A wireless sensor node for quantification of volatile organic compounds

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Abstract

In museum environments, gas sensing systems can be used to better preserve and conserve artifacts and collections as well as to keep the environment healthier, safer, and more comfortable for visitors and staff. For this reason, we have developed a cost-effective and easy-to-use portable gas detection system based on a nanostructured metal-gated gas-sensitive field-effect transistor that allows to quantify the concentration of certain volatile organic compounds well-known for deterioration promotion of cultural heritage. By using cloud solutions, the museum staff can perform long-term analysis, and monitor in real time the status of the indoor environment so that the artifacts are never exposed to damaging gas concentrations.

Portable detection system

- Silicon Carbide Field Effect Transistor working as gas sensor
- Single-board computer
- LoRa transceiver for wireless data communication
- Customized PCB and 3D housing
- Possibility to include temperature and RH sensor

Figure 1: portable sensor system

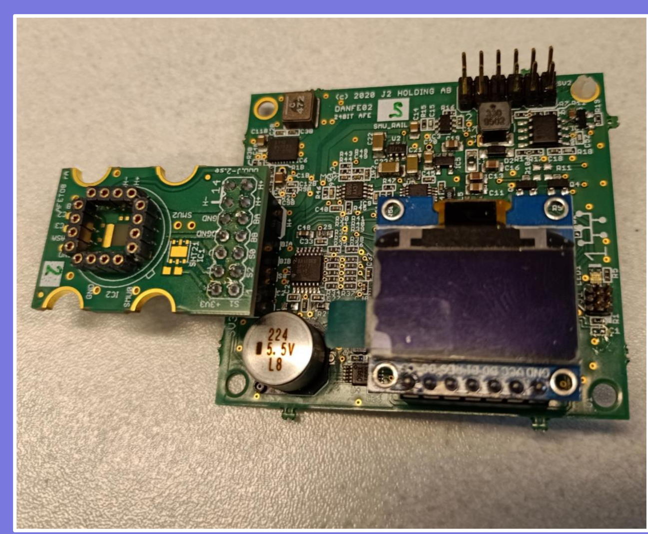

Figure 2: PCB and sensor holder (by J2 Holding AB, Sweden)

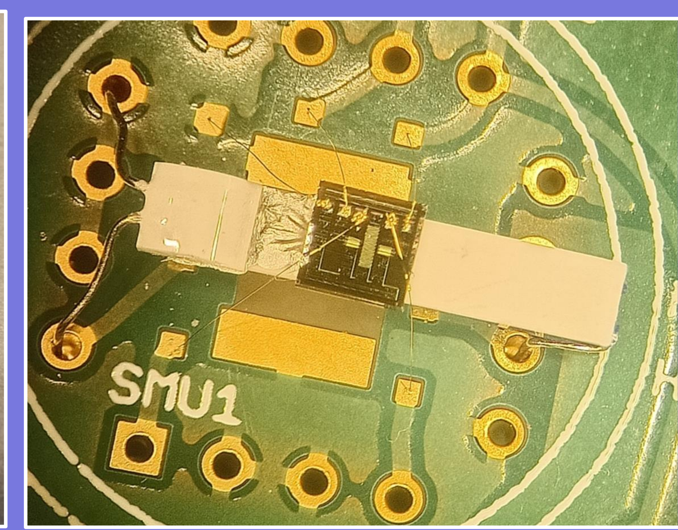

Figure 3: gas sensor, heater and temperature sensor

Temperature cycled operation

- Simulates an array of sensors (e-nose)
- Constant temperature data acquired
- Information of the transient response obtained
- Most sensitive temperatures for different gases included
- Reports information about complex gas mixtures
- Gas fingerprint determination
- Temperature cycle chosen: 150 s between 270°C and 390°C

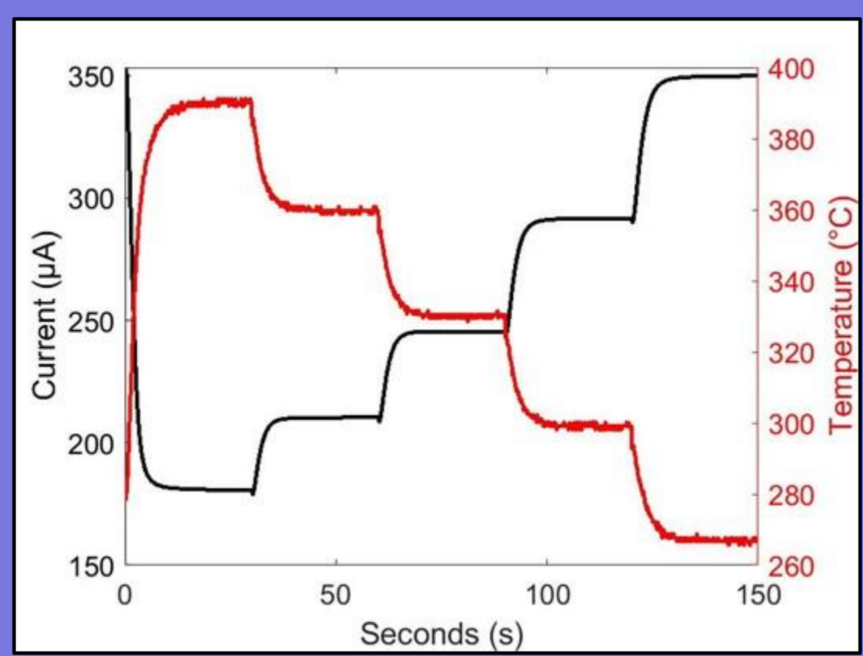

Figure 4: Temperature cycle and corresponding sensor signal
doi:10.3390/proceedings2020056037

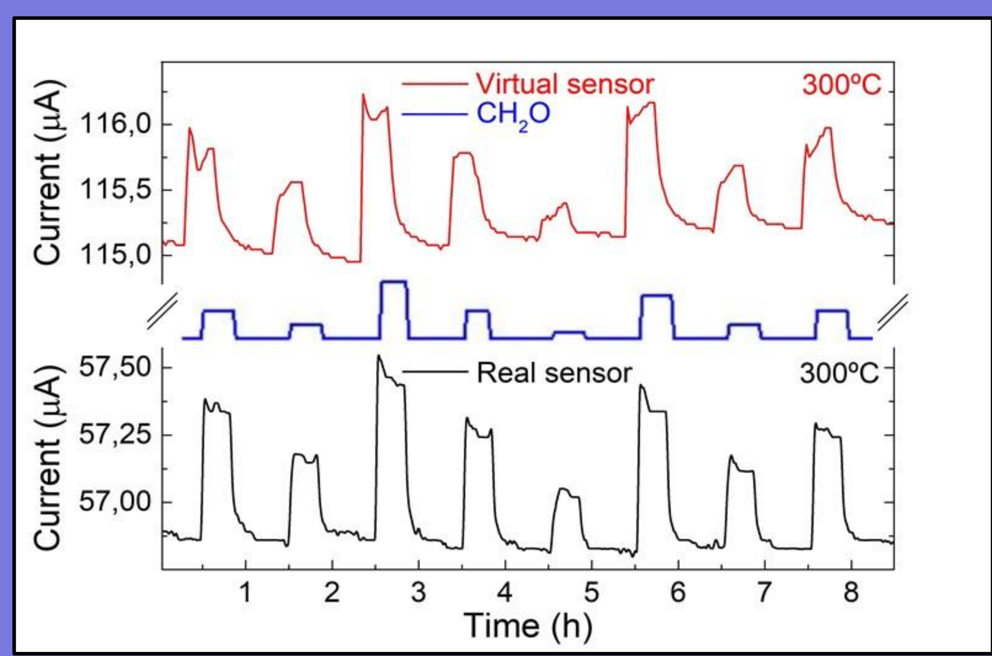

Figure 5: virtual sensor and real sensor comparison working at 300 °C exposed to different concentrations of formaldehyde
doi: 10.1016/j.snb.2021.130294

Chemometrics and cloud solutions

- Quantification with partial least square regression reports the concentration of the gas of interest always with a success rate higher than 80%
- A customized software allows to change parameters for the quantification of different gases (for developers)
- A portal prepared to monitor and log the acquired data is available (for end-users)

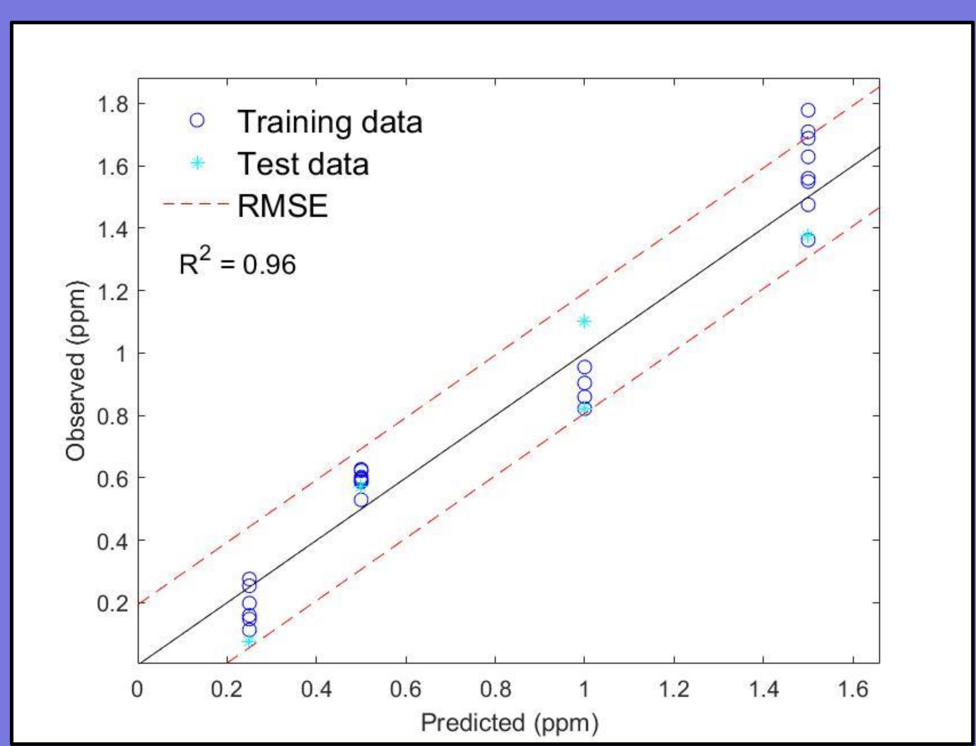

Figure 6: partial least square regression quantification results for different concentrations of formaldehyde

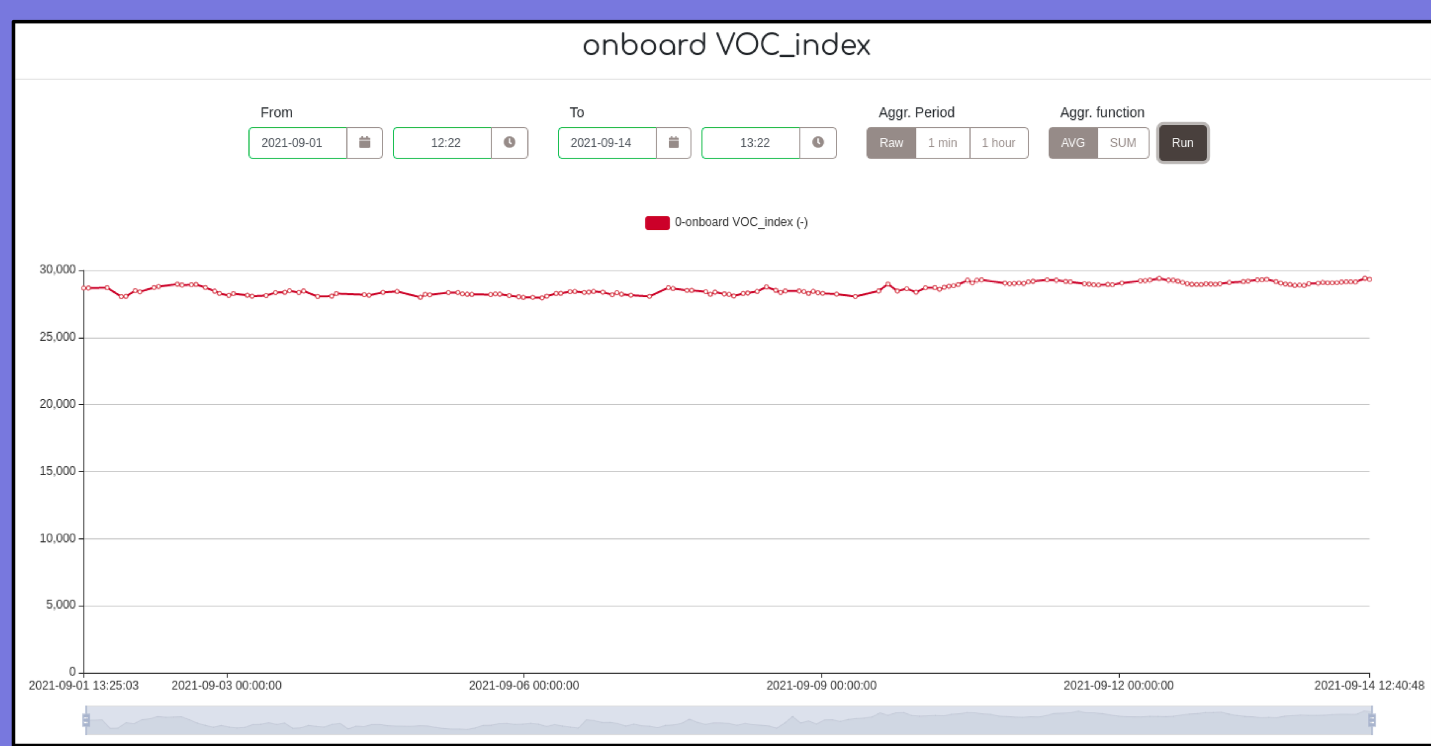

Figure 7: SensMat portal (DevLab) where end-users can monitor the status of the installed sensor systems

Conclusions

- **E-nose was successfully emulated by using a single sensor and data treatment**
- **Quantification of the three studied volatile organic compounds always with R^2 > 80% was obtained**
- **A portable and ease-to-use gas sensor system that can quantify volatile organic compounds has been successfully developed**
- **The concentration of the gases of interest can be monitored by the end-users via the SensMat portal**

The project has received funding from the EU's H2020 research and innovation program under grant agreement No. 814596 (SensMat) and from the Vinnova Innovation project 2019-02095.