Photoluminescence and Optical Properties of Ga-doped ZnO Thin Film Grown on (0001) Sapphire Substrate by rf Magnetron Sputtering through Rapid Thermal Annealing

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Transparent and conductive Ga (1wt%)-doped ZnO (GZO) films for UV emission device were deposited at 600°C by rf magnetron sputtering on α-Al_2O_3(0001). To improve the electrical and optical properties, photoluminescene (PL), and the mobility of GZO thin films, a rapid thermal annealing was performed between 800□ ~ 1000□ in N_2 atmosphere. Annealed GZO thin films at 800°C showed low resistivity of ρ=2.6 x 10^{-4} Ω cm and n_e=3.9x10^{20}/cm^3, and high mobility of μ=60 cm^2/V· s. These properties are explained in terms of translation of Ga atoms from interstitial to substitutional site. After annealing, optical band gap was also increased from E_g= 3.27 eV to 3.35 eV by Moss-Burstein effect. As n_e is increased, all the binding energies of O1s, Zn2$p_{3/2}$, and Ga2$p_{3/2}$ core-levels in XPS spectra were shifted to lower binding energy. After annealing, PL spectra of GZO films show dominant near-band edge emission corresponding to free exciton emission.

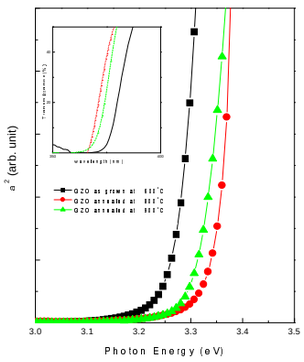

Fig. 1 Square of the absorption coefficient as a function of photon energy for the Ga doped ZnO (GZO) deposited at 600 °C with and without RTA treatment.

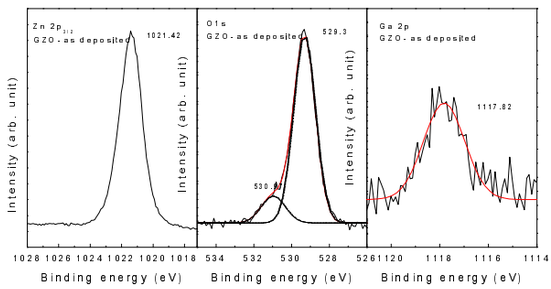

Fig. 2 Zn $2p_{3/2}$, O1s & Ga 2p core-level spectra of as-deposited GZO films.

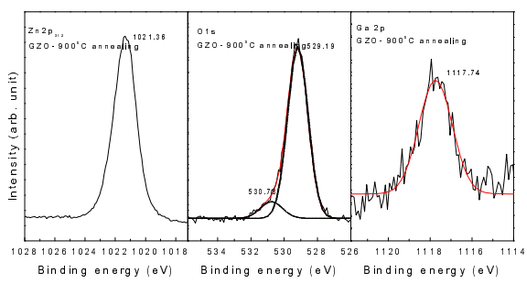

Fig. 3 Zn $2p_{3/2}$, O1s & Ga 2p core-level spectra of annealed GZO films.