Study of Mössbauer and neutron diffraction for La$_{0.67}$Pb$_{0.33}$Mn$_{1-x}$Fe$_x$O$_3$

Lee H.M. 1, Kim S.B. 2, Kim S.J. 1, Shim I.B. 1, Kim C.S. 1
1 Dept. of Physics, Kookmin University, Seoul 136-702, Korea 2 Neutron Physics Department, KAERI, Daejeon 305-600, Korea

Observations of the colossal magnetoresistance (CMR) and other intricate physical phenomena in the perovskite manganite oxides R$_{1-x}$A$_x$MnO$_3$ (R = La, Nd, Pr, Sn, Y; A = Ca, Sr, Ba, Pb) have triggered renewed attention to this class of materials[1,2]. Polycrystalline samples of La$_{0.67}$Pb$_{0.33}$Mn$_{0.99}$Fe$_{0.01}$O$_3$ have been prepared with the aim of investigating the influence of the presence of the metal $^{57}$Fe. Their magnetic and crystallographic properties are studied using Mössbauer spectroscopy and neutron diffraction. The structure of La$_{0.67}$Pb$_{0.33}$MnO$_3$ was found to be rhombohedral, with lattice constants $a_0 = 5.4932$ Å and $\alpha = 60.207$ °. The lattice constants $a_0$ of the samples became almost similar with increasing $^{57}$Fe contents ($0.01 \leq x \leq 0.05$). However, the lattice constants $\alpha$ increased. Increased $^{57}$Fe contents dropped rapidly the magnetization and the Curie temperature ($T_C$). This results show that Fe favours an antiferromagnetic coupling in the Mn-O layer, and finally it leads to weakening of the ferromagnetic double exchange coupling. Also our magnitic structure neutron diffraction refinements support above results. Mössbauer spectra of La$_{0.67}$Pb$_{0.33}$Mn$_{0.99}$Fe$_{0.01}$O$_3$ were taken at various temperatures ranging from 14 to 350 K. As the temperature increased towards ($T_C$) = 340 K, line broadening and 1, 6 and 3, 4 line width differences occurred because of anisotropic hyperfine field fluctuation. The anisotropic field fluctuation of $+H$ ($P_+ = 0.83$) was greater than $H$ ($P_- = 0.17$). We also calculated the frequency factor and the anisotropy energy as 49.34 $\Gamma/\hbar$ and 383 erg/cm$^3$, respectively, using the relatively accurate data for $T = 130$ K that is associated with the large line broadening.