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Ferromagnetism in a Mixture of Antiferromagnetic $FeTiO_3$ and α-Fe_2O_3 as Observed by Using Mössbauer Spectroscopy

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Solid solutions $(1-x)FeTiO_3$-xFe_2O_3 of different compositions (x = 0.0, 0.1, 0.3, 0.5 and 1.0) were prepared by using a standard ceramic processing method and were studied by using X-ray diffraction, Mössbauer spectroscopy and vibrating sample magnetometer (VSM). The crystal samples were found to have a rhombohedral structure. The lattice parameters (a and c) decreased linearly with increasing Fe concentration (x) and followed Vegard's law approximately. For the sample with x = 0.1, the Mössbauer spectrum at room temperature was obtained by using the asymmetry two doublet corresponding to Fe^{2+} and Fe^{3+}. On the other hand, for the x = 0.3 and 0.5 samples, an anomalous six-line absorption curve was observed. The Mössbauer spectra at 4.5 K for the sample with x = 0.5 was fitted to three six-line hyperfine patterns with magnetic hyperfine fields of H_{hf} = 554.4, 528.4 and 438.5 kOe and isomer shifts of δ = 0.43, 0.59 and 0.89 mm/s. The values of the isomer shifts show that for all temperature ranges, the states are ferric (Fe^{3+}) and ferrous (Fe^{2+}). The slopes of the hyperfine magnetic fields depended on the temperature change at temperatures between 240 and 295 K, suggesting that a spin-rotation transition takes place. The Néel temperature and the Debye temperature were found to be 575 K and 355 K, respectively. The magnetic hysteresis curve measurements showed a ferromagnetic behavior at room temperature.

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