Hybrid Nano-Materials for Sensors in Biomedical, Environmental And Industrial Applications

Oleg Lupan [1], Mihai Brinza [1], Nicolai Ababii [1], Thomas Strunskus [2], Nicolae Magariu [1], Thierry Pauporté [3], Rainer Adelung [4], Franz Faupel [2], Stefan Schröder [2]

[1]Center for Nanotechnology and Nanosensors, Department of Microelectronics and Biomedical Engineering, Technical University of Moldova 168 Stefan cel Mare Blvd., MD-2004 Chisinau, Republic of Moldova, oleg.lupan@mib.utm.md, mihai.brinza@mib.utm.md, nicolai.ababii@mib.utm.md, nicolae.magariu@mib.utm.md, ORCID: 0000-0002-7913-9712, 0000-0001-8438-3800, 0000-0001-5046-8611, 0000-0001-7006-3443

[2]Department of Materials Science, Chair for Functional Multicomponent Materials, Faculty of Engineering Christian-Albrechts Universität zu Kiel, Kiel, Germany, ts@tf.uni-kiel.de, ff@tf.uni-kiel.de, ssch@tf.uni-kiel.de, ORCID: 0000-0003-3931-5635, 0000-0003-3367-1655, 0000-0001-9996-2637

[3]CNRS, Institut de Recherche de Chimie Paris PSL University, Paris, France, thierry.pauporte@chimieparistech.psl.eu, ORCID: 0000-0001-5906-8075

[4]Department of Materials Science, Chair for Functional Nanomaterials, Faculty of Engineering Christian-Albrechts Universität zu Kiel, Kiel, Germany, ra@tf.uni-kiel.de ORCID: 0000-0002-2617-678X

Keywords: Hybrid materials, gas sensor, polymer, biomarker, safety

Abstract. Technological advances create opportunities for further research, applications and breakthroughs. Medical, environmental and industrial requirements call for accurate gas sensors with high sensitivity to certain gases and even water resistance. Potentially, sensors based on different methods using metal oxide-based materials as gas sensing structures and tailoring their properties by different techniques, such as nanoparticle doping and coating with different polymers, tend to meet the requirements of the demanding fields.

Fortunately, the possibilities are limitless, as different materials offer unique results. In a recent study TiO_2 coated with V4D4 polymer shows

selectivity towards 2-propanol gas vapor with a response stated as 225% at a relative high operating temperature of 400 °C [1], while Teflon (PTFE) coated TiO_2 shows selectivity towards 2-propanol at 350 °C operating temperature with a response value of 45% [2]. Thus, this shows potential in detecting lung cancer. Another sample of TiO_2 pre-annealed at 610 °C doped with Ag and Pt nanoparticles and coated with V4D4 polymer showed an a selectivity towards H_2 at operating temperatures such as 250, 300 and 350 °C with the highest response of 709% in the last case [3]. Using different techniques such as pre-annealing TiO_2 at 610 °C and coating it with V4D4 polymer, a response of 52% to 100 ppm of ammonia vapor at room temperature and 100% response to H_2 at relative higher operating temperature of 300 °C [4], thus obtaining a sensor that can be used for food quality assessment and as kidney failure biomarker.

Acknowledgments. This work was partially supported by the State Program LIFETECH No. 020404 and No. 020401 at the Technical University of Moldova.

References

[1] Schröder, S.; Ababii, N.; Brînză, M.; Magariu, N.; Zimoch, L.; Bodduluri, M.T.; Strunskus, T.; Adelung, R.; Faupel, F.; Lupan, O. Tuning the Selectivity of Metal Oxide Gas Sensors with Vapor Phase Deposited Ultrathin Polymer Thin Films. *Polymers (Basel).* **2023**, *15*, 524, doi:10.3390/polym15030524.

[2] Schröder, S.; Brinza, M.; Cretu, V.; Zimoch, L.; Gronenberg, M.; Ababii, N.; Railean, S.; Strunskus, T.; Pauporte, T.; Adelung, R.; et al. A New Approach in Detection of Biomarker 2-Propanol with PTFE-Coated TiO2 Nanostructured Films BT - 6th International Conference on Nanotechnologies and Biomedical Engineering.; Sontea, V., Tiginyanu, I., Railean, S., Eds.; Springer Nature Switzerland: Cham, 2024; pp. 75–83.

[3] Lupan, O.; Brinza, M.; Piehl, J.; Ababii, N.; Magariu, N.; Zimoch, L.; Strunskus, T.; Pauporte, T.; Adelung, R.; Faupel, F.; et al. Influence of Silsesquioxane-Containing Ultra-Thin Polymer Films on Metal Oxide Gas Sensor Performance for the Tunable Detection of Biomarkers. *Chemosensors* **2024**, *12*, 76, doi:10.3390/chemosensors12050076.

[4] Brinza, M.; Schröder, S.; Ababii, N.; Gronenberg, M.; Strunskus, T.; Pauporte, T.; Adelung, R.; Faupel, F.; Lupan, O. Two-in-One Sensor Based on PV4D4-Coated TiO2 Films for Food Spoilage Detection and as a Breath Marker for Several Diseases. *Biosensors* **2023**, *13*, 538, doi:10.3390/bios13050538.