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Hydrogen gas sensing properties of WO_3 sputter-deposited thin films enhanced by on-top deposited CuO nanoclusters

Stanislav Haviar [a,*], *Jiří Čapek* [a], *Šárka Batková* [a], *Nirmal Kumar* [a], *Filip Dvořák* [b], *Tomáš Duchoň* [b,c], *Markéta Fialová* [a], *Petr Zeman* [a]

[a] *Department of Physics and NTIS-European Centre of Excellence, University of West Bohemia, Univerzitní 8, 30614, Plzeň, Czech Republic*

[b] *Department of Surface and Plasma Science, Faculty of Mathematics and Physics, Charles University, V Holešovičkách 2, 18000 Prague 8, Czech Republic*

[c] *Forschungszentrum Jülich GmbH, Peter Grünberg Institut 6, 52425, Jülich, Germany*

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ABSTRACT

Magnetron-based gas aggregation cluster source (GAS) was used to prepare high-purity CuO (cupric oxide) nanoclusters on top of sputter-deposited thin film of tungsten trioxide (WO_3). The material was assembled as a conductometric hydrogen gas sensor and its response was tested and evaluated. It is demonstrated that addition of CuO clusters noticeably enhances the sensitivity of the pure WO_3 thin film. With an increasing amount of CuO clusters the sensitivity of CuO/WO_3 system rises further. When CuO clusters form a sufficiently thick and compact layer, the resistance response is reversed. Based on the sensorial behavior, conventional and near-ambient pressure X-Ray photoemission spectroscopies, and resistivity measurements, we propose that the sensing mechanism is based on the formation of nano-sized *p-n* junctions in between *p*-type CuO and *n*-type WO_3. The advantages of the GAS technique for preparing sensorial and/or catalytically active materials are emphasized.

Introduction

The hydrogen (H_2) energy market is rapidly growing and there is a strong interest in development of fast, stable and sensitive hydrogen gas sensors [1]. One of the most often explored approaches are chemiresistors based on metal-oxide semiconductors (MOSs) [2–4]. The main effort has been put into an improvement of the sensitivity, selectivity, stability and durability of the sensors [4]. Less attention has been paid to a development of new preparation methods that are compatible with thin-film microcircuit technology and also allowing large-scale production of the sensors. This is, however, a vital requirement for full integration of nanostructured sensorial materials into modern devices [5], such as on-chip fuel-cells. Last but not least, there is an effort to employ economically and environmentally reasonable materials for sensor production.

* *Corresponding author.*
E-mail address: haviar@ntis.zcu.cz (S. Haviar).
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