

## **Ferromagnetic properties of anatase $\text{Ti}_{1-x}\text{Fe}_x\text{O}_{2-\delta}$ thin films**

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(Presented on 2 November 2005; published online 26 April 2006)

The effects of Fe doping on the magnetic and electronic properties of reduced  $\text{TiO}_{2-\delta}$  thin films have been investigated. Anatase  $\text{Ti}_{1-x}\text{Fe}_x\text{O}_{2-\delta}$  films exhibit a ferromagnetic behavior at room temperature for a certain range of Fe doping. Conversion electron Mössbauer spectroscopy measurements indicate that  $\text{Fe}^{2+}$  and  $\text{Fe}^{3+}$  ions coexist in the Fe-doped films, substituting the octahedral  $\text{Ti}^{4+}$  sites. The contribution of possible  $\text{Fe}_3\text{O}_4$  clusters to the observed ferromagnetism is not likely to happen. The  $\text{Ti}_{1-x}\text{Fe}_x\text{O}_{2-\delta}$  films exhibit a *p*-type character by Hall effect measurements but the observed ferromagnetism turns out to be independent of the hole concentration. The observed ferromagnetism in the  $\text{Ti}_{1-x}\text{Fe}_x\text{O}_{2-\delta}$  films can be explained in terms of a direct ferromagnetic coupling between two neighboring  $\text{Fe}^{3+}$  ions via an electron trapped in oxygen vacancy nearby. © 2006 American Institute of Physics. [DOI: [10.1063/1.2176087](https://doi.org/10.1063/1.2176087)]