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# *Synthesis and Characterization of Optical Device for High Temperature Environment Applications using Laser Ablation*

***A Thesis Submitted***

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## ABSTRACT

The gallium nitride (GaN) nanostructure thin film was prepared and deposited on the quartz, silicon and porous silicon substrates by using pulsed laser ablation in liquid (PLAL) technique and drop casting method for photoelectric detecting and $NO_2$ gas sensor applications.

Firstly, GaN nanoparticles have been ablated using PLAL technique using Nd:YAG laser (Q-switching) at a wavelength of 532 nm with 500 pulses of different energies 1000, 1200, 1400, 1600, 1800 and 2000 mJ. Drop casting method has been adopted to deposit GaN on quartz substrates. The images characterization for the laser ablation energies 1400 mJ and 1600 mJ shows that in the XRD results there are enhancements in the thin film crystallization. This can be attributed to the increase in the peak intensity. Morphological analysis exhibits increase in GaN grain size and roughness. Optical analysis demonstrates that the ablation energies 1400 mJ and 1600 mJ exhibit a blue shift and the highest energy gap.

Secondly, the same process has been done at the optimum ablation energies 1400 mJ and 1600 mJ with a wavelength of 532 nm and drop cast on n-type silicon (111) for photoelectric detector application. The result shows that GaN/Si photoelectric detector exhibits an enhanced performance at 1600 mJ.

Finally, Porous silicon has been prepared from n-type silicon via photoelectrochemical etching (PECE) technique with current density of 60 $mA/cm^2$, and hydrogen fluoride (HF) concentration (48%). GaN nanoparticles were prepared by the same process of PLAL technique and drop casting method at the optimum ablation energy 1600 mJ at different

laser wavelengths 532 nm and 1064 nm. The result shows that GaN/psSi prepared at ablation energy 1600 mJ and laser wavelength 532 nm has the best responsivity, specific detectivity and the shortest response time in the UV region. The $NO_2$ gas sensor shows the highest sensitivity at temperature 250$^{o}$C and pressure 30 ppm and the best response time (15.3 s) at the same preparing conditions.