Republic of Iraq
Ministry of Higher Education and Scientific Research
University of Technology
Laser and Optoelectronic Engineering Department

Biosensors Based on Indium Tri-Oxide Nanostructures Deposited on Porous Si Using Pulsed Laser Deposition

A Thesis

Submitted to the Laser and Optoelectronics Engineering Department at the University of Technology as a partial fulfillment of the requirements for the Degree of Master of Science in Laser Engineering.

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2023 **1445**

Abstract

Gas sensors are essential in monitoring air quality, safety, and industrial operations. On the other hand, many typical gas sensors consume a large amount of energy and may struggle to work at high temperatures, causing issues for long-term, efficient sensing applications. It is critical to advance energy-efficient and environmentally-monitoring gas sensors.

This research work created a porous silicon structure using the photo-electrochemical etching (PECE) method. It was made from an n-type (111) silicon and has been quite helpful in this research. In_2O_3 thin film was prepared using a pulsed laser deposition technique (PLD) and deposited onto the porous silicon and quartz substrates. The thin film has been beneficial for detecting H_2S gas in sensing applications.

The characterization tests were conducted for the thin film to determine the optimum conditions. The first stage involved varying the laser wavelengths (355 nm, 532 nm, and 1064 nm) with a laser energy of 2000 mJ and a substrate temperature of 300. In the second stage, different laser energies were employed (1200, 1400, 1600, and 1800 mJ) with a laser wavelength of 1064 nm and substrate temperature of 300; the third stage involved testing at various substrate temperatures (200, 250, 350, and 400 °C) with a laser wavelength of 1064 nm and laser energy of 1600 mJ. H_2S, encompassing two stages of experimentation. The first stage involved testing at varying substrate temperatures (100 °C, 150 °C, and 200 °C) while maintaining a constant gas concentration of 75 ppm. In the second stage, the gas concentration was varied (50 ppm, 75 ppm, and 100 ppm) while keeping the substrate temperature constant at 150 °C. The results show the H_2S gas achieved its peak sensitivity (264.22) under identical

conditions of 75 ppm, with a substrate temperature of 150 °C and (275.33)
a gas concentration of 100 ppm.