Magnetron sputtered thin films as gas sensors activated by UV-VIS light

Dagmara Michoń [a], Andrzej Brudnik [a], Katarzyna Zakrzewska [a]

Damian Wojcieszak [b] , Michał Mazur [b], Danuta Kaczmarek [b]

[a] *AGH University of Science and Technology, Faculty of Computer Science, Electronics and Telecommunications, Department of Electronics, Al. Mickiewicza 30, 30-059 Krakow, Poland*
[b] *Wroclaw University of Science and Technology, Faculty of Microsystem Electronics and Photonics, Janiszewskiego 11/17, 50-372 Wroclaw, Poland*
e-mail: dagmaramichon@agh.edu.pl

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Abstract

Nitrogen dioxide (NO_2) air pollution is one of the most important environmental issues. It may arise as a result of combination of nitrogen oxide (NO) with oxygen in the air. NO_2 is very toxic, pungency odour and reddish brown gas [1]. Frequent exposure to air polluted by NO_2 may lead to asthma, lung cancer and problems with circulatory system [2]. This implies the need to constantly monitor air quality. To make it possible, it is necessary to develop a sensor specifically selective to NO_2. The main problem in gas detection with metal oxides is high operating temperatures. Illumination of gas sensors with ultra-violet (UV) light allows to lower operating temperature because the UV light activates chemical reactions. This way one can reduce power consumption, explosion hazards and extend sensor lifetime. Semiconductor metal oxide gas sensors (CuO, ZnO, TiO_2, SnO_2, In_2O_3) are known in detection of many chemical species (organic and non-organic) for example acetone, methane.

The mechanism of gas detection by semiconductor gas sensors with UV radiation is based on adsorption and band theory. The oxygen from air is adsorbed at the sensors surface at higher temperature. This process is the most important part of detection mechanism. The illumination increases the number of charge carriers in the conduction band. Excited electrons/holes react with absorbed gas molecules. It changes the conductivity of sensor layer. The final stage of this mechanism is desorption. The UV radiation allows for desorption of molecules Thin film sensors have been deposited by reactive magnetron sputtering under different technological conditions, e.g. at different O_2/Ar ratios in the atmosphere. Crystallographic structure of the samples was

determined by X- ray diffraction, the layer thickness, density and roughness were measured by X- ray reflectivity, optical measurements and Scanning Electron Microscopy (SEM) observations were also carried out.

References

[1] E. Comini, G. Faglia, G. Sberveglieri, UV light activation of tin oxide thin films for NO_2 sensing at low temperatures, Sensors Actuators B Chem. 78 (2001) 73-77

[2] E. Espid, F.Taghipour, UV-LED Photo-activated Chemical Gas Sensors: A Review, Critical Reviews in Solid State and Materials Science. 42 (2017) 416-432

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