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A STUDY OF THE EFFECTS OF Fe IN $TiO_{2-\delta}$ THIN FILMS

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We have investigated Fe-doped $TiO_{2-\delta}$ thin films grown by sol-gel method on $Al_2O_3(0001)$ substrates by X-ray diffraction, Hall effect measurement, vibrating sample magnetometry (VSM), X-ray photoelectron spectroscopy and conversion electron Mössbauer spectroscopy (CEMS). The films have been found to be transparent ferromagnets at room temperature. The present anatase and rutile Fe-doped $TiO_{2-\delta}$ thin films exhibited p-type electrical conductivity while the undoped film n-type conductivity. As shown in Fig. 1, anomalous magnetic moments were observed for highly resistive Fe-doped anatase $TiO_{2-\delta}$ samples at room temperature with the saturation magnetic moment of ~2 μ_B/Fe and ~1.5 μ_B/Fe for 2.4- and 5.8-at.% Fe, respectively. This room-temperature ferromagnetism is explicable with a direct ferromagnetic coupling between two Fe^{3+} ions via trapped electron in oxygen vacancy. XPS and CEMS measurements on the Fe-doped $TiO_{2-\delta}$ films reveal that Fe ions have Fe^{3+} ionic valence mostly, substituting the octahedral sites of $TiO_{2-\delta}$. CEMS spectra on the $TiO_{2-\delta}$:Fe films also reveal the change of the magnetic properties with Fe composition and thickness of the films as shown in Fig. 2.

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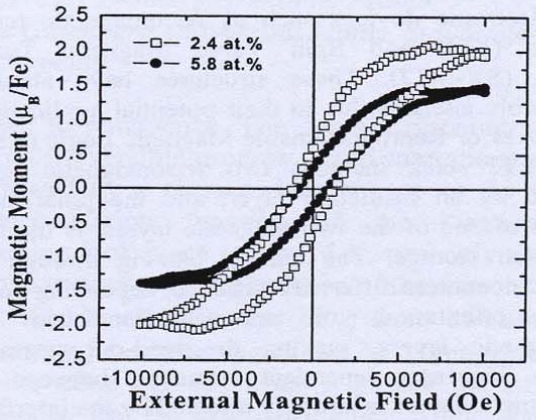

Figure 1. Hysteresis curves of anatase $Fe_xTi_{1-x}O_{2-\delta}$ (x = 2.4 and 5.8 at.%) films.

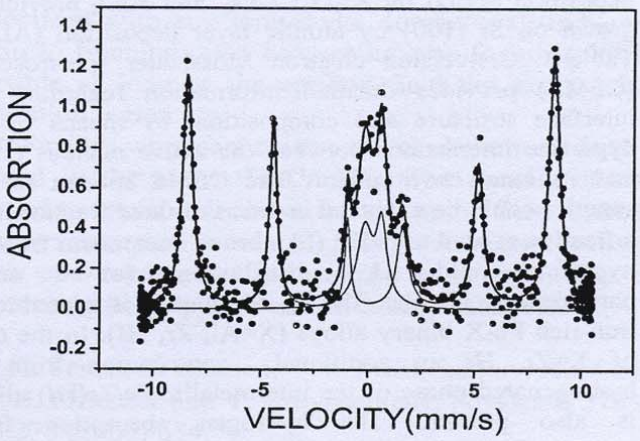

Figure 2. CEMS spectra of $Fe_xTi_{1-x}O_{2-\delta}$ film (x=5.8 at.%).