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Discrimination of gas-phase emissions from building material samples by combining two gas-sensor arrays

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Introduction

As part of the European project SYSPAQ, aiming at the conception of sensor systems to measure perceived air quality, experiments have been performed to assess the discrimination power of two gas-sensor systems as regards typical building material emissions. The first is based on individual metal oxide sensors and the second more compact constituted by a segmented sputtered layer of Pt-doped tin oxide differentiated by a temperature gradient and a thickness variation of a gas permeable SiO₂ coating. The 2 systems are intended to be integrated in a larger system in the framework of the project. The objective of the preliminary experiments presented here is to check the discrimination performance of the merged system to emissions of 20 building materials.

Methods

Experiments with each system were performed separately with different sample conditioning. A pulse from the static headspace of samples mildly heated at 35 °C was introduced in the first system, whereas the second system was exposed continuously to a dynamic headspace of the samples. Each sample provided a significant change in the sensor signals based on conductivity variations. A method has been developed to select optimal signal features in order to increase discrimination power. Three extracted features were selected: t_{max} , the time needed to reach maximum signal change, $\Delta R/R$ and dR/dt , respectively relative change in resistance and resistance change rate chosen at a time corresponding to the maximum variance between sensors. This pre-conditioning

resulted in the determination of a single pattern associated to each sample. Multivariate statistical analysis such as principal component analysis with a subsequent hierarchical classification resulted in several discriminated groups of samples.

Results

The best discrimination level (9 classes) was achieved by combining normalized $\Delta R/R$ values of the two gas-sensors array. This selection was performed by first choosing the partition with the maximum number of classes from the three best automatically selected. Finally, the best discrimination level was the partition with the maximum value in the inter-class on $\max(\text{intra-class})$ inertia ratio.

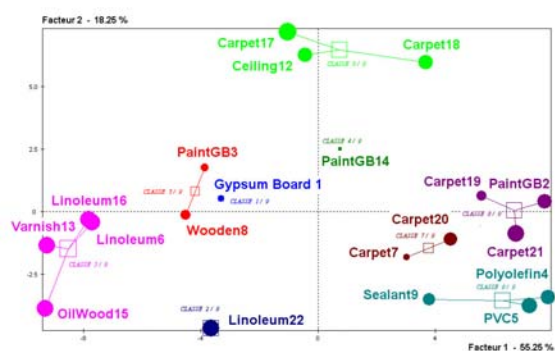


Figure 1. PCA plot of the 20 building materials.

Conclusion

A coherent statistical discrimination level was achieved. However, in order to relate it with human perception of air quality, the perceivable olfactory differences between samples need to be assessed. This will be achieved in the next step of the SYSPAQ project.