Metal Doping effects on ZnO Tetrapods with Bismuth and Tin Oxides

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A highly porous interconnected three-dimensional (3D) structure comprised by a network of nano- and micro-scale ZnO tetrapods (ZnO-T) possess a large surface-to--volume ratio, offering many gas diffusion channels, which is highly beneficial for sensor devices with enhanced gas sensing response. The formation of heterojunctions in these tetrapodal networks was demonstrated to be the main key feature for further improving their sensing properties. Recently, novel hybrid materials based on highly porous ZnO-T 3D networks with different types of metal oxides (Me_xO_y) and ternary alloyed systems ($Zn_xMe_{1-x}O_y$) were produced, and were found to exhibit unique properties, making them promising candidates for a wide range of applications, including gas sensing [1].

In this work, the characteristics of the hybrid ZnO-Bi_2O_3 and ZnO-Zn_2SnO_4 tetrapod networks were investigated. Detailed morphological, structural, vibrational, and optical studies of the materials were performed and discussed [1]. Raman spectra were dominated by the vibrational modes expected for the ZnO wurtzite structure. However, for the hybrid Zn_2SnO_4 tetrapod networks, additional vibrational modes were identified and assigned to the zinc stannate phase, corroborating the X-ray diffraction patterns. The correlation between photoluminescence excitation (PLE), absorption and photoluminescence (PL) results allowed to provide the necessary information to form possible configuration of *n*-Zn_2SnO_4/*n*-ZnO-T and *p*-Bi_2O_3/*n*-ZnO-T heterojunctions in the thermal equilibrium parameters necessary for the fabrication of the sensing device. The gas sensing studies reveal improved performance of the hybrid networks compared to pure ZnO-T networks: an enhancement of H_2 gas response was obtained for the ZnO-T-Bi_2O_3 network, while in ZnO-T-Zn_2SnO_4 networks, a change of selectivity to CO gas with high response was achieved [1].

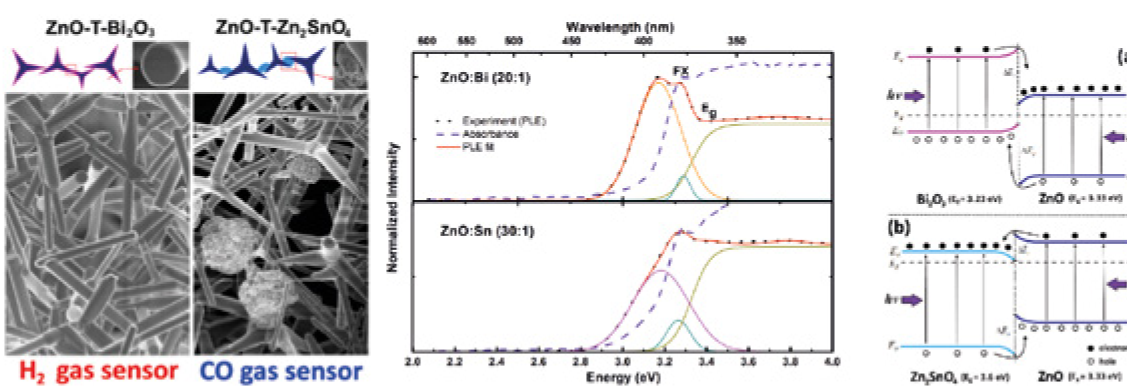

FIGURE 1
Left: SEM images of novel ZnO tetrapod with hybrid 3D networks of Bi_2O_3 and ZnO-Zn_2SnO_4.
Middle: Room-temperature PLE (monitored at ~2.4 eV) and absorbance spectra of the ZnO-T with hybrid 3D networks of Bi_2O_3 and ZnO-Zn_2SnO_4.
Right: Schematic energy band diagram of the heterojunctions at the thermal equilibrium (adapted from [1]).