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Comparison of Thermal Annealing versus Hydrothermal Treatment Effects on the Detection Performances of ZnO Nanowires

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Abstract

A comparative investigation of the post-electroplating treatment influence on the gas detecting performances of single ZnO nanorod/nanowire (NR/NW), as grown by electrochemical deposition (ECD) and integrated into nanosensor devices, is presented. In this work, hydrothermal treatment (HT) in a H2O steam and conventional thermal annealing (CTA) in a furnace at 150 °C in ambient were used as post-growth treatments to improve the material properties. Herein, the morphological, optical, chemical, structural, vibrational, and gas sensing performances of the as-electrodeposited and treated specimens are investigated and presented in detail. By varying the growth temperature and type of post-growth treatment, the morphology is maintained, whereas the optical and structural properties show increased sample crystallization. It is shown that HT in H2O vapors affects the optical and vibrational properties of the material. After investigation of nanodevices based on single ZnO NR/NWs, it was observed that higher temperature

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during the synthesis results in a higher gas response to H2 gas within the investigated operating temperature range from 25 to 150 °C. CTA and HT or autoclave treatment showed the capability of a further increase in gas response of the prepared sensors by a factor of ~8. Density functional theory calculations reveal structural and electronic band changes in ZnO surfaces as a result of strong interaction with H2 gas molecules. Our results demonstrate that high-performance devices can be obtained with high-crystallinity NWs/NRs after HT. The obtained devices could be the key element for flexible nanoelectronics and wearable electronics and have attracted great interest due to their unique specifications.

Keywords: nanorods, nanowires, electroplating treatment, electrochemical depositions, nanosensors, photoluminescence