

# Thick-film Sensors for Analytical and Bioanalytical Applications

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Thick-film technology is one of the most used technique for sensor production, since the equipment needed is less complex and costly than other ones; moreover thick-film electrochemical transducers can be easily mass produced at low cost and thus used as disposable. Nowadays disposable thick-film electrochemical transducers are mainly produced by the screen-printing technique. Screen-printing technique allows the production of planar devices by depositing different layers of inks on a plastic substrate. The obtained devices can be applied to environmental as well for clinical or food analysis, and in the field of electrochemical biosensors.

## Screen-printed Electrodes



Our research group is engaged in the field of sensor and biosensor development using such screen-printed sensors as transducers for analytical and bioanalytical applications. Different kind of inks (graphite, gold) together with different draws are combined in order to obtain sensors and array of sensors suitable for target analytical application. These devices are then coupled with fast and sensitive electroanalytical techniques such as differential pulse voltammetry (DPV), square wave voltammetry (SWV), chronopotentiometry at constant current, or chronoamperometry in order to obtain an accurate analytical result in term of minutes, and this is of great significance when in field analyses are performed.

## Analytical Applications

### DNA-based biosensor for genotoxicity detection

**Working Electrode surface**     **Analyte**     **Working electrode surface**

I - Molecular recognition system: double stranded DNA

II - The analyte produces a chemical-physical modification of the immobilised DNA. Therefore, this causes a different availability in the guanine oxidation.

**Analytical signal**

— DNA alone SS  
 - - - DNA + analyte Ss

**Palm Sens® & pocket PC**

A system based on a screen printed electrochemical cell, and a portable instrument for electrochemical analysis was developed

**Toxicity index:** Signal % = (Ss/Sb)\*100

### Computer-controlled semi-automatised system for on-line monitoring

**Targets**

- Trace measurements of pollutants (intercalators, binders of DNA)
- Hybridization indicator (bacteria, virus, genetic inherited diseases)
- Biosensing of drugs, proteins and toxins

### Heavy Metal Monitoring

#### On site.....

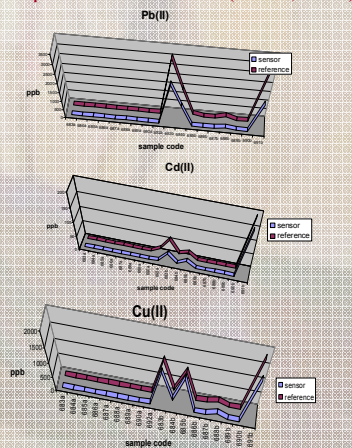


Square wave (SW) voltammetry conditions :

- conditioning potential : - 0.3 V for 60 s under stirring condition
- deposition potential - 1.1 V for 120 s under stirring condition
- equilibration time 30 s
- SW amplitude 28 mV
- step 3 mV
- frequency 15 Hz.

For the analysis, 5 mL of raw sample solution collected on site were acidified with 50 µL of 1 M HCl, in order to obtain a final acid concentration of 0.1M. The standard addition method as technique was used.

#### Soil/Sediment Samples Analysis Acetic Acid Extraction Comparison with reference methods (ICP-AES, ICP-MS)



#### ...and in continuous



### Eight-electrodes screen-printed array for applications with magnetic beads for immunochemistry

**Array coupled with a suitable magnet**

**Possibility to process eight samples simultaneously**

### Recent publications

- Sonia Centi, Serena Laschi, Milan Fránek, Marco Mascini, "A disposable immunomagnetic electrochemical sensor based on functionalised magnetic beads and carbon-based screen-printed electrodes (SPCEs) for the detection of Polychlorinated Biphenyls (PCBs)", *Anal. Chim. Acta.* 2005, 538, 205-212.
- Serena Laschi, Marco Mascini, "Planar electrochemical sensors for biomedical applications", *Medical Engineering & Physics*, 2006, 28, 934-943.
- Francesca Bettazzi, Serena Laschi, Marco Mascini, "One-shot screen-printed thylakoid membrane-based biosensor for the detection of photosynthetic inhibitors in discrete samples", *Anal. Chim. Acta.* 2007, 589, 14-21.
- S. Centi, G. Messina, S. Tombelli, I. Palchetti, M. Mascini, "Different approaches for the detection of thrombin by an electrochemical aptamer-based assay coupled to magnetic beads", *Biosensors & Bioelectronics*, 2008, 23, 1602-1609.
- Serena Laschi, Ilaria Palchetti, Giovanna Marrazza, Marco Mascini, "Enzyme-amplified electrochemical hybridization assay based on PNA, LNA and DNA probe-modified micro-magnetic beads", *Bioelectrochemistry*, accepted, in press.