Construction of transition metal dichalcogenide based nanohybrids for NO_2 detection

Yutong Han, Zhi-gang Zhu
School of Medical Instrument and Food Engineering, University of Shanghai for Science and Technology, Shanghai 200093, People's Republic of China

yutonghan@usst.edu.cn

With the widespread applications of gas sensors in the Internet of Things, such as smart homes, wearable devices and mobile terminals, the high-performance gas sensors with low operation temperature, miniaturization and easy integration have become a hot topic [1]. Generally, the core development of gas sensors always involves the design and innovation of sensitive materials. Two dimensional materials are ideal nanomaterials for the building blocks of room-temperature gas sensors due to their large specific surface area, many adsorption sites, and high room-temperature carrier mobility. Transition metal dichalcogenides (TMDs) have shown great potential in the applications of room temperature gas sensors as their adjustable band structures, high carrier mobility, and unique electrical properties. However, during the formation of the conductive network on the electrodes, TMD nanosheets may restack or aggregate due to the electrostatic force between each layer, which may influence the adsorption between the conductive network and the gas molecules [2]. Thus, the sensitivity and response/recovery speed of TMD gas sensors need to be further improved. This thesis focuses on the designing and optimizing TMD heterostructures by decorating MOS nanoparticles or nanosheets on the surface of TMD nanosheets, such as MoS_2/SnO_2, MoS_2/ZnO, and WS_2/WO_3. The gas sensing characteristics of TMD heterostructures are improved including the sensitivity, response/recovery speed, and long-term stability compared with the pure TMD room temperature gas sensors. Moreover, the gas sensing mechanisms and the relationships between the gas sensing performance and the nanostructure of sensitive materials are further explored.

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[2] E. Lee, Y. S. Yoon, D. J. Kim, Two-dimensional transition metal dichalcogenides and metal oxide hybrids for gas sensing. ACS Sens. **3**, 10 (2018).