PO1062

Characterization of the energy flux towards the substrate during magnetron sputter deposition of ZnO thin films

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Control and improvement of the crystalline structure of ZnO thin films deposited by PVD processes are very important for industrial manufacturing of solar cells, where ZnO films are used as a passivation layer. Therefore, the description of the particle fluxes and related energy fluxes and their effect on the energy balance at the substrate surface and for the resulting film properties is of essential interest for understanding and tailoring this process.
Calorimetric measurements [1] at the substrate position were carried out in a triple rf-magnetron sputter deposition system with ceramic ZnO targets using different gas mixtures (Ar/N_2 and Ar/H_2). By variation of the probe bias the various contributions originating from kinetic energy of charge carriers, recombination of charge carriers at surfaces as well as contributions by impact of neutral sputtered particles and subsequent film growth are determined. It was found that the influence of N_2 addition is marginal, while the influence of H_2 addition is quite remarkable. Due to the lower binding energy of the hydrogen molecule the dissociation is much more effective than for the N_2 molecule. The recombination of hydrogen atoms leads to an effective energy transfer via the release of recombination energy. Radial scans in the substrate plane were recorded for a spatial resolution of the total energy influx in the substrate position. The properties of the ZnO films grown under comparable conditions were investigated using XRD and XRR. The dependence of gas mixture and substrate temperature on crystalline structure, growth rate and grain size are presented.

[1] Stahl et al., Rev Sci Instrum, 81(2010), 023504

Keywords
magnetron sputtering
calorimetric probe
ZnO
nitrogen
XRD