Effect of Deposition Time on Structural Properties of Zinc Oxide Thin Films

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Abstract

Using of zinc oxide as a material of conductive and window layers of solar cells provides new possibilities for the creation of photoconverters based on Si, CdTe, CIGS and CZTSe absorbers. Due to large exciton binding energy, low toxicity and high band gap zinc oxide can be used as a material of detectors, light-emitting devices and filters of UV-radiation.

In this paper we investigated ZnO layers obtained via chemical bath deposition from zinc nitrate, hexamethylenetetramine and ammonia solutions at a temperature of 90 ^{0}C. Effect of deposition time on the structure and substructure was investigated using scanning electron microscopy, X-ray analysis and Raman spectroscopy.

There is formed the densely packed array of ZnO nanorods with diameter (0.2–0.8 μm) and length (2.0-3.5 μm) with different angle to substrate. With increasing of duration to 90 min there take place an increase thickness (1.0-1.9 μm) and length (4.8-6.7 μm) of nanorods. Increasing the deposition time to 120 min leads to overgrowing of gaps between nanorods by lamellar crystallites with thickness of (0.10-0.16) μm and formation of continuous film.

Condensates have hexagonal structure with growth texture of [002] and lattice constants a = 0.32486 nm, c = 0.52087 nm. Grain size and microstrain in the direction perpendicular to the crystallographic planes (002) were L ~ 26-42 nm and ε ~ (0.59-3.09)·10^{-3}, and decreased with increased time of deposition.

In the Raman spectra there is detected intensity peaks at frequencies of 339, 439 and 578 cm^{-1}, which were interpreted as 2E2 (low), E2 (high), A1 (LO) phonon modes of ZnO.

It is found that via varying of the deposition time we can obtain ZnO layers with pre-defined structural properties from nanorods to continuous films.

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