PhD Course in Models and Methods for Materials and Environmental Sciences – Cycle XXXVII

PhD Candidate: Alessandro Monari

Tutor Prof. Laura Pigani

A new electrochemical sensoristic approach for the analysis of complex matrices

Electrochemical sensors are often considered a viable alternative to the bulky, expensive and complex analytical instruments used in the laboratory, as they can provide reliable results at lower times and costs. In recent years, there has been a considerable growing interest in the development of amperometric sensors to detect analytes of technological and medical interest in complex matrices. Good analytical performances (i.e. sensitivity, selectivity, reproducibility, linearity, life-time, etc.) are ensured by the development of materials or electrodic coatings which can selectively oxidize or reduce the electroactive species of interest in the solution.

When the analyses are made on a complex matrix the first step is the selection of a suitable sensor; in other words, it is necessary to find the right material for the detection of the analyte of interest because different matrices can present very different physical properties and chemical compositions. In this type of samples a lot of different interfering molecules are usually present, therefore it is necessary to find the suitable material that, in the best case, can detect selectively the analyte of interest. Nowadays electrodic materials can be simple or composite, commercially available products but also originally synthesized ones; for example, nanosized materials offer several advantages over traditional bulk materials, such as a higher surface area and different functional groups able to interact with different species. Testing different materials to find the best one for a specific matrix can be a tricky task mainly due to the presence of interferent species.

Once the specific sensor for the complex matrix of interest is found, and the analyses are made, the next step is the interpretation of the results. In many cases the signal obtained is not easy to understand, because it can be the sum of different signals coming from different molecules, which very often interfere generating noise. Then a multivariate approach may be mandatory for a correct interpretation of the signal acquired. Chemometrics provides the right tools to work with complex signals, and it is useful to obtain classification or multivariate regression models for the detection or quantification of different analytes.

Therefore, I will develop sensors for the detection of different polyphenols mainly in food and plants-related matrices. The know-how and the different expertise I will obtain will allow me to study different aspects of this problem: the choice and the characterization of the material constituting the sensing element, the development of optimized procedures, interpretation of the results through chemometrics and, in the best case, the development of a sensing device for a real application.