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Performance of ZnGa₂O₄ deep ultraviolet photodetectors

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A single-crystalline ZnGa₂O₄ epilayer was successfully grown on c-plane (0001) sapphire substrate by MOCVD for application as high performance metal-semiconductor-metal (MSM) visible-blind deep-ultraviolet (DUV) photodetector (PD). The optimized growth parameters for the growth pressure and growth temperature were 15 torr and 650 °C, respectively. The result presented here demonstrate the performance of as grown and annealed at 800 °C in a nitrogen environment for 1 h ZnGa₂O₄ epitaxial films photodetectors. Compared to as grown ZnGa₂O₄ film improved UV properties of annealed ZnGa₂O₄ film were observed. It was found that as-grown films exhibit the highest density of cation-anion pair defects, which could contribute deep trapping centers that increases the generation current or trap assisted leakage current delaying the response and recovery times of as-grown PD devices. However, post-annealing provides sufficient energy to reduce the cation-anion pair defects in the as-grown samples to repair each other. The magnitude of the photocurrent and the rise time are found to increase considerably with decrease number of trap levels. At 5 V bias voltage, the annealed ZnGa₂O₄ PD shows superior performance with an extremely low dark current of 1 pA, a responsivity of 86.3 A/W corresponding, cutoff wavelength of 280 nm, a highest DUV-to-visible discrimination ratio up to 107 upon 233 nm DUV illumination. The rise time of annealed ZnGa₂O₄ PD was 0.5 s and PD has been shown a relatively slow decay time of 0.7 s. In this study, our approach provides a simple and controllable method to fabricate single crystalline ZnGaO films based high-performance DUV photodetectors, which has been rarely reported.

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