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Abstract

Efficient Screening of Hybrid Nanomaterials for Optimizing Chemical Sensor Devices †

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Abstract: Chemical sensors based on metal oxides (MOx) are one of the most promising gas sensing devices due to their high sensitivity to numerous gases, fast response, miniaturization, and simple production. The detection principle of these sensors is a conductivity change of the MOx-sensing material due to the chemical reactions of gases with surface molecules. Cross sensitivities and interference to humidity, however, are still significant drawbacks of these sensors. The functionalization of MOx-sensing films with catalytic nanoparticles (NP) is a highly promising technology for optimizing sensor performance. The huge variety of potential MOx–NP combinations requires efficient screening technologies to find proper hybrid material mixtures which enable the controlled adjustment of the sensor response to specific target gases. This is of high importance for the realization of a multi-gas sensor device capable of the clear discrimination of single gas components from a gas mixture. In this work we introduce our approach for the efficient screening of hybrid MOx–NP material combinations. We have developed a specific Si-platform chip along with a gas measurement setup which enables the simultaneous characterization of 16 chemical sensor structures in parallel. The Si-chips feature an array of Ti/Pt electrodes for contacting ultrathin MOx-sensing films, which are deposited by spray pyrolysis, and structured by photolithography to a size of 50 × 100 µm^2. On these platform chips we tested three different MOx (SnO_2, ZnO, and CuO) before and after functionalization with mono- and bimetallic NPs (such as Au, Pt, Pd, and NiPt) on several test gases (CO, HCmix, toluene, CO_2). Measurements were performed in a background gas of synthetic air at different relative humidity levels (25–75%) and at different operating temperatures up to 350 °C. We present the sensing performance results of various MOx-NP combinations, exhibiting an optimized response to specific target gases.

Keywords: nanosensors; hybrid nanomaterials

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