Research articles

Antiferromagnetic ordering in lithium deintercalated $Fe_{1-x}Zn_xPO_4$: A Mössbauer spectroscopy study

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ABSTRACT

Various compositions of $Fe_{1-x}Zn_xPO_4$ (x = 0.1, 0.2, 0.3, and 0.5) were synthesized by solid-state reaction and chemical lithium deintercalation processes, and their magnetic properties were characterized based on Mössbauer analysis. The synthesized $Fe_{1-x}Zn_xPO_4$ have orthorhombic structures with space group *Pnma*. The magnetization curves of $Fe_{1-x}Zn_xPO_4$ show the antiferromagnetic behaviors and magnetic phase transition caused by the strong crystal field in the FeO_6 octahedral sites. The Néel temperature (T_N) of $Fe_{1-x}Zn_xPO_4$ for x = 0.1, 0.2, 0.3, and 0.5 was found to be 97, 82, 63, and 62 K, respectively. Mössbauer spectra below T_N appeared to have eight Lorentzian lines with antiferromagnetic ordering. The charge state of Fe ions is the high spin state of Fe^{3+}, as characterized by an isomer shift (δ = 0.28–0.43 mm/s). The value of magnetic hyperfine field (H_{hf}) decreased with increasing Zn concentration because the superexchange interaction via Fe–O–Zn link is weaker than that via Fe–O–Fe link. Also, the value of electric quadrupole splitting (ΔE_Q) gradually decreased with increasing Zn concentration due to the substitution of a Zn ion for the Fe ion, inducing a change in the charge asymmetry at the FeO_6 sites. The Debye temperatures are found to decrease with increasing Zn concentration.