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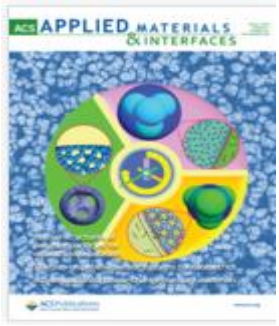

Direct Growth of Freestanding ZnO Tetrapod Networks for Multifunctional Applications in Photocatalysis, UV Photodetection, and Gas Sensing

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Abstract

Growth of freestanding nano- and microstructures with complex morphologies is a highly desired aspect for real applications of nanoscale materials in various technologies. Zinc oxide tetrapods (ZnO-T), which exhibit three-dimensional (3D) shapes, are of major importance from a technological applications point of view, and thus efficient techniques for growth of different varieties of tetrapod-based networks are demanded. Here, we demonstrate the versatile and single-step synthesis of ZnO-T with different arm morphologies by a simple flame transport synthesis (FTS) approach, forming a network. Morphological evolutions and structural intactness of these tetrapods have been investigated in detail by scanning electron microscopy, X-ray diffraction, and micro-Raman measurements. For a deeper understanding of the crystallinity, detailed high-resolution transmission electron microscopic studies on a typical ZnO tetrapod structure are presented. The involved growth mechanism for ZnO tetrapods with various arm morphologies is discussed with respect to variations in experimental conditions. These ZnO-T have been utilized for photocatalytic degradation and nanosensing applications. The photocatalytic activities of these ZnO-T with different arm morphologies forming networks have been investigated through the photocatalytic decolorization of a methylene blue (MB) solution under UV light illumination at ambient temperature. The results show that these ZnO-T exhibit strong photocatalytic activities against MB and its complete degradation can be achieved in very short time. In another application, a prototype of nanoelectronic sensing device has been built from these ZnO-T interconnected networks and accordingly utilized for UV detection and H2 gas sensing. The fabricated device structures showed excellent sensing behaviors for promising practical applications. The involved sensing mechanisms with respect to UV photons and H2 gas are discussed in detail. We consider that such multifunctional nanodevices based on ZnO tetrapod interconnected networks will be of interest for various advanced applications.