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Structural and Electrical Properties of VO_2/ZnO Nanostructures

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Abstract : We examined structural and electrical properties of uniformly-oriented VO_2/ZnO nanostructures. VO_2 was deposited on ZnO templates by using a direct current-sputtering deposition. Scanning electron microscope and transmission electron microscope measurements indicated that b-oriented VO_2 were uniformly crystallized on ZnO templates with different lengths. VO_2/ZnO formed nanorods on ZnO nanorods with length longer than 250 nm. X-ray absorption fine structure at V K edge of VO_2/ZnO showed M1 and R phases of VO_2 at 30 and 100 ℃, respectively, suggesting structural phase transition between temperatures. Temperature-dependent resistance measurements of VO_2/ZnO nanostructures revealed metal-to-insulator transition at 65 ℃ and 55 ℃ during heating and cooling, respectively, regardless of ZnO length. The bond lengths of V-O and V-V pairs in VO_2/ZnO nanorods were somewhat distorted, and a substantial amount of structural disorder existed in the atomic pairs, compared to those of VO_2 films without ZnO. Resistance from VO_2/ZnO nanorods revealed a sharp MIT near 65 ℃ during heating and a hysteresis behavior. The resistance results suggest that microchannel for charge carriers exist nearly room temperature during cooling. VO_2/ZnO nanorods are quite stable and reproducible so that they can be widely used for practical applications to electronic devices, gas sensors, and ultra-fast switches, as examples.

Keywords : metal-to-insulator transition, VO_2, ZnO, XAFS, structural-phase transition
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