H_2S and SO_2 Sensing with SMOX Materials: the Case of SnO_2, In_2O_3 and WO_3

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Toxic hydrogen sulfide (H_2S) and corrosive sulfur dioxide (SO_2) are the most prominent and abudant representatives of sulfur-containing gases. Both may occur in the natural environment, like the decomposition of organic materials or volcanic erruptions, while also playing a key role in industrial processes [1]. The occurence of these gases necessitates fast and reliable detection as well as precise quantification in regard of worker safety and environmental protection. Gas sensors based on semiconduction metal oxides (SMOX) proved to be an appropriate means in fulfilling these tasks. They can be realized as cheap and compact sensing devices. The lack of selectivity in the presence of interfering gases remains challenging [2]. Measurements with CuO have shown strong response and selectivity to H_2S due to an irreversible phase transistion to CuS, however, at the cost of considerable changes to the material's morphology [3]. In an effort to expand our knowledge about the interaction of H_2S and SO_2 with commonly used SMOX materials, a systematic study was conducted. Hereinafter, we show the results of various characterization techniques employed on SnO_2, In_2O_3 and WO_3. These include in-operando direct current (DC) resistance measurements conducted in a wide temperature range and at three levels of relative humidity, scanning electron microscopy (SEM), energy-dispersive X-ray spectroscopy (EDX) and X-ray photoelectron spectroscopy (XPS). To some extent, response and recovery differ significantly for the different materials at the various operating temperatures, while no changes in the morphology could be observed. However, for SnO_2 and In_2O_3 heterogeneities were found on the sensors' layers, whose composition and possible origins will be discussed.

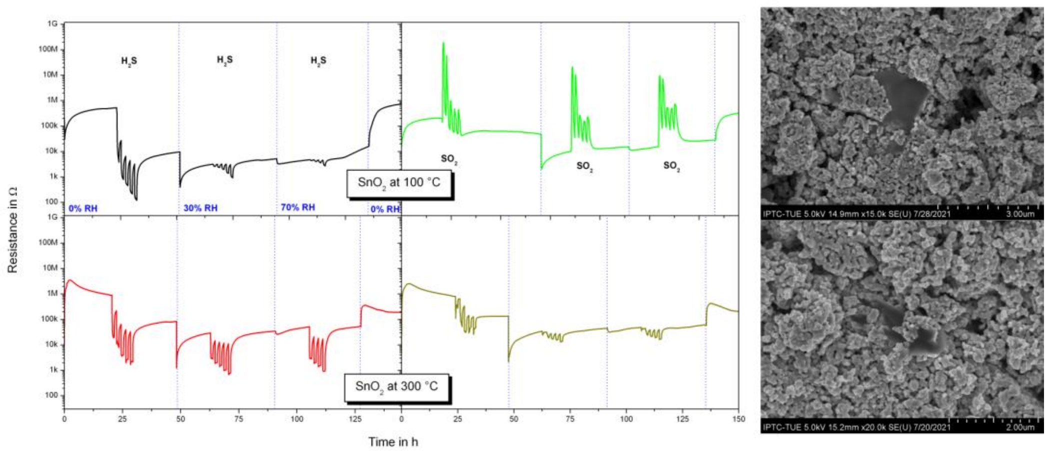

Fig. 1. Exemplary DC resistance measurements for SnO_2 exposed to H_2S and SO_2 and SEM pictures taken afterwards.

[1] X. Zhang et al., ACS Catal. **5**, 1053 (2015).
[2] N. Barsan, D. Koziej, and U. Weimar, Sens. Actuator B Chem. **121**, 18 (2007).
[3] M. Boepple et al., Sens. Actuator B Chem. **321**, 128523 (2020).