Potential of polycrystalline GaN deposited by electron beam evaporator for metal-semiconductor-metal (MSM) photodetector device

A. Ariff[1,*], Z. Hassan[1], N. Zainal[1]

[1]*Institute of Nano Optoelectronics Research and Technology (INOR), Universiti Sains Malaysia, 11800 USM, Penang, Malaysia.*

*Corresponding author: a.ariff@live.com

Polycrystalline GaN has the potential in photodetector application for a wide range of ultraviolet (UV) light. Nonetheless, devices based on this material have not received much attention as compared to its single crystal counterpart. Therefore, this work describes one of the pioneering works on MSM photodetector based polycrystalline GaN deposited by electron beam evaporator, which particularly investigates the effect of electrical contact on the performance of the photodetector. The deposition of GaN layer by the e-beam evaporator was followed by successive ammonia (NH_3) annealing at a temperature of 950 °C. Aluminum (Al), indium-tin-oxide (ITO), nickel (Ni) and platinum (Pt) contacts were deposited via RF-sputtering on the polycrystalline GaN using a MSM metal mask. Overall, Ni is the most suitable electrical contact (especially at λ = 385 nm) for the polycrystalline GaN based MSM photodetector than its counterparts. This relates to the presence of Ni_xO inclusions inside the Ni contact due to diffusion of residual oxide from the surface of the polycrystalline GaN, which helps to increase carrier collection in the photodetector. With the Ni contact, the MSM photodetector demonstrated increasing gain behavior with bias voltage. Furthermore, the resistivity, internal quantum efficiency, rise time, recovery time and sensitivity were recorded at 2.02 $M\Omega.cm^2$, 3.13% (λ=342 nm), 1.75 sec, 1.87 sec and 5840%, respectively. More importantly, the MSM photodetector in this work showed a sharp responsivity at the wavelengths of 342 nm, 385 nm and 416 nm, which has extended the cut-off wavelength than other reported single crystal GaN based MSM photodetector.