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Extended Abstract

Surface Properties of SnO_2 Nanolayers Deposited by Rheotaxial Growth and Vacuum Oxidation for Potential Gas Sensor Applications †

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Aim

Within this work the advantages of Rheotaxial Growth and Vacuum Oxidation i.e. maximal extension of internal surfaces, small degree of nanograins agglomeration and reduced influence of undesired contaminations together with exceedingly well—promising features of SnO_2 in terms of gas detection, have driven us to study RGVO SnO_2 nanolayers for potential gas sensing applications. Moreover, the influence of doping SiO_2 substrate with Cr and Al on the surface chemistry and morphology of RGVO SnO_2 nanolayers is under investigation.

Results

For the purpose of the better understanding the surface chemical properties, with the special empathizes on nonstoichiometry, carbon contaminations, the relative concentrations of the main components and bondings, the XPS technique was applied. Figure 1a demonstrates XPS survey spectra with the main core level lines for RGVO SnO_2 nanostructures deposited on SiO_2 substrates for as deposited and additionally oxidized samples. As it can be clearly seen, the spectra contain well recognized peaks related to O1s, Sn3d, and Sn4d (basic components of the expected SnO_2). The contribution of adventitious C contamination has not been detected neither in the case of raw samples nor after additional oxidation. The inset to Figure 1a shows the respective O–Sn3d spectral window required for the quantitative analysis of the surface chemistry performed in the subsequent part of the paper. In the case of RGVO SnO_2 nanolayers deposited on SiO_2 substrate modified with Cr and Al additives (also as deposited and after additional oxidation) the only visible XPS core level peaks also belong to the expected SnO_2 compound (Figure 1b). There is no contribution from Cr nor Al that can be treated as an indirect proof of the continuous SnO_2 nanolayer formation. The results of the calculation of the atomic relative concentrations [O]/[Sn] are presented in Table 1. As it can be seen, SnO2 nanolayers are highly nonstoichiometric—namely oxygen deficient. This leads to conclusion that the obtained oxides are the mixture of SnO_2 with significant contribution of SnO phase which is present in both: RGVO SnO_2 samples obtained on pure as well as on doped substrates. A slight increase in [O]/[Sn] can be observed each time in the case of the samples that underwent additional oxidation. Moreover the atomic relative concentration [O]/[Sn] is higher for nanolayers deposited on the substrates covered with Cr and Al.

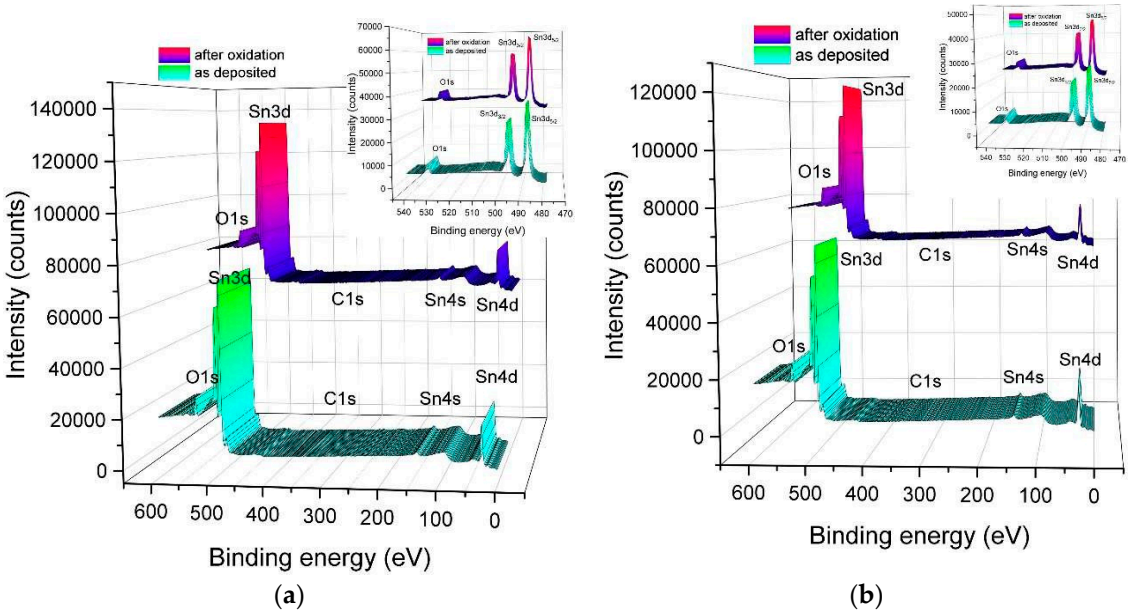

Figure 1. XPS survey spectra with the main core level lines of: (**a**) RGVO SnO_2 nanolayers deposited on SiO_2 substrate both as deposited and after additional oxidation, together with the corresponding O – Sn3d spectral window (in the inset); (**b**) RGVO SnO_2 nanolayers deposited on SiO_2 substrate modified with Cr and Al additives both as deposited and after additional oxidation, together with the corresponding O–Sn3d spectral window (in the inset).

Table 1. The results of XPS investigation: relative intensity (RI) of XPS lines and the atomic relative concentrations (ARC) of the main components for RGVO SnO_2 nanolayers.

Samples		XPS lines RI		ARC
Substrates	**RGVO SnO_2**	**O1s (a.u.)**	**Sn3d5/2 (a.u.)**	**[O]/[Sn]**
Pure SiO_2	As-deposited	47	340	0.90
	After oxidation	48	336	0.93
SiO_2 covered with Cr and Al	As-deposited	46	328	0.95
	After oxidation	50	320	1.02

Figure 2 shows the AFM data of RGVO SnO_2 nanolayers containing the 3D image, average grain height distribution and the respective depth profile. As it can be seen from AFM data, that

RGVO SnO_2 nanolayers exhibit the grain type surface morphology. The lateral grain dimension is in the range of 15–50 nm, whereas their height is at the level of several nm with distribution of maximum at ~5 nm, what finally causes that these nanolayers are of high flatness in a large surface area up to several μm.

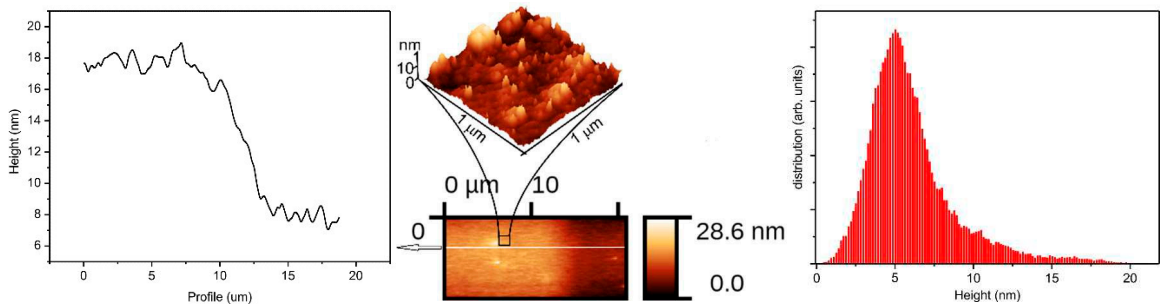

Figure 2. AFM data of RGVO SnO_2 nanolayers including the main image, average height distribution and the layer's edge profile.

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Conflicts of Interest: The authors declare no conflict of interest.

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