Investigation of Optical Properties and Defects Structure of Rare Earth (Sm, Gd, Ho) Doped Zinc Oxide Thin Films Prepared by Pulsed Laser Deposition

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In past decades a lot of affords have been put in fabrication of high quality ZnO thin films. Such films of low defects concentrations can serve as a part of several optoelectronics devices (waveguides, LEDs, solar cells and sensors). The optical properties can be tuned and enhanced by doping ZnO with rare earth (RE^+) elements up to 3 at. %. Strong emission lines in ZnO:RE structures can be obtained in visible and infrared spectral region.

Pulsed Laser Deposition (PLD) has been shown as promising technique for fabrication of thin films of complex structure. ZnO films prepared by PLD exhibit typically oxygen deficiency leading to enhanced concentration of oxygen vacancies. Deposition in oxygen enriched atmosphere can eliminate this problem and eventually create Zn vacancies.

ZnO:RE thin films were grown by PLD (Nd:YAG, λ= 266 nm, τ = 6 ns) from ZnO:Sm_2O_3, ZnO:Gd_2O_3 and ZnO:Ho_2O_3 targets (RE content was 1 at. %) in oxygen ambient at pressure of 5, 10 and 20 Pa on fused silica and Si (100) substrates at room temperature. Defects structure was examined by variable energy positron annihilation spectroscopy (VEPAS). Doppler broadening of annihilation radiation was evaluated using S and W line-shape parameters as a function of energy of implanted positrons. Morphology of the films was characterized by atomic force microscopy. The optical properties were analysed by spectrophotometry, spectral ellipsometry and photoluminescence. Electrotransport properties were characterized by resistivity measurements.

All ZnO:RE films exhibited significantly higher values of the S parameter as well as shorter positron diffusion lengths compared to ZnO monocrystal reference due to nanocrystalline structure of the films as was observed by AFM. We assume positrons were predominantly trapped at grain boundaries.

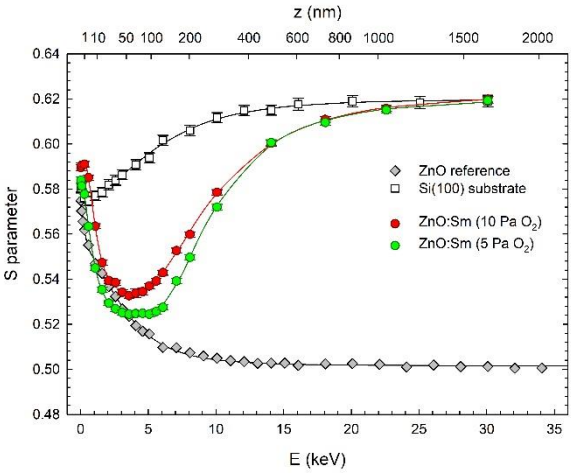

Figure 1 S(E) curves for ZnO:Sm films prepared under 10 Pa and 5 Pa O2 atmosphere, reference curves of the Si substrate and ZnO reference are included.

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