Identification of Explosive Materials by LibraNose

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Introduction

Recently, great interest has been aroused around the possibility to utilise the electronic nose technology to identify explosive materials.This interest is mainly driven by the necessity to reduce the insurgence of threatening actions.

In this paper, a number of experiments aimed at testing the identification capabilities of an electronic nose are illustrated. Such experiments, performed in cooperation with the *"Scuola del Genio"* of the Italian Army,aimed at identifying very basic and common explosives.

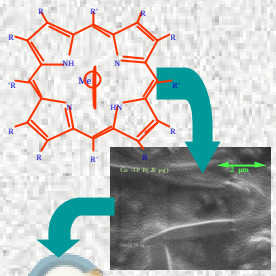
The identification of these materials from the analysis of their headspace is highly complicated by the scarce volatility of the explosive compounds. On the other hands, the manufacturing of explosives requires the use of addictional substances necessary, for instance, the keep toghether the explosive materials that sometimes is in dusty form. The presence of this auxiliary substance, not harmful in principle, helps in the formation of a more rich headspace composition bringing to the identification of the explosive in its usable form.

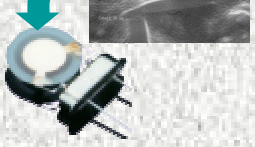
An electronic nose "LibraNose" developed by Technobiochip has been utilised for this experiment.

Five different explosive were tested: pentrite, TNT, a mixture of PE4 and Pentrite, and T4-pb.

LibraNose

- Eight Thickness Shear Mode Resonators
- Sensitive coating: tetrapyrrolics macrocycles (porphyrins)
- Main current applications:
  - food analysis: fish, meat, tomato, wine, milk, fruits…
  - Industrial applications: tobacco, leather industry…
  - *Medical applications: Skin odour, Urine, Blood, Breath …..*





Experimental

Amount of explosive materials were closed in sealed bottles and held at 25 °C for 30 minutes before to be measured.

Measurements were performed at the *"Scuola del Genio"* facilities of the Italian Army in Rome.

Results

The extreme lability of the samples induced a strong non-linearity in the data. This gave the opportunity to test several data analysis techniques along with advanced pre-processing like Independent Component Analysis.

Here the performance of a simple linear approach like the discriminant analysis solved by partial least squares (PLS-DA) and a non linear technique like fuzzy logics are compared. Data were used with ICA pre-processing and without.

In the table the performances are reported in terms of correct identification per single class and for the total 4-classes problem.

The highest non linear approach (ICA + Fuzzy Logics) achieves the best performances.

It has also to be remarked that pure explosives are fully identified while the mixtures are mostly affected by identification errors. This can be due to the non perfect reproducibility of the mixtures in the explosive fabrication process and also to a more dispersed presence of those spurious substances necessary to held the mixture.

class	*PLS-DA*	*ICA + PLS-DA*	*Fuzzy Logics*	*ICA + Fuzzy Logics*
PE4-PEntrite	50%	70%	66%	66%
TNT	33%	77%	66%	100%
PEntrite	44%	77%	100%	100%
T4-PB	60%	80%	0%	50%
Total	45%	76%	63%	81%