Electrochemical Laboratory Kits

Refs. PL1 PL2 PL3 PL4 PL5 PL6

Reference	Description
DRP-PL1	Electrochemical lab kit: ***Ascorbic Acid in juice***
DRP-PL2	Electrochemical lab kit: ***Uric Acid in urine***
DRP-PL3	Electrochemical lab kit: ***Paracetamol in drugs***
DRP-PL4	Electrochemical lab kit: ***Copper in tap water***
DRP-PL5	Electrochemical lab kit: ***Glucose in drinks for babies and in honey***
DRP-PL6	Electrochemical lab kit: ***L-lactic acid in wines***

These practical kits allow students with or without electrochemical experience to complement their academic programs by an inquiry-based learning on research experiences.

The kit contains:

- ***The Professor's manual:*** theoretical and practical guidance at specific electrochemical methods and more extended information about the experiments. It has the figures corresponding to voltammograms, regression curves, optimized parameters, etc.
- ***The Student's manual:*** a brief explanation about the analyte and an outline of the experiment. Students are guided through the different steps to develop an analytical method: prepare the standard solutions, apply certain method to do the electrochemical characterization, optimize the different parameters in a measurement and choose the best ones to develop the method for the analyte quantification.
- ***Screen printed electrodes*** to undertake the sessions and ***analyte samples*** in the needed kits.

The electrodes are screen-printed, disposable and easier to use than conventional carbon paste or glassy carbon electrodes, so the most of the practical sessions' time is made. Students do not waste the time preparing the carbon paste or cleaning the glassy carbon electrode, therefore they learn the electrochemical techniques (cyclic voltammetry, differential pulse voltammetry, square wave voltammetry, flow-injection, amperometry) and the **rational design of an analytical method**: electrochemical characterization of the analyte, optimization of parameters such as pH or electrochemical factors (i.e. scan rate), select an adequate method and determine its analytical characteristics. Finally they apply the developed method to a real sample.

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· **Ascorbic Acid in juice (ref. PL1)**:
Most of the methods described for ascorbic acid determination are based on the ascorbic acid oxidation, therefore **Cyclic Voltammetry** (CV) is used to identify the oxidation process over screen-printed electrodes. CV is a powerful technique also to determine if the process is controlled by ***adsorption or diffusion*** and study ***the effect of pH variation*** on the ascorbic acid electrochemical behaviour.
On a second step, **Differential Pulse Voltammetry** (DPV) is used for developing an electrochemical method for ascorbic acid detection. Its ***analytical characteristics*** are determine and measurement of the analyte in a real sample is carried out in batch and in flow-injection analysis.

· **Uric Acid in urine (ref. PL2)**:
Characterization of uric acid oxidation process is done by **Cyclic Voltammetry**, including if the process is ***adsorption or diffusion controlled*** and if the ***accumulation time*** could affect the electrochemical signal.
Once a calibration curve is defined, the quantification of ***uric acid in urine*** can be easily done by ***direct quantification*** or by ***standard additions*** methods. Real samples can be analyzed in a simple and easy way.

· **Paracetamol in drugs (ref. PL3)**:
The determination method is based in the electrochemical oxidation of acetaminophen to N-acetyl-p-benzoquinone imine. ***Identify the reduction-oxidation process*** is done by **CV** that allows also define if the process is controlled ***by adsorption or by diffusion***. After process characterization, **Cyclic Voltammetry** and **Square Wave Voltammetry** parameters and analytical characteristics of both methods are studied and defined. Comparison of the results obtained with both electrochemical methods can be done by determination of paracetamol in pharmaceutical preparations- by ***direct quantification*** or ***standard additions***. Also, **Amperometric Detection** (AD) is optimized in a **flow-injection analysis** system, defining the ***hydrodynamic curve*** and allowing the measurement of different samples under flow conditions.

· **Copper in tap water (ref. PL4)**:
Stripping analysis is widely used in metal analysis. This technique incorporate an electrolytic pre-concentration step before stripping performed by a voltammetry technique. **Cyclic Voltammetry** allows to characterize and define the ***oxidation and reducction processes*** on screen-printed electrodes, as well as the possibility of applying this electrolytic pre-concentration step. **Square Wave Voltammetry** is used for an enhancement of the electrochemical signal once ***frequency, amplitude, potential and time of deposition*** are optimized. Analytical characteristics are determined and measurement of copper in tap water can be easily carried out.

· **Glucose in drinks for babies and honey (ref. PL5)**:
In amperometric biosensors the analytical signal is a faradaic current generated when a fixed potential is applied. This current is related to analyte concentration. Glucose sensor is one of the more studied a **amperometric enzymatic biosensor** and this practice is focused on working with glucose biosensors and define the detection potential in **Amperometric Detection**, the posible re-usuability of sensors through sampling, define the analytical characteristics of the biosensor: ***calibration plot, concentration range of analysis and interelectrode reproducibility***. Finally, glucose determination in drinks and honey can be easily carried out.

· **L-lactic acid in wines (ref. PL6)**:
Lactate detection is of great importance in a wide range of areas, including the wine industry, where it is frequently used as key indicator of wine quality. Amperometric biosensors for lactate detection, used in this practice, are an optimal alternative to perform this analysis since they allow the selective detection of this analyte at low concentrations in a simple way.
The main goals in this laboratory teaching kit are: defining the detection potential, studying the inter-electrode reproducibility, the establishment of a calibration curve, and the measurement of L-lactic acid in wine samples.

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