

Enhancement in Seebeck Coefficient of MBE Grown Un-Doped ZnO by Thermal Annealing

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Abstract : In this paper, we have reported an enhancement in Seebeck coefficient of un-doped zinc oxide (ZnO) grown by molecular beam epitaxy (MBE) on silicon (001) substrate by annealing treatment. The grown ZnO thin films were annealed in oxygen environment at 500°C - 800°C, keeping a step of 100°C for one hour. Room temperature Seebeck measurements showed that Seebeck coefficient and power factor increased from 222 to 510 $\mu\text{V/K}$ and 8.8×10^{-6} to $2.6 \times 10^{-4} \text{ Wm}^{-1}\text{K}^{-2}$ as annealing temperature increased from 500°C to 800°C respectively. This is the highest value of Seebeck coefficient ever reported for un-doped MBE grown ZnO according to best of our knowledge. This observation was related with the improvement of crystal structure of grown films with annealing temperature. X-ray diffraction (XRD) results demonstrated that full width half maximum (FWHM) of ZnO (002) plane decreased and crystalline size increased as the annealing temperature increased. Photoluminescence study revealed that the intensity of band edge emission increased and defect emission decreased as annealing temperature increased because the density of oxygen vacancy related donor defects decreased with annealing temperature. This argument was further justified by the Hall measurements which showed a decreasing trend of carrier concentration with annealing temperature.

Keywords : ZnO, MBE, thermoelectric properties, annealing temperature, crystal structure

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