Chemical transducers Group:
Electrochemical devices

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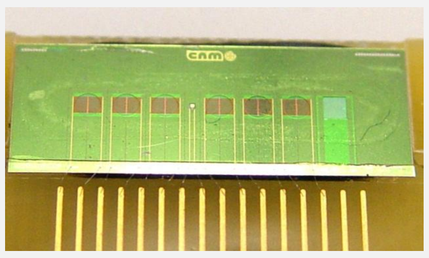
Research interests

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

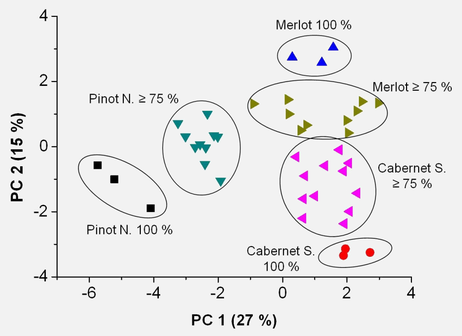
Electronic tongue

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



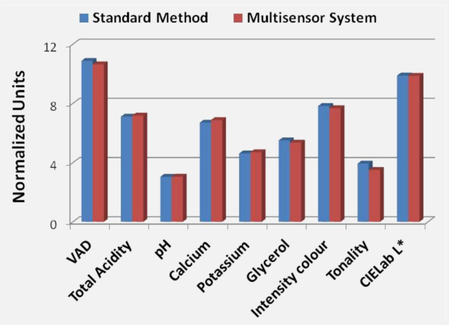
- Array of electrochemical microsensors based on **ISFETs and metal thin film microelectrodes, and a miniaturized optofluidic system**.
- Application of **chemometric tools** to characterize, classify and quantify the parameters of interest.

Classification approach



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

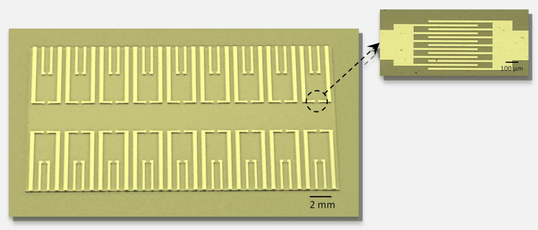
Quantification approach



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

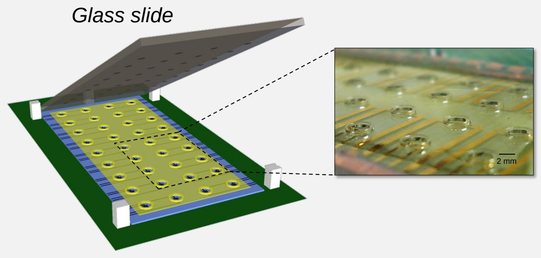
Conductimetric interdigitated electrode array

Reusable electrical readout system for low-density bioarrays developed on glass slides

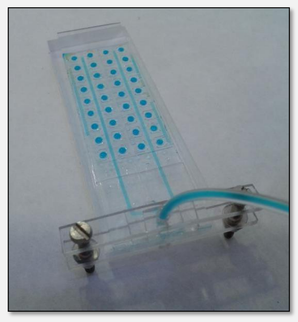


- Array 36 gold 20 µm x 20 µm **interdigitated electrodes** (IDEs).

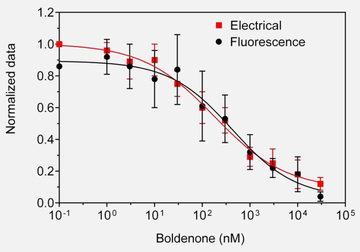
Glass slide



- **PDMS microwell array** to host the measuring solution.
- Measuring principle: Changes in **solution conductance** directly related to the analyte concentration.



Microfluidic PDMS microwell device for the automatic filling and rinsing of the microwells

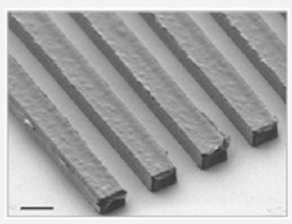


- Applied to the measurement of proteins and haptens – different immunoassay formats.
- Analytical performance similar to fluorescent scanner approaches

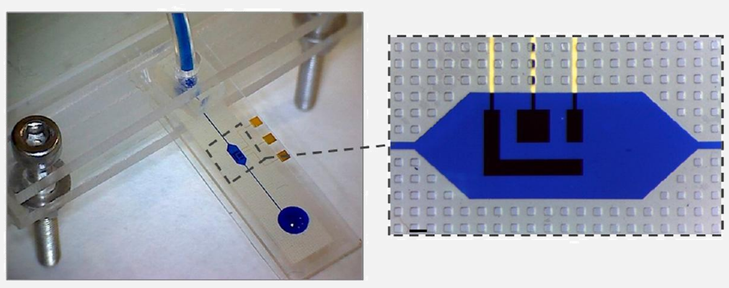
Wax-based lab-on-chip platform

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.

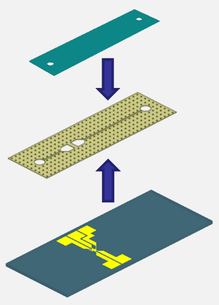
Wax patterning down to 25 µm



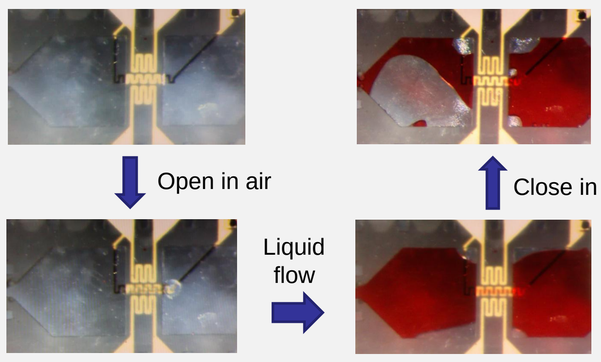
LoC with amperometric detection



Assembly of a LoC with valve

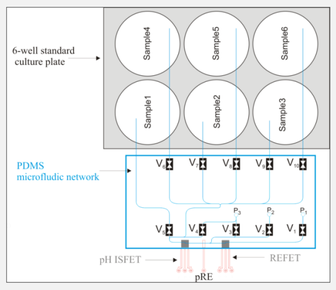


Operation of the wax valve in air and liquid

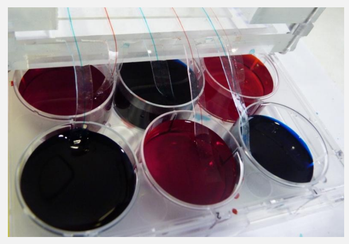


Lab-on-chip for cell culture monitoring

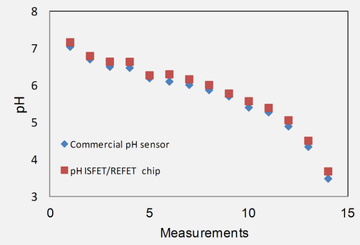
Microfluidic device with pH integrated sensors for automatic cell culture monitoring



Schematic overview of the system comprising: ISFET/REFET pH sensitive system. PDMS microfluidic network for liquid control and sampling.

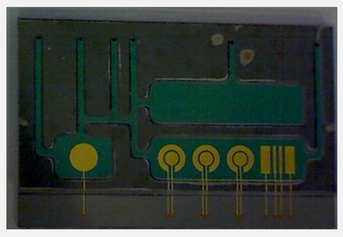


Flexible microchannel fingers for 6 well plates



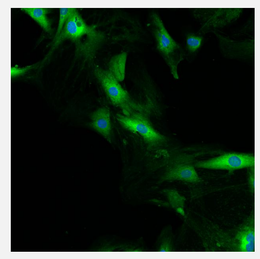
Values of pH for commercial electrode and ISFET/REFET microfluidic chip for sequential measurements.

Silicon/glass µTAS for simultaneous electrochemical and optical cell culture monitoring



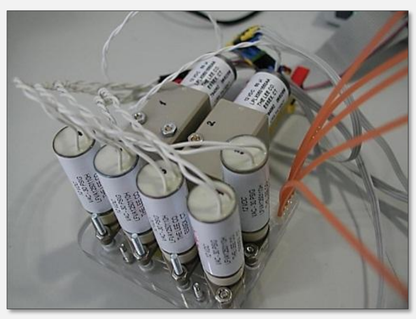
Scheme of the chip (15 mm x 23 mm) with reference electrode, working electrodes and cell culture chamber.

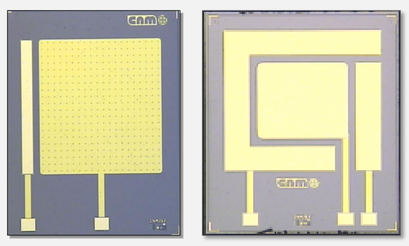
Fluorescence images of stained cells in the uTAS. Cytoplasm stained with eosin (green) and nuclei with 4',6-diamidino-2-phenylindole (blue).



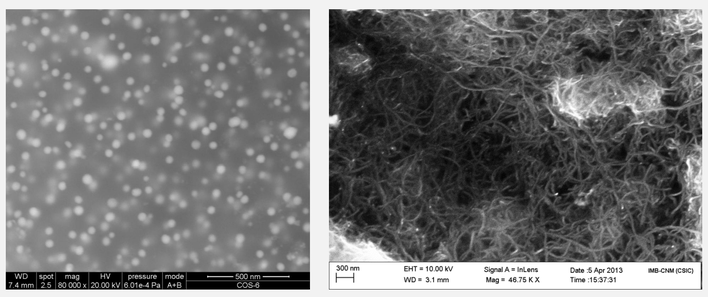
Analytical flow microsystems for environmental analysis

Compact automatic systems incorporating different electrochemical transducers

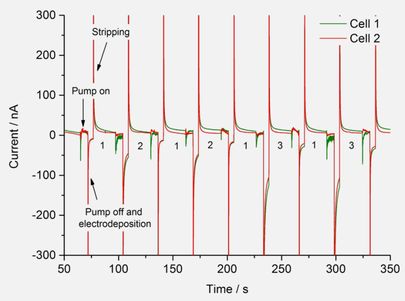




Three-electrode electrochemical cells and ultramicroelectrode arrays (UMEAs) modified with gold nanoparticles or bismuth films for heavy metal detection.



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

Centro Nacional de Microelectrónica IMB

Projects: TEC2010-17274, TEC2010-19467, TEC2011-29045-C04-01, IPT-20111020

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