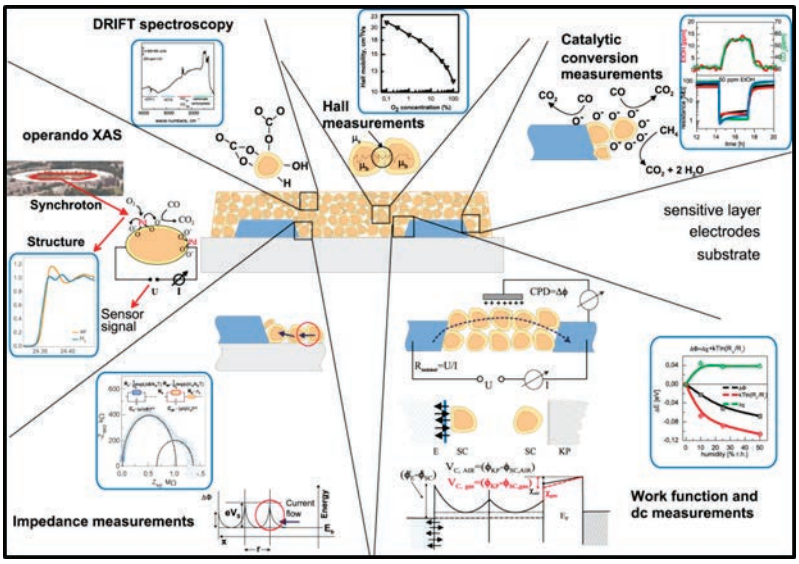
Chemoresistive gas sensors based on semiconducting metal oxides (SMOX) are sold in millions for solving applications spanning from the detection of explosive gas leakages in residential premises to hindering the access of pollutants inside cars. All started after metal oxides were identified as possible sensitive materials by Heiland et al. [1], Bielanski et al. [2] and Seiyama et al. [3] and brought to the market by Taguchi [4](1971), who founded the still largest manufacturer of SMOX sensors, namely Figaro Engineering (Figaro). They were so successful because they are inexpensive, easy to use, very sensitive and stable, easy to integrate into arrays and low power when realized on the appropriate transducer structures.

In principle, gas detection with SMOX based gas sensors is simple: in air, at temperatures between 150 and 400°C, oxygen is adsorbed at the surface of the metal oxides by trapping electrons from the bulk with the overall effect of increasing the resistance of the sensor, for n-type materials, or decreasing it, for p-type materials. The occurrence of a target gas in the atmosphere, which reacts with the pre-adsorbed oxygen or directly with the oxide, determines a change of the sensor resistance, which is recorded as a sensor signal and the magnitude of which is correlated to the concentration of the target gas. Even from this simplified picture it is clear that one has to examine two aspects: the surface reaction taking place between the material and the gases (called the receptor function) and the transduction of it into the corresponding changes of the electrical resistance of the sensor. In this contribution we will examine more in detail the way in which the actual SMOX based gas sensors function, taking into consideration all their relevant parts, and then will use the example of CO detection in humid air to illustrate the power of Operando investigation techniques [5] to explain the dependence of sensor signals on ambient conditions.



Overview of Operando investigation techniques.

[1] G. Heiland, Zum Einfluss von Wasserstoff auf die elektrische Leitfähigkeit von ZnO-Kristallen, *Z.Physik,* 138, 459–464 (1954); doi: 10.1007/BF01327362

[2] A. Bielanski, J. Deren and J. Haber, Electric conductivity and catalytic activity of semiconducting oxide catalysts, *Nature*, 179, 668–669 (1957); doi: 10.1038/179668a0

[3] T. Seiyama, A. Kato, K. Fujiishi and M. Nagatani, A new detector for gaseous components using semiconductive thin films, *Anal Chem*, 34, 1502f (1962); doi: 10.1021/ac60191a001

[4] N. Taguchi (1971) US Patent No. 3631436

[5] N. Barsan, D. Koziej and U. Weimar, Metal oxide based gas sensor research: how to? Sensors and Actuators B 121 (2007) 18-35; doi: 10.1016/j.snb.2006.09.047