Crystallite Growth Inhibition and Density Improvement

Celso V. Santilli, Alessandro Rizzatoa, Sandra Pulcinelli, Peter Hammer, Valerie Briois
LURE - France

Abstract

Dense SnO2 films can be used as transparent conductors in various optoelectronic devices such as screens or solar cells, while high surface area porous films are desired for the development of specific gas sensors. The development of new strategies to control the nanoporous structure is of fundamental importance for wet coating deposition of SnO2 films on plastic or glass substrates. In this work we compare the effect of organic (Tiron) and inorganic (Mn(II)) additives on the control of the nanostructural features of sol-gel dip-coated SnO2 films. The replacement of surface hydroxyl groups by Tiron molecules has produced redispersible and non-agglomerated nanoparticles that do not condense during firing. In fact, a more compact packing of nanoparticles is obtained in dried films, and crystallite growth is effectively inhibited during firing below 450oC. The presence of non-homogeneous distribution of manganese doping was associated to the presence of Mn(III) and Mn(II). The careful structural analyses done by EXAFS and the simulation of experimental results have given unquestionable evidence of solid solution formation, in which the Mn(III) replaces tin atoms in the cassiterite type structure, while Mn(II) are segregated at the surface of nanocrystals. The solid solution favors the film densification, while the segregated additive restricts the grain boundary mobility at elevated temperature (500oC).