Electrochemical Performance of $\text{Li}_{0.995}\text{Al}_{0.005}\text{Mn}_{0.85}\text{Fe}_{0.15}\text{PO}_4/\text{C}$ as a Cathode Material for Lithium-Ion Batteries

Yun-Fei Long^{1, 2}, Qiao-Ying Huang¹, Zhi Wu¹, Jing Su^{1, 2}, Xiao-Yan Lv³, Yan-Xuan Wen^{1, 2, *}

¹ School of Chemistry and Chemical Engineering, Guangxi University, Nanning 530004, PR China

² Guangxi Colleges and Universities Key Laboratory of Novel Energy Materials and Related Technology, Nanning 530004, PR China

³ The New Rural Development Research Institute, Guangxi University, Nanning 530004, PR China

* E-mail: wenyanxuan@vip.163.com

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A solid-state reaction route was used to prepare $\text{Li}_{0.995}\text{Al}_{0.005}\text{Mn}_{0.85}\text{Fe}_{0.15}\text{PO}_4/\text{C}$, and the prepared sample were characterized by X-ray diffraction (XRD), X-ray photoelectron spectroscopy (XPS), scanning electron microscopy (SEM) and electrochemical tests. The results of XRD and XPS show that Al^{3+} and Fe^{2+} are soluble in the Li site and the Mn site to generate a solid-solution, resulting in a shrinkage of crystal lattice and creations of Al^{3+} -vacancy pairs and Fe^{3+} -vacancy pairs. Compared with $\text{Li}_{0.995}\text{Al}_{0.005}\text{MnPO}_4/\text{C}$, $\text{LiMn}_{0.85}\text{Fe}_{0.15}\text{PO}_4/\text{C}$ and LiMnPO_4/C , $\text{Li}_{0.995}\text{Al}_{0.005}\text{Mn}_{0.85}\text{Fe}_{0.15}\text{PO}_4/\text{C}$ exhibits much better rate capability and cycling stability. When charged and discharged at 1 C, $\text{Li}_{0.995}\text{Al}_{0.005}\text{Mn}_{0.85}\text{Fe}_{0.15}\text{PO}_4/\text{C}$ delivers a discharge capacity of 139 and 160 $\text{mAh}\cdot\text{g}^{-1}$ at 25 and 60 °C, and its capacity retention ratio is 100 % after 50 cycles, respectively. The enhanced property of LiMnPO_4/C can be attributed to the synergistic effect of Al^{3+} doping at the Li site and Fe^{2+} doping at the Mn site, leading to a great improvement in the dynamic stability of the olivine structure, Li^+ diffusion and electrode kinetics. Thus, the electrochemical properties of lithium manganese phosphate can be effectively improved by Fe^{2+} doping at the Mn site and aliovalent ion doping at the Li site.

Keywords: Lithium ion batteries; Cathode; Lithium manganese phosphate; Cation substitution

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