Preparation of multi-composite nanoparticle based thin-films for gas sensing

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1 Introduction

Working principle of conductometric gas sensors is based on a modulation in electrical conductivity of the sensing material due to adsorption-desorption reactions between the target gas and the sensor surface. Nano-structuring the sensing material increases the effective surface area for interaction between the target gas and the sensing material thereby enhancing the sensorial response. Metal oxide semiconductors (MOS) have shown remarkable sensing performance to oxidizing and reducing gases. Combination of different MOS has often shown to synergistically improve the gas sensing performance via formation of highly sensitive heterojunctions at their interface.

2 Experimental details

In this work, we deposited thin films composed of nanoparticles (NPs) of p-type CuO_x and n-type WO_x to enhance the effective surface area of the material and to realize the maximum number of nano p-n heterojunctions in the material. The films were prepared using the Nanogen-Trio NP source equipped with three 1" magnetrons, mounted on a custom-built deposition chamber and sputtered by a DC power supply. Depositions were executed in Ar+O_2 gas mixture. As one can see in Figure 1, the O_2 admixture may significantly enhance the mass flux of NPs, Γ_m. Furthemore, the O_2 admixture allows one to tune the desired stoichiometry of the respective metal oxides. On the other hand, the pronounced hysteresis complicates the deposition of WO_x NPs. The deposition process was controlled using a complex in-house developed software to prepare thin films composing a mixture of NPs with a defined volumetric ratio of the individual materials.

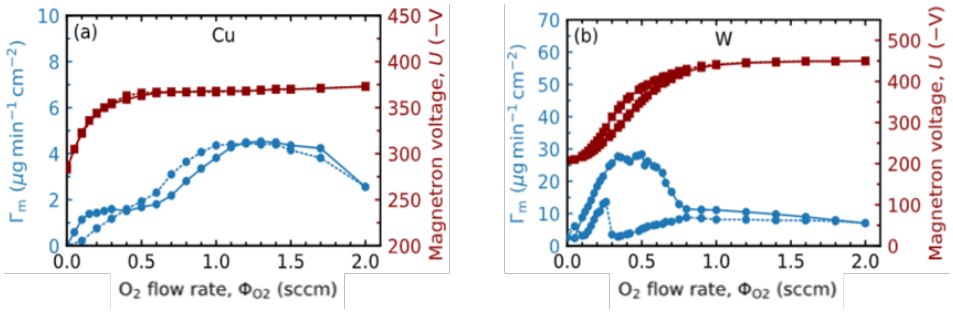

Figure 1: Mass flux of nanoparticles, Γ_m, and magnetron voltage, U, as a function of increasing (solid line) and decreasing (dotted line) flow rate of oxygen, Φ_{O2}, for Cu (a) and W (b) targets

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This project demonstrates the versatility of our custom-built gas aggregation source that enables to effectively control the deposition parameters for each target material thereby facilitating the preparation of multi-composite NP-based thin film giving the best sensorial response.

References

Haviar S et al. (2018) *Hydrogen gas sensing properties of WO_3 sputter-deposited thin films enhanced by on-top deposited CuO nanoclusters*.Available from: https://doi.org/10.1016/j.ijhydene.2018.10.127