Semiconducting Metal Oxides Core−Shell Heterostructures for Gas Sensing

Muhammad Hamid Raza[1] and Nicola Pinna[1*]

1-Institut für Chemie and IRIS Adlershof, Humboldt-Universität zu Berlin, Brook-Taylor-Str. 2, 12489 Berlin, Germany

*nicola.pinna@hu-berlin.de

Semiconducting metal oxides (SMOX) gas sensors are the most appealing because of their low cost, simplicity, and compatibility with state-of-the-art electronic devices. Even with their increasing importance in real-world applications, researchers have yet to fully understand their gas sensing properties including the transduction mechanism, which is hampering the development of new sensing strategies for high sensitivities, rapid responses, and superior selectivity. Therefore, it is vital to develop well-defined SMOX-based heterostructures to better understand how sensing works. The study here presents a synthesis approach to prepare a range of well-defined one-dimensional (1D) core-shell heterostructures (CSHS) with conformal and homogeneous depositions of different shell materials of controlled thicknesses by atomic layer deposition (ALD). The gas-sensing properties and mechanism, and the role of the shell thickness of structurally well-defined SnO_2-NiO and SnO_2-SiO_2, NiO-CNT, SnO_2-CNT, NiO-SnO_2-CNT and SnO_2-NiO-CNT hierarchical CSHS are studies in a systematic way. Both the electrical and gas sensing properties are strongly influenced by the thickness of the shell. In addition, we will discuss the role of heterojunctions in gas sensing that is highly dependent on the sequence of device preparation, *i.e*. the electronic conduction pathway, and the thickness of the shell and the core materials. The study presents an approach to engineering next-generation gas sensors by developing well-defined hierarchical CSHS, and understanding the mechanism behind gas sensing.