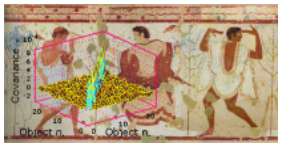
**Invited Lecture** CMA4CH 2008, Mediterraneum Meeting

Multivariate Analysis and Chemometry Applied to Environment and Cultural Heritage
2nd ed., Ventotene Island, Italy, Europe, 1-4 June 2008



# The Chemical Approach to the Assessment of the State of the Environment and Ecosystem, Included Man-Kind and Cultural Heritage

**Luigi Campanella**

Chemistry Department, Rome University, La Sapienza, Pl. Aldo Moro 5, Rome, Italy

## Abstract

The chemical approach to the assessment of the state of the environment and ecosystem, included man-kind and cultural heritage is an important way to help safety politics is assuming opportune and calibrates regulations and laws.

The continuously increasing number of compounds, new and already known ones, disposed into environment obliges to very complicated and time wasting controls and analysis in order to establish if alarm and risk situations for citizens and users are reached.

These analyses are generally very costly and so not always - and anyway not as frequently as needed - and not everywhere permitted.

## Introduction

So a new methods must be probably more opportunely followed: the approach of the crossing light, preliminary screening and markers. The first approach is a simple test in waiting for a red or a green light that means a negative or a positive sample: if green, detailed and specific analysis can be avoided, if red they must be carefully performed in order to account for the negative indication a specific compound

Some new lines in this way refer to:

1. Radicals production in energy process as guideline to evaluate impacts on ecosystem: The secondary pathways of the processes generally produce radicals, very reactive chemical species able to react with practically all the substances producing them damages and alternations;
2. Integral toxicity following energy reactions and environmental pollution, first off all toxicity to biosystems: the looking for a biological monitoring able to well represent this impact is continuously active in the scientific community. Yeast and algae seem promising biological systems, the impact being measured basing respectively on respiratory and photosybthetic activity;
3. Degradability of chemicals (reagents and products) polluting: Potentially fuels able to be completely degraded to water and carbon dioxide are leastly dangerous compared with other one which produce many different products each one able to react with ecosystem. The design and building of a photosensor based on titanium dioxide in anatase form seems to allow to get this kind of information, basing on the property of $TiO_2$ to simultaneously act as catalyst and as pH indicator.

## Discussion

During and following an energy production different chemicals are produced able, each one and all together with synergic action, to impact on ecosystem: so the possibility emerges to evaluate this impact not basing on the cause but on the effects, first of all toxicity to biosystems. The looking foe a biological monitoring able to well represent this impact is continuously active in the scientific community. Yeast and algae seem promising biological systems, the impact being measured basing respectively on respiratory and photosynthetic activity.

For some years, the toxicity of many chemical substances has been studied by means of living organisms used as biological indicators.

Higher organisms are generally used as the guinea pig, as the results they produce are often extremely reliable, even though the response times may be lengthy (ranging from a few days to several months, or even years in the testing for chronic toxicity). Nevertheless, by exploiting

unicellular organisms, in particular yeasts, it is possible to reduce testing time considerably. Furthermore, by using suitable biological systems, such as immobilised yeast colonies, it is possible to implement the method even in situ, with the advantage to obtain a value of integral toxicity as due neither to this nor to that compound but to all together with the eventual antagonisms and synergisms too.

Today immobilised yeast cell biosensor has been developed for the total toxicity testing of a sample that may contain a number of different pollutant species; the biosensor often uses an amperometric gas diffusion oxygen as indicator electrode.

The method is based on the perturbation of the respiratory activity of yeast (Saccharomyces Cerevisiae as example) cells immobilised on an agar containing the culture medium (i.e., agarised medium), due to the toxic tested substance. Glucose is used as substrate while the tested substances in the setting operations were several metallic ions, phenols and cationic or anionic surfactants, pesticides and other toxics.

Recall the previuos point 3, potentially fuels able to be completely degraded to water and carbon dioxide are leastly dangerous compared with others which produce many different products each one able to react with ecosystem. The setting up of photosensors based on titanium dioxide in anatase form seems to allow to get this kind of information, basing on the property of $TiO_2$ to simultaneously act as catalyst and as pH indicator.

**Conclusions**

It must be emphasised the difference between degradation and mineralization, the former bringing to a lower molecular weight compound, the toxicity of which can be also higher than that one of the original compound, the latter one ensuring the total production of $CO_2$, $H_2O$ and the mineral acids corresponding to the elements present in the mineralized molecule. So the ability to be degraded down to mineralization of the pollutants is a precious behaviour to protect environment and to evaluate it can be useful for environment quality assessment.

Monitoring more parameters and use Multivariate Analysis could be of great help in the case of an unknown or not characterised compound: a White Book of European Community invites scientific community to make the most of efforts in order to set up chemical tests able to give information - especially alarm advices - in real - or almost real - time about the toxicity of a compound or the state of a workplace or of an environment.

$NO_2$, $SO_2$, $O_3$, benzene, and toluene can be also measured by differential optical absorption spectroscopy (DOAS) technique. DOAS measurements can be compared with the conventional measurement instruments (API automatic monitoring instrument) and show that both systems exhibit strong compatibility with good correlation, therefor the DOAS system is able to provide reliable information on distribution patterns of major air pollutants.

**References**

- D. Dvoranová, V. Brezová, M. Mazúr, M.A. Malati, Investigations of metal-doped titanium dioxide photocatalysts, Appl. Catal. B-environ., 37(2) (2002) 91-105
- L.R. Skubal, N.K. Meshkov, Reduction and removal of mercury from water using arginine-modified $TiO_2$, J. Photoch. Photobio. A, 148(1-3) (2002) 211-214
- L. Campanella, M.P. Sammartino, M. Tomassetti, S. Zannella, Hydroperoxide determination by a catalase OPEE: application to the study of extra virgin olive oil rancidification process, Sensor Actuat B-chem, 76(1-3) (2001) 158-165
- L. Campanella, S. De Luca, G. Favero, L. Persi, M. Tomassetti, Superoxide dismutase biosensors working in non-aqueous solvent, Fresen. J. Anal. Chem., 369(7-8) (2001) 594-600