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Mössbauer studies of $^{57}$Fe doped LiMnPO$_4$
by external magnetic field

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Olivine structure LiMPO$_4$ has received much attention because the covalently bonded PO$_4$ groups offer structure stability, excellent thermal, and environmentally friendly. These materials are known for their exceptionally large magnetoelastic (ME) effect. From these complex magnetic structures, LiMnPO$_4$ show the various anomaly effects. Therefore, we have substituted a small amount of $^{57}$Fe ions for Mn sites and investigated the hyperfine electromagnetic interaction of Fe ions in crystal symmetry. The crystal and magnetic properties of $^{57}$Fe doped LiMnPO$_4$ have been investigated by XRD, VSM, and Mössbauer spectroscopy. The pure Li$^{^{57}}$Fe$_{0.01}$Mn$_{0.99}$PO$_4$ sample was prepared using the solid-state reaction method. The crystal structure is found to be an orthorhombic (space group: Pmnb). The determined lattice constants $a_0$, $b_0$, and $c_0$ are 6.1009 Å, 10.4435 Å, and 4.7427 Å, respectively. The magnetic susceptibility measured by VSM show that Néel temperature is 34 K. Mössbauer spectra of Li$^{^{57}}$Fe$_{0.01}$Mn$_{0.99}$PO$_4$ have been taken at various temperatures ranging from 4.2 to 295 K. The charge state of the iron ions is ferrous in character by isomer shift. Magnetic hyperfine ($H_{hf}$) and electric quadrupole splitting ($\Delta E_Q$) at 4.2 K have been studied, yielding the following results; $H_{hf} = 320$ kOe, $\Delta E_Q = 2.81$ mm/s. We find an abrupt change in $\Delta E_Q$ near 8 K due to the spin ordering. Also, Mössbauer spectra under various external fields at 4.2 K were performed parallel to the direction of the gamma-ray emission. From the analysis of Mössbauer spectra, we confirmed that an increase in the canting angle between the applied and $H_{hf}$ due to spin ordering by the strong external field.

Fig. 1. Mössbauer spectra of Li$^{^{57}}$Fe$_{0.01}$Mn$_{0.99}$PO$_4$ at 4.2 K under applied fields up to 4.8 T.