Effects of thermal annealing on the optical, spectroscopic, and structural properties of tris (8-hydroxyquinolinate) gallium films grown on quartz substrates

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ABSTRACT

In this study we report the optical, spectroscopic, and structural properties of vacuum deposited tris (8-hydroxyquinolinate) gallium film upon thermal annealing in the temperature range from 85 °C to 255 °C under a flowing nitrogen gas for 10 min. The optical UV-vis-NIR and luminescence spectroscopy measurements were performed to estimate the absorption bands, optical energy gap (Eg), and photoluminescence (PL) of the films. Fourier transform infrared (FTIR) spectroscopy and X-ray diffraction (XRD) techniques were used to probe the spectroscopic and structural nature of the films. We show that, by annealing the films from 85 °C to 255 °C, it is possible to achieve an enhanced absorption and increased photoluminescence to five times stronger than that of the pristine film. The PL quenching at 255 °C was attributed to the presence of planar chains allowing easy going for excitons to a long distance due to the crystalline region formation of α-GaO3 polymorph. The reduction in Eg and infrared absorption bands upon annealing were referred to the enhancement in n−π interchain interaction and conformational changes by re-arrangement of the GaO3 quinolate ligands, respectively. Stokes shift for the films were observed and calculated. From the differential scanning calorimetry, DSC measurements, higher glass transition temperature was observed for GaO3 (Tg = 182 °C) compared to that of AlO3 (Tg = 173 °C), which suggests the existence of stronger dipolar interaction in GaO3 due to the Ga³⁺ cation effect, in comparison to that of AlO3.

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