

# Effects of Nb Doping on the Magnetism of Anatase Fe-Doped $\text{TiO}_2$

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$\text{Ti}_{1-x}\text{Fe}_x\text{O}_2$  and  $\text{Ti}_{1-2x}\text{Fe}_x\text{Nb}_x\text{O}_2$  ( $x = 0.0, 0.01$ ) powders were synthesized by the sol-gel method. X-ray diffraction patterns showed a pure anatase single phase and no different peaks other than anatase titanium dioxide were observed. Mössbauer spectra of all samples showed that the magnetically ordered and paramagnetic phases coexisted in all temperature ranges (4.2–295 K), where Fe is not metallic but in the +3 state substituting for Ti. Although the Fe/Nb co-doped samples showed more magnetically ordered phase than Fe-single-doped samples with the same amount of Fe ions in 295 K spectra, the smaller magnetic moments were observed in Fe/Nb co-doped samples. This result suggests that the Nb co-doping decreases the ferromagnetic contribution of Fe ions in  $\text{TiO}_2$  and increases the antiferromagnetic contribution.

*Index Terms*—Diluted magnetic semiconductor (DMS), ferromagnetic, Mössbauer spectroscopy, titanium dioxide.