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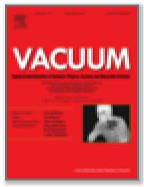

UV detection properties of hybrid ZnO tetrapod 3-D networks

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Abstract

Hybridization of micro- and nanostructures of semiconducting oxides is known to be an efficient way to greatly improve their sensing properties and photocatalytic activity. In this work, zinc oxide (ZnO) tetrapod (T) three-dimensional (3-D) highly porous networks were hybridized with Me_xO_y and $Zn_xMe_{1-x}O_y$ compounds (Me = Sn, Fe, Bi, Cu or Al), and their ultraviolet (UV) sensing properties were investigated. Additionally, individual Al-doped ZnO-T (ZnO-T:Al) with different diameters were integrated into devices using a FIB/SEM system to study the influence of diameter on the UV sensing properties. ZnO-T–CuO hybrid networks demonstrated the highest increase in UV response (with about 2.5 times) and decrease in response and recovery time ($\tau_{r1} = \tau_{r2} \approx 0.03$ s and $\tau_{d1} = \tau_{d2} \approx 0.045$ s) compared to pristine ZnO-T networks before hybridization, which is quite promising for applications in fast optical communication. The ZnO-T–Zn_2SnO_4 hybrid networks showed only a slight increase in UV response while other types of hybrid networks showed a considerable decrease in UV response, especially in the case of ZnO-T–Bi_2O_3 hybrid networks, which could be attributed to the fast recombination of photoexcited electrons and holes in Bi_2O_3 under the UV light illumination. The results demonstrate that hybridization with p-type materials is more efficient due to higher photogenerated charge separation properties. In the case of individual structures the device based on a microwire with lower diameter showed higher stability and good repeatability with a relatively high UV response of about 5.5. The excellent UV sensing properties combined with ultra-low power consumption make such devices very attractive for real applications like portable UV dosimeters. This work demonstrated the high efficiency of ZnO-T hybridization with p-type metal oxides for improvement of UV sensing properties.