Photoluminescence of ZnO nanowires with Eu diffusion process

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ZnO nanowires with europium (Eu) diffusion process are studied. The ZnO nanowires were grown by chemical vapor deposition (CVD) on Si substrate with employing Au as catalyst. From photoluminescence spectra, the green luminescence of the ZnO nanowires with Eu diffusion process observed at about 515 nm is attributed to Eu impurity in ZnO nanowires. Thermal annealing of diffusion process could cause the red shift of NBE emission of ZnO nanowires.

Zinc oxide (ZnO) is an emerging material for next-generation short-wavelength optoelectronic devices due to its large band gap of 3.37 eV at room temperature (RT) and large exciton binding energy of 60 meV [1]. High quality ZnO semiconductor nanocrystals also become materials for doping of optically active impurities. Rare-earth metals were chosen as dopants because of their long-lived, spectrally narrow luminescence emissions in the visible range of the spectrum when in their trivalent form [2]. In this work, ZnO nanowires were grown by chemical vapor deposition (CVD). Europium (Eu) atoms were doped into ZnO nanowires by diffusion process.

The ZnO nanowires used in this study were grown by CVD with employing Au as catalyst [3]. Zn shots with 6N purity were placed in a quartz boat in the center of a quartz tube in a furnace. In the process of growth, the furnace was heated up to 950 °C by flowing Ar with a flow rate of 100 SCCM. When the temperature reached this synthesis temperature, high purity oxygen gas with 6N purity was introduced into the quartz tube with a flow rate of 5 SCCM for the growth of the ZnO nanowires. The growth time of the process was 1 hr before terminating the oxygen flow and cooling down to room temperature. The diameter of the resulting nanowires is about 200 nm with the length of about 1 μm. To perform the diffusion process, the ZnO nanowires were placed with an Eu shot in a furnace at 950 °C. Annealing was performed in flowing Ar with a flow rate of 100 SCCM for 1 hr.

Fig. 1 shows PL spectra of as-grown ZnO nanowires, ZnO nanowires with Eu diffusion process, and thermal annealed ZnO nanowires.

In summary, ZnO nanowires with Eu diffusion process have been studied. The green luminescence of the ZnO nanowires with Eu diffusion process observed at about 515 nm is attributed to Eu impurity in ZnO nanowires. The thermal annealing of diffusion process could cause the red shift of NBE emission of ZnO nanowires.

ACKNOWLEDGEMENTS
This work was supported by the National Science Council of Taiwan. The authors from the University of Florida are partially supported by the National Science Foundation, Department of Energy, and Army Research Office.

REFERENCES