Rapid synthesis of $\text{LiCo}_{1-x}\text{Fe}_x\text{PO}_4/\text{C}$ Cathodes via Microwave Solvothermal Method for Li-ion Batteries

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Olivine-structured $\text{LiCo}_{1-x}\text{Fe}_x\text{PO}_4/\text{C}$ ($0.2 \leq x \leq 0.5$) materials were rapidly synthesized via a microwave solvothermal method at 200 °C for 20 min. According to the XRD and SEM mapping results, partial Co sites are successfully substituted with Fe to form a solid solution and expand the Li^+ diffusion channel. Both the discharge capacity and cyclic capacity retention as well as the rate capacity of the $\text{LiCo}_{1-x}\text{Fe}_x\text{PO}_4/\text{C}$ ($0.2 \leq x \leq 0.5$) samples increase with increasing x. Furthermore, the optimized Fe substitution content should be $x=0.4$ with respect to the energy density. The $\text{LiCo}_{0.5}\text{Fe}_{0.5}\text{PO}_4/\text{C}$ exhibits the highest capacity retention of 87.7% after 50 cycles at 0.5 C, which could result from its high lithium ion diffusion coefficient (D_{Li}) of $1.48 \times 10^{-13} \text{ cm}^2 \text{ s}^{-1}$ and low charge transfer resistance (R_{ct}) of 74 Ω based on the EIS results. According to the XPS analysis, Fe^{2+} and a small amount of Fe^{3+} coexist in $\text{LiCo}_{0.5}\text{Fe}_{0.5}\text{PO}_4/\text{C}$. The substitution of Fe^{3+} in the Co^{2+} sites produces Co vacancies accompanied by conduction electrons to maintain the neutrality of the lattice in LiCoPO_4 , which improves D_{Li} and the bulk electronic conductivity.

Keywords: Cathode, LiCoPO_4 , Microwave solvothermal, Fe, Vacancy

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