Highly Sensitive MEMS Cantilever Gas Sensor Using Deposited Nanostructured Sb-doped ZnO Thin Film Deposited by PLD for Low Concentration Detection of Ammonia Gas

Almansour, Abdulmohsen (School: Riyadh School for Boys and Girls)

Ammonia is a toxic gas that irritates and burns at low concentrations and can be fatal at high concentrations. The aim of this work was to deposit a 7% Sb-doped ZnO thin-film on a Si micro electromechanical system (MEMS) cantilever for the detection of trace ammonia gas concentrations, and to compare it to a ZnO MEMS cantilever sensor. A 100nm Sb-doped ZnO thin-film was deposited using a Pulsed Laser Deposition (PLD) onto a Si-cantilever. The microstructures were examined using Atomic Force Microscope (AFM). In comparison to the ZnO sensor, the Sb-doped ZnO sensor showed a very rough surface, which increased the sensitivity of the sensor. A laser detection system “Picomeasure PM3” was used to detect the change in the cantilevers' deflection when exposed to ammonia gas by monitoring the cantilevers' surface's deflection variations with respect to time. The sensors were evaluated at room temperature and 1%-0.01% of ammonia concentration. At 1% Ammonia gas concentration, the microstructure results showed that the ZnO thin-film had a deflection of 185nm, And the Sb-doped ZnO at 400nm of deflection. Furthermore, a selectivity study was performed using methanol gas at 1% concentration, and the selectivity of the developed sensor to Ammonia gas showed a higher response to Ammonia by 300nm of deflection. Nitrogen gas showed no adsorption, while methanol showed a weak response. At 1% ammonia concentration; the resulted in deflection was 400nm for the Sb-doped ZnO sample, and at 0.01%, which is well above the detection limit of the Picomeasure PM3 (detection setup). The sensor increased the safety of Ammonia related facilities, such as fertilizing manufacturing facilities; by alerting nearby workers when very low concentrations of Ammonia gas is leaked.