Q.I. 2008

(2)

FACULTAD DE CIENCIAS EXACTAS Y NATURALES
UNIVERSIDAD DE BUENOS AIRES

Departamento de Química Inorgánica, Analítica y Química Física

CARRERA: Doctorado en Ciencias Químicas.

CUATRIMESTRE: segundo. **AÑO:** 2008

CODIGO DE CARRERA: 51

MATERIA: **Curso-Taller de Materiales para Sensores Químicos**
First Workshop of Materials for Chemical Sensors

CODIGO: nuevo

PUNTAJE: 2 (dos)

PLAN DE ESTUDIO: ---------

CARÁCTER DE LA MATERIA: Curso de ampliación de conocimientos y actualización.

DURACIÓN: 1 semana

HORAS DE CLASE SEMANAL:

- **Teóricas:** 25 horas.
- **Problemas:** 10 horas.
- **Laboratorio:** 5 horas

Total: 40 hs.

CARGA HORARIA TOTAL: 40 hs.

ASIGNATURAS CORRELATIVAS: Licenciados en Química, Biología, Física y carreras afines. Estudiantes de grado en química que tengan aprobado Química Física 1.

FORMA DE EVALUACIÓN: examen final.

PROGRAMA ANALÍTICO:

Unit 1:
"Nano-bioelectronics for the 21st century: Nanostructured chemically modified electrodes as platforms for electrochemical biosensors."

Dr. Mike Lyons, Physical and Materials Electrochemistry Laboratory, School of Chemistry, University of Dublin, Trinity College, Dublin 2, Ireland.
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Dr. Fernando Battaglini
INQUIMAE-DQIAQF. Universidad de Buenos Aires.
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A general overview of the potential offered by nanostructured chemically modified electrodes to serve as efficient amperometric biosensors will be presented. Emphasis will be placed on surveying the general redox and catalytic properties of electrodes which have been modified with (i) self assembled monolayer (SAM) films, (ii) single wall carbon nanotube (SWNT) meshes and ordered arrays, and (iii) electroactive/electronically conducting polymer (EAP/ECP) films, in which biocatalysts such as redox enzymes have been immobilized. Key experimental methodologies which may be used to characterize the kinetic and material transport phenomena within these complex integrated systems will be described and recent theoretical approaches to produce coherent mathematical models of enzyme catalysis in the latter systems will be discussed.

1) Survey of chemically modified electrodes: SAM's, CNT modified electrodes and ECP systems. Basic ideas which underlie redox mediation. Overview of enzyme properties. Enzyme immobilization strategies at nanostructured chemically modified electrodes CME's.

2) Review of steady state and transient electrochemical and gravimetric methods to probe dynamic redox and mass transfer processes in nanostructured CME's. In particular, the application of cyclic voltammetry, potential step chronoamperometry, complex impedance spectroscopy, hydrodynamic voltammetry , EQCM and PBD methods will be discussed in connection with the elucidation of redox processes in redox active alkane thiol monolayers, glucose oxidase immobilized in SWNT meshes and in polypyrrole and polyaniline thin films.

3) Overview of amperometric enzyme electrodes. Concept of mediated electron transfer. Membrane enzyme electrodes. Homogeneous mediation. Heterogeneous mediation. Specific examples of GOx catalyzed glucose oxidation, NADH oxidation, vitamin C and neurotransmitter detection.

4) Mathematical modelling of amperometric enzyme electrodes based on SAM and SWNT nanostructures and electroactive polymer matrices. Definition of boundary value problem, setting up and solution of relevant kinetic equations and construction of pertinent kinetic case diagrams. Comparison of predicted rate equations with experiment.

Detailed lecture notes in pdf format will be provided.

__Unit 2:__

"Miniaturization of biological analyses : From DNA chips to protein chips".

Prof. Thierry Livache. Group leader Chimie de la Reconnaissance et Etude des Assemblages Biologiques .CREAB UMR SPRAM (CEA,CNRS,Université Joseph Fourier)
Email : thierry.livache@cea.fr

Introduction and basic concepts

- introduction
- miniaturization of the sample ? Concentration game*.
- Detection processes used in analytical biochemistry
- Revision game*: how works a pregnancy test?

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Miniaturization of DNA based assays: the DNA chips

- General rules
- Short story of DNA chips:
  The human genome sequencing project: sequencing on a DNA chip?
- How to construct a DNA chip? Addressing processes, surface chemistry.
- How to us it? Detection strategies.
- Examples of applications.

Evolution of the DNA chip technology:

- Example of protein chips
- Nanotechnologies for biological sensing

An example of real time label free approach compatible with a biochip format:
The Surface Plasmon Resonance Imaging (SPRi)

** With student participation*

<u>Unit 3</u>

"Pathways for growth of potentiometric sensors".

Prof. Luc Nagels. Group leader Chromatographic Organic Trace Analysis, School of Sciences, University of Antwerpen, Belgium.
luc.nagels@ua.ac.be

We first take a look at the evolution of potentiometric sensors and at their present distribution in the analytical laboratories. Special attention is then given to the evolution of the ideas about the working principle of these sensitive devices during the past decennium. How selective is an ion selective electrode? A few simple models are used to explain the way electrochemists look at these working principles at present. Special attention is paid to the possibilities of these sensors to determine ionisable organic substances. It is shown how the potentiometric membrane characteristics determine which types of compounds will be sensitively detected, and which will not. Organic ionic substances will certainly be an important growth sector for potentiometric devices. Surprisingly, many multiply charged molecules such as e.g. DNA are very well detectable with potentiometry. This forces us to review the interaction between multiply charged molecules and potentiometric sensor surfaces. Even more surprising are the results of a number of groups using potentiometry to detect bio-molecules (marker proteins) and bio-particles (viruses, bacteria) very successfully. Potentiometry is very often coupled to flow injection analysis. Other hydrodynamic systems such as HPLC and CE are much less combined to this electrochemical method. We show that this coupling is very successful, especially in HPLC. Being a surface interaction type sensor, sensorgrams can be used in an FIA mode, to obtain information on the analyte-surface interaction. All mentioned topics will be explained. They show that potentiometry has not been explored to its full extent. Spectroscopic techniques have been very successful in the last decade, but we have reasons to think that the next "shift forward" will be in electrochemistry.

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Unit 4:

"Principles and applications of Electronic Noses and Electronic Tongues"

Dr. Martín Negri. INQUIMAE-DQIAQF. Universidad de Buenos Aires.
rmn@qi.fcen.uba.ar

1) Definition of the analytical problem

The analytical problem and analytical process associated to the methodology of E-Noses and E-Tongues. Fundaments, advantages and drawbacks of devices based on chemical sensors arrays.

2) Gas Sensors

Gas sensors based on: metal-oxide-semiconductors (MOS), conducting polymers (CP), surface acoustic waves (SAW), phthalocyanines, etc.

3) Electronic Noses: devices and instrumentation.

Principles of the methodology. Instrumental aspects. Review of different commercial equipments and lab prototypes. Sampling and data collection.

3) Data analysis associated to sensor´s array devices..

Principles of Pattern Recognition. Unsupervised methods: Principal Component Analysis (PCA), Cluster Analysis (CA). Supervised methods: introduction to back-propagation artificial neural networks.

4) Electronic Noses: application cases.

Application of electronic noses to studies of: fish freshness, cosmetic chemistry, pheromone detection, flavour release from gels, etc.

5) Electronic Tongues.

Electronic tongues based on ion-selective-sensors (ISES), oxidation-reduction probes (ORP) and voltammetric probes. Quality parameters of the sensors and applications to taste studies.

Unit 5.

Silicon based materials: general properties and applications

Dr. Delia Bernik. INQUIMAE-CONICET.
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The chemistry of covalent inorganic-organic silicon compounds is in permanent development. Some authors called these materials IPN's (inorganic-organic interpenetrating networks), but a more specific name given to this kind of silicon hybrids is ormosils (organically modified silanes). As a result, biomaterials with unique mechanical properties combined with high mechanical strength can be derived with a wide variety of applications.

In this talk the following types of hybrid organic-inorganic polymers and their applications will be described:

a- Bioactive Materials (highly porous structures with the ability to integrate with living cells). This area comprises bone repairing materials, prothesis and materials for bioreactors (5.1, 5.2).

b- Application to controlled drug delivery devices and biosensors (5.3).

c- Quantum dots encapsulation. Photoactive and magnetic materials (5.4).

References

5.1 "Ceramic composites as matrices and scaffolds for drug delivery in tissue engineering" Habraken WJ, Wolke JG, Jansen JA. Adv Drug Deliv Rev. 2007 May 30;59(4-5):234-48.

5.2 "From the bioactive glasses to the star gels." María Vallet-Regí, Antonio J. Salinas and Daniel Arcos. Journal of Materials Science: Materials in Medicine 2006, 17:1011–1017.

5.3 "Silicon based materials for controlled delivery devices and implants" D.L. Bernik. Recent patents on nanotechnology 1 (3) 2007, 186-192.

5.4 "Biological applications of quantum dots" Timothy Jamieson, Raheleh Bakhshi, Daniela Petrova, Rachael Pocock, Mo Imani, Alexander M. Seifalian Biomaterials 28 2007, 4717–4732.

Bibliografía (disponible en FCEyN-UBA)

1) "Sensors. A comprhensive Survey". . Volumen 2. Editado por W.Gopel, J.Hese y J.N.Zemel. VCH Ed.

2) "Biomolecular films. Design, Function and Applications". Editado por J.F.Rusling. Marcel Dekker.Ed.

3)"Colloids and Colloid Assemblies". Editado por F.Caruso. Wiley-VCH

4) "Chemically Modified Surfaces". Editado por H..Mottola y J.R.Steinmetz. Elsevier Ed.

Dr. Martín Negri **Dr. Fernando Battaglini**

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Facultad de Ciencias Exactas y Naturales

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Buenos Aires, 2 1 JUL 2008

VISTO:

la nota presentada por el Dr. Fernando Molina Director Adjunto del Departamento de Química Inorgánica, Analítica y Química Física, mediante la cual eleva la Información y el Programa del Curso de posgrado **CURSO-TALLER DE MATERIALES PARA SENSORES QUIMICOS**, que será dictado en el **Segundo Cuatrimestre** de 2008 (entre el 25 y el 29 de Agosto 2008) en el mencionado Departamento por el Dr. Fernando BATTAGLINI y el Dr. Martín R. Negri del DQIAyQF/ INQUIMAE – UBA; con la participación de los siguientes Profesores invitados Dr. **Mike Lyons** (University of Dublin, Trinity College – Ireland; Prof. **Thierry Livache** (CEA, CNRS, Universite Joseph Fourier - France); Prof. **Luc Nagels** (University of Antwerpen – Belgium)

CONSIDERANDO:

lo actuado por la Comisión de Doctorado el 04/06/08,
lo actuado por la Comisión de Enseñanza, Programas, Planes de Estudio y Posgrado
lo actuado por la Comisión de Presupuesto y Administración,
lo actuado por este cuerpo en Sesión Ordinaria realizada en el día de la fecha,
en uso de las atribuciones que le confiere el Artículo Nº 113º del Estatuto Universitario,

EL CONSEJO DIRECTIVO DE LA FACULTAD DE CIENCIAS EXACTAS Y NATURALES
RESUELVE:

Artículo 1º: Autorizar el dictado del Curso de Posgrado **CURSO-TALLER DE MATERIALES PARA SENSORES QUIMICOS** de 40hs de duración, durante el segundo cuatristre de 2008.

Artículo 2º: Aprobar el Programa Analítico del Curso de Posgrado **CURSO-TALLER DE MATERIALES PARA SENSORES QUIMICOS.**

Artículo 3º: Aprobar un puntaje de dos (2) puntos para la Carrera de Doctorado.

Artículo 4º: Aprobar un arancel de 50 Módulos.Disponer que los montos recaudados sean utilizados conforme a lo dispuesto por Resolución CD Nº 072/03.

Artículo 5º: Comuníquese a la Dirección del Departamento de Química Inorgánica, Analítica y Química Física, a la Biblioteca de la FCEyN y a la Subsecretaría de Postgrado (con fotocopia del programa incluida)

Artículo 6º: Comuníquese a la Dirección de Alumnos (sin fotocopia del programa). Cumplido archívese.

Resolución CD Nº 1686
SP/med 14/07/2008

Dra. NORA CEBALLOS
SECRETARIA ACADEMICA

Dr. JORGE ALIAGA
DECANO