

ELECTROCHEMISTRY WITH ULTRASOUND

**University of Alicante: Grupo de Electroquímica Aplicada y Electrocatalisis. Departamento de Química Física e Instituto de Electroquímica. Spain*

**University of Oxford: Physical and Theoretical Chemistry Laboratory. UK*

**University of Coventry: School of Science and the Environment. UK*

**University of Franche-Comté: Laboratoire de Chimie des Matériaux et des Interfaces. Site de l'IUT. Département Chimie. France*

**University of Paris: Département de Chimie. France*

**Academy of Sciences of the Czech Republic: J. Heyrovsky Institute of Physical Chemistry. Czech Republic*

OBJECTIVES AND EXPECTED ACHIEVEMENTS

Electroanalysis

Development of enhanced electroanalytical procedures that are effective in real media, leading to improved sensors and biosensors

Sensitive electroanalyses for metal ions and other deleterious electroactive species in the environment

New systems

Novel electrosynthesis reactions with applications in organic and biochemistry

Novel functional materials and their practical applications, including nanoparticles and conducting polymers.

Development of new electrode materials and the understanding of surface processes in these processes

OBJECTIVES AND EXPECTED ACHIEVEMENTS

Environmental applications

Improved strategies for waste minimisation:

obviation of environmental-unfriendly systems in synthesis

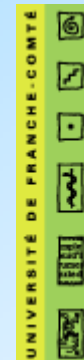
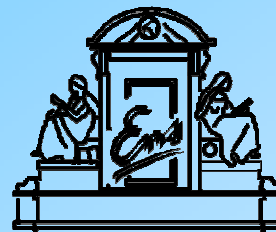
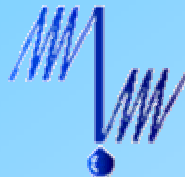
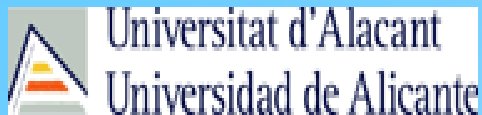
sonochemical reactor design

Degradation of pollutants and enhanced environmental clean-up using sonochemistry

Technological applications

Improved methods for electrodeposition, electrodisolution, including effects on morphology, hardness, microstructure...

Scale-up from micro-scale to pilot-plant scale



WORK PROGRAMME FOR THE FIRST YEAR

Events

Kick off COST D-32 Meeting, held in Alicante, July 2004.

Kick off Working Group Meeting, held in Alicante, December 2004.

Tasks

General task: Finding and development of common research interests by means of:
Research interactions
Short term scientific missions

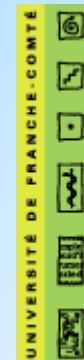
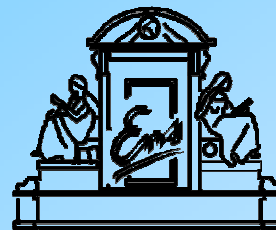
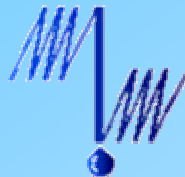
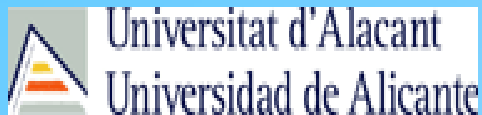
Specific tasks:

Sonoelectrochemical reactor design

Degradation of pollutants using sonoelectrochemistry

Development of new electrode materials

Sensitive electroanalyses for metal ions



ACTIVITIES DURING THE FIRST YEAR

Events

Kick off COST D-32 Meeting, held in Alicante, July 2004.

Kick off Working Group Meeting , held in Alicante, December 2004.

Research interactions

Short term scientific mission (financed by COST)

Verónica Sáez (University of Alicante) in Coventry University

Short term scientific mission (financed by COST)

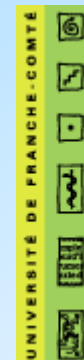
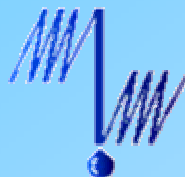
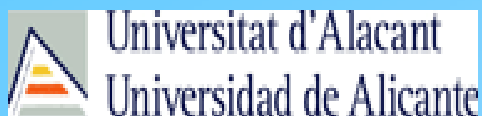
Jiri Klima (J. Heyrovsky Institute of Physical Chemistry) in University of Alicante

One-year visit (financed by Ministerio Educación y Ciencia (Spain)) in progress

José González-García (University of Alicante) in University of Oxford

Further actions

Annual Working Group Meeting , to be held in Prague, November 2005.



Kick off Working Group Meeting

Kick off Working Group Meeting , held in Alicante, 3^{er}-4th December 2004.

Participants and talks

University of Alicante

Welcome J. González-García

“Sonoelectrochemistry: fundamental and applied studies” V. Sáez

“Optimization of Hydrodynamics in Electrochemical Reactors:

Use of numerical and experimental methods” A. J. Frías-Ferrer

University of Oxford

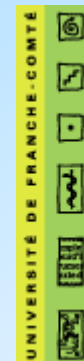
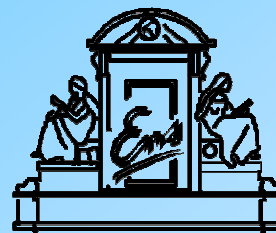
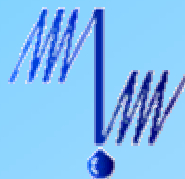
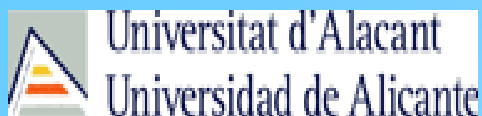
“Sonoelectroanalysis” R. G. Compton

“A hand held probe for the sonoelectroanalysis of arsenic”. A. Simm

“Materials for the sonoelectrosynthesis of hydrogen peroxide” C. Banks

University of Bath (Invited speaker)

“Microwave Effects and Applications in Electrochemistry” F. Marken



Kick off Working Group Meeting (II)

Participants and talks (II)

University of Coventry

“Electrooxidation and Photooxidation of Thiphenes-Oxides” D. Walton

University of Franche-Comté

“Electrochemistry under ultrasound at the interface” J.-Y. Hihn

“Design of sonoreactors and application in surface treatment” M. L. Doche

J. Heyrovsky Institute of Physical Chemistry. Czech Republic

“Intensity of ultrasound in sonochemical and sonoelectrochemical measurements”

J. Klima

“Electrochemical reduction and dimerization of halogenated benzothiophenes and benzothiophene-2-oxazolines. Use of sonication” J. Ludvik

Université de Paris

“Ultrafast sonoelectrochemistry” E. Masionhaute

Kick off Working Group Meeting (III)

Other activities

Visit to the pilot plant. The existence of this facility is an important aspect of the Operation at Alicante, which is not available at other laboratories in the network

Achievements and objectives

*Talks reviewed the active research in the working group labs

Alicante: Electrodeposition, pollutant degradation assisted by ultrasound
Design and Characterization of (sono)electrochemical reactors

Oxford: Sonoelectroanalysis in real practical applications
Sonoelectrosynthesis, in particular hydrogen peroxide from oxygen

Coventry: Electroorganic and photoelectroorganic synthesis focused on the oxidation of thiophene-S-oxides

Kick off Working Group Meeting (IV)

Objectives and achievements(II)

Prague: Physical background in sonochemistry and sonoelectrochemistry
Sonoelectrosynthesis in organic media. Mechanisms.

Besançon: Better modelling of sonoelectrochemical systems
Electroplating assisted by ultrasound
Open to new emerging fields: Room temperature Ionic liquids
polymer synthesis under US

Paris: Cavitation analysis with nanosecond time base equipment
Fundamental approach to the cavitation event

*Relevant points which can fit WG objectives

Definition of reproducibility and characterization of operating conditions
Identification of problems in applications or phenomena needing theoretical understanding
Sonoelectrochemical reactor design

Kick off Working Group Meeting (V)

Objectives and achievements (III)

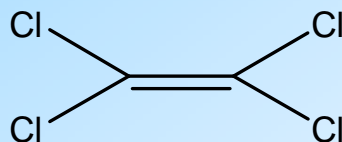
- *As a first step, development of STSMs in order to establish bilateral collaborations for:
 - Mutual exchange of expertise
 - Mutual training
 - Finding specific collaborating targets
 - Definition of the tasks and contributions in a future research project
- *After, applications for the 7th European Framework will be considered looking at:
 - Complementarity among laboratories
 - Possibility to open the applicant list to other COST laboratories

Short Term Scientific Mission: V. Sáez (Alicante) in Coventry

Objectives

Study of the degradation of a chlorinated organic compound using sonochemical, electrochemical and finally the exploitation of the combination of both methodologies at 850 kHz (equipment not available in UA)

Degradation of perchloroethylene as a model molecule in aqueous solution.



Perchloroethylene

Publications

“Sonoelectrochemical degradation of perchloroethylene at 850 kHz”
V. Sáez, J. Iniesta, A. Frías-Ferrer, J. González-García and D. J. Walton
Electrochem 2005, Newcastle, UK

Short Term Scientific Mission: J. Klima (Prague) in Alicante

Objectives

Knowledge of local distribution of ultrasonic intensity is necessary

measurement of intensity:

$$I = Wc = \frac{1}{2} \rho c \omega^2 A^2 = \frac{P_0^2}{2\rho c}$$

$$I = \frac{P_{US}}{S}$$

calculation

only for progressive wave !

Publications

“Physical aspects of Sono(electro)chemistry: Distribution of intensity of ultrasound”
J. Klíma, A. Frias-Ferrer, J. González-García, J. Ludvík, V. Sáez, J. Iniesta
COST WG 2 Workshop 9-10 June 2005, Oxford, UK

One-year visit: J. González-García (Alicante) in Oxford

Objectives

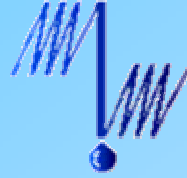
Identification of practical electrocatalysts capable of acting as electrode materials in a sonoelectrochemical reactor for the reduction of oxygen (air) to hydrogen peroxide

The determination of the stability of the electrocatalysts in respect of insonation to identify the optimal sonoelectrocatalysts for hydrogen peroxide formation

Design, development and optimisation of a reliable and efficient laboratory bench scale sonoelectrochemical reactor



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Interactions between Working Groups

Short Term Scientific Mission: D. Bogdal WG10 in Coventry

Objectives

Carbazole electropolymerization in acetonitrile/ammonium system. Influence of the ultrasound and a magnetic field

Results

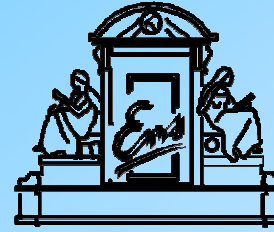
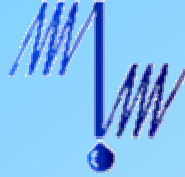
Polycarbazole films on indium-tin oxide coated (ITO) glass

Further work

Characterization of the luminiscent properties in Politechnika Krakowska



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COST D-32 –Action. Results presented in Modena

