Miniaturized MOS gas sensors as highly sensitive GC detector

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The need of analytical grade gas detection systems in various fields of everyday life fuels the development of portable gas chromatography (GC) systems. Many recent applications require systems that are able to monitor a few components in the lower ppb range against a complex background of interfering gases at concentrations several orders of magnitude higher. Most stand-alone sensor systems lack the selectivity or sensitivity to perform the required tasks. A GC column increases selectivity considerably and opens the field for additional sensor principles to fulfill the application requirements.

Metal oxide semiconductor (MOS) gas sensors are excellent candidates as detectors for portable gas chromatographs due to their sensitivity, size, low cost and low power consumption. The sensor itself is easily integrated and only needs an oxygen source to function. The new generation of MOS gas sensors integrates multiple sensitive layers, which can be measured separately to enable a selective measurement of an even broader spectrum of gases. Limitations such as sensor drift and poisoning through siloxanes from column bleaching, however, are highly significant and need to be addressed.

MOS gas sensors achieve even higher sensitivity and selectivity in a temperature cycled operation [1]. While this approach is not intuitive for the application as a GC detector it helps to address the problems of drift and the often long recovery time after the exposure to a gas, which is especially important for species that elute at nearly the same time. MOS gas sensor systems offer great potential of selective measurement of trace gases beyond the laboratory but interfering gases impede the realization. Combining MOS gas sensors with a GC column therefore enables its sensitivity to be used, while the column accomplishes the necessary selectivity.

Putting a commercially available MOS gas sensor as GC detector into operation demands a well-thought-out design of the measuring chamber and the connection between column and detector. The requirement to keep dead volumes to a minimum while keeping the gas sensor in close vicinity to the gas flow is an important part for successful measurement of gas peaks. Unfortunately, some sensors disqualify their potential as GC detector by cap design alone. Multiphysics simulations can greatly support the design of the sensor chamber and the overall detection system.

[1] A. Schütze and T. Sauerwald, in *Woodhead Publishing Series in Electronic and Optical Materials*, Semiconductor Gas Sensors, Chapter Twelve – Dynamic operation of semiconductor sensors, 2020, p. 385-412