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Enhancing Performance of Porous Si-Doped GaN based MSM Photodetector Using AC Technique

AINORKHILAH Mahmood[1, a *], ZAINURIAH Hassan[2, b], ALHAN FARHANAH Abd Rahim[3, c], ROSFARIZA Radzali[3, d] and NASER M. Ahmed[2, e]

[1]Department of Applied Sciences, Universiti Teknologi MARA Cawangan Pulau Pinang, 13500 Permatang Pauh, Penang, Malaysia.

[2]Institute of Nano Optoelectronics Research and Technology Laboratory (INOR), School of Physics, Universiti Sains Malaysia, 11800 Penang, Malaysia.

[3]Faculty of Electrical Engineering, Universiti Teknologi MARA Cawangan Pulau Pinang, 13500 Permatang Pauh, Penang, Malaysia.

[a]ainorkhilah_sp@ppinang.uitm.edu.my, [b]zai@usm.my, [c]alhan570@ppinang.uitm.edu.my, [d]rosfariza074@ppinang.uitm.edu.my, [e]naser@usm.my

In this work, we report the formation of porous Si-doped GaN films under a novel alternating current (sine-wave a.c. (50 Hz)) photo-assisted electrochemical etching (ACPEC) conditions. The formation of porous Si-doped GaN by the novel ACPEC is performed in the same electrolyte concentration (4% KOH) used in common dc constant current electrochemical etching process. Ultra-violet (UV) illumination is used to assist in the generation of electron-hole pairs, where etching proceeds through the oxidation and consequently, dissolution of the semiconductor surface. The ac formed porous Si-doped GaN with excellent structural and optical properties. According to the FESEM micrographs, the GaN thin films exhibit a homogeneous nanoporous structures with spatial nano-flakes arrangement. The porous layer exhibited a substantial photoluminescence (PL) intensity enhancement with red-shifted band-edge PL peaks associated with the relaxation of compressive stress. The shift of E_2(high) to the lower frequency in Raman spectra of the porous GaN films further confirms such a stress relaxation. Electrical characterizations of the MSM photodiodes were carried out by using current-voltage (I-V) measurements indicated that the devices were highly sensitive to ambient light.

Keywords: Porous Si-Doped GaN; Alternating current photo-assisted electrochemical etching (ACPEC); Field Effect Scanning Electron Microscopy (FESEM); Photoluminescence; Raman spectroscopy; metal-semiconductor-metal-photodetector