

Influence of the Fe²⁺ ions concentration on the magnetic behavior of (Ti,Fe)O₂ samples

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Abstract – In this work we present the structural and magnetic characterization of TiO₂/FeO samples with 2.5, 5, 7.5 and 10 at% of Fe, prepared by mechano-synthesis. Mössbauer spectroscopy results show two paramagnetic interactions, one corresponding to Fe²⁺ and the other to Fe³⁺. X ray absorption spectroscopy (XAS) results showed that Fe ions are incorporated into the rutile phase but with oxygen coordination lower than that expected in this phase. AC- susceptibility measurements show a behavior mainly paramagnetic.

Diluted magnetic semiconductors (DMSs) have been extensively studied with the aim of finding new materials for potential applications in spintronics and microelectronics. Among them, oxides-based DMSs (O-DMSs) have attracted considerable attention since the discovery of O-DMS room-temperature ferromagnetism [1]. Much work has been done in the study of this kind of materials, but a real problem is to understand the origin of the observed magnetic behavior [2, 3]. In order to contribute to understanding the magnetism in this type of materials, powders of rutile TiO₂ and FeO in appropriate proportions were milled during 12 h in Ar atmosphere at 32 Hz. Mössbauer spectroscopy, XAS and AC-susceptibility measurements were employed in order to characterize the Fe-doped TiO₂ powders. XAS results showed that Fe ions are incorporated into the rutile phase with oxygen coordination lower than that expected in this phase. The RT Mössbauer spectra of 2.5, 5, 7.5 and 10 Fe at.% samples (Fig. 1) were reproduced using two paramagnetic interactions, one corresponding to Fe²⁺ ($\delta \sim 0.87$ mms⁻¹) and the other to Fe³⁺ ($\delta \sim 0.31$ mms⁻¹). The relative fraction of Fe²⁺ increases with the concentration of Fe in the samples. AC-susceptibility measurements show paramagnetic behavior for low Fe concentrations with a shoulder in the signal at 45 and 35 K for 7.5 and 10 at.%, respectively (see figure 2). These results will be explained based on the relative fraction of Fe²⁺ in the samples.

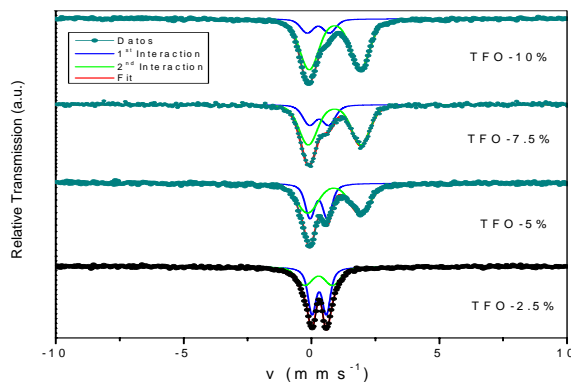


Figure 1: Mössbauer spectra of Ti_{1-x}Fe_xO₂ samples at room temperature.

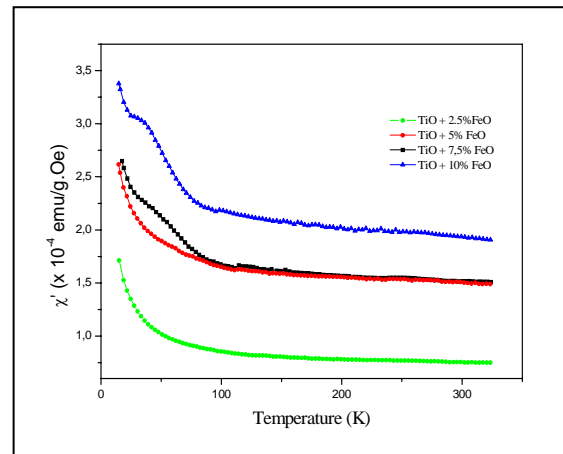


Figure 2: Susceptibility AC for all samples.

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