Reliability of UV solar-blind photodetectors based on ε-Ga_2O_3

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Abstract: *Performance of ε-Ga_2O_3 as active layer for UV solar-blind detector is presented. By using un-doped films, UV/Visible rejection ratio at least of 10^4 is obtained via planar configuration.*
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1. Introduction

Among Ga_2O_3 polymorphs, ε-phase shows an interesting high energy gap, similar to that of the more investigated β-phase, also higher symmetry and less critical growth conditions with respect to the latter. In addition, the hexagonal crystalline symmetry allows a well matched deposition on *c*-oriented sapphire and gallium nitride substrates, which is good in view of developing a novel oxide nitride technology. This phase is metastable but does exhibit good thermodynamic stability up to 700°C, while a full conversion to β occurs only above 900°C [1, 2]. Therefore, this phase may be utilized for device fabrication. We show here, the performance of a highly responsive and highly reliable resistive UV solar-blind detector based on ε-Ga_2O_3 thin layers.

2. Experimental section

Active layers of ε-Ga_2O_3 were grown by metal-organic vapour phase epitaxy on c-oriented 2-inches sapphire substrates heated at 650°C; trimethylgallium (TMG) and ultrapure H_2O were used as precursors and H_e as carrier gas.
SEM analysis evidenced a good morphology and XRD confirmed the presence of the ε-phase only.
One-face planar geometry MSM (metal-semiconductor-metal) was designed through a stencil metal mask by sputtering deposition of SnO_x+ITO bilayer.
Reproducibility and ohmic behaviour of electrodes were verified on a large number of thin films, confirming the robustness of the fabrication procedure. Typically, thin film large-area photodetectors, with a distance of 0.2 mm between electrodes, were fabricated and measured in this study.

3. Results and discussion

The typical responsivity of the detector in the UV/VIS range is shown in Fig. 1 together with absorbance measurement. A significant suppression of response to visible excitation provides a high rejection ratio (see Table 1) which is mandatory for UV solar blind detection.
On/off switching times at two different wavelengths were also analyzed (Fig. 2): both up and down photocurrent (PC) transients at $\lambda = 265nm$ may be well described by a bi-exponential behavior, with faster (τ_1) and slower (τ_2) characteristic times. In both rising and decaying PC signals the fast process can be attributed to band-band transitions, while the slow one is due to the transitions involving in gap states. The τ_1 values, that characterize the performance of the device, are comparable to those generally reported for β -Ga_2O_3 photodetectors, designed with interdigitated pattern of contacts [3].

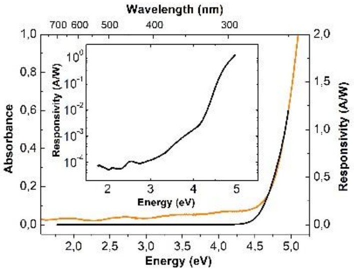

Fig.1 Absorbance (orange line) and responsivity (black line) spectra of ε-Ga_2O_3 resistive photodetector. Modulations in the absorption spectrum below the band edge are due to interference fringes. Insert: responsivity in Log scale to evidence the UV-visible rejection ratio.

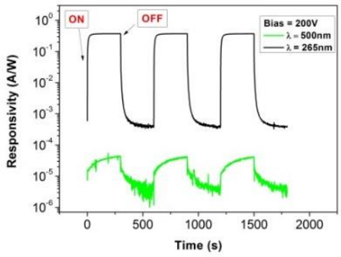

Fig. 2 On-off photoresponse at two different excitation wavelengths, (sample #479Ud).

Detector	Rejection ratio ($\times 10^4$)	Rise Time (s) $\tau_1(\tau_2)$	Decay Time (s) $\tau_1(\tau_2)$
#478Ud	1	5.2(31.8)	0.6 (5.3)
#479Ud	1	5.1(32.4)	0.5 (3.9)

Table 1 Performance parameters of UV solar-blind tested photodetectors

References

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