Nano electronic noses

M. Tonezzer[1,2]

[1] IMEM-CNR, sede di Trento - FBK, Via alla Cascata 56/C, Povo - Trento, Italy

[2] Center Agriculture Food Environment, University of Trento/Fondazione Edmund Mach, via E. Mach 1, San Michele all'Adige,TN, 38010, Italy

Abstract:

Gas detection is increasingly important in many fields: from environmental monitoring to food quality to health, both as gases breathed by people in various places (home, office and public places), and as exhaled gas for early diagnosis. However, existing techniques (gas chromatography, mass spectrometry) are cumbersome, complicated and expensive, and cannot be used extensively in the field. Small inexpensive devices, perhaps integrated into the smartphone, could instead measure the presence of gas autonomously in real time. Metal oxides are excellent sensing materials since their resistance varies depending on the gas surrounding them.

Unfortunately, the response of resistive sensors is non-selective: selectivity is simply defined as the response ratio to the target gas and the interfering gases and this is insufficient when it is not possible to guess the gas present. On the other hand, in each application it is essential to know which gas the sensor is measuring and what its concentration is. Different harmful gases present various hazards (flammability, explosiveness, toxicity ...) at different threshold values; the concentration of specific markers indicates the freshness of the food; different biomarkers in breath indicate different possible diseases.
A single resistive sensor cannot provide the necessary selectivity and distinguish different gases or their concentration. Therefore, electronic noses (which are arrays of different sensing materials) are usually used, but they are obviously more complex, bulky and expensive than single chemoresistors.

Our approach aims to discriminate gases while keeping the device simple, cheap and tiny, using a single metal oxide nanosensor subjected to a temperature gradient (temporal or spatial). The sensor response to different temperatures forms a "thermal fingerprint" which is specific to each gas. The fingerprint changes as the gas concentration increases, but remains recognizable to the sensor. We will show different variations of this approach using different materials and sensor designs and demonstrating how the performance of this type of sensor is more than satisfactory.
A sensor smaller than one mm^2 (and therefore easily integrated into any electronic device) can perfectly distinguish all the gases tested, and estimate their concentration with an error of around 5-15%.

Corresponding author: M. Tonezzer

Phone number: 0461 314828

Email address: matteo.tonezzer@cnr.it