Gas sensing properties of $(Sn,Ti,Nb)_xO_2$ solid solution

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Recently, great attention has been paid to nanostructures solid solutions based on metal oxides to enhance sensing performance with respect to those of single-oxide counterparts [1]. Tin and titanium dioxides (SnO_2 and TiO_2) are wide-gap n-type semiconductors extensively investigated for the fabrication of solid-state devices for gas sensing applications. They would easily form solid solutions since they can exhibit a rutile type structure where octahedrally coordinated Ti^{4+} and Sn^{4+} have similar ionic radii. Such solid solution combines the positive qualities of the singles oxides, e.g. high sensitivity towards reducing gases and low influence by humidity [2,3].
Despite the good sensing performances of $Sn_{1-x}Ti_xO_2$, a further improvement has been attempted by means of an Nb doping. The incorporation of Nb^{5+} would increase the conductivity of the material, as niobium acts as donor dopant in n-type semiconductors, and inhibit grain growth [4]. $(Sn,Ti,Nb)_xO_2$ powders were synthetized through co-precipitation by keeping the Sn/Ti proportion constant at the optimal value for sensing performance, while changing Nb concentrations and calcination temperature. Powder compositions, structures and morphologies were investigated by different techniques. Observations at SEM microscopy revealed that the morphology consists of rounded nanoparticles (see Fig.1) and X-ray powder diffraction analyses confirm that $(Sn,Ti,Nb)_xO_2$ samples were a rutile-type solid solution of tin, titanium and niobium. Electrical characterization of the films shows high sensitivity and marked selectivity towards H_2 (see. Fig.2) and poor influence by humidity. Gas-surface reactions are under investigation through diffuse reflectance Fourier infrared spectroscopy in operando condition.

Fig. 1.

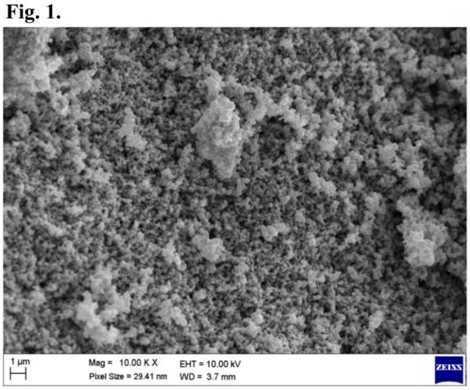

Fig. 2.

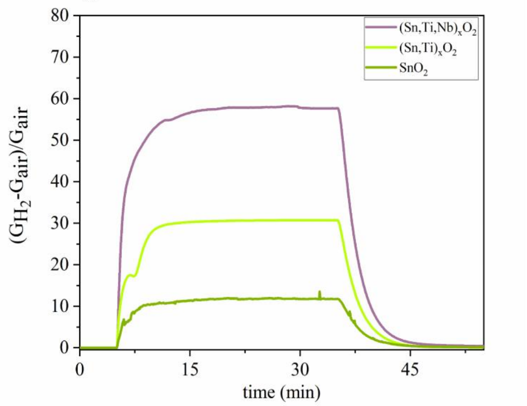

Fig. 1. SEM images of $(Sn,Ti,Nb)_XO_2$ powders fired at 650°C highlighting the spherical-like morphology.
Fig. 2. Comparison between the dynamical responses of $(Sn,Ti,Nb)_xO_2$, $(Sn,Ti)_xO_2$ and SnO_2 films to 50 ppm of H_2

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