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CRYSTALLOGRAPHIC AND MAGNETIC PROPERTIES OF Fe-DOPED SnO_2 NANOPARTICLES OBTAINED BY A SOL-GEL METHOD

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Abstract – We have prepared $Sn_{1-x}Fe_xO_2$ (x = 0, 0.03, 0.05 and 0.10) nanoparticles by a modified polymeric precursor method based on the Pechini process. Two types of starting reactants for both iron and tin were explored. The samples were characterized by XRD, FT Raman, and ^{119}Sn and ^{57}Fe Mössbauer spectroscopies recorded at room temperature. Results showed that by using Fe(III) and Sn(IV) reactives, the products were only $Sn_{1-x}Fe_xO_2$ with small grains seizes. In contrast, the samples prepared from Fe(II) and Sn(II) reactives were of larger grain seizes but exhibited the presence of hematite.

The search of proper conditions to prepare pure and iron doped tin oxide nanoparticles free of contaminants is motivated by its multiple applications such as solid state gas sensor, catalyst, transparent conductor and recently as a spintronic like material. $Sn_{1-x}Fe_xO_2$ samples were obtained from a sol-gel method using $FeCl_3.6H_2O$ (or $FeCl_2.4H_2O$) and $SnCl_4.5H_2O$ (or $SnCl_2$) as precursors, and using ethylene glycol and citric acid as polymerization-complexation agents. The XRD patterns for those samples prepared from Fe (III) and Sn (IV) were adequately fitted by introducing only the cassiterite phase of SnO_2 with average grain sizes of about 14 nm (Fig. 1). FT Raman also showed only the characteristics bands of cassiterite and the presence of iron broadened and reduced the intensities of the principal peaks (Fig. 2). RT ^{119}Sn Mössbauer spectra indicated only the presence of Sn^{4+}, whereas RT ^{57}Fe Mössbauer spectra suggested the presence of two Fe^{3+} sites located at different distorted sites (Fig. 3). On the other hand, those samples prepared from Fe(II) and Sn(II) precursors showed the formation of hematite as an impurity phase, and large average grain sizes for the cassiterite phase of SnO_2 (Fig. 1 and 2).

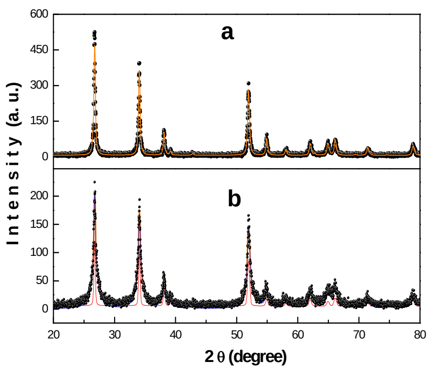

Figure 1. XRD patterns of $Sn_{0.90}Fe_{0.10}O_2$ of a) $SnCl_2$ precursor and b) $SnCl_4$ precursor.

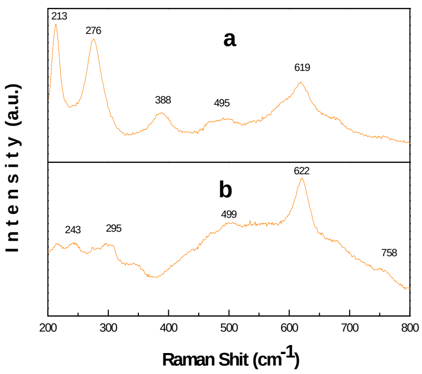

Figure 2. FT Raman spectra $Sn_{0.90}Fe_{0.10}O_2$ of a) $SnCl_2$ precursor and b) $SnCl_4$ precursor.

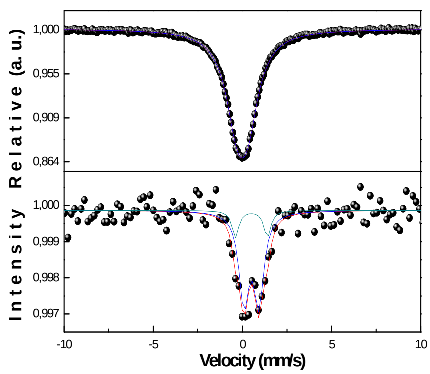

Figure 3: Room temperature a) ^{119}Sn and b) ^{57}Fe Mössbauer spectra of $Sn_{0.90}Fe_{0.10}O_2$ sample of $SnCl_4$ precursor.