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International Workshop on Next Generation HDD Technology & KMS 2005 Summer Conference

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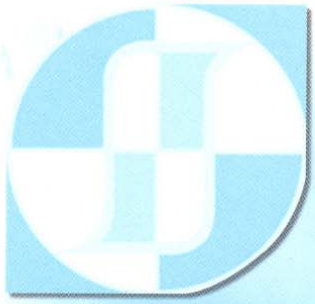

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Room-Temperature Ferromagnetism in Anatase $Ti_{1-x}Fe_xO_{2-\delta}$ Thin Films

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Recently, there have been a large number of investigations on semiconducting oxides that exhibit ferromagnetism with high Curie temperature above 300 K. Such diluted magnetic semiconductors are achieved by doping 3d tramsition-metal elements such as V, Mn, Fe, Co, and Ni into base oxides such as ZnO, SnO_2, and TiO_2.

In the present work, magnetic and electronic properties of Fe-doped anatase $TiO_{2-\delta}$ thin films grown on $Al_2O_3(0001)$ substrates by a sol-gel method have been investigated by vibrating-sample magnetometry (VSM), conversion electron Mössbauer spectroscopy (CEMS), and Hall effect measurements.

Anatase $Ti_{1-x}Fe_xO_{2-\delta}$ thin films were found to exhibit ferromagnetism at room temperature by VSM. The saturation magnetic moment of the ferromagnetic films are ~2 and ~1.5 μ_B per Fe ion for x = 2.4 and 5.8 at.%, respectively, as shown in Fig. 1. The isomer shifts in CEMS measurements as shown in Fig. 2, are 0.26-0.28 mm/s, indicating a ferric character. The Mössbauer spectra also revealed that Fe^{3+} ions mostly substitute the octahedral Ti^{4+} sites of $Ti_{1-x}Fe_xO_{2-\delta}$. The $Ti_{1-x}Fe_xO_{2-\delta}$ films exhibited poor electrical conductivity with p-type character. The ferromagnetism in the present $Ti_{1-x}Fe_xO_{2-\delta}$ films can be interpreted in terms of a direct ferromagnetic coupling between two neighboring Fe^{3+} ions via an electron trapped in oxygen vacancy [1]. The reduction of the net magnetization by the increase of the Fe content in the film can be explained in terms of an antiferromagnetic superexchange interaction between two neighboring Fe^{3+} ions via O^{2-} ion.

Reference

[1] J. M. D. Coey, A. P. Douvalis, C. B. Fitzgerald, and M. Venkatesan Appl. Phys. Lett. **84**, 1332 (2004).

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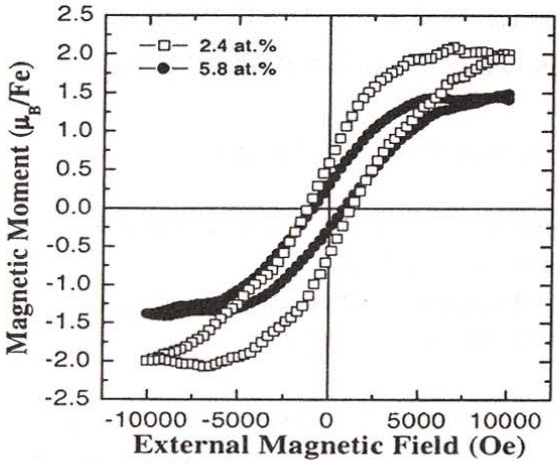

Fig. 1. Room-temperature VSM measurement result of anatase $Ti_{1-x}Fe_xO_{2-\delta}$ (x = 2.4 and 5.8 at.%) films.

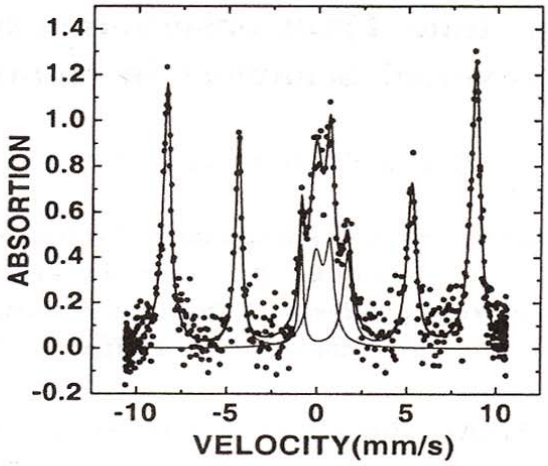

Fig. 2. CEMS spectrum of $Ti_{1-x}Fe_xO_{2-\delta}$ (x = 5.8 at.%) film measured at room temperature