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Influence of the spray pyrolysis seeding and growth parameters on the structure and optical properties of ZnO nanorod arrays

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Abstract

ZnO nanorods (NRs) were grown on fluorine doped tin oxide (FTO) substrates at low temperatures (90 degrees C) from Zn²⁺ precursors in alkaline media previously seeded with ZnO nanoparticles. These were deposited onto the FTO substrate heated at 350 degrees C by spray pyrolysis of a Zn acetate solution in a water ethanol mixture. The structure of seeds was tuned by the ethanol to water ratio, Gamma, which controls the solvent evaporation rate of drops impinging the substrate. From a detailed characterization using a combination of scanning electron microscopy, X-ray diffraction, UV-visible absorption and cathodoluminescence spectroscopies, the dependence of the morphology and optical properties of the ZnO NRs on the seeding conditions was demonstrated. NRs grown on seeds deposited from solutions with in the 0.03-0.06 range - i.e. when the surface excess of ethanol in the water-ethanol mixture has a maximum - show thinner average diameters and stacking faults due to the presence of zinc blende domains embedded into an overall wurtzite NR. They furthermore exhibit blue-shifted near band edge emission peak and a high deep level emission in cathodoluminescence. All these findings support the use of spray pyrolysis as a simple and reproducible way to control the seeds deposition, influencing the growth, the structure and the optical properties of the final ZnO NRs. (C) 2014 Published by Elsevier B.V.

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