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Spin-reorientation in the antiferromagnetic ordering of $LiFe_{1-x}Mn_xPO_4$ investigated with Mössbauer spectroscopy

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The crystal structures of $LiFe_{1-x}Mn_xPO_4$ ($x = 0.1$, 0.3, 0.5) samples have been characterized with x-ray diffraction (XRD) and were determined to be orthorhombic with space group *Pnma* by Rietveld refinement method. The temperature dependence of the magnetization curves showed abnormal antiferromagnetic behavior as well as a decrease in Néel temperature (T_N) with Mn substitution from superconducting quantum interference device (SQUID) measurement. The magnetization decreases until the temperature reaches the spin-reorientation temperature (T_S), and then increases with temperature up to T_N. The Mössbauer spectra of the $LiFe_{1-x}Mn_xPO_4$ show that the magnetic hyperfine field (H_{hf}) and electric quadrupole splitting (ΔE_Q) values change with increasing temperature, compared to values at T_S, which is caused by the strong electric crystalline field originating from distorted octahedral symmetry. The decrease in T_S of $LiFe_{1-x}Mn_xPO_4$ can be explained by the Mn-concentration-dependent crystal field and spin-orbit coupling in the Fe^{2+} site.
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