The main aim of the Electrochemical devices team is to fabricate microsystems that fulfill the requirements for analytical on-site /point-of-care testing, such as low-cost, low-power, low reagent consumption, autonomy and compactness, also providing multiplexed / multiparametric analysis whether required. To that end, different fabrication technologies and lab on a chip (LoC) platforms are being developed based on new materials and processes for the integration of microfluidic components and electrochemical transducers. We do applied research with a clear focus on transferring our technology and providing analytical solutions to the environmental, biomedical and industrial sectors.

### Multiparametric analytical systems

**Electronic tongue**
A multiparametric sensor system known as hybrid electronic tongue applied to analyze food products such as wines, beverages and soups.

- Array of electrochemical microsensors based on ISFETs and metal thin film microelectrodes, and a miniaturized optofluidic system.
- Application of chemometric tools to characterize, classify and quantify the parameters of interest.

![Classification approach](image)

Classification of trivariate red wines according to the percentage of grape varieties

![Quantification approach](image)

Parameters obtained with the multisensor system and comparison with standard methods for a set of white wines

**Conductimetric interdigitated electrode array**
Reusable electrical readout system for low-density bioarrays developed on glass slides

- Array 36 gold 20 µm x 20 µm interdigitated electrodes (IDEs).
- PDMS microwell array to host the measuring solution.
- Measuring principle: Changes in solution conductance directly related to the analyte concentration.

**Lab-on-chip for cell culture monitoring**

**Microfluidic device with pH integrated sensors for automatic cell culture monitoring**

- Schematic overview of the system comprising: ISFET/REFET pH sensitive system, PDMS microfluidic network for liquid control and sampling.
- Flexible microchannel fingers for 6 well plates
- Values of pH for commercial electrodes and ISFET/REFET microfluidic chip for sequential measurements.

![Scheme of the chip (15 mm x 23 mm)](image)

Fluorescence images of stained cells in the chip. Cytoplasm stained with eosin (green) and nuclei with 4',6-diamidino-2-phenylindole (blue).

### Wax-based lab-on-chip platform

A patterned layer of wax is used to bond two substrates (plastic or glass) and to form microfluidic structures. Valves, pumps, sealed reservoirs, and electrochemical cells are easily integrated in monolithic lab-on-chip systems.

**Wax patterning down to 25 µm**

**LoC with amperometric detection**

- Assembly of a LoC with valve
- Operation of the wax valve in air and liquid

**Analytical flow microsystems for environmental analysis**

Compact automatic systems incorporating different electrochemical transducers

- Three-electrode electrochemical cells and ultramicroelectrode arrays (UMEAs) modified with gold nanoparticles or bismuth films for heavy metal detection.
- Carbon-based electrodes containing metal nanoparticles for heavy metal and chemical oxygen demand detection in polluted water samples
- Simultaneous amperometric signal of two electrodes integrated in the flow system in a solution containing different copper concentrations