 °C for 24 h. Following the synthesis, the phase, chemical structure and purity of the materials are analysed using X-Ray Diffraction (XRD). Based on the XRD results, all materials demonstrate a single-phase structure with a rhombohedral layered structure. Based on the FESEM and EDX results, all samples exhibit polyhedral like shape, while the Al-doped samples display smaller crystallite size compare to the undoped sample. As for the electrochemical performances, the initial discharged capacities of all stoichiometry of Al-doped materials are higher than LNCT. Al-doped into cobalt site with x=0.01 (LCA1) gives the best initial discharge capacity of 238.6 $mAhg^{-1}$ meanwhile the best initial discharge capacity for Al-doped into nickel site is at x=0.01 (LNA1) with a capacity of 214.7 $mAhg^{-1}$. Even though LCA1 owns higher initial capacity than LNA1, LNA1 has lower capacity fading after the fiftieth cycle compared to LCA1 sample which makes it a more excellent candidate in electrochemical performance. The main reason for the excellent electrochemical behaviour of LNA1 is due to lower cation mixing. Furthermore, Rietveld refinements reveal that LNA1 sample has a longer atomic distance of Li-O and shorter TM-O in the cathode structure which makes Li^+ ion diffusion more efficient which then leads to excellent electrochemical performance. These findings further proved the potential of the novel nano cathode material of $LiNi_{0.6-x}Co_{0.3}Al_xTi_{0.1}O_2$ (LNA1) to replace the existing commercialized cathode materials for rechargeable Li-ion batteries.

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