Planar GaN-based UV Photodetectors formed by Si Implantation

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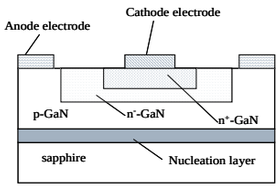
Abstract

In this study, planar GaN-based p-n$^-$-n$^+$ photodetectors were fabricated by Si implantation into p-GaN to form the p-n junction. Two-step triple Si implantation was performed to form a selective n$^+$ and n$^-$area in p-GaN epitaxial layer with uniform doping profile. Therefore, a planar GaN p-n$^-$-n$^+$ ultra-violet (UV) photodetector can be achieved. When the reverse bias was below 4V, the photodetectors showed a near constant dark current around 20 pA. The dark current is somewhat high compared with conventional epitaxial p-i-n photodiodes. It might be due to the incomplete damage (from implantation) removal and thereby results in the higher leakage current. Spectral response measurements revealed peak of responsivity up to 12.4 mA/W at 365nm for the planar p-n$^-$-n$^+$ UV photodetectors. It was also found that the visible (450nm)-to-UV (360nm) rejection ratio was around 700. Furthermore, temporal response measurements for the planar GaN-based p-n$^-$-n$^+$ UV photodetectors were measured to be as low as 5.7 ns for 90%-to-10% fall time. More detailed results for the novel planar GaN-based p-n$^-$-n$^+$ UV photodetector will be discussed.



(a)

(b)

Fig.1. (a) Schematic device structure in Cross-section view. (b) Photograph of a Si-implanted p-n$^-$-n$^+$ photodetector with a concentric-circle configuration.

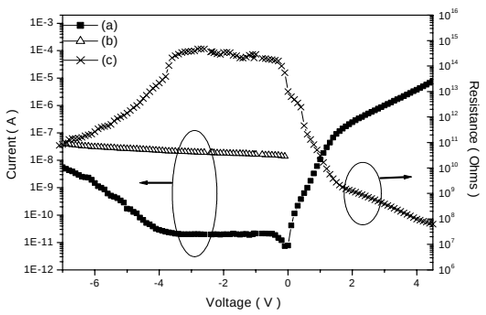


Fig.2. Logarithmic current-voltage characteristics of typical Si-implanted p-n$^-$-n$^+$ GaN photodetectors. (a) dark current. (b) photocurrent illuminated at 350nm with a optical power of 12μW. (c) dynamic resistance $R_d = (dI/dV)^{-1}$ derived from dark current.

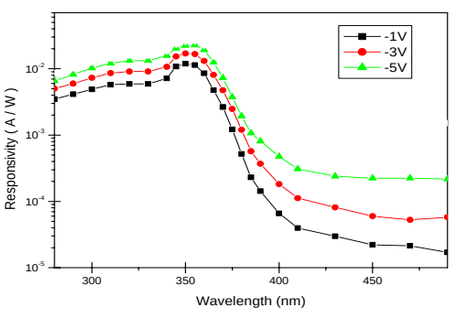


Fig. 3. Spectra responses of the typical Si-implanted planar p-n$^-$-n$^+$ GaN photodetectors with reverse bias of 1, 3 and 5V.