

Outstandingly improved electrochemical performance of new LiMn_2O_4 -based Li-ion cathode materials by simultaneous doping with K and Ni

Monika Bakierska, Michał Świątosławski, Marcelina Lis, Krystian Chudzik, Marcin Molenda
Jagiellonian University, Faculty of Chemistry, Gronostajowa 2, 30-387 Krakow, Poland

E-mail: m.swietoslowski@uj.edu.pl

With ever-increasing energy demand, more efforts should be dedicated to designing and synthesizing innovative electrode materials providing higher storage capability and faster power delivery. In this regard, lithium manganese oxide spinel (LiMn_2O_4 , LMO) is considered as one of the most promising candidates owing to its high operating voltage, relatively high specific capacity, good rate performance, excellent safety characteristics and three-dimensional framework structure for lithium ion diffusion [1]. A stoichiometric LMO spinel, although used commercially in battery packs for electric vehicles (EV), still has limited applications. Most of all, it is caused by its unstable structure at the room temperature, and by solubility of manganese ions in the liquid electrolyte, both leading to a drop in the capacity and a deterioration of the battery life [2]. Methods for improvement of the LMO spinel stability and electrochemical properties are known in the literature [3-5].

Herein, we investigate the synergetic effect of co-doping the LMO material with potassium in the lithium site and nickel in the manganese sublattice. The main aim is to discover how the modification of the spinel structure with K and Ni affects the physicochemical characteristics and electrochemical performance of new cathode materials in Li-ion battery.

Nanosized $\text{Li}_{1-x}\text{K}_x\text{Mn}_{2-y}\text{Ni}_y\text{O}_4$ (LKMNO) spinels were synthesized via a sol-gel method [6]. To determine the physicochemical properties of the modified spinels X-ray powder diffraction (XRD), inductively coupled plasma optical emission spectrometry (ICP-OES), differential scanning calorimetry (DSC), X-ray photoelectron spectroscopy (XPS) and transmission electron microscopy (TEM) were performed. The electrochemical performance of $\text{Li}/\text{Li}^+/\text{LKMNO}$ cells was examined by galvanostatic charge/discharge tests (GCDT), cyclic voltammetry (CV) and electrochemical impedance spectroscopy (EIS).

To conclude, our recent studies on spinel materials have revealed that simultaneous doping of the LMO spinel in the lithium and manganese sublattices with K and Ni causes an extraordinary, unexpected increase in the capacity, reaching up to 70% (in relation to the theoretical capacity of LMO, amounting to approx. 148 mAh/g). Additionally, the new spinel materials are characterized by high coulombic reversibility (more than 99%), as well as a cell operation efficiency under high-current conditions (possibility to transfer current loads of the order of 100C-200C).

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