

Study on Preparation, Characterization and Photoelectrochemical Properties of Highly Oriented ZnO Nanorods

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As the ordered ZnO nanostructure has been envisioned to enhance performance of various technologically important devices such as short-wavelength lasers and Grätzel-type solar cell, the interest in synthesis well-aligned ZnO nanowires or nanorods on substrates keeps growing. Perpendicularly oriented single-crystalline ZnO nanorod arrays have been recently fabricated on sapphire substrates using VLS and CVD methods. However, these methods involve complex procedures, sophisticated equipment and high temperature. For many practical applications, it still remains a great challenge to fabricate well-aligned single-crystalline ZnO nanorods by using a simple and low-temperature method.

Well-aligned single-crystalline wurtzite zinc oxide nanorods with the *c* axis of the crystallites perpendicular to the substrate have been prepared for the first time by a low cost, low temperature hydrothermal approach. A two-step growth mechanism, which involves an initial formation step of densely packed wurtzite-structured nanocrystal seeds followed by a pure solution growth step on these seeds, is proposed to be responsible for the formation of well-aligned ZnO nanorods. Scanning electron microscopy (SEM), high-resolution transmission electron microscopy (HRTEM), X-ray diffraction (XRD) and Raman spectroscopy have been used to characterize the ZnO nanorod arrays. More than 90% ZnO nanorods have diameter of 120 to 180 nm and the typical length is ~ 4 μm for 2 h growth time. The thin films composed of ZnO nanorods with controlled orientation onto ITO substrates allow a more efficient transport and collection of photogenerated electrons through a designed path. For a sandwich-type cell, with 0.3M LiI and 0.03M I₂ in 1,2-propanediol carbonate electrolyte, the IPCE (incident photo-to-current conversion efficiency) reaches 60% at 370nm.

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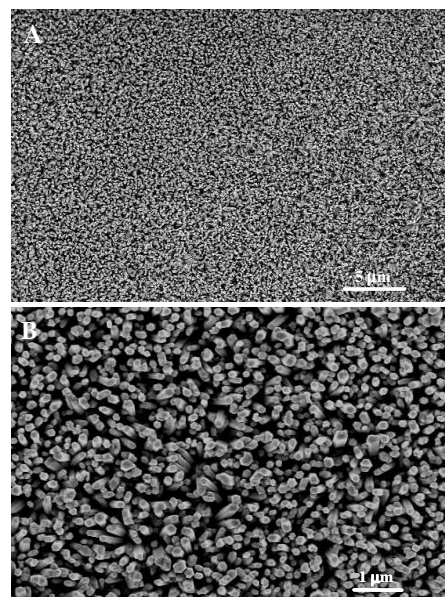


Figure. (A)-(B) top view of SEM images of ZnO nanorod arrays grown on ITO substrates pre-modified with densely and uniformly dispersed ZnO nanoparticles.