ACETONE SENSOR STRUCTURE FOR BIOMEDICAL APPLICATIONS

N. Ababii, V. Postica, V. Cretu, E. Lazari, V. Sontea, O. Lupan*
Department of Microelectronics and Biomedical Engineering, Technical University of Moldova, Chisinau, Republic of Moldova
*E-mail: lupanoleg@yahoo.com

In presents, it is well known that diagnose of human diseases tends to use non-invasive diagnostic methods. They not cause discomfort to patients and the samples are collected rapidly without necessity of special conditions [1]. Thus, different effective methods of real time monitoring and detection of different biomarkers, such as acetone vapour, NO_x, NH_3, and H_2 are highly desirable [2]. Also these method need to be simple in use for all consumers. One of the leading causes of death nowadays according to the World Health Organization is diabetes mellitus, which is also fast-growing problem. Acetone in human breath is known to be the biomarker for clinical diagnosis of diabetes mellitus. It is known that concentration of acetone vapour in exhaled breath of persons diagnosed with diabetes mellitus varies from 1.7 ppm to 3.7 ppm [3,4]. Detection of such low concentrations requires a high selectivity and sensitivity sensor. In this context, the semiconducting oxides nanostructures of CuO demonstrated promising results [5,6].

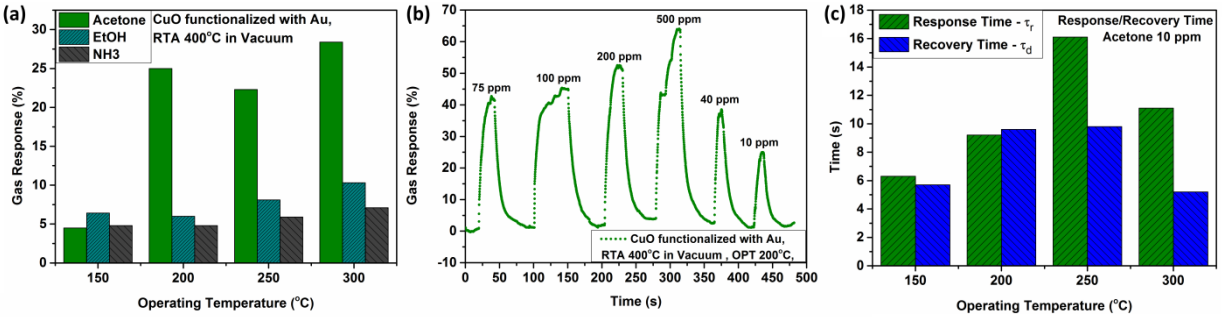

Figure 1. (a) The gas response versus operating temperature to acetone, ethanol, ammonia vapour with concentrations of 10 ppm. (b) Dynamic acetone vapour response at 200 °C operating temperature to different concentrations of acetone of the sensor samples treated by rapid thermal annealing at 400 °C in vacuum for 30 s and functionalized with gold nanoparticles on top; (c) Response/recovery times of sensor structure to acetone vapour versus operating temperature.

Figure 1(a) present gas sensing investigations of the sensor based on CuO structures functionalized with Au nanoparticles to different volatile organic compounds (VOCs) vapour such as acetone, ethanol (EtOH) and NH_3 with 10 ppm concentration at different operating temperatures, in order to study the selectivity. It can be observed that at operating temperatures (OPT) higher than 200 °C the sensors have good selectivity to acetone vapour. At OPT of 200 °C the acetone response is 25%. Fig. 1(b) shows the dynamic gas response to different concentrations of acetone vapour (10, 40, 75, 100, 200, 500 ppm). Fig. 1(c) shows response/recovery times versus OPT. At OPT of 200 °C values are relatively small τ_r~9.2 s and τ_d~9.6 s, respectively. It was observed experimentally, that the sensors demonstrates good reproducibility and an increase in acetone vapour concentration lead to a higher gas response, which is typical for gas sensors based on semiconducting oxides.

Acknowledgements. This research was supported by the project Institutional 45inst-15.818.02.29A funded by the Government of the Republic of Moldova.

[1] A. Thati, A. Biswas, S. R. Chowdhury, T. K. Sau. International Journal on Smart Sensing and Intelligent Systems volume 8 (2015) 1244-1260.
[2] H. Lei, L. Yi. Chinese Sci. Bull. volume 56 (2011) 2644−2648.
[3] C. Deng, J. Zhang, X. Yu, W. Zhang, X. Zhang. Journal of Chromatography B. volume 810 (2004) 269–275.
[4] S. Chakraborty, D. Banerjee, I. Ray, A. Sen. Current Science. volume 94 (2008) 237.
[5] V. Cretu, V. Postica, A. K. Mishra, M. Hoppe, I. Tiginyanu, Y. K. Mishra, L. Chow, Nora H. de Leeuw, R. Adelungc, O. Lupan. Journal of Materials Chemistry A. volume 4 (2016) 6527-6539.
[6] O. Lupan, V. Cretu, V. Postica, O. Polonskyi, N. Ababii, F. Schütt, V. Kaidas, F. Faupel, R. Adelung. Sensors and Actuators B: Chemical. volume 230 (2016) 832–843.