Nanostructure Enhanced Electronic Nose Microsystem

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Intelligent systems can be realized with electronic nose microsystems (ENMS) as an integrated chemical condition monitor to enable autonomous online response on changing chemical conditions. The ENMS, usually a gas sensor array, converts the composition of even complex gas ensembles into a signal pattern often applied as fingerprint for process control, environmental surveillance or realtime quality assessment at a production line. A unique ENMS has been developed at the Research Center Karlsruhe with an excellent gas analytical performance which rests to substantial extent on two nanoscaled components. The electrical conductivity of semiconducting metal oxides (e.g. SnO_2 at ca. 300°C) depends sensitively and reversibly on type and quantity of ambient gas components providing an unsophisticated way for gas detection. The Karlsruhe Micronose KAMINA is a gradient gas sensor microarray based on a single metal oxide layer subdivided by parallel electrode strips into 38 or 16 sensor segments. Contrary to conventional gas sensor arrays the KAMINA microsystem has no separate sensors anymore. Advantages such as simple and inexpensive microfabrication, detectability of nearly all gases, avoidance of individual sensor ageing, self-validation, outstanding mechanical and thermal robustness furnish the high application potential.

The formerly sputtered metal oxide layer was recently made from SnO_2-nanoparticles the size of a few nm only. Originally prepared in a CVD process the nanoparticles were dispersed in a colloidal solution and spin-coated onto surface-oxidized Si wafers. Annealed at 400°C such layers proved to be considerably more sensitive than sputtered layers. So far for NO_2, hydrocarbons and alcohols gas detection limits have been found a magnitude better or even more. However, alcohol exposure degrades the gas detection in a long term process the reason why is currently under investigation.

Moreover, a few nm thickness variation of a gas permeable SiO_2 coating topping the metal oxide and a temperature difference of e.g. 250°-300°C modify especially the gas selectivity of the segments across the microarray. Therefore, each segment responds somewhat different on gas exposures and characteristic conductivity patterns can be read-out from the KAMINA microarray reflecting the ambient gas composition. Recent results on the gas analytical optimization of the membrane's nanoprofile and the temperature gradient will be presented.