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Layered P2- Type Novel $Na_{0.7}Ni_{0.3}Mn_{0.59}Co_{0.1}Cu_{0.01}O_2$ Cathode Material for High-Capacity & Stable Rechargeable Sodium Ion Battery

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Abstract

Sodium ion battery (SIB) technology is a promising technology for energy storage systems. Due to the abundance of sodium in nature and lower cost, it can be a viable alternative to the current Lithium ion battery (LIB) technology. In this research article P2-type layered sodium ion transition metal oxide $Na_{0.7}Ni_{0.3}Mn_{0.59}Co_{0.1}Cu_{0.01}O_2$ cathode material was synthesized using a citric acid assisted sol-gel method. It provided a very good reversible discharge capacity and better capacity retention than the state-of-the- art SIB. XRD pattern confirmed the successful insertion of copper ions in the lattice structure of Na-Ni-Co-Mn layered oxide. This material exhibited a high reversible capacity of 150 mAh/gm vs Na^+ as the counter electrode when discharged through the voltage window of 4-1.5 V. The lesser polarization loss during cycling of the proposed cathode material helped to retain 94% of its maximum discharge capacity even after 80 cycles.

Key Words: Sodium ion batteries, Transition metal oxide, Sol-gel method, Cathode materials.

1. Introduction

The complete electrification of road transportation, stand-alone and grid connection of photovoltaic and wind energy system requires transformative research in battery technologies. LIB is the most successful battery technology and is widely implemented today for storage applications, hybrid electric vehicles and full electric vehicles [1][2]. It has been calculated back in 2008 that overall global consumption of Li resources is 21,280 tons and with a 5 % growth rate it could last for just 65 years [3][4]. With the above scenario it will be difficult to address the ever increasing demands of energy storage. SIB technology has been able to garner a great attention because of sodium having similar physical and chemical properties as of lithium [5] and also being the sixth most abundant element on earth [6]. Sodium is regarded as the second lightest and smallest metal element second to