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A High Sensitive Chemiresistive-gassensor on Assembly Grown Doped GaN Porous Layer

A Thesis

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Abstract

The process of manufacturing sensors had been designed to monitor and measure gases effectively. However, this technology encountered challenges such as: sensor response, measurement accuracy, and delayed response time. In order to overcome these challenges, devices are being developed to improve sensor performance, ensure accurate results, and achieve the best response time possible.

In this work, Gallium Nitride (GaN) thin films were deposited on Porous Silicon (PSi) substrates using the Pulsed Laser Deposition (PLD) method. Under different growth conditions of laser wavelengths (355, 532, and 1064) nm, laser energies (1200mJ–2000mJ), and substrate temperatures (200°C - 400°C). PSi substrates were fabricated by photoelectrochemical etching (PECE). Aided with a diode laser under etching parameters of current density (10 mA/s) and etching time (10 minutes). The influence of laser wavelength, laser energy, and substrate temperature have been investigated to study the structural, topographical, morphological, spectroscopic, and electrical properties of GaN thin films. The structural properties of the sensor membranes were also studied by XRD, AFM, and FESEM films.

Based on the membrane type and method, all prepared substrate of polycrystalline type and Crystalline size, nanoparticle size, morphology, and surface topography.

The XRD analysis revealed that Gallium Nitride on PSi was polycrystalline and cubic structure. Further, hexagonal structure has been found in optimum condition (532 nm, 1600 mJ, 400 °C) with high peak intensity and crystallite size at 2θ = 25.95°, 36.69°, 57.80°, and 63.75°

related to the (200), (101), (110) and (103) planes, respectively. The FESEM images showed an average particle size reduction, the nanoparticles spherical like cauliflower. The AFM results showed that the average roughness increased to 10.64 in 532nm, 8.51 nm in 1600 mJ, and 9.39 nm in 400 °C. It was also observed that the root means square increased due to uniform distribution of high-quality crystals and the excellent quality of the crystal structure at 532 nm and 1600 mJ at 400°C.

The UV examination showed an inverse proportion between transmission and absorption, where smaller wavelength decreased the transmission value. As for the optical properties, the optical transmittance and the energy gap were examined using a UV-VIS spectrophotometer.

Sensor properties were studied gas Hydrogen sulphide (H_2S), including the change in electrical resistance after the sensor reacts with gas at different base temperatures and concentrations. As for sensitivity, it was found that the highest sensitivity of (40.98%) at a temperature of 200°C and the highest sensitivity of (57.62%) at a concentration of 100 ppm.