

Live Demonstration: A Highly Selective Temperature and Humidity Compensated MOX Based Multi-Gas Sensor Module with Bluetooth 5.0 Connectivity

S. Pétré¹, T. Walewyns¹, R. Lontio Fomekong², D. Lahem³, M. Debliquy⁴, L. A. Francis¹

¹Electrical Engineering Department, ICTEAM Institute, Université catholique de Louvain, Louvain-la-Neuve, Belgium

²German Aerospace Center (DLR), Köln, Germany,

³Materia Nova, Mons, Belgique, ⁴Department of Materials Science, Université de Mons, Mons, Belgium

I. INTRODUCTION

The growing interest in detecting specific volatile organic compounds (formaldehyde, toluene, xylene, etc.), toxic or even carcinogenic, involves new techniques to ensure both selectivity and sensitivity of gas sensors. Furthermore, the indoor pollution monitoring requires small, low power and wireless module. Looking at novel metal oxide (MOX) gas sensors, the working temperature is critical for selectivity. Also, its good regulation ensures an optimized tradeoff between the response time, the recovery time and the sensitivity [1]. Finally, the baseline resistance is humidity dependent and it is necessary to compensate it.

We developed a multi-gas sensor module built with a low power readout interface, a temperature heater control and a Bluetooth[®] 5.0 wireless connectivity. Edge computing enables compensation and calibration. A live visualization developed on MATLAB[®] allows plotting the temperature, the resistance and the estimated concentration of the target gas. The temperature regulation reaches an accuracy of less than 1 %. The heater interface is low power (1.32 mW) and the total consumption essentially depends on the heating resistance and geometry.

II. DEMONSTRATION SETUP

The demonstration setup consists of:

- a readout circuit based on a resistance-to-frequency converter made of commercial off-the-shelf components, together with a dedicated MCU,
- the heater control circuit based on a current source digitally controlled by a DAC and a feedback loop with an analog-to-digital converter to ensure PID regulation,
- the developed MOX gas sensor with two commercial gas sensors from AMS (CCS801) and SGX Sensortech (MiCS-6814) for comparison, as well as a SHT31 temperature & humidity sensor from Sensirion AG for compensation;
- two nRF52840-DK SoC with Bluetooth[®] 5.0 support built on a 32-bit ARM[®] Cortex[™]-M4 CPU with floating point unit running at 64 MHz, respectively for data processing and transmission, as well as for wireless reception;
- ammonia or formaldehyde (nail polish) solutions for sensing.

For the experience, a gas chamber mounted above the sensing elements allows confining the gas sensors for increased stability and precision, as shown in Fig. 1. An air pump injects a constant airflow inside the chamber with gas (ammonia or formaldehyde) and/or humidity perturbation.

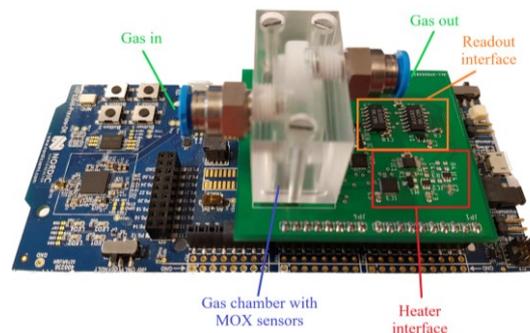


Fig. 1. Dedicated expansion board and associated elements.

III. VISITOR EXPERIENCE

The visitor will experience the effect of sensor temperature on both selectivity and sensitivity of MOX gas sensor, as well as its impact on response and recovery time, as seen on the screenshot in Fig. 2. Furthermore, he will see the humidity influence on the

baseline resistance variation and the related compensation on the gas concentration. Such a smart device is very promising for future remote autonomous sensing applications in the roadmap of the Internet of Things (IoT) and Industry 4.0, as edge node.

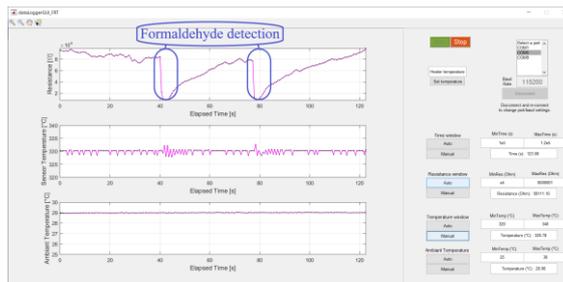


Fig. 2. Data visualization and user interface on MATLAB®.

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REFERENCES

- [1] R. L. Fomekong, H. M. T. Kamta, J. N. Lambi, D. Lahem, P. Eloy, M. Debliquy, A. Delcorte, "A sub-ppm level formaldehyde gas sensor based on Zn-doped NiO prepared by a co-precipitation route", *Journal of Alloys and Compounds*, 731, 2018, pp. 1186-1198.