GOBIERNO DE ESPAÑA
MINISTERIO DE CIENCIA E INNOVACIÓN

Inmaculada Rodríguez Ramos

“Nanostructured catalysts for sustainable chemical processes”

Instituto de Catálisis y Petroleoquímica (ICP)

“Institute of Catalysis and Petroleochemistry”

http://www.icp.csic.es

Main Research Lines

- **ENERGY LINE.** Catalysts and catalytic processes for the production and transformation of energy resources.

- **ENVIRONMENT PROTECTION LINE**. Catalysts and catalytic processes for pollutant abatement and disinfection.

- **LINE OF SELECTIVE SYNTHESIS OF CHEMICALS.** Catalysts and processes for the synthesis of commodities and high value added chemicals.

Main general objective for the three research lines: to develop both **advanced catalysts** and innovative chemical processes.

Sublines in the Energy Field

- FUEL CELLS.
- PRODUCTION AND USES OF HYDROGEN.
- COMPETITIVE AND SUSTAINABLE PRODUCTION OF FUELS.

The general objective of the Energy Line is the development of new catalysts and electrocatalysts for the chemical conversion of renewable energy resources into hydrogen, liquid fuels and chemicals. Such processes include biomass transformation into fuels and chemicals, upgrading of non-edible oils and glycerol, synthesis of liquid hydrocarbons from carbon oxides, and production of electricity in FCs using both H_2 and organic carriers.

Fuel Cells

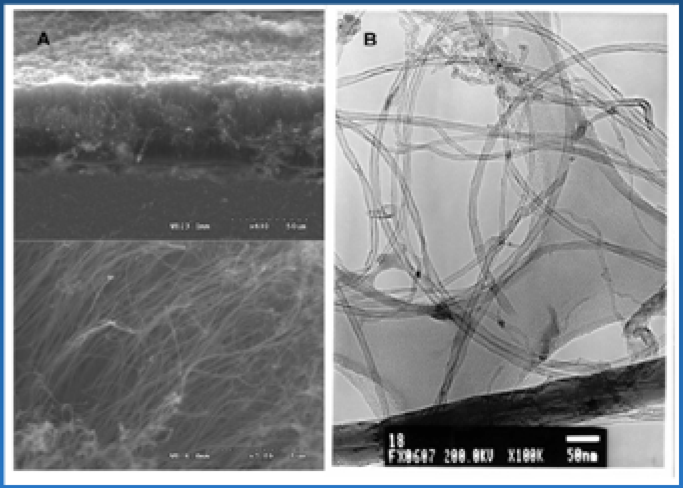
Proton Exchange Membrane Fuel Cells (PEMFC)

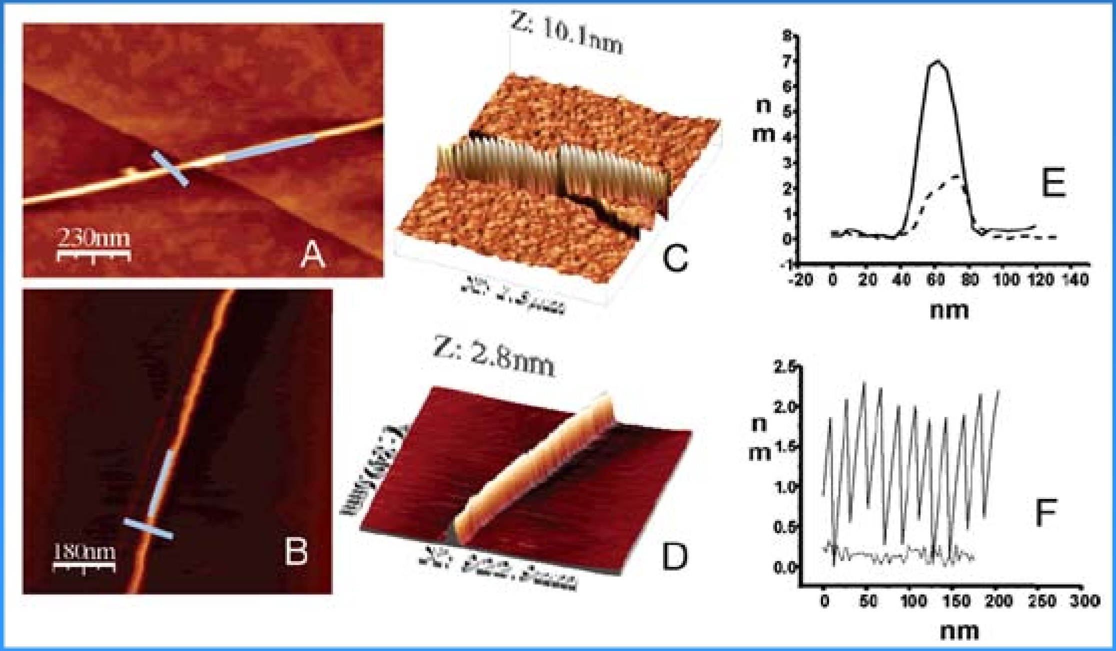
- Research, development and fabrication of FC
- Electrocatalysts
  - Optimization of inorganic (Pt-based) electrodes
  - Development of new active phases for substitution of platinum as main active metal (anode and cathode).
  - Metalloenzimes-based electrodes: Development of interfaces for efficient electron transfer between metalloenzymes that activate H2 and O2 and electrodes as an alternative to Pt-based electrodes

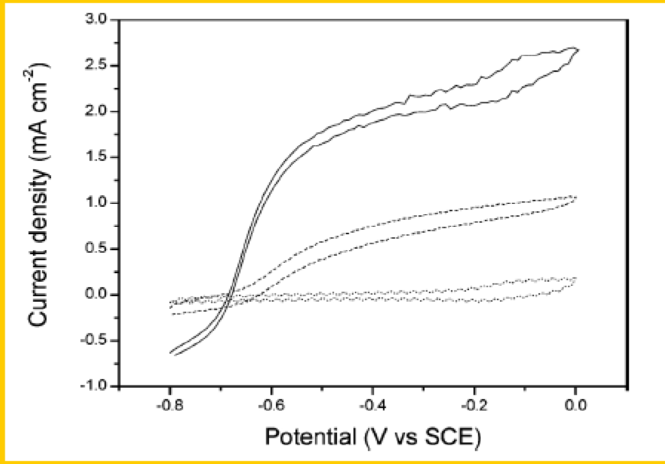
Solid Oxide Fuel Cells (SOFC)

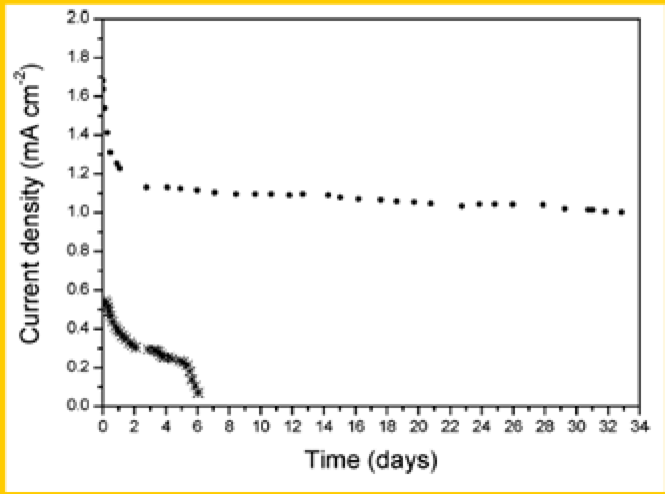
New catalytic formulations for intermediate temperature direct fuel oxidation.

Biofuel cells



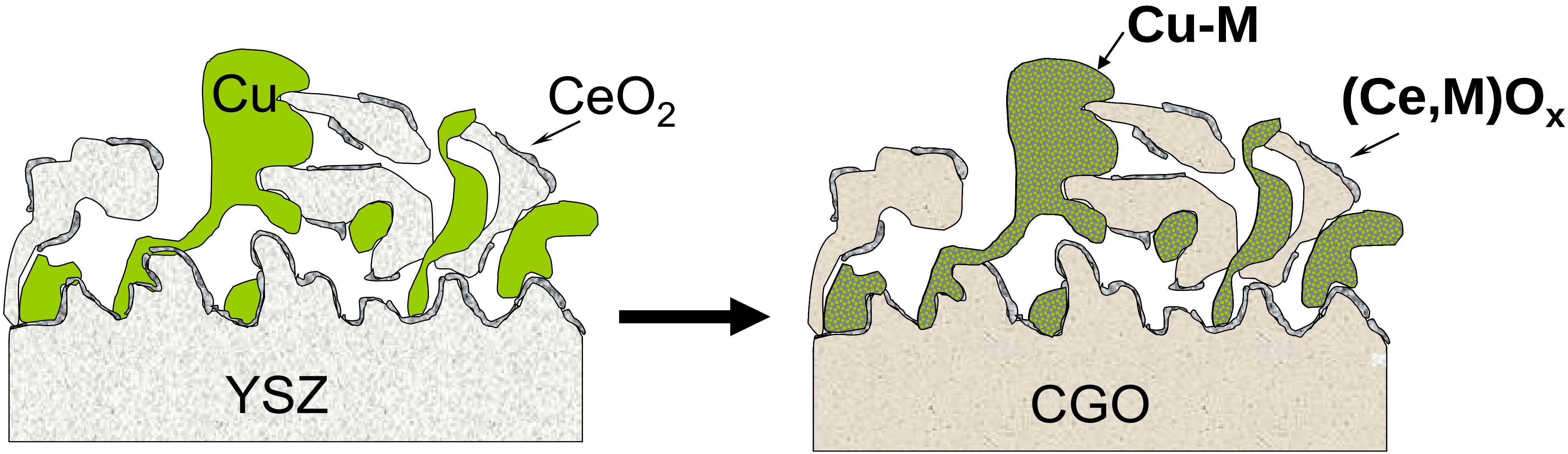


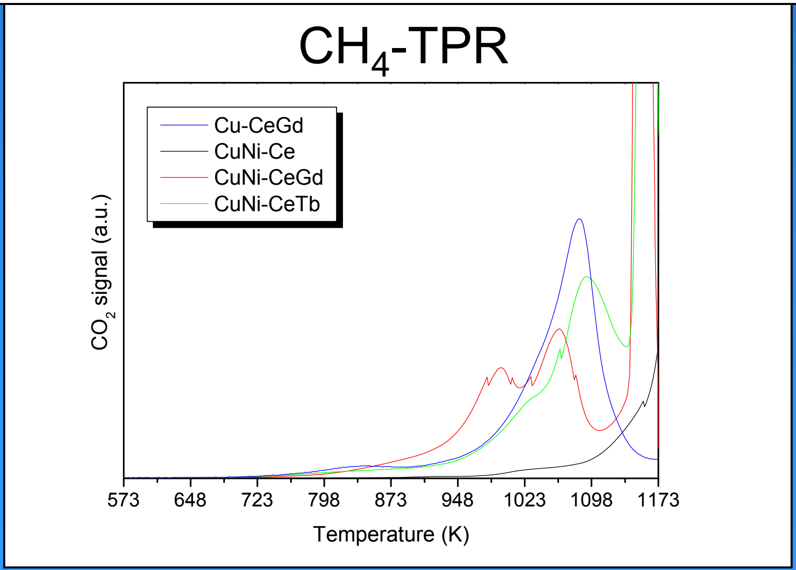


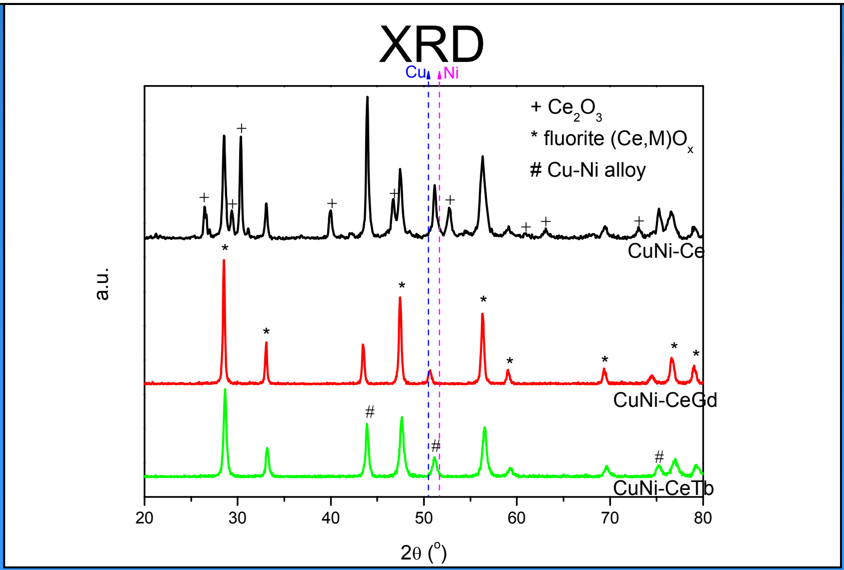


M. Asuncion Alonso-Lomillo et al., NanoLetters 7 (2007) 1603.

SOFC







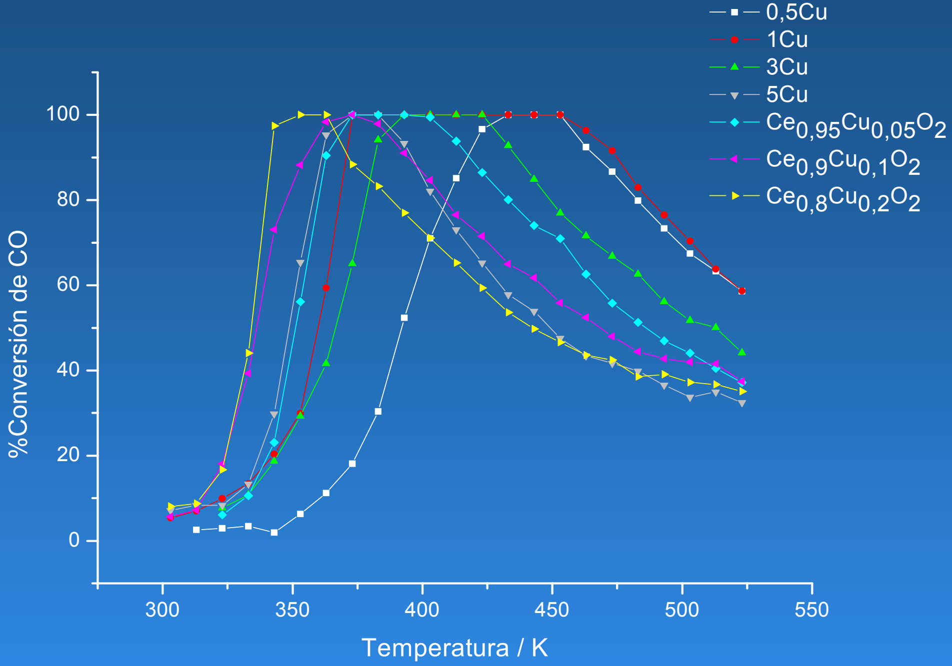
A. Hornés et al. Journal of Power Sources 169 (2007) 9–16 and in press (doi:10.1016/j.jpowsour.2008.12.015)

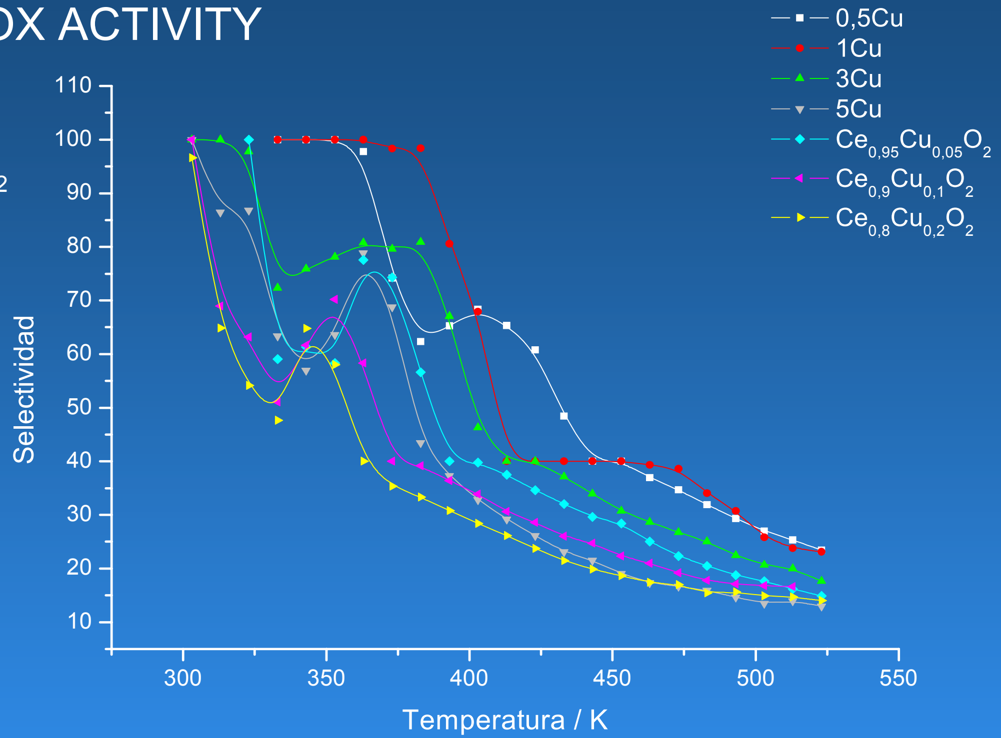
Production and uses of Hydrogen

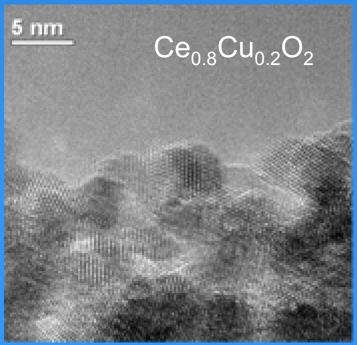
- General projects dealing with hydrogen as clean energy vector as well as including full hydrocarbon or biofuel processing for production of hydrogen usable in fuel cells.
- Electrolysis of water/sacarose solutions.
- CO2-free alternatives. Visible-light water photodissociation.
- Diesel reforming.
- Natural gas catalytic decomposition.
- WGS or CO-PROX with Pt-free catalysts.

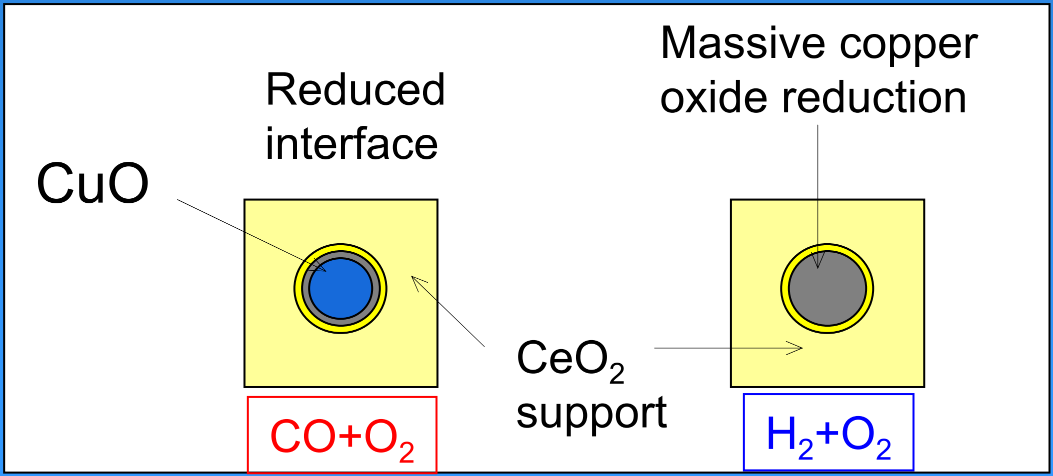
Production and uses of Hydrogen

CO-PROX ACTIVITY



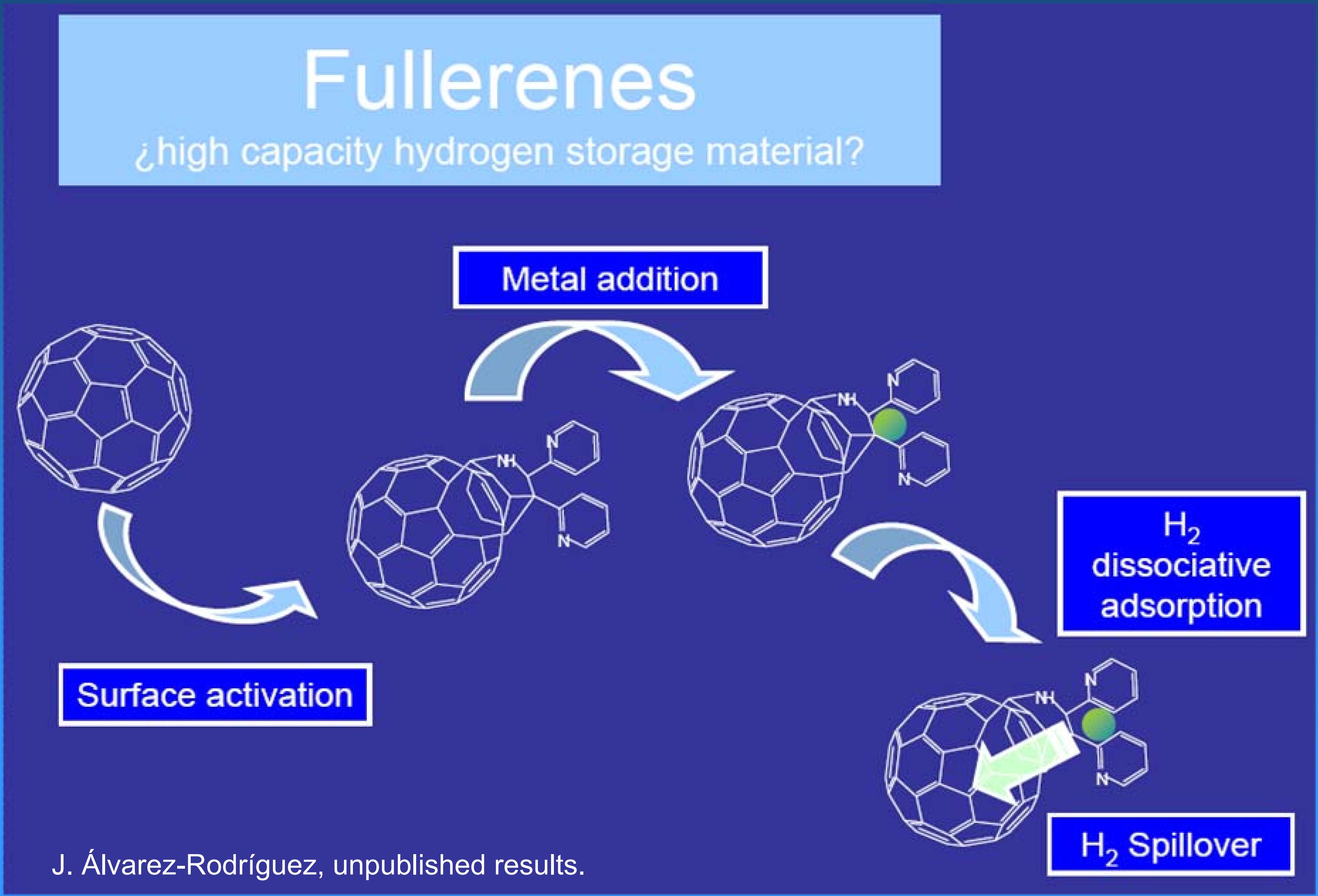






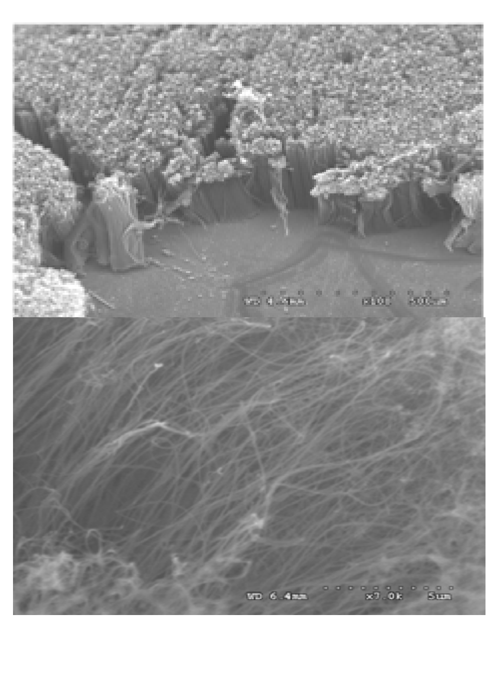
D. Gamarra et al. Journal of the American Chemical Society 129 (2007) 12064

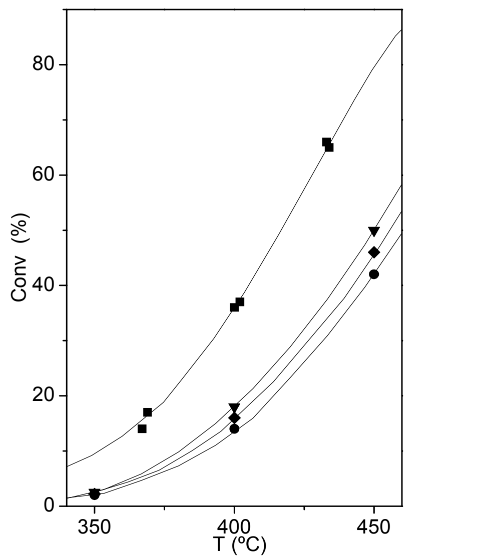
Production and uses of Hydrogen



J. Álvarez-Rodríguez, unpublished results.

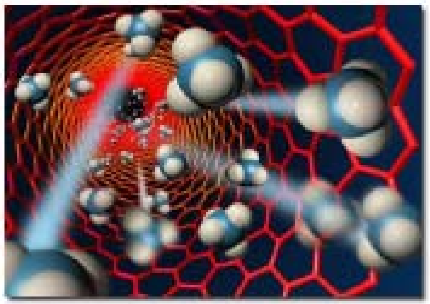
Carbon nanotubes based catalysts

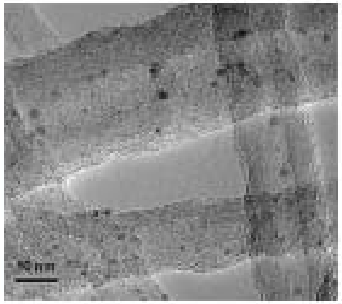




Conversion in ammonia decomposition reaction (●) RuCNTs-0, (■) RuCNTs-N, (◆) RuCNTs-1 and (▼) RuCNTs-2

CNTs and N-doped CNTs





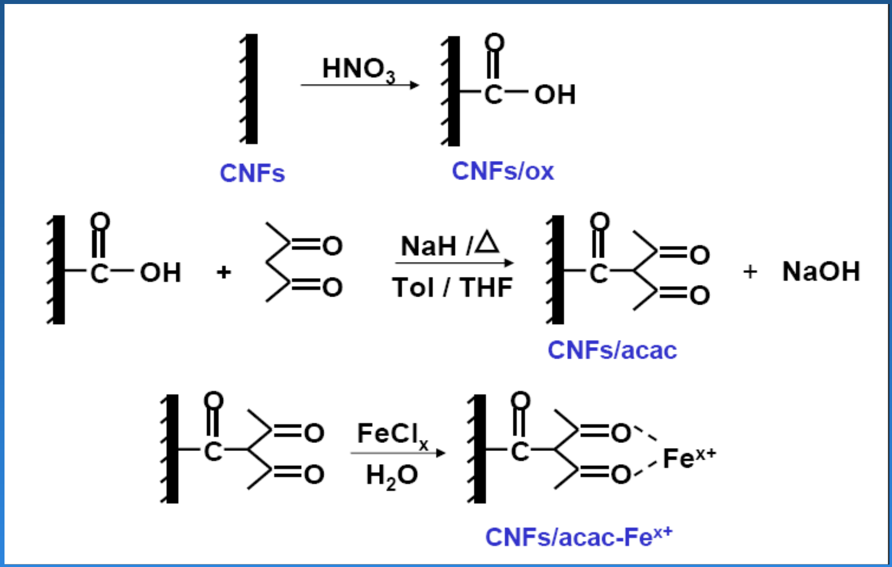
Selective confinement of discrete nanoparticles (NPs) in the CNT cavity.

Catalytic performance in FT and CO-PROX.

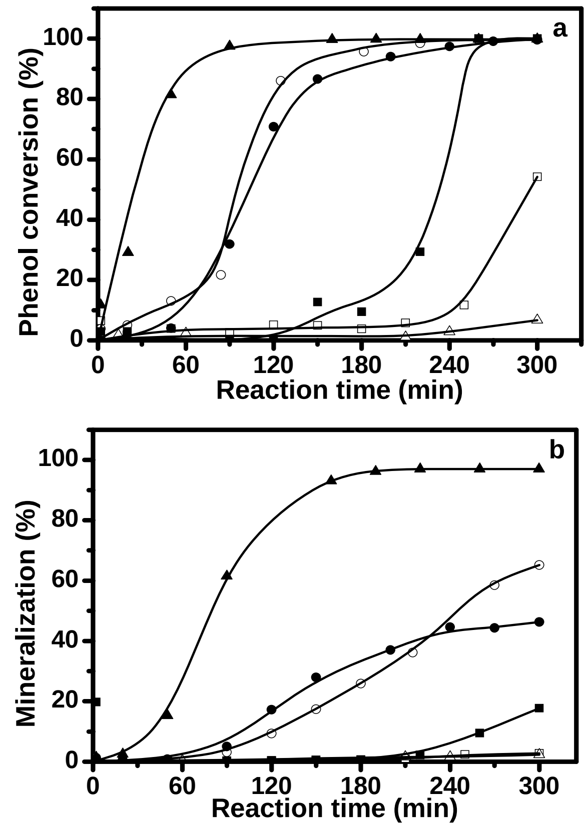
Carbon 44 (2006) 799–823
Diamond & Related Materials 16 (2007) 542–549
Nano Lett., 7, (2007) 1603

Metal supported systems for abatements of organic pollutants in contaminated waters.

- Aniline and phenol oxidation in water.



In subsequent cycles the Fe/C ratio remains constant and the catalytic activity is almost equivalent during all reaction cycles.



Evolution of (a) conversion and (b) mineralization with the reaction time in the CWAO of Phenol over:
(□) CNFs; (○) ox/CNFs; (Δ) acac/CNFs; (■) Fe(II)-CNFs; (●) Fe(II)-ox/CNFs; (▲) Fe(II)-acac/CNFs.

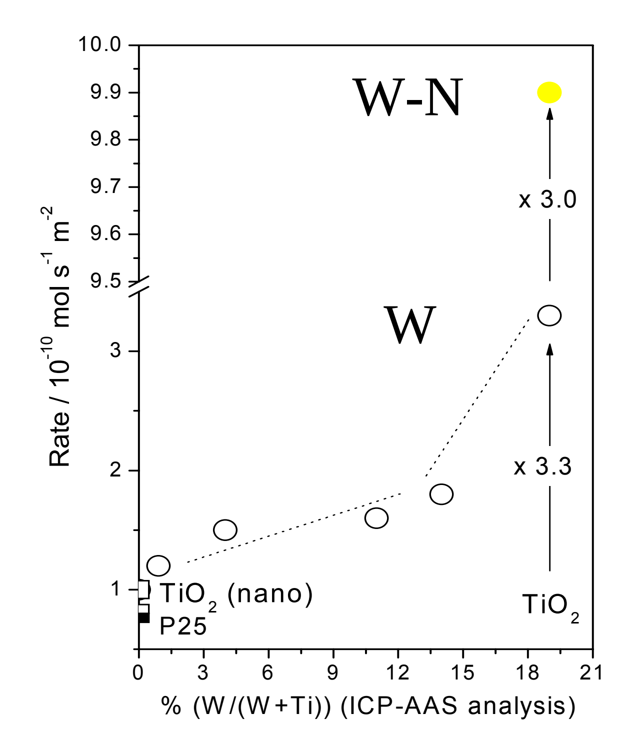
M. Soria et al, Carbon, in press.

Sunlight excitation

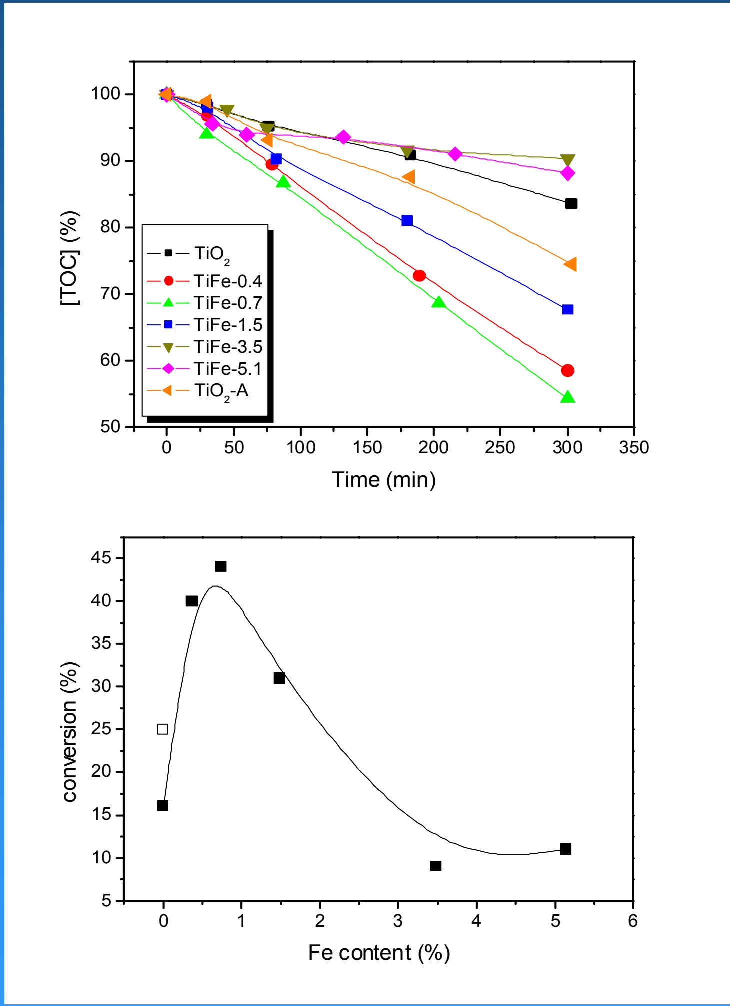
TiO2 modification: cationic/anionic doping

- **Cationic: Fe, V (low loaded samples)**
  Mo, W (high loaded samples)
- **Anionic: N; "self-doped" samples**
- **Both: W-N**

Gas: Toluene



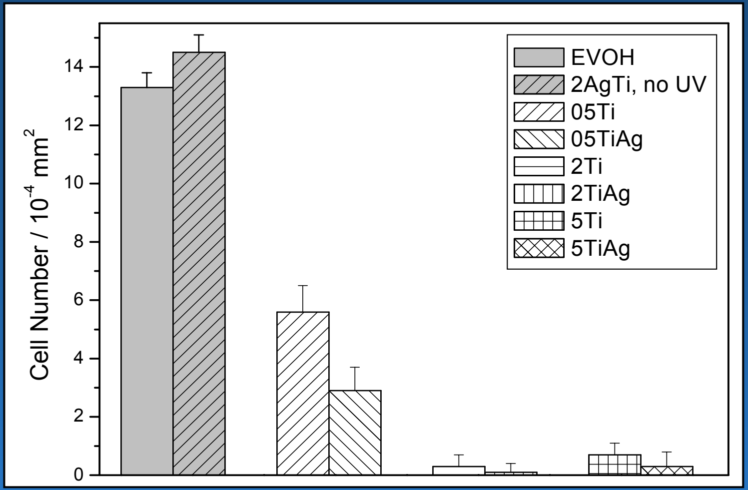
Liquid: Phenol

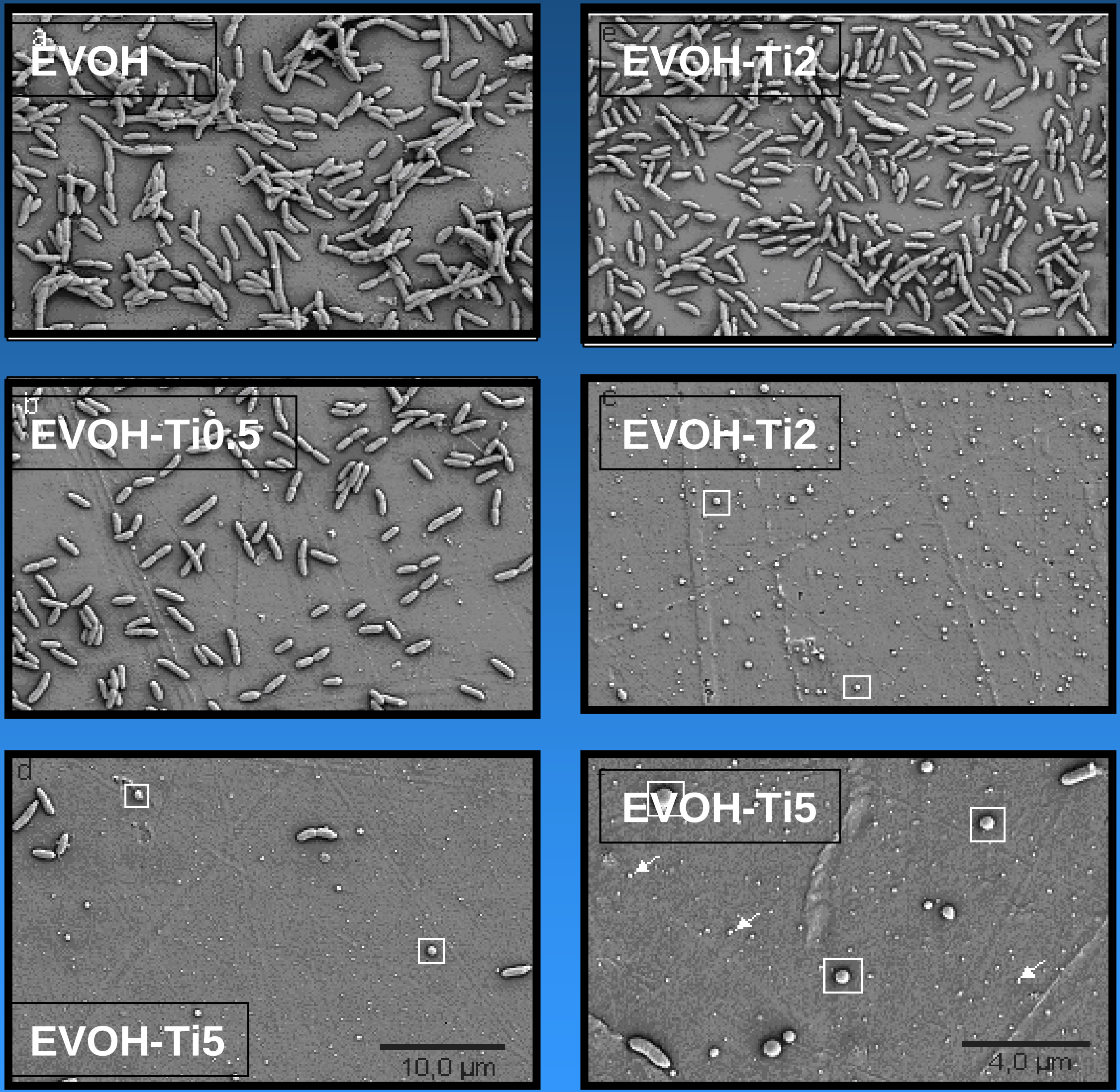


Intimate structure-activity link

A. Kubacka Chem. Comm. 2001; Appl. Catal. B 72 (2007) 11; 74 (2007) 26

Self-sterilized Plastic Materials





Capabilities

strong germicidal (biofilm)
controlled self-degradation

Optimum 2-5 wt%

Ag; visible-light active materials

Kubacka et al. *Nano Letters* 7 (2007) 2529
Advanced Functional Materials 18 (2008) 1949
*Env. Sic. Technol.*43 (2009) 1630; *J. Phys. Chem. C* (accepted).

Thank you for your attention