High performance gas detection systems on the microscale

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Optimization of gas sensors & dynamic operating modes for selective & reliable detection of ultra low gas concentrations. Focus on metal oxide semiconductor sensors, applicable also to, e.g., ionic conductors, electrochemical, FET, infrared.

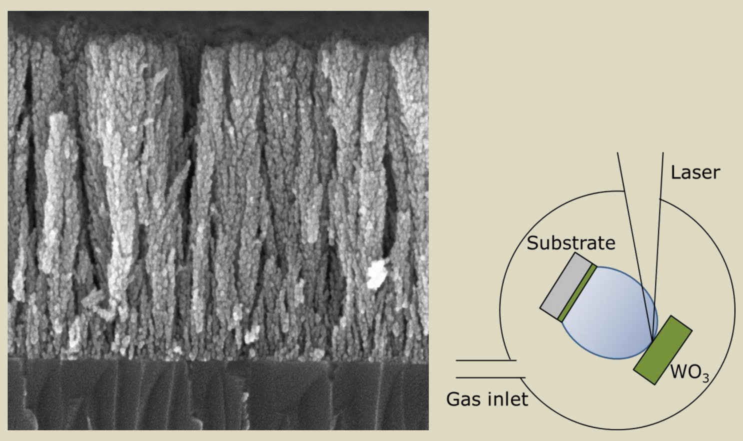
Enables new applications in air quality, breath analysis or food safety.

Integration of additional components, e.g. fluidic components or pre-concentrators including modelling of the gas transport. Stationary and mobile test standards traceable to analytic methods like GC-MS and FTIR.

Cost efficient systems on the microscale. High performance and traceable detection.

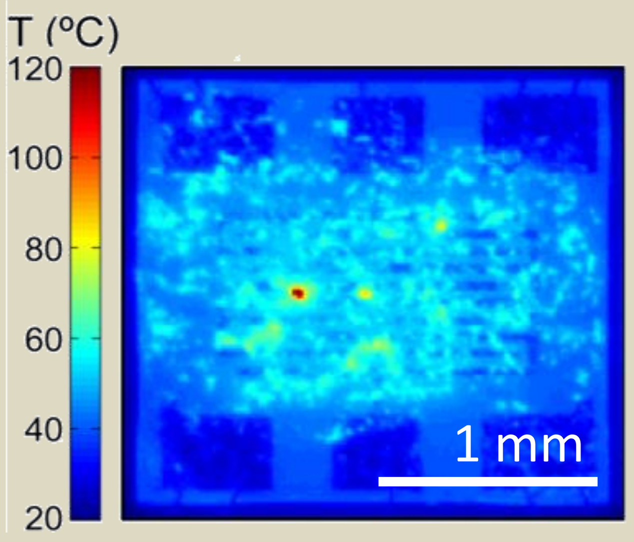
device | **dynamic operation** | **system** | **test**

Sensor development (in collaboration)



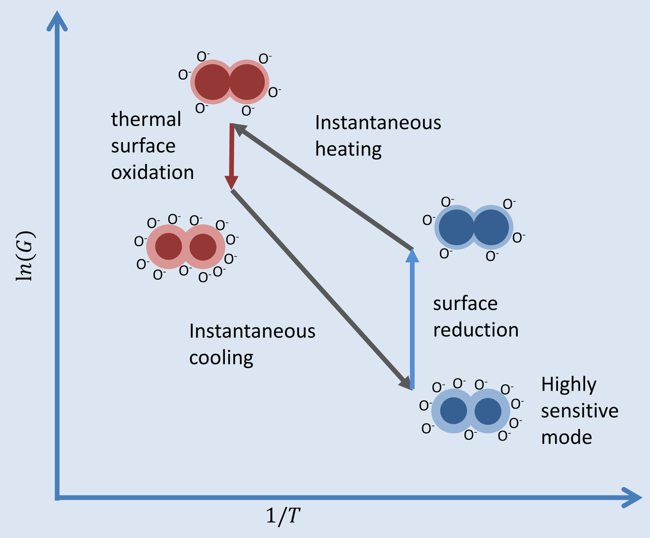
Tin dioxide sensing layer prepared by pulsed laser deposition. Collaboration with University of Oulu und Picodeon.
J. Huotari et al., Sensors and Actuators B Chemical, 246, p 978-987, 2016

Thermal and electrical characterization



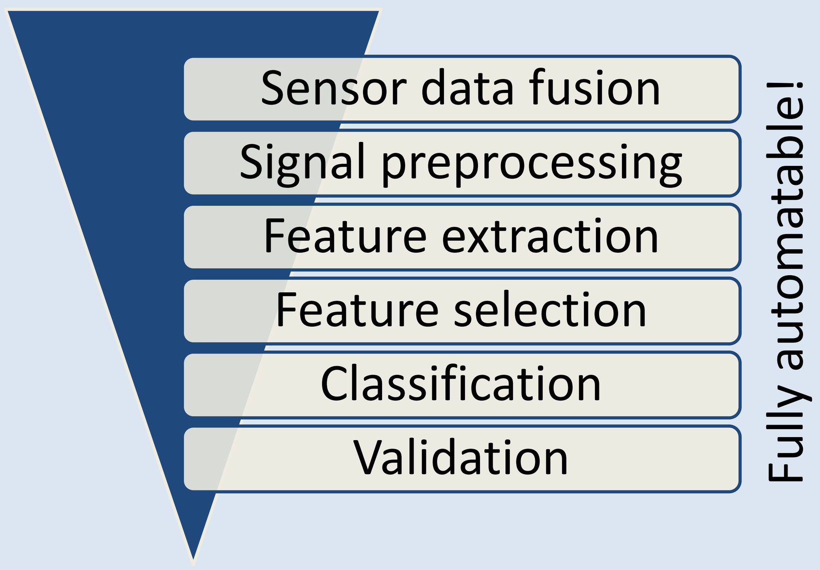
Self-heating of carbon nanofibers measured with a high-resolution infrared camera. The self-heating effect strongly reduces power consumption.
O. Monereo et al., Nanoscale 8 (9), 5082-5088, 2016

Temperature cycled operation

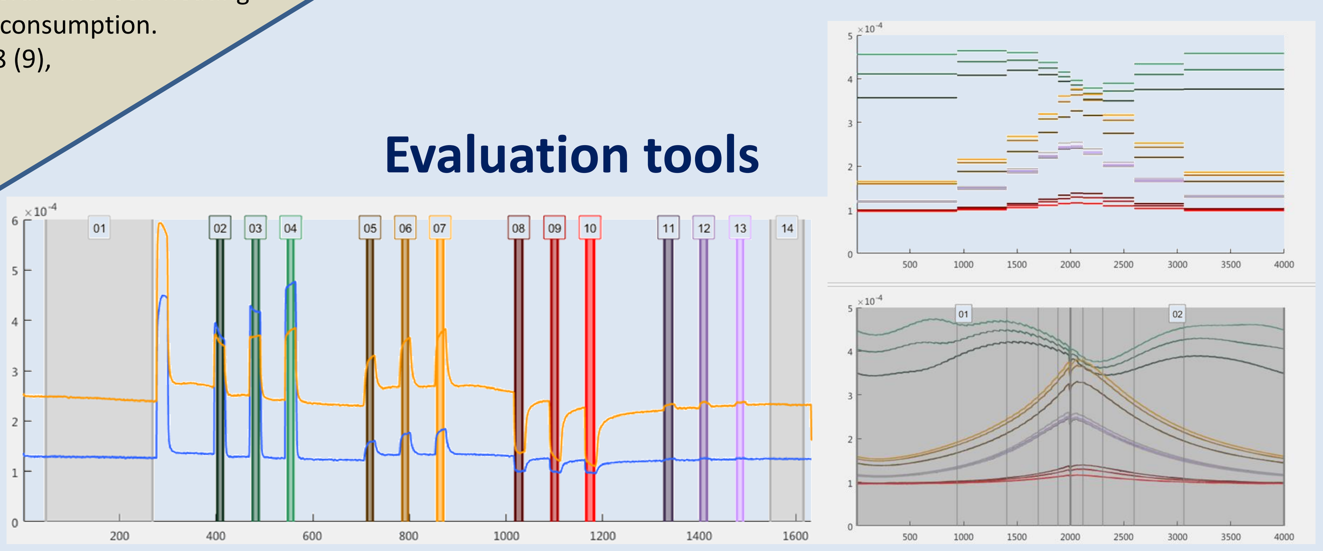


Schematic of an operating cycle in temperature cycled operation (TCO). Oxidation at high temperature and instantaneous cooling lead to a strongly oxidized surface which is highly sensitive to reducing gases.
C. Schultealbert et al., Sensors and Actuators B: Chemical (2017), 239, pp 390–396

Signal processing workflow

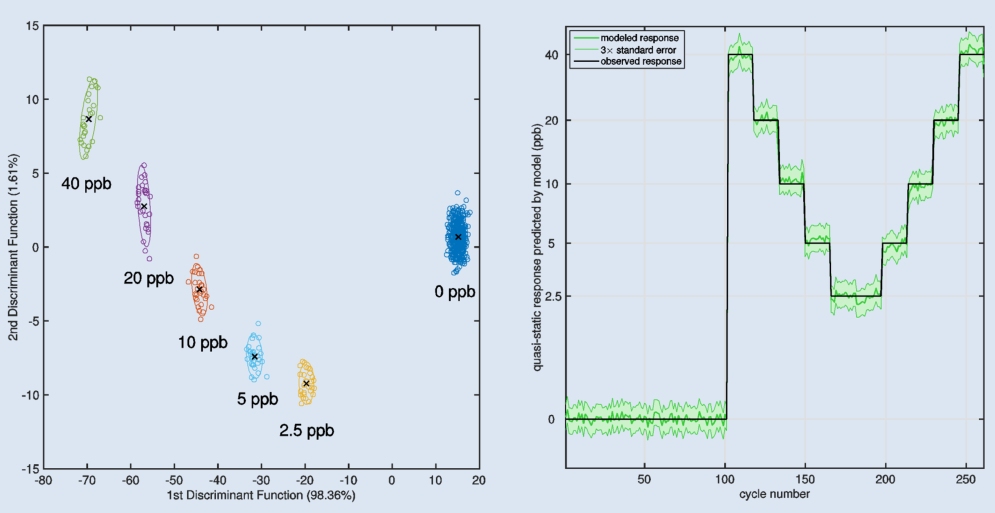


Evaluation tools



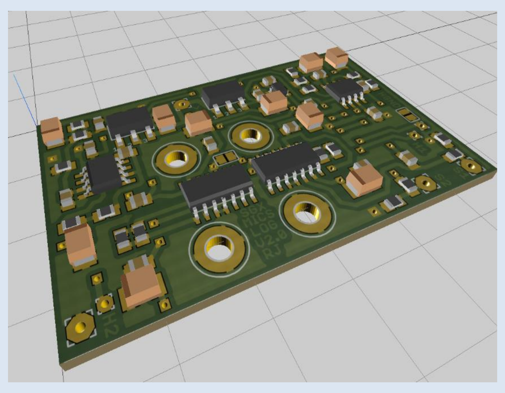
Tools for visualization, verification and validation of the signal processing throughout the complete workflow. On the left: Quasi-static sensor signal throughout the gas measurement, highlighted with colors are the selected gas pulses. On the right: Sensor signals within a temperature cycle for different gases (bottom) and representative features calculated from these (top)
M. Bastuck et al., 18. GMA/ITG Fachtagung Sensoren und Messsysteme 2016, 10. und 11. Mai 2016, Nürnberg

Classification and quantification of detected trace gases



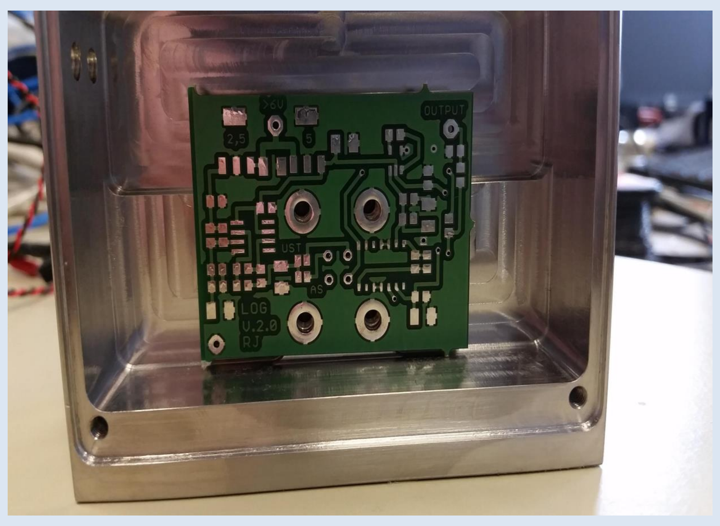
Signal processing is based on simple and reliable algorithms for discrimination, e.g. LDA (linear discriminant analysis, left), and quantification, e.g. PLSR (partial least squares regression, right).
cf. M. Leidinger et al., J. Sens. Sens. Syst. (2016), 5, 147-156

High precision electronics



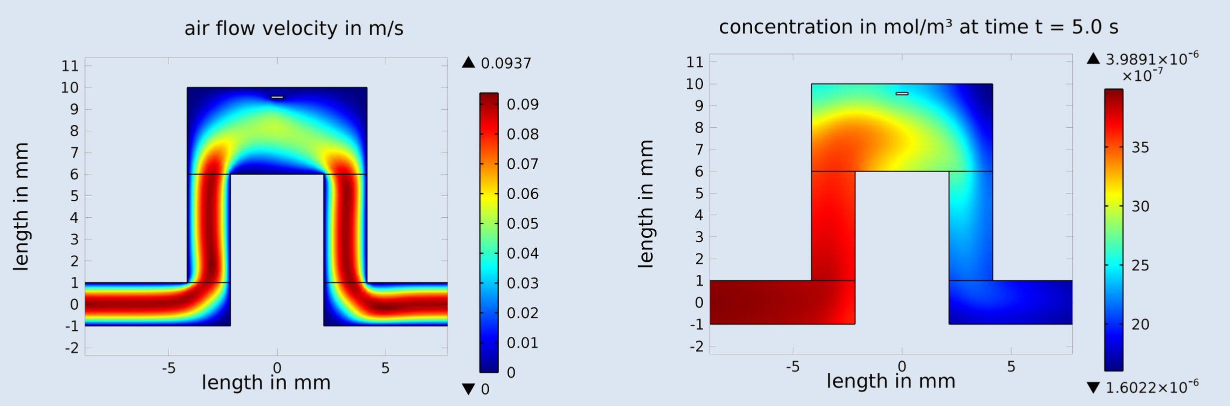
High precision conductance measurement over more than seven orders of magnitude at constant sensor voltage.
cf. T. Baur et al., tm - Technisches Messen, 82

Integration in fluidic systems



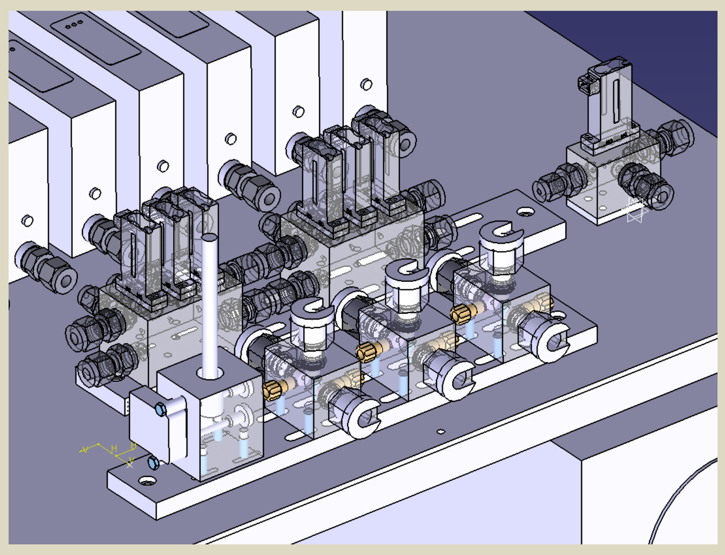
Integrated system with optimized fluidic components and shielding against electromagnetic noise. The detector unit is optimized for short pulses of trace gases, e.g. to be utilized as a GC detector.

Flow and gas concentration in a micro detector



Simulation of the gas flow and gas concentration through the detector at the onset of a GC peak.

Gas mixing apparatus for trace gases down to sub-ppb

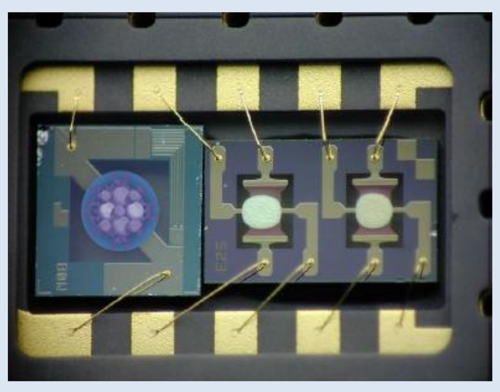


Several gas mixing systems for up to eight gases or volatile organic compounds (VOCs) and up to three semi-volatile organic compounds. Additional make-up gases and humidity generator included.
cf. N. Helwig et al., Meas. Sci. Technol. 25, 055903, 2014

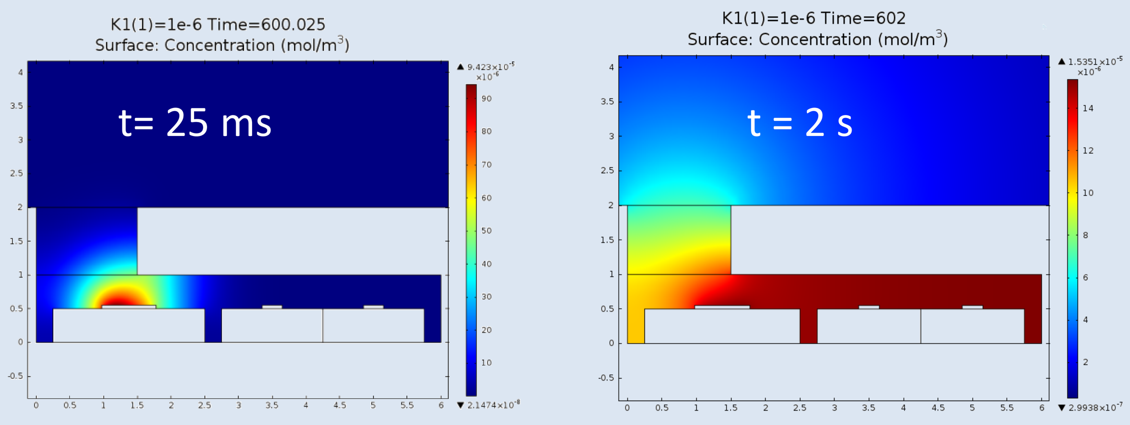
Mobile calibration standards

Mobile calibration standards for volatile organic compounds using two phase equilibrium between the gas phase and an extended VOC reservoir. Large concentration range including zero standard.
cf. C. Schultealbert et al., Sensors and Actuators B: Chemical (2017), 239, pp 390–396

Integrated sensor pre-concentrator system with diffusive gas transport



Sensor system with one pre-concentrator (left) and two sensors (right).
Collaboration with SGX and Fraunhofer ICT



Simulation of the pre-concentrator desorption and subsequent diffusion of the gases to the adjacent sensor surfaces – no active pumping required!
Martin Leidinger et al., Sensors and Actuators B: Chemical, 236, 988–996, 2016