Role of electronic charge transfer mechanisms in core-shell nanostructures for gas sensing

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Electronic charge transfer mechanisms have been postulated to explain the functioning of chemoresistive gas sensors based on semiconductor metal oxide (SMOX). However, comprehensive knowledge of the gas sensor mechanisms demands a detailed command of the physicochemical properties and features of the active sensing materials and their interaction with the analyte gas molecules. Nowadays, heterostructures made from SMOX are fundamental for the development of high-performance gas sensors. Yet, despite the recognition of their importance in real applications, the understanding of the transduction mechanism either related to the heterojunction, or simply to the core and shell materials is still lacking. A better understanding of the sensing response of heterostructured nanomaterials requires the engineering of heterojunctions with well- defined core and shell layers. Here, we report data collected on a series of hierarchical CNTs core- SMOX shell heterostructures allowing us to directly relate the sensing response to the SMOX shell, or to the p-n heterojunction. NiO and SnO_2 are selected as representative p- and n-type SMOX, respectively, and the response of a set of samples is studied toward some selected target gases. We demonstrated that sensing response in these chemoresistive gas sensors is governed by the heterojunctions between nSMOX and pSMOX and strongly depends on the thickness of the SMOX layers. Due to the fundamental nature of this study, these findings are important for the development of next generation gas sensing devices.