Universitat d'Alacant
Universidad de Alicante

42GERSEQ SANTANDER 2022

INSTITUTO DE ELECTROQUÍMICA
UNIVERSIDAD DE ALICANTE

Study of the electrochemical behavior of C_1-C_3 molecules on well-defined Pt surfaces

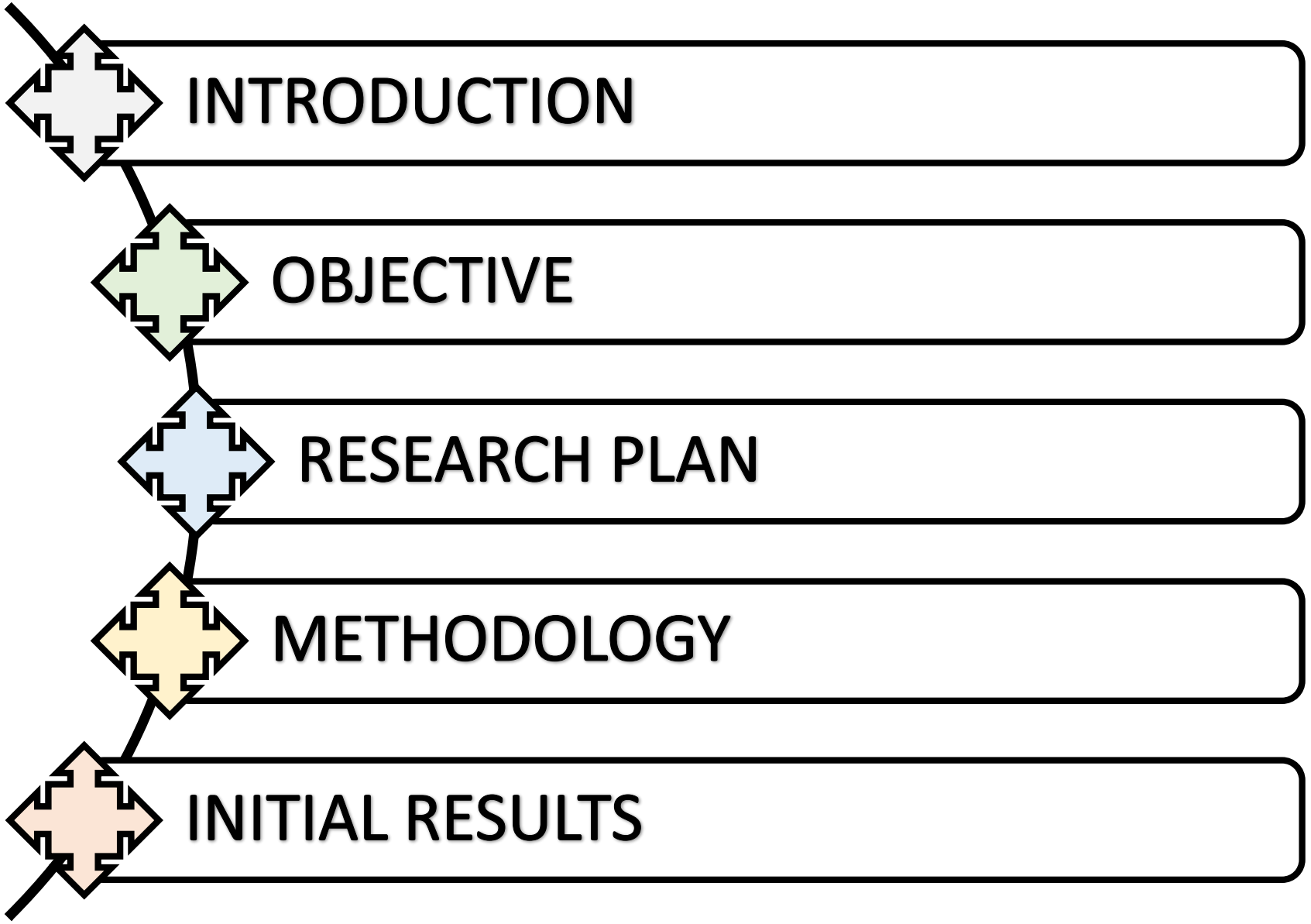
Dalila Soumicha Mekazni

Directors: Enrique Herrero Rodriguez

Rosa M. Arán-Ais

XLII Reunión del Grupo Especializado de Electroquímica de la RSEQ (42 GERSEQ 2022)

Santander, 6 de julio de 2022


INTRODUCTION
OBJECTIVE
RESEARCH PLAN
METHODOLOGY
INITIAL RESULTS

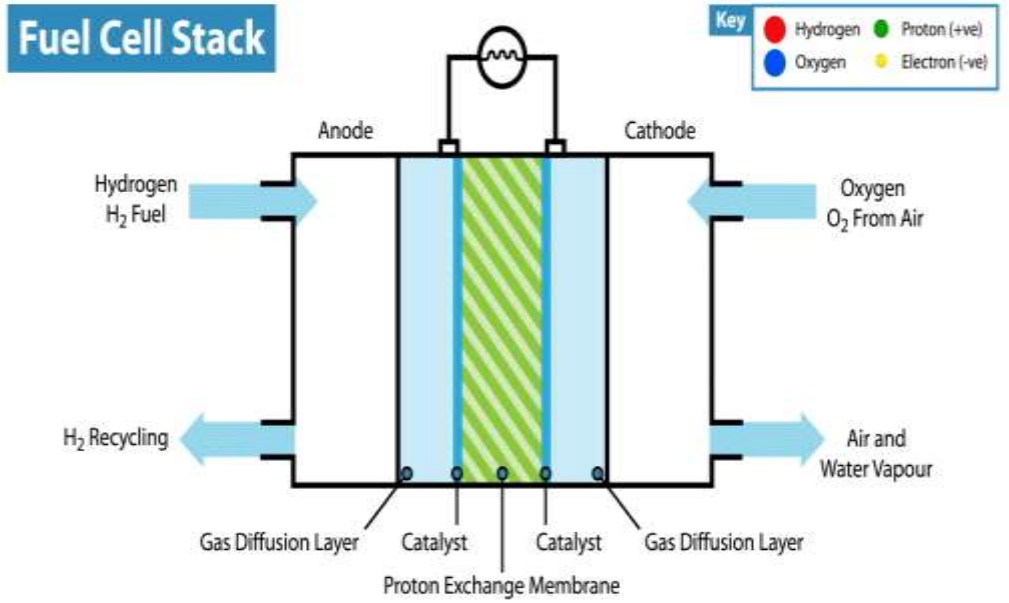
Energy at the heart of the problem – and key to the solution !

✖ Fossil fuels ⟹ Environmental problem

Driving the transition from fossil fuels to efficient, renewable and sustainable energy

Fuel cells

Chemical Reactions ⟹ Electric Power



Anode :

$H_2 \rightleftharpoons 2H^+ + 2e^-$

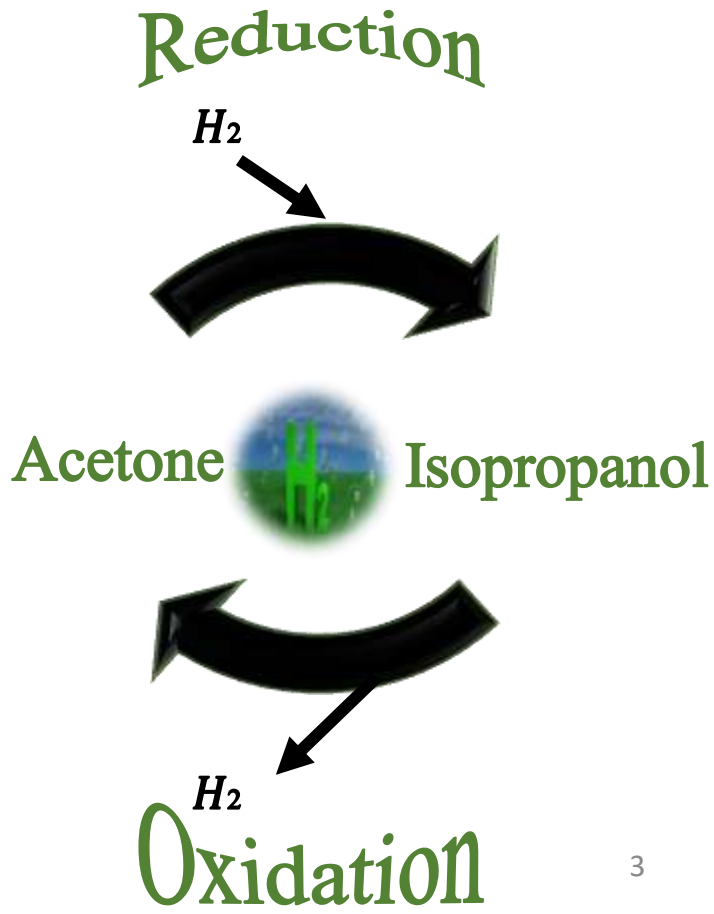
Cathode:

$O_2 + 4H^+ + 4e^- \rightleftharpoons H_2O$

- Technologies based on **electrocatalysis** have become a promising alternative to carry out the production of electricity in a clean and sustainable way,
- the electrochemical hydrogenation of biomass can be a valuable source of chemicals for industry
- produce the transformation of **organic molecules**, under **environmental conditions**, with high yield and high selectivity

Acetone / Isopropanol

- Liquid organic system
- Hydrogen Carrier
- Electricity carrier



Platinum Single crystal

Platinum ⇨ The most efficient catalysts for speeding up chemical reactions in hydrogen fuel cells

Structure sensitive reaction

Single cristal ⇨ well-organized and well-defined surface

- Regular periodic arrangement of atoms
- distinctive shape

General objective

- Study of the electrocatalysis of C_1-C_3 molecules on well-defined Pt electrodes

- Evaluate the effect of:
  - Surface structure
  - Electrode composition
  - Electrolyte composition

Specific objectives

- Electrochemical oxidation of methanol as model reaction.
- Electrochemical reduction of acetone on Pt(hkl) electrodes.
- Electrochemical oxidation of 1-propanol and 2-propanol on Pt(hkl) electrodes.
  - Effect of the pH
  - Electrodes modified with foreign adatoms
  - Shaped Pt nanoparticles

	1	2	3	4	5	6
Bibliographic search						
objectifve 01						
objective 02						
objective 03						
Objective 04						
Writing thesis						

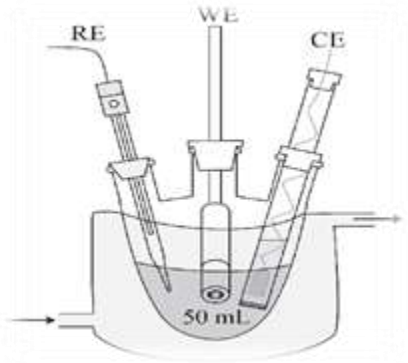
Beginning of 2023

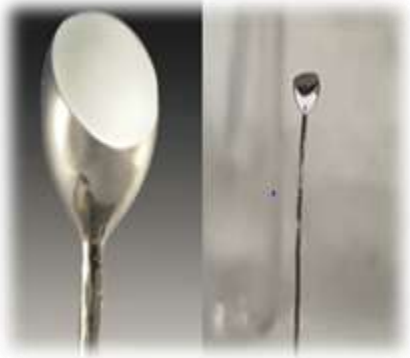
Research stay “Sorsorbonne university”
“ Dr Carlos M. SANCHEZ-SANCHEZ”

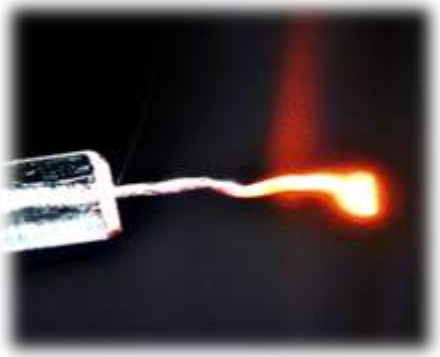
SORBONNE UNIVERSITÉ

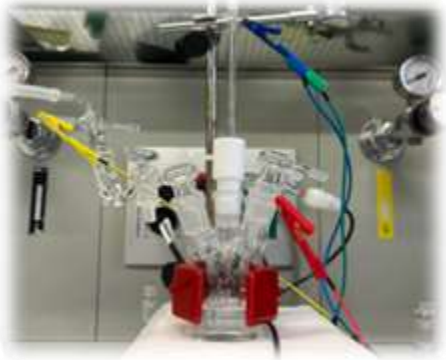
Laboratory of Interfaces and Electrochemical Systems

- Electrochemical characterization of Pt single crystal surfaces and evaluation of electrocatalytic activity for the reactions studied
  - Acetone reduction
  - Propanol / isopropanol oxidation









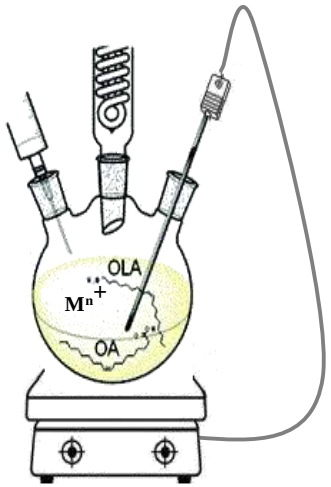
- Study the effect of the pH

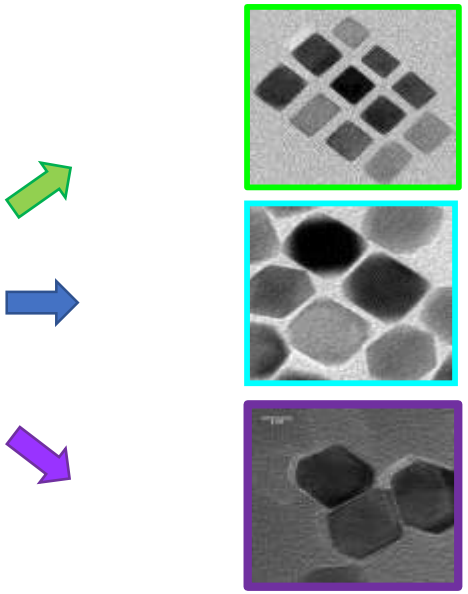
- Study the effect of Surface composition: electrode modification with elements of groups 15 and 16 (As, Sb, Bi, S, Se and Te). Evaluation of the impact on the electrocatalytic activity in the reactions studied.
- Synthesis and characterization of shaped Pt NPS, Use as electrocatalysts for the studied reactions

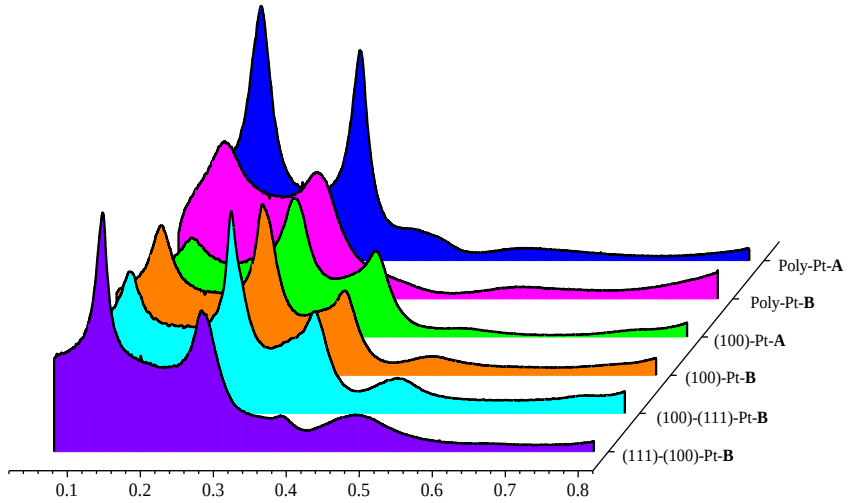

Cyclic Voltammetry


FTIR


DEMS







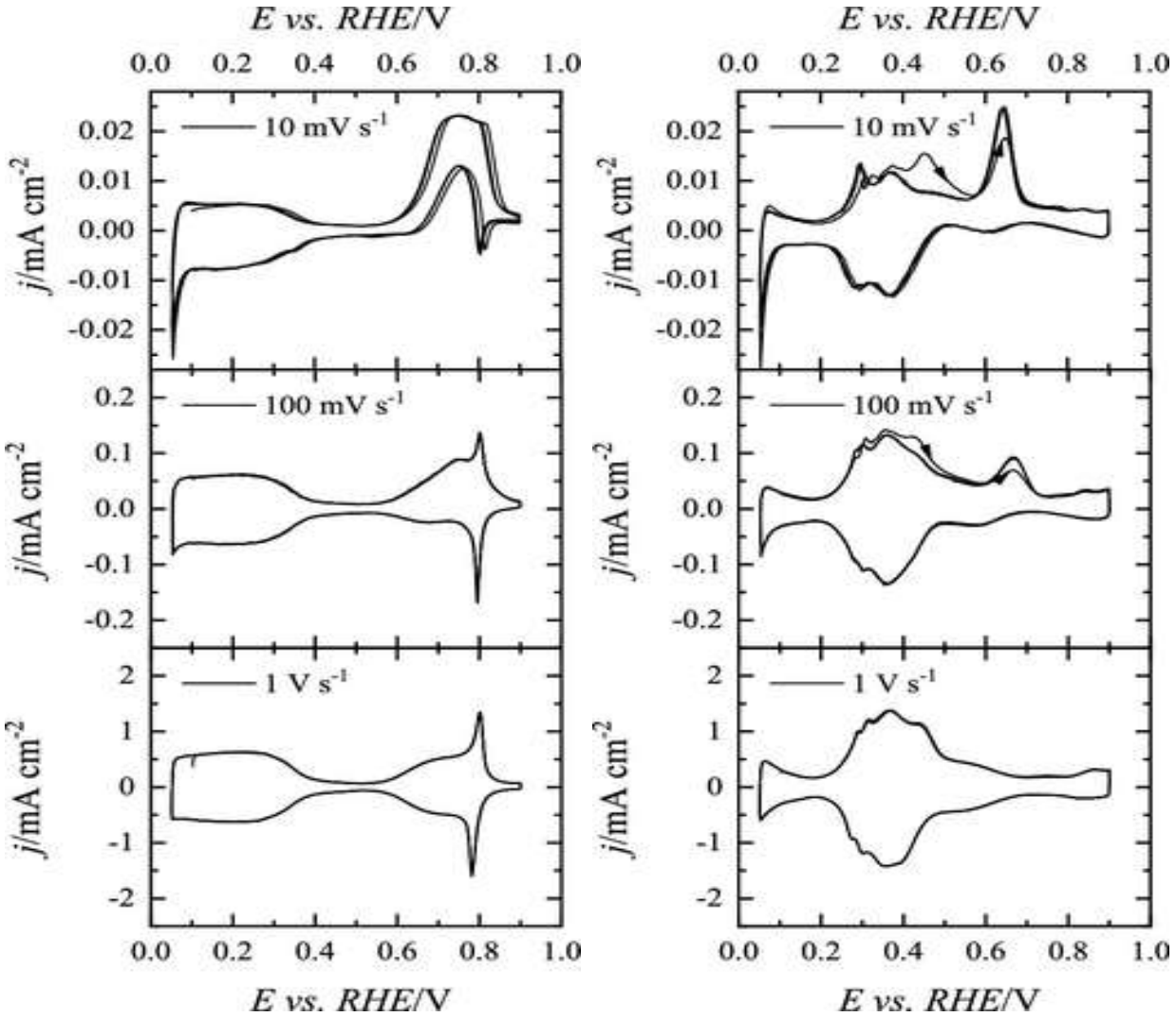
ACS Catalysis

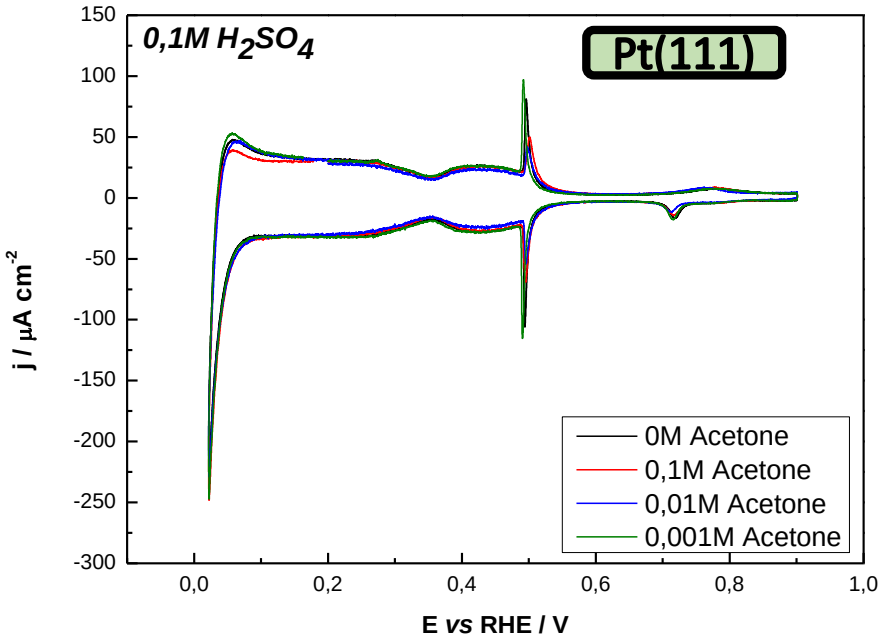
pubs.acs.org/acscatalysis Letter

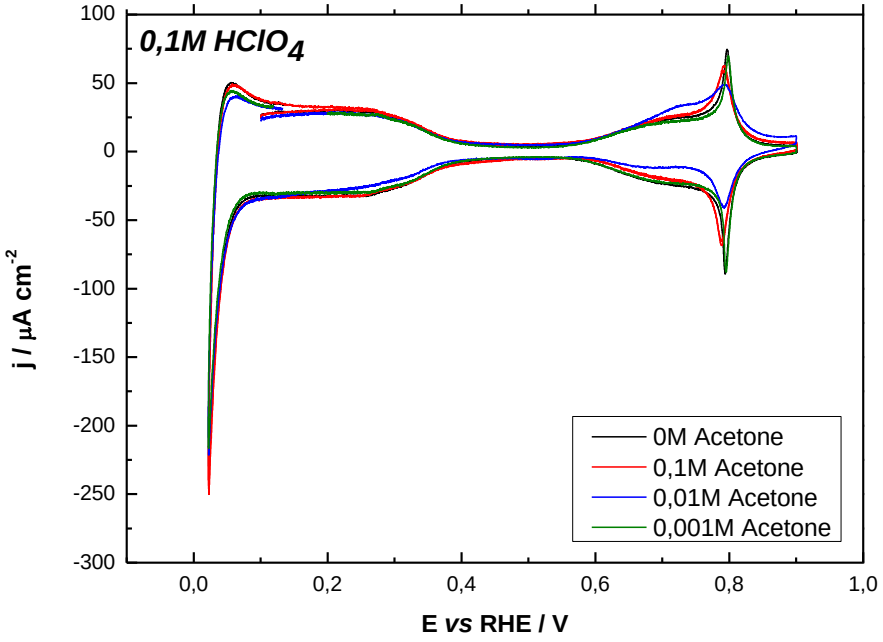
Why Methanol Electro-oxidation on Platinum in Water Takes Place Only in the Presence of Adsorbed OH

Dalila S. Mekazni, Rosa M. Arán-Ais, Adolfo Ferre-Vilaplana,* and Enrique Herrero*

- ✓ The interaction of methanol with the surface is weak.,
- ✓ Detection of adsorbed processes: low methanol concentrations and high scan rates.
  - Methanol oxidation currents are independent of the scan rate.
  - Adsorption related currents increase linearly with scan rate
- ✓ Methanol Electro-oxidation on Platinum in Water Takes Place only in the Presence of Adsorbed OH

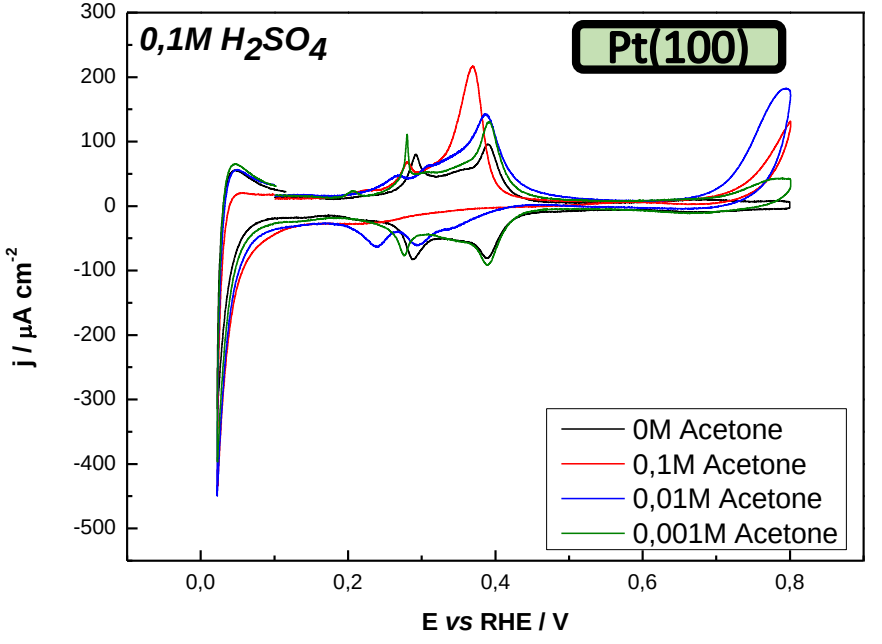


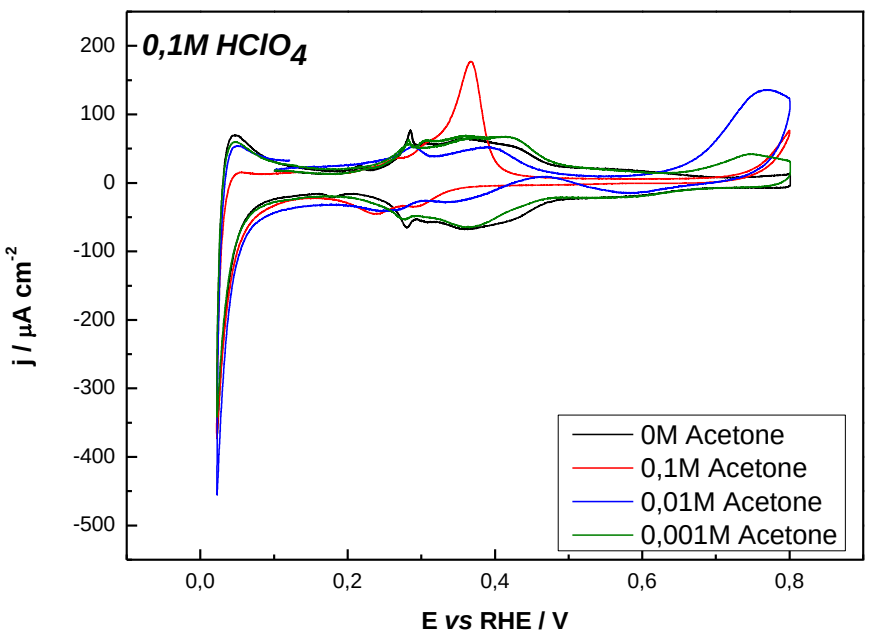




Pt(111)

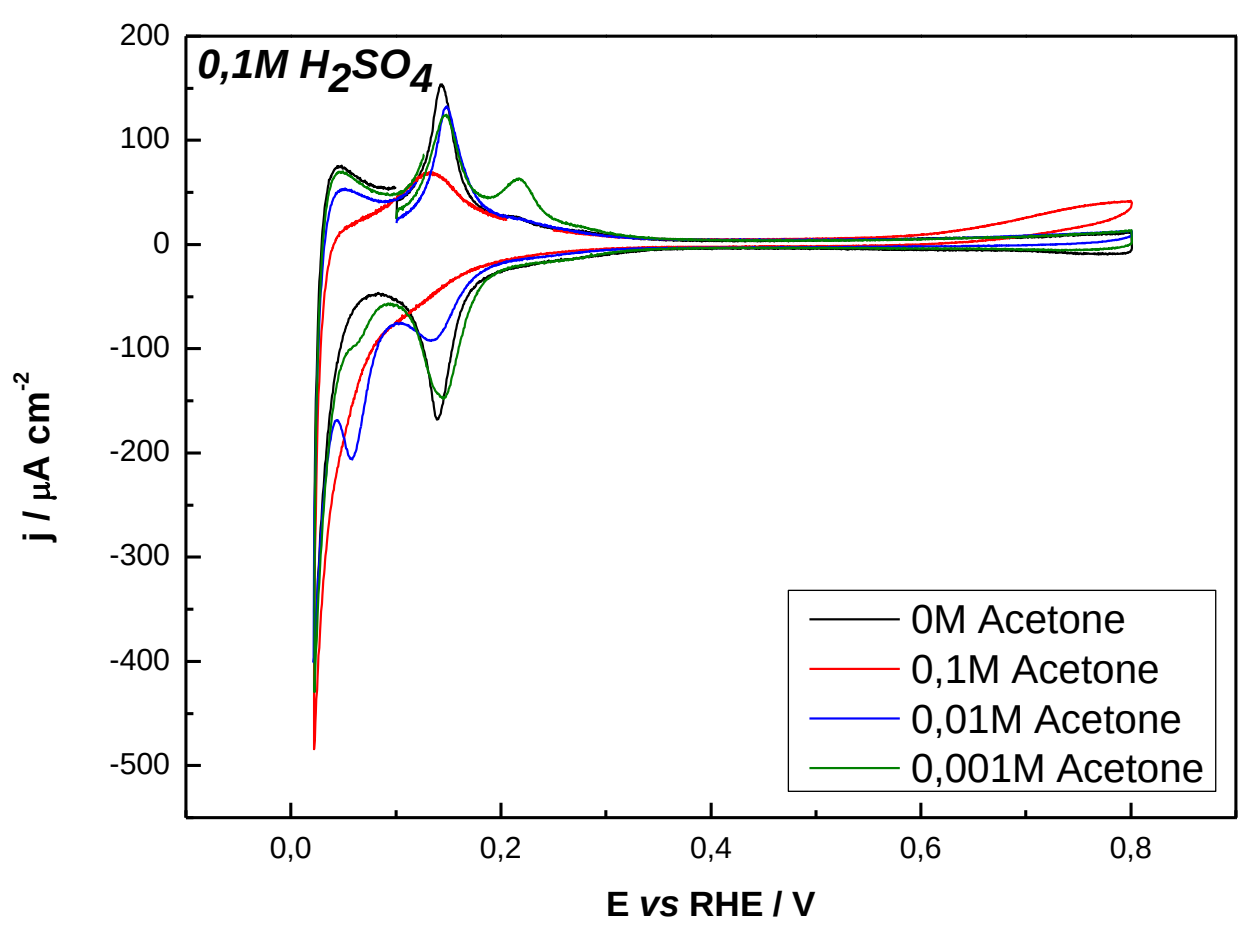
- ✓ No additional oxidation or reduction currents are observed,
- ✓ Acetone is not undergoing a redox reaction on Pt(111)



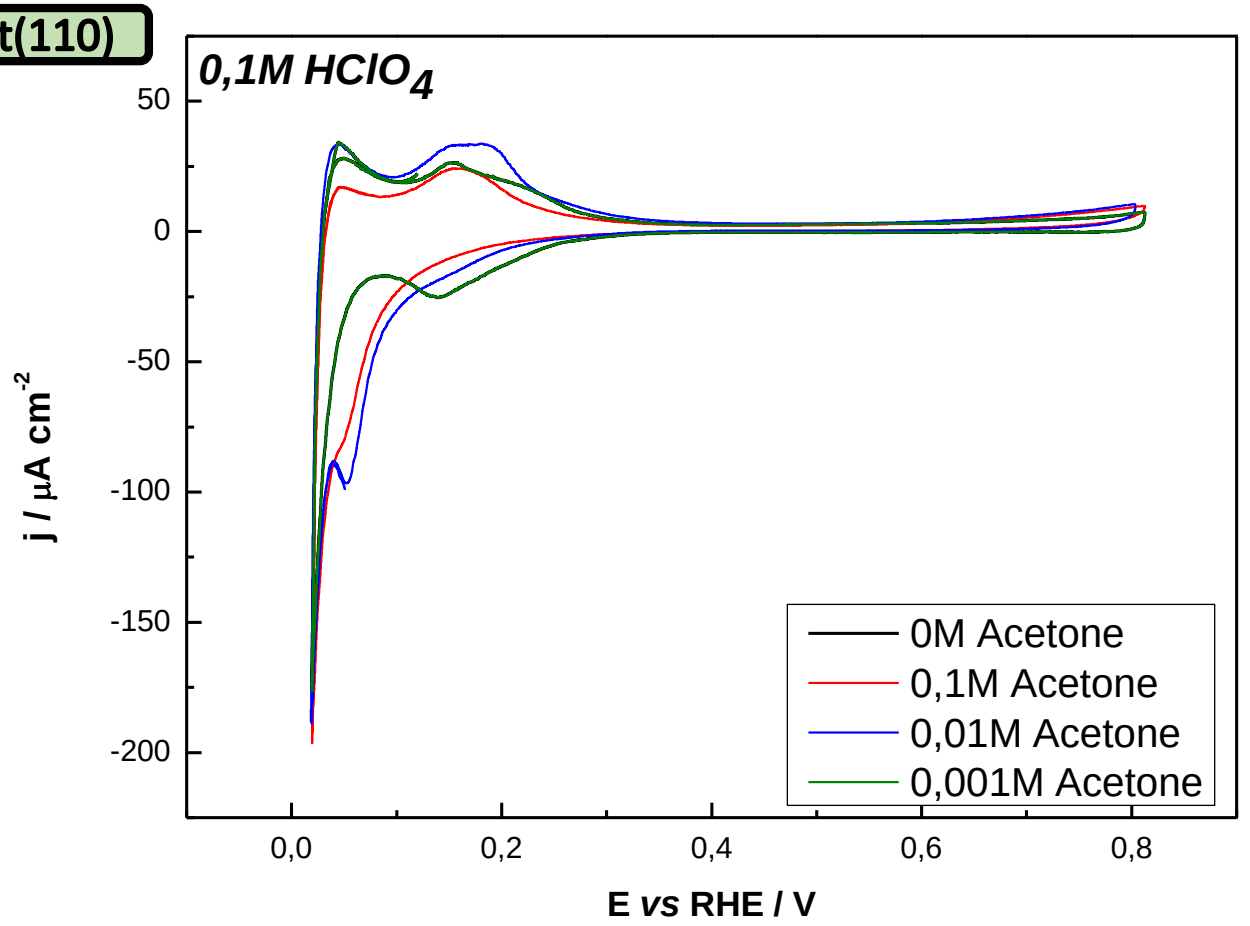


Pt(100)

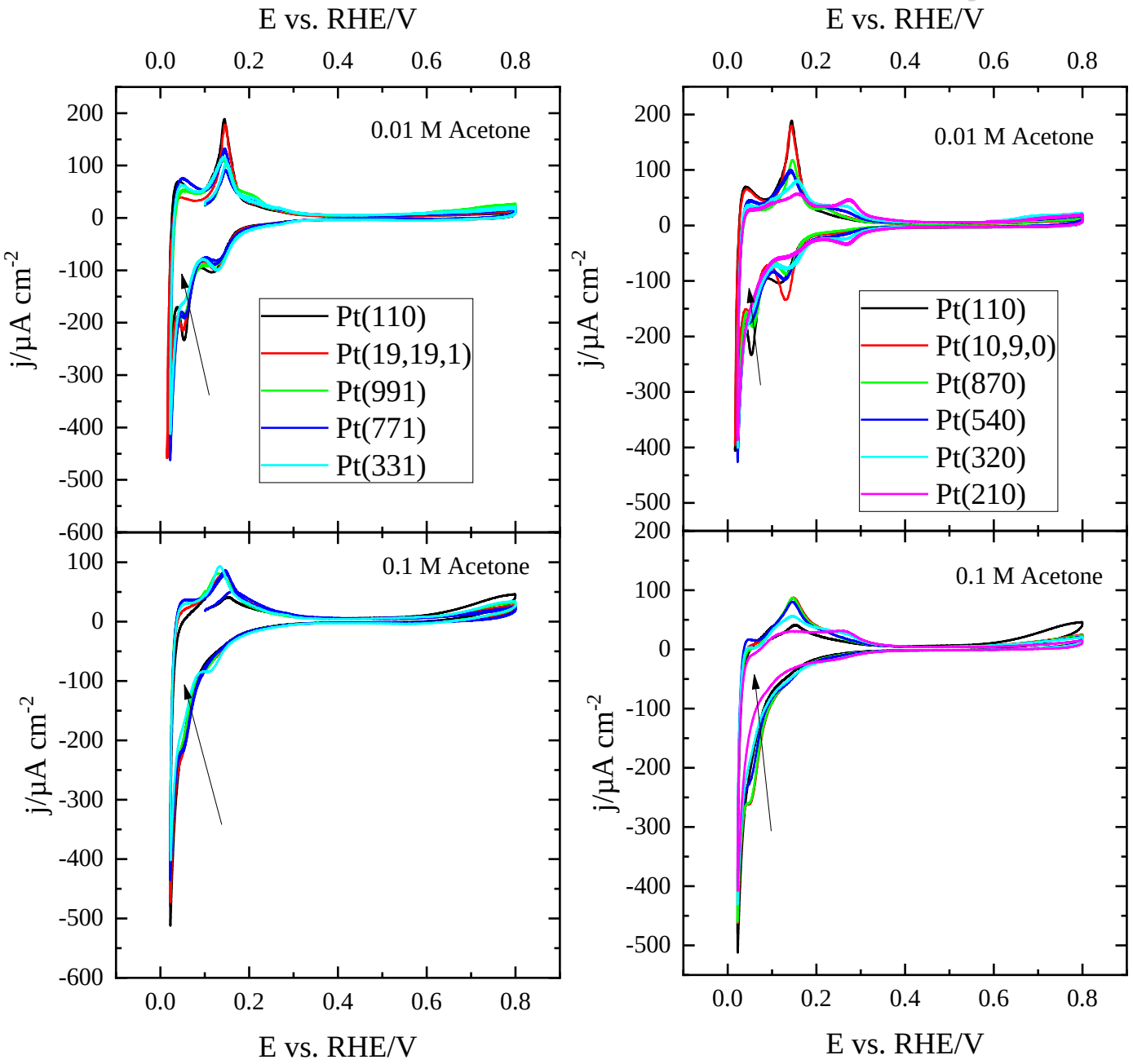
- ✓ Presence of oxidative adsorption on Pt(100) Surface,
- ✓ absence of any significant reduction on this electrode



Pt(110)

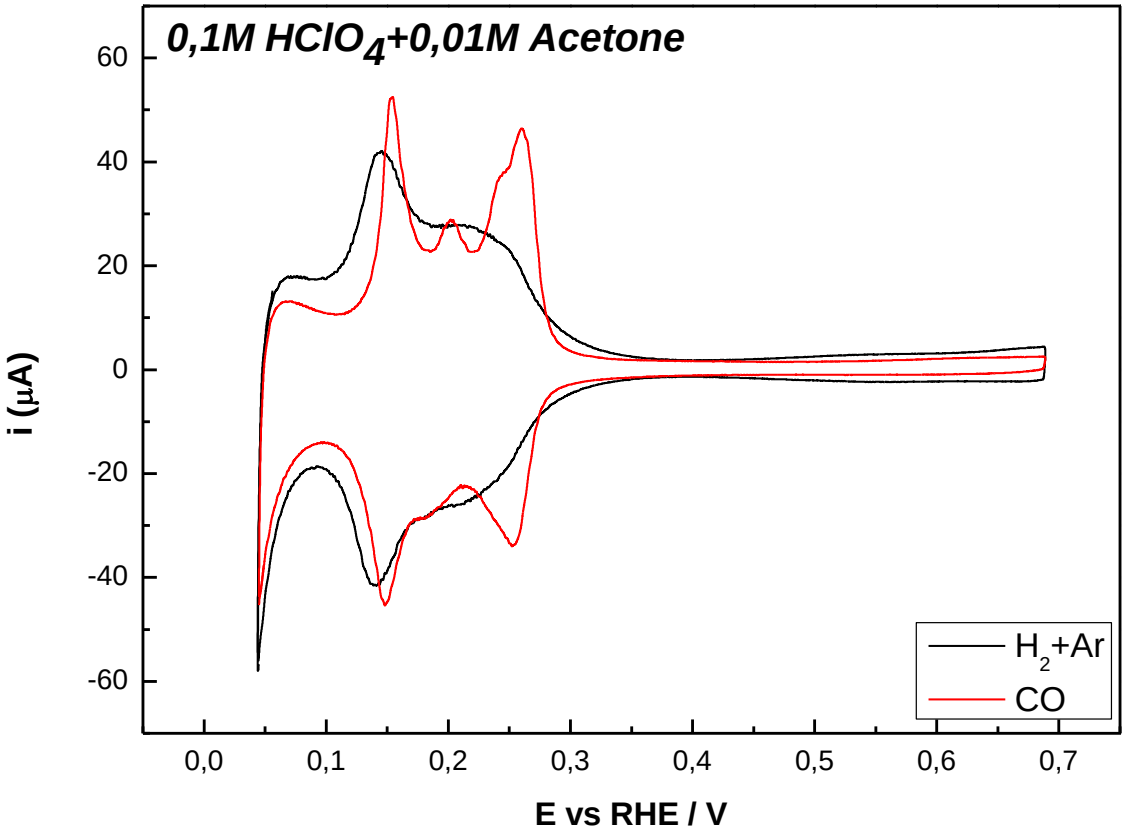


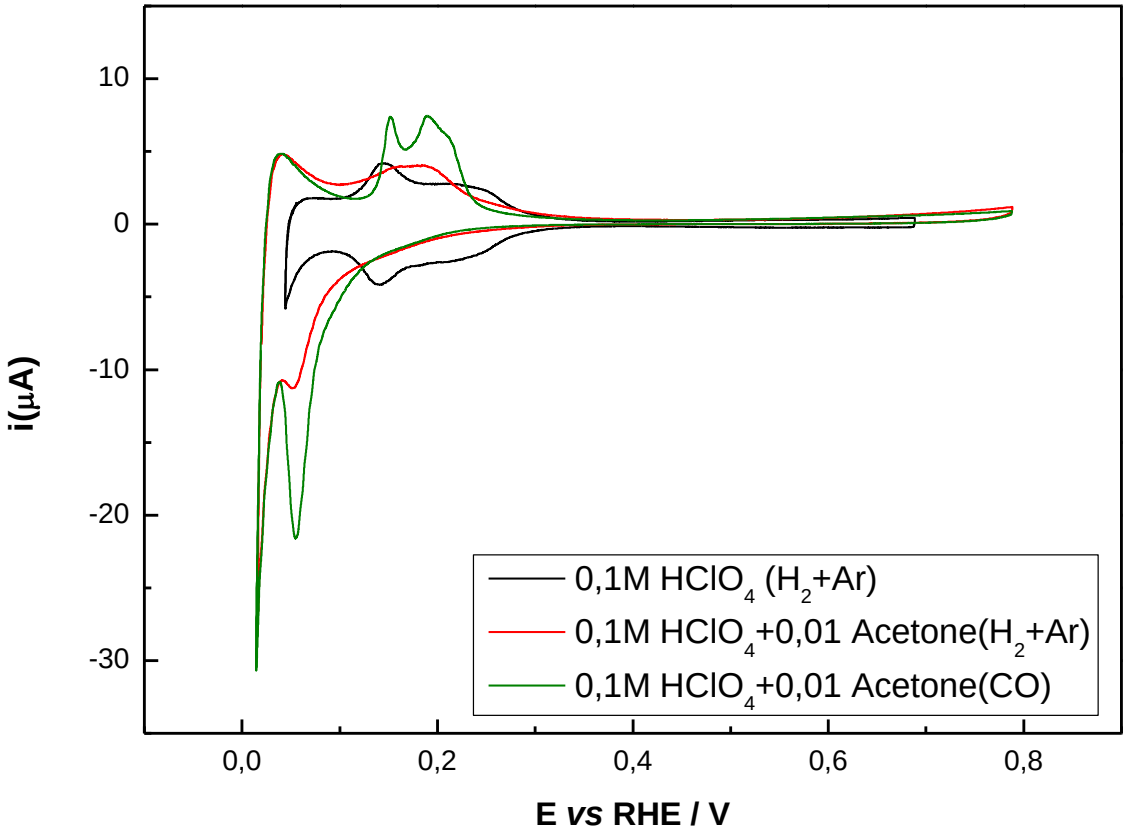
- ✓ Pt(110) is the only one active for the electroreduction of acetone,



Pt[(n+1)(100)×(110)] / Pt[(n-1)(111)×(110)]

- ✓ Diminution in the reduction current is observed as the step density increases
- ✓ The behavior is different depending on the step symmetry
- ✓ Absence of reduction currents for electrolytes containing 0.1M acetone,

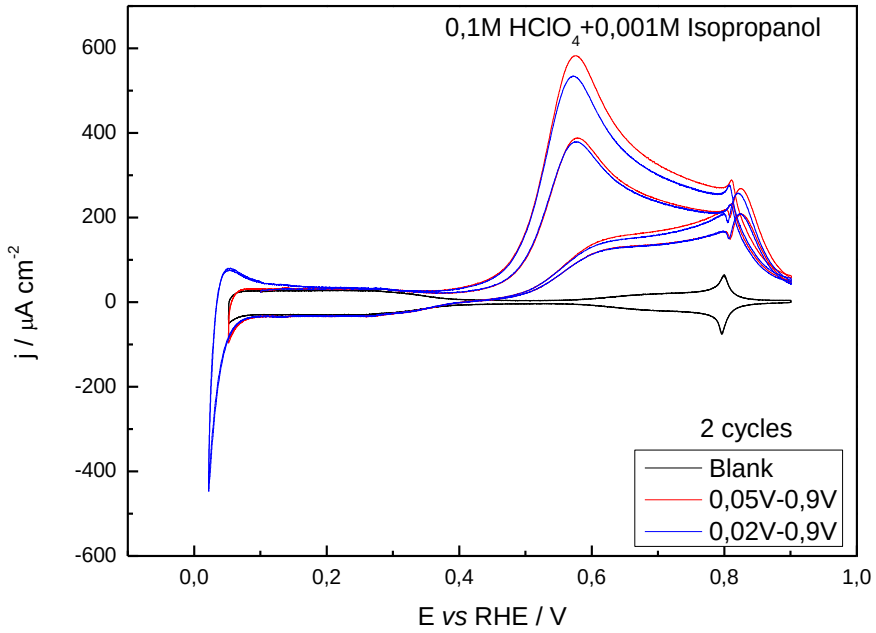


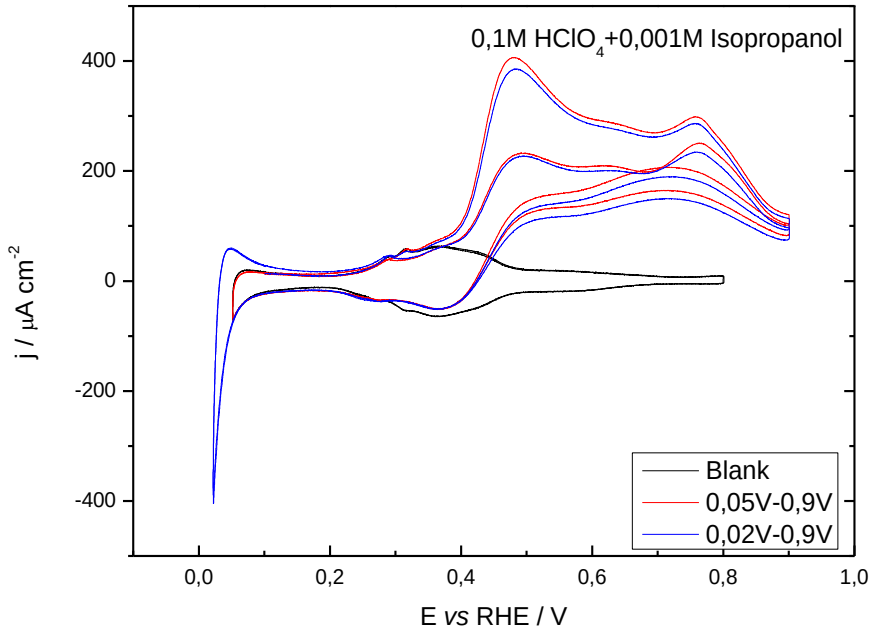


Surface reconstruction ⇨ **Different reactivity**

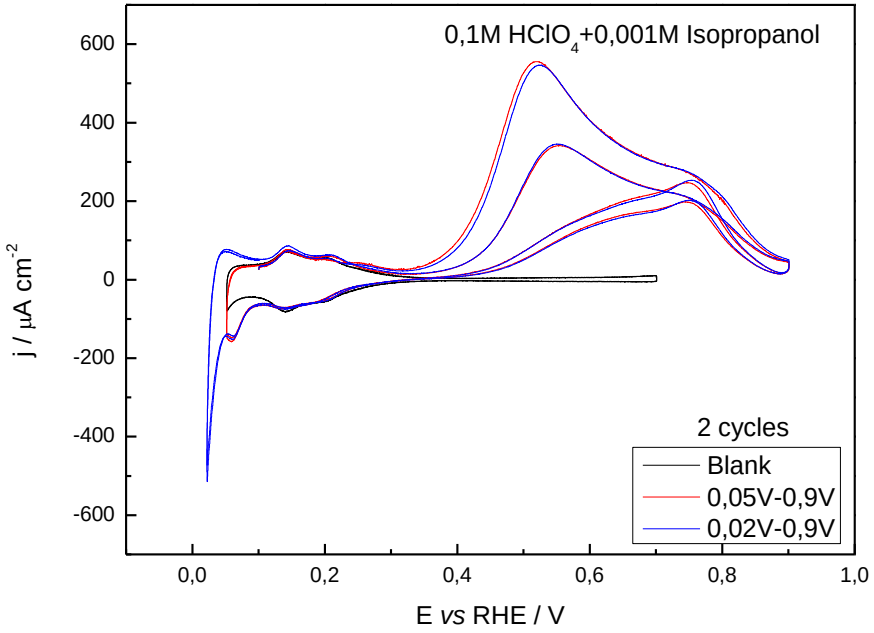
✓ The acetone reduction is well defined on Pt(110) cooled In CO than on that cooled in AR+H2

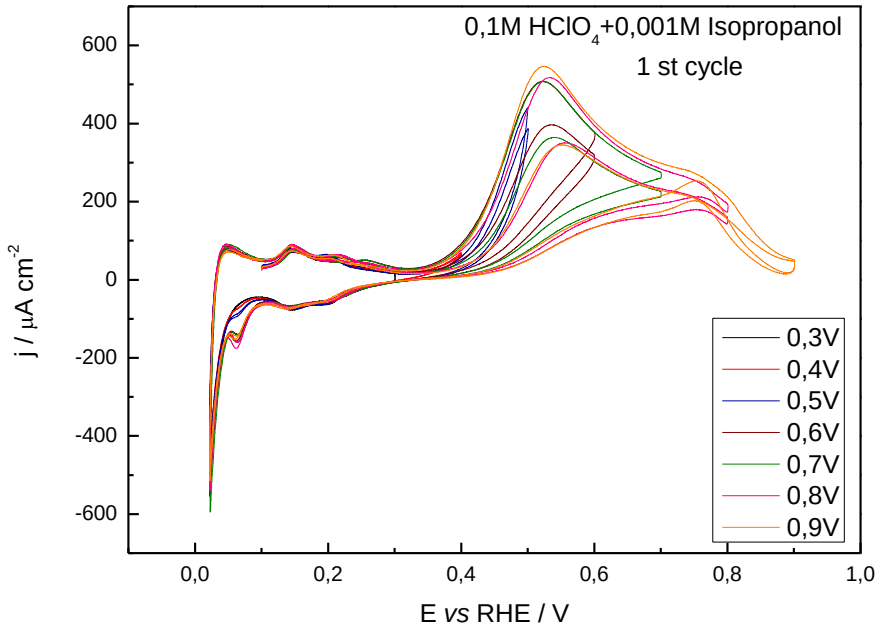
The thermal treatment and the subsequent cooling procedure will influence strongly on the final real structure of the surface



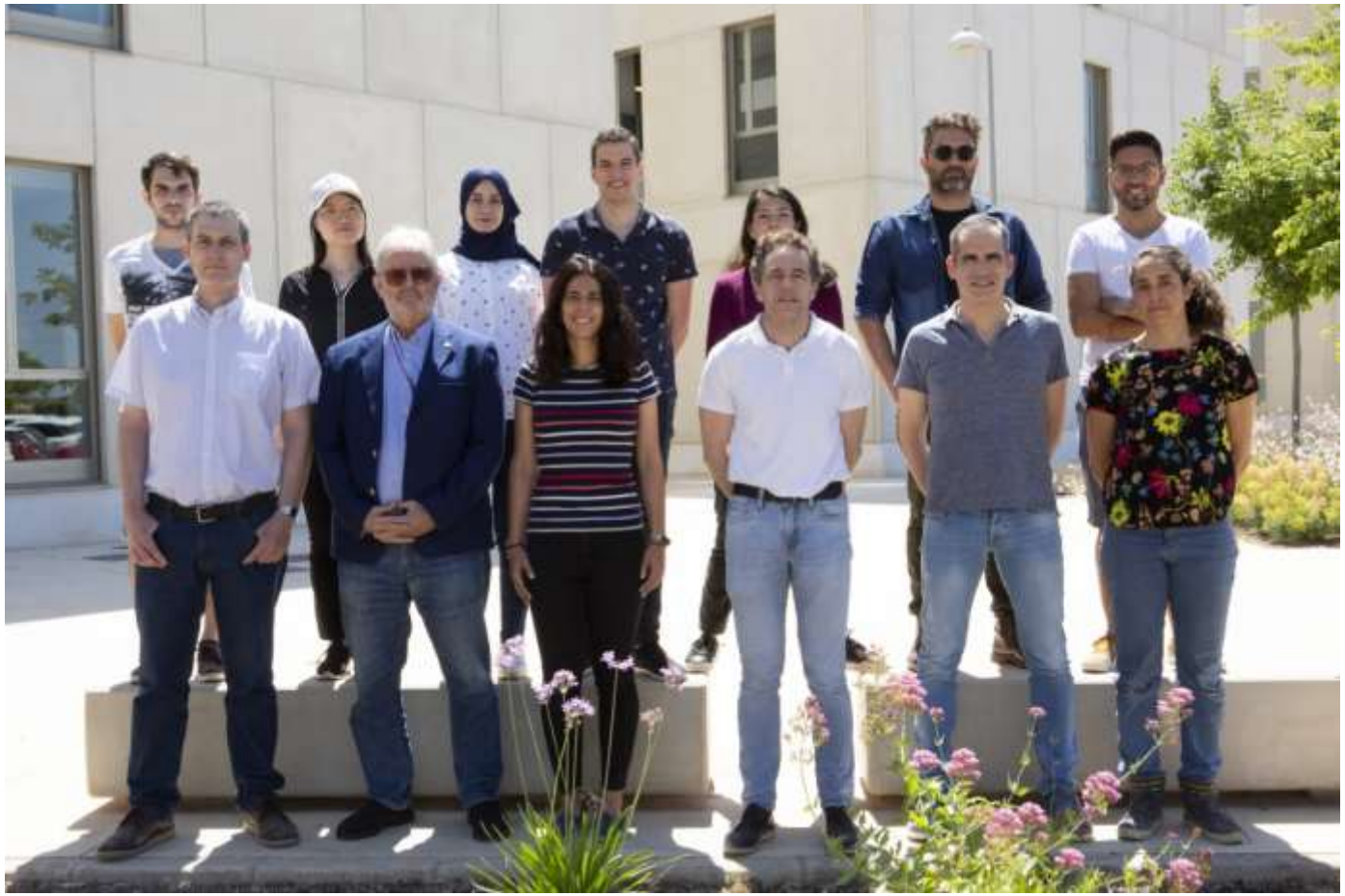


- ✓ Pt(111) and Pt(100) show any reduction of acetone





- ✓ Presence of acetone reduction on Pt (110)



E. Herrero
R. Arán-Ais
J.M. Feliu

Thanks for your attention

République Algérienne Démocratique et Populaire
Ministère de l'Enseignement Supérieur et de la Recherche Scientifique

GOBIERNO DE ESPAÑA
MINISTERIO DE CIENCIA E INNOVACIÓN

GENERALITAT VALENCIANA
CONSELLERIA D'EDUCACIÓ, INVESTIGACIÓ, CULTURA I ESPORT