ULTRAVIOLET-SENSITIVE, VISIBLE-BLIND GaN DETECTORS GROWN BY MOCVD EPITAXY

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First results of development of UV photodetectors based on GaN pn junction are presented. GaN layers have been grown by MOCVD technique on Al_2O_3 substrates. The p type of GaN has been obtained during epitaxy using Mg metaloorganics. The spectral characteristic of GaN photodiode, which exclusively lies within the UV range of radiation of great advantage for detector application.

Gallium nitride which has a direct energy gap of 3.4 eV (366 nm) and is transparent for wave lengths longer than the band gap, is among the most promising materials for photodetectors operating in the ultraviolet region of the solar spectrum. GaN photodetectors such as photodiodes [1], photoconductors [2] and Schottky barrier devices [3] have been already reported mostly in United States.

Below, we describe the first results of our study of UV photodetectors based on GaN pn junctions grown by MOCVD method on sapphire substrates.

GaN layers have been grown by MOCVD technique on Al_2O_3 substrates. The growth took place at 1050 °C using NH_3 as a source of nitrogen and TMG metalorganics as a source of gallium. The low temperature buffer layer was grown as a initial stage of the process. Thickness of the grown layer was close to 4 μm. The n side of the p-n junction was undoped and the p side was doped with Mg using CpMg metalorganics.

Dry etching was used to isolate particular diodes and to expose the n side of the p-n junction. Both metals (n and p contact) have been deposited using the lift-off technique and contacts have been alloyed using an RTP reactor. The working area of the diodes was 0.1 mm^2 determined by interdigital type electrodes with separation of 25 μm.

The breakdown voltage of the best samples of the photodiodes was about 40 V and the dark current, at the reverse bias voltage of 5 V, was about 200 nA.

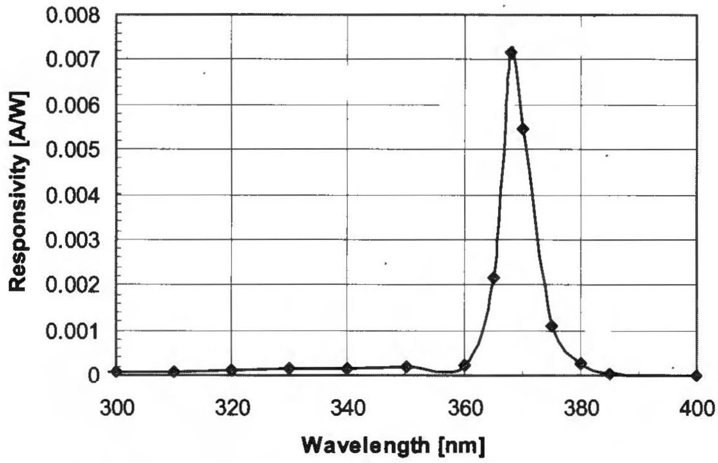

Fig. 1. Spectral response of GaN photodiode (V_R = 0 V).

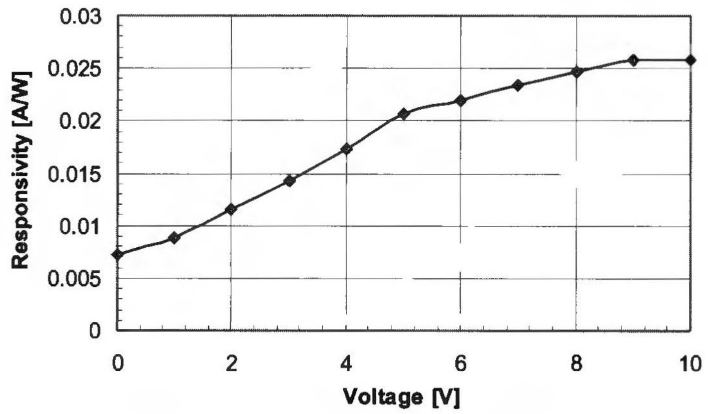

Fig. 2. Responsivity (at λ = 367nm) v.s. voltage.

While the magnitude of spectral sensitivity corresponding to the maximum value of the spectral characteristic ($\lambda_{opt} \approx$ 367 nm) for the diodes was only within the range of 0.0061 ÷ 0.00952 A/W, the dispersion of relative spectral characteristics was negligible.

Spectral response at $V_R = 0$ and the voltage dependence of sensitivity at $\lambda = \lambda_{opt}$ for a typical photodiode are plotted in Figs. 1, 2.

These are only the first results and it is expected that considerable improvement of the parameters will be achieved in near future.

The results obtained at the present stage of this work are already promising. Although, the obtained sensitivity (typical 0.008 A/W) is very low in comparison to silicon photodiodes at the same wavelengths, the use of Si photodiodes as UV radiation detectors, because of their high sensitivity in IR and visible range of radiation optic filters, implies the application of optical filters. As result the sensitivities of these detector systems (Si photodiode + filters) are considerable lower.

The spectral characteristic of GaN photodiode, which exclusively lies within the UV range of radiation is of great advantage for detector application. It can be predicted that in a near future GaN photodiode will become the basic UV photodetector.

References

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