Sol-gel derived ZnO:Y nanostructured films: structural and optical study

T.Ivanova[1*], A. Harizanova[1], T.Koutzarova[2], B. Vetruyen[3]

[1]*Central Laboratory of Solar Energy and New Energy Sources, Bulgarian Academy of Sciences, blvd. Tzarigradsko chaussee 72, Sofia, Bulgaria*
[2]*Institute of Electronics, Bulgarian Academy of Sciences, blvd. Tzarigradsko chaussee 72, Sofia, Bulgaria*
[3]*LCIS/SUPRATECS, Institute of Chemistry B6, University of Liege, Sart-Tilman, B-4000 Liege, Belgium*

**tativan@phys.bas.bg*

ZnO has various applications such as solar cell, gas sensors, optoelectronic devices, biological applications and UV photodetector etc. ZnO has a low material cost and low deposition temperature. Yttrium is an environmentally friendly and abundant rare earth element, and yttrium oxide (Y_2O_3) has important parameters such as thermal and crystallographic stability (2325°C), mechanical strength, dielectric constant (~18), band gap (~5.8 eV), optically transparent over a wide spectral range (0.28–8 μm), refractive index (n = 2). Y_2O_3, both a rare-earth oxide and a transition oxide, is claimed to be a theoretically interesting and technologically useful material [1]. Y_2O_3 films are found to be applicable for electroluminescent devices due to high dielectric constant and thermal stabilities.
Previously [2], it has been reported a study of sol-gel ZnO:Y nanostructured films with small concentrations. There, we continue to investigate sol-gel ZnO:Y films prepared from sols with higher concentrations of yttrium precursor $Y(NO_3)_3$. The precursor used is zinc acetate, dissolved in an absolute ethanol (0,4 M concentration). As a complexing agent and stabilizer is used monoethanolamine. The yttrium is involved by adding $Y(NO_3)_3$ in the weight percent : 2 and 3. The corresponding sols and the obtained films are labeled ZnO:Y 2, ZnO:Y 3. The sol-gel Y doped ZnO films have been successfully deposited on Si and quartz substrates by spin coating method, then annealed at the temperatures 300-800^{o}C. XRD and FTIR analyses are applied to reveal structural and vibrational properties. The optical behavior, depending on Y dopant and annealing has been studied by UV-VIS spectrophotometry, optical band gaps are estimated.
XRD patterns have been compared with standard JCPDS data. It is noticeable that the XRD peaks of Y doped ZnO films are significantly broader and less intense compared to single ZnO. The XRD analysis reveals that higher Y concentrations result in the formation of cubic yttrium oxide appeared as separate phase in the film structure after high temperature annealing (Figure 1). The crystallite sizes, lattice parameters and texture coefficients for lines (100), (002) and (101) of wurtzite phase are estimated. This conclusion has been confirmed by FTIR analysis. Optical transmittance in the visible spectral range diminishes with yttrium doping especially significant for ZnO:Y 3. The determined optical band gaps of ZnO:Y are widening compared to single ZnO.

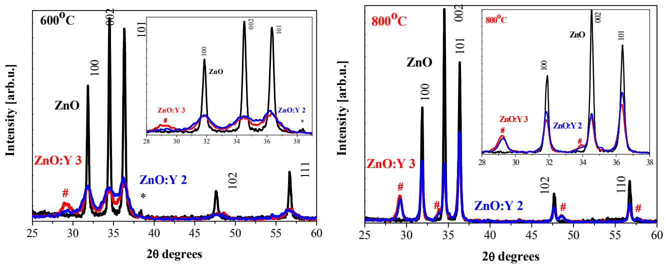

Figure 1. XRD spectra of ZnO:Y 2 and ZnO:Y 3, compared with ZnO and annealed at 600 and 800^{o}C. The inset figures show enlarged part of the spectra 28 – 38 degrees.

[1] P. Lei, B. Dai, J. Zhu, X. Chen, G. Liu, Y. Zhu and J. Han, *Ceramics International*, 2015, 41, 8921.
[2] T.Ivanova, A. Harizanova, T. Koutzarova and B Vertruyen, *IOP Confer. Series*m 2016, 682, 012023