Highly selective formaldehyde (FA) detection with flame-made gas sensors for indoor air quality monitoring

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Air quality monitoring

Monitoring gaseous compounds in aerosols is of high interest. Formaldehyde (FA), for instance, is a carcinogenic indoor air pollutant released from wood-based furniture, laser-printers or paints, and one of the proposed lung cancer markers in exhaled breath. The recommended indoor air exposure limit should not exceed 100 ppb, but suitable devices to monitor FA emission are missing.

Chemo-resistive metal-oxide sensors made by flame spray pyrolysis (FSP) are quite attractive as they can detect sufficiently low FA levels, offer fast response and recovery times and can be produced cost-effectively. Also, they feature small size and low power needed for integration into autanic FA monitors. However, they lack selectivity.

Here, a modular sensor system is developed that overcomes this limitation by placing a highly selective membrane ahead of the sensor, enabling ultra-low FA detection in simulated gas mixtures.

Outstanding performance in gas mixture

FA calibration curve at 50% RH. The membrane/sensor assembly can accurately detect FA down to 30 ppb even in a gas mixture containing NH₃, acetone, isoprene and ethanol each at 1000 ppb.

FA selectivity enhancement by microporous membrane

A microporous MFI zeolite membrane pre-separate the gas mixture by molecular sieving and chemical separation, ideally allowing only FA to permeate. This enables highly selective FA detection with a chemoresistive sensor consisting of flame-made Pd-doped SnO₂ (1 mol%) nanoparticles that aggregate to a fine and extremely porous network.

Interference at higher concentrations

Comparison of responses to interfering gases at a concentration of 10 and 25 ppm and the response to 30 ppm FA. This outstanding selectivity enables FA detection even at much higher interfering concentrations.

Conclusions

- Unprecedented FA selectivity enabled by combination of MFI/Al₂O₃ membrane with a Pd:SnO₂ sensor
- Sufficiently low FA levels are selectively detected down to 30 ppb in simulated mixtures enabling FA level monitoring
- Easy integration into portable detectors due to small and modular design
- Paradigm change in gas sensordevelopment?

References