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Surface characterisation of ZnO nanorods grown by Chemical Bath Deposition on Si substrate

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Abstract content
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There is a growing interest in quasi-one-dimensional ZnO nanostructures (e.g. nanorods, nanowires, nanobelts and nanotubes) considered as potential candidates for application such as gas sensors, biosensors, nanolasers, optical waveguides and light emitting diodes. However, nanostructured materials have a large surface-to-volume ratio compared to bulk-like material that amplifies surface related effect in many ways. For opto-electronic applications such as light emitting diodes and solar cells, surface states in the band gap can lead to technical challenges. Therefore, it is important to investigate the complete chemical composition of ZnO, the surface stoichiometry and identify the chemical origin and the nature of surface recombination centres in ZnO nanostructures. In this work, we report on the surface characterization of solution grown ZnO nanorod arrays (ZNAs) by Time of Flight Secondary Ion Mass Spectroscopy (TOF-SIMS), X-ray Photoelectron Spectroscopy (XPS) and Auger Electron Spectroscopy (AES).
X-ray diffraction and SEM analysis revealed that as-grown nanorods are well-aligned with the c-axis approximately perpendicular to the substrate and have good crystalline quality. TOF-SIMS revealed species such as hydrogen, hydroxyl groups, and zinc hydroxide to be the most abundant near the surface, but less abundant in the bulk. Annealing caused a complete out-diffusion of H (and OH) from the near surface but not from the bulk region. XPS and AES supported the above TOF-SIMS observations. From XPS results, the near surface region has been found to be ˜30 nm in width. Finally XPS and AES showed also that the near surface region of as-grown ZNAs are Zn-rich and that annealing in an oxygen environment reduces the activation rate of oxygen vacancies at elevated temperatures (˜600 oC).

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