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PII: S0040-6090(13)00497-5
DOI: doi: 10.1016/j.tsf.2013.03.051
Reference: TSF 31817

To appear in: *Thin Solid Films*

Received date: 21 December 2011
Revised date: 15 March 2013
Accepted date: 19 March 2013

Please cite this article as: E.P. Domashevskaya, O.A. Chuvenkova, S.V. Ryabtsev, Yu.A. Yurakov, V.M. Kashkarov, A.V. Shchukarev, S.Yu. Turishchev, Electronic structure of undoped and doped SnO_x nanolayers, *Thin Solid Films* (2013), doi: 10.1016/j.tsf.2013.03.051

Electronic structure of undoped and doped SnO_x nanolayers

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Abstract

Results of electronic structure investigations for tin oxide nanolayers obtained by tin magnetron sputtering and their following oxidation in the air at different temperatures are presented. Using X-ray photoelectron spectroscopy (XPS) and X-ray absorption near edge structure (XANES) spectroscopy techniques it was shown that at the 240 °C anneal a predominant phase in the samples surface layers is tin monoxide. With the annealing temperature increase up to 450 °C the phase composition corresponds to tin dioxide. Rather high sorption sensitivity for the samples oxidized at 450 °C was found. The compositional model of the gap structure based on XANES and XPS data matching for SnO_x nanolayers revealed occurrence of the crossed transitions with the energy of ~3.7 eV in the presence of two phases: the SnO and the SnO_2 or SnO_x with vacancies. Under surface doping of SnO_2 nanolayers with palladium PdO and PdO_2 is observed where PdO is the most intensive component. O_2 and H_2 multiple alternate exposures resulted in the disappearance of palladium dioxide and PdO recovery to the metallic Pd. Under Pd bulk doping of nanolayers PdO and PdO_2 were observed in the surface layers. In this case PdO_2 was presented by two types of particles different in size, one of them having the greatest binding energy of Pd $3d_{5/2}$ (339.0 eV).

Keywords: X-ray absorption near edge structure; X-ray photoelectron spectroscopy; tin oxides; nanolayers; the model of crossed transition.

1. Introduction

Designing of the gas-sensitive layers for sensors to the different kinds of gases with certain parameters is quite an actual problem at present time. The layers formed on the basis of tin oxide are of a specific interest due to their high stability and sensitivity