Programa de Doctorado
Electroquímica. Ciencia y Tecnología

SYNTHESIS AND CHARACTERIZATION OF NANOPARTICULATED SUPPORTED CATALYSTS FOR POROUS ELECTRODES AND ENVIRONMENTAL APPLICATIONS

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Introduction

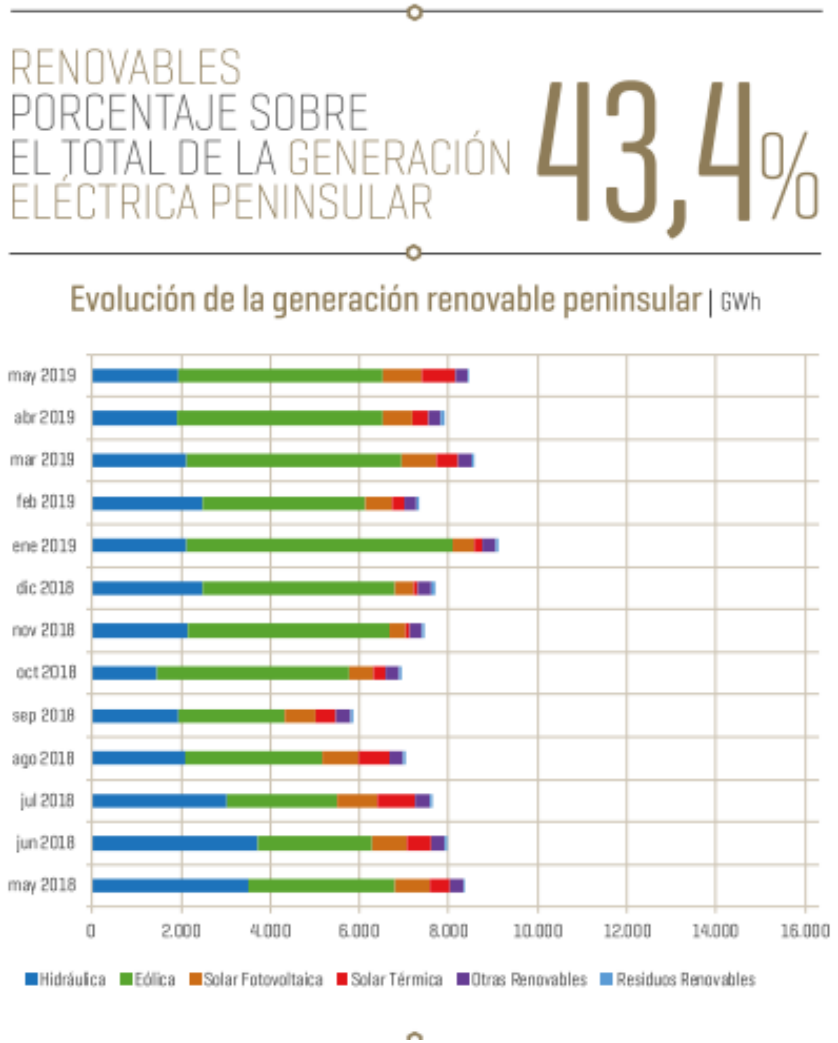
Current energy crisis: Consumed energy mostly non renewable

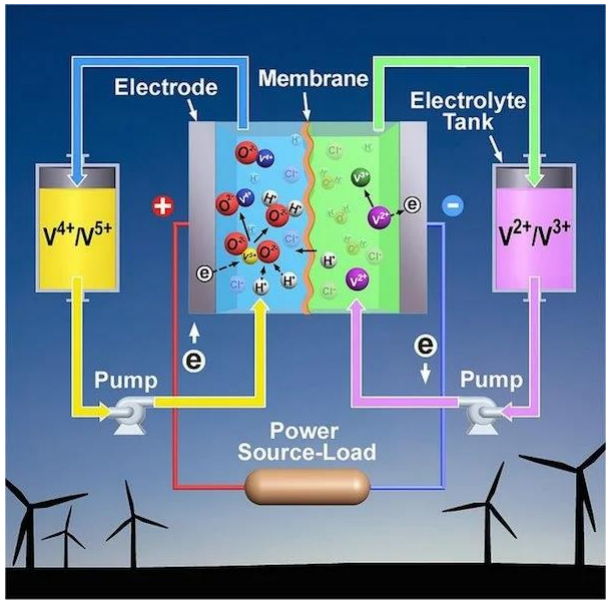
Fossil fuels are rapidly depleting

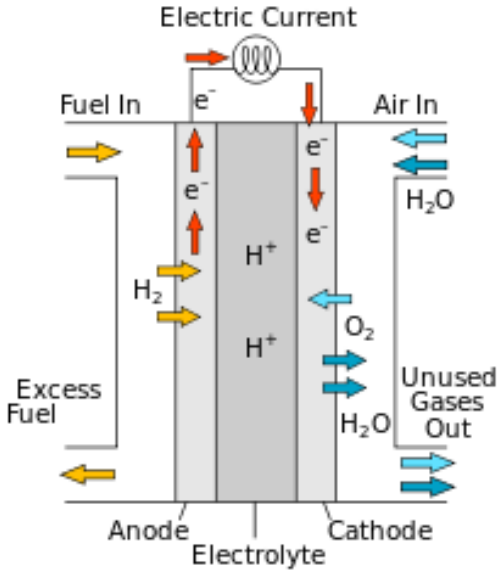
Emission of greenhouse effect gases

Introduction

Solutions: Alternative energy sources





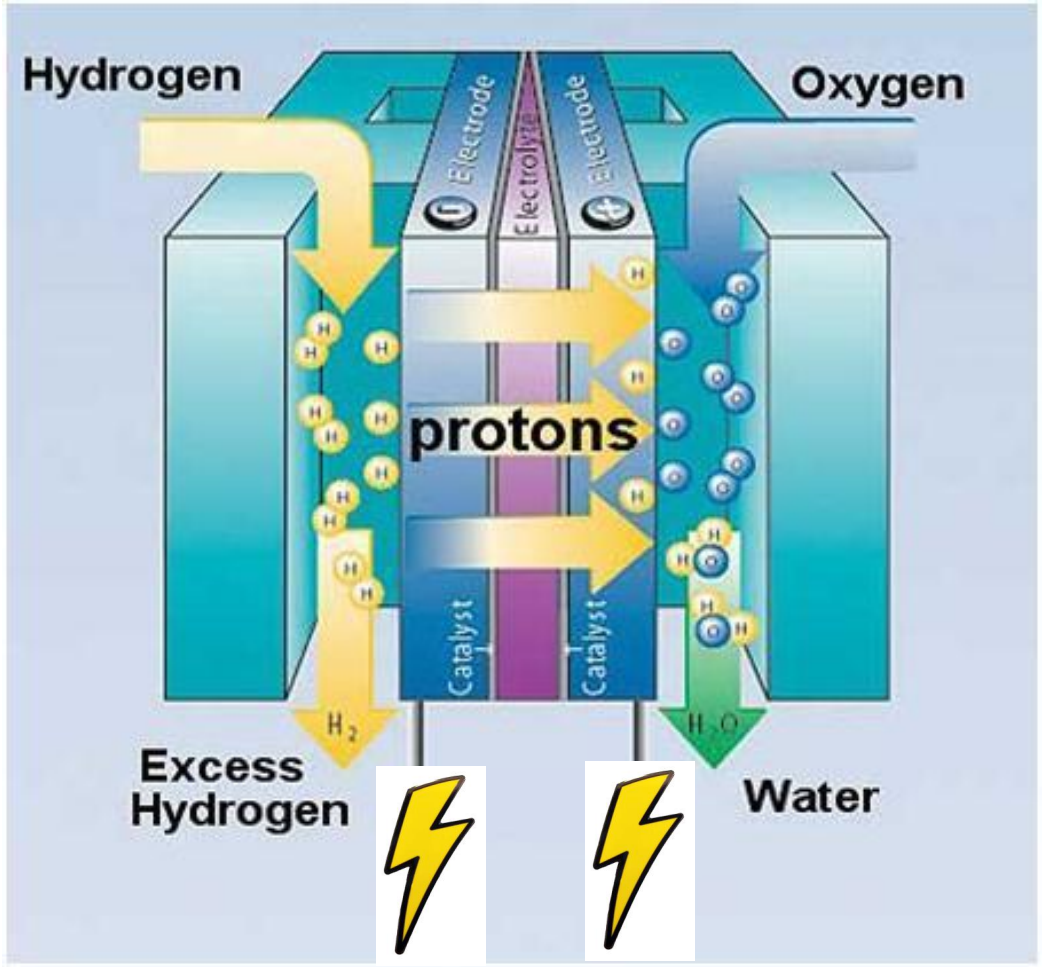


Boletín mensual de energía eléctrica, mayo 2019, Red Eléctrica de España

Introduction

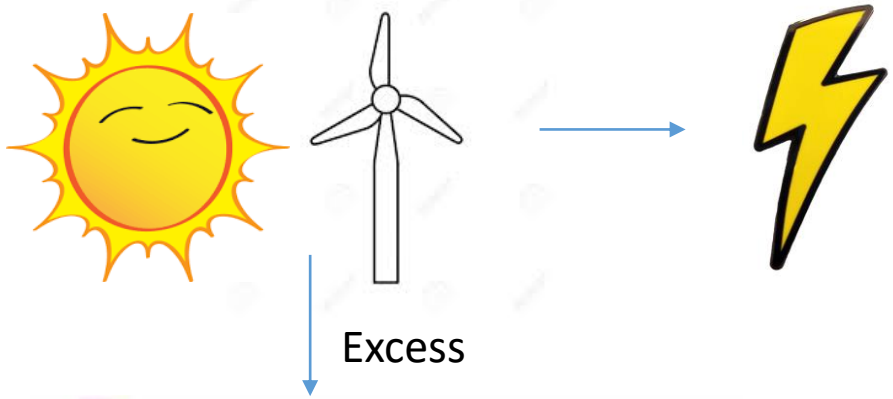
Hydrogen as energy vector

Energy production

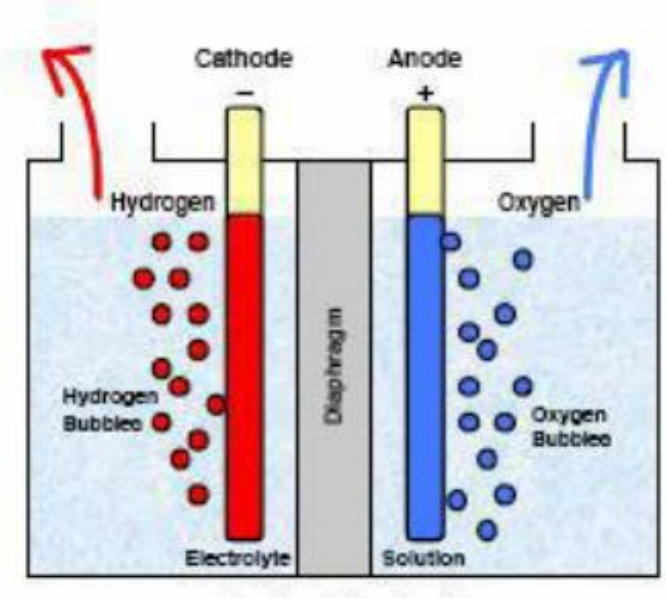


H_2 FUEL

Energy storage



Excess

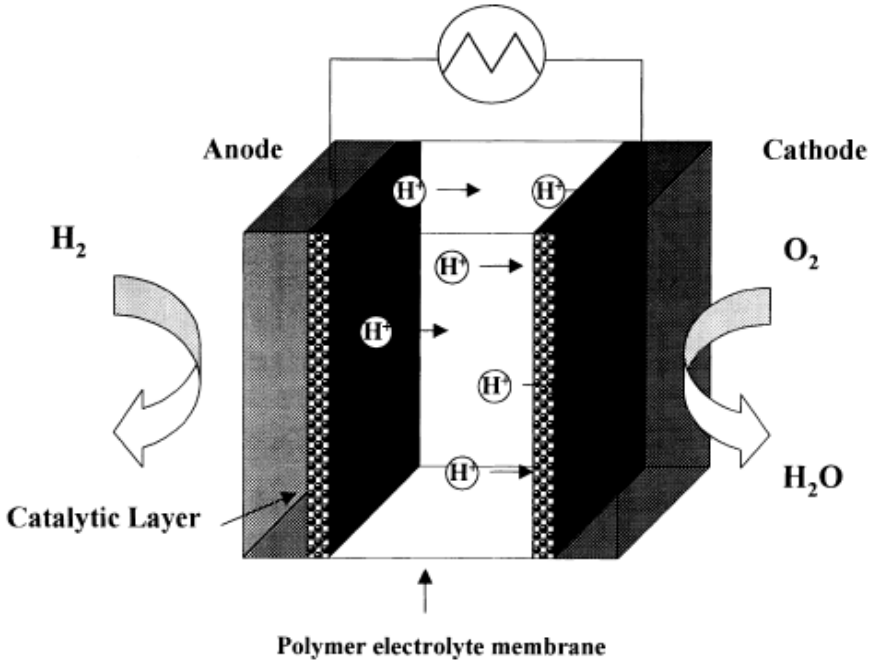


Introduction

Different types of fuel cells: depending on the electrolyte used

PEM fuel cells:

- ✓ Low operating temperature
- ✓ Low weight



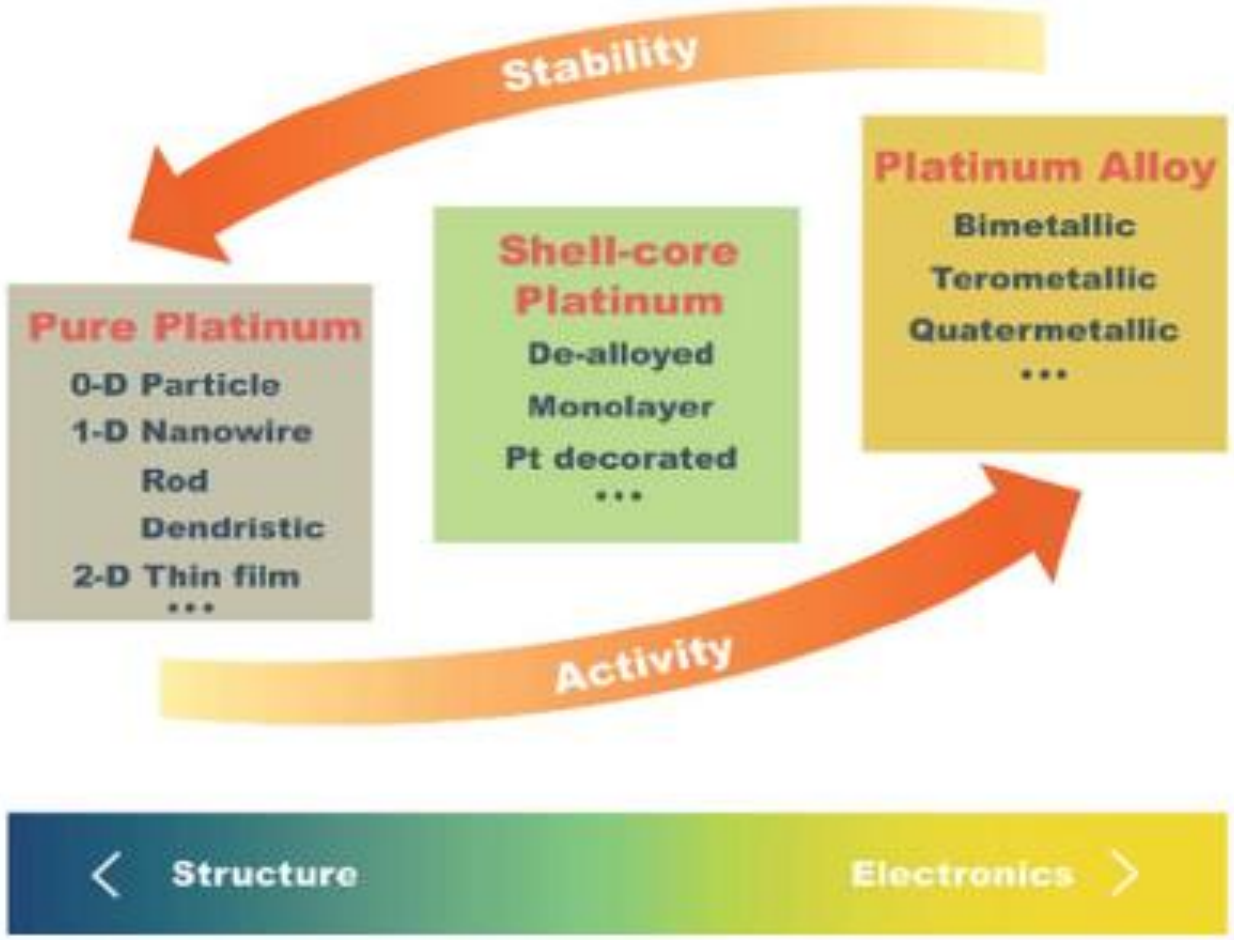
Prog. Polym. Sci., vol. 25, pp. 1463–1502, 2000.

The main problem of PEM fuel cells: Pt catalysts

- ✗ High cost (55% of total cost)
- ✗ Scarcity
- ✗ CO poisoning

Introduction

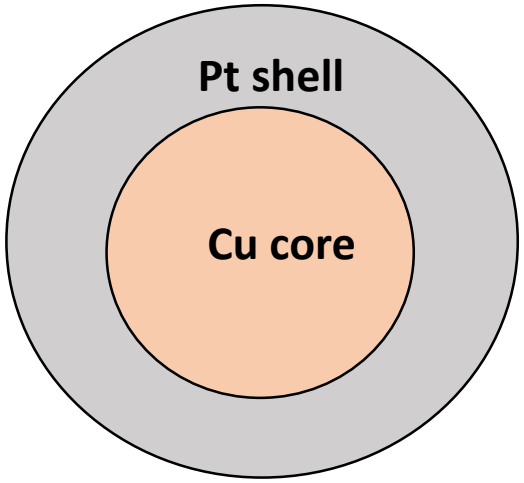
Catalysts



J. Mater. Chem. A, 2017, 5, 1808–1825

Introduction

The use Pt(Cu) core-shell nanoparticles supported on carbon blacks



Core –shell nanoparticles → Lower amount of Pt

Electronic effect → Higher tolerance to CO

[1] Caballero-Manrique, G. et al. *Catalysts* 6 (2016) 125.
[2] Liu, Y. et al. Chem. Eng. J. 197 (2012) 80–87.
[3] Mintsouli, I. et al. Applied Catal. B, Environ. 136-137 (2013) 160–167
[4] Georgieva, J. et al J. Appl. Electrochem. 44 (2014) 215–224.
[5] Dimitrova, N. et al. J. Electroanal. Chem. 823 (2018) 624–632.

🎯 Objectives

1. Update the existing bibliography.
2. Synthesize core-shell Pt(Cu)/C.
3. Electrochemical performance of the catalysts.
4. Crystalline structure, composition, size and distribution of nanoparticles.
5. Kinetics study of the HOR and ORR.
6. Comparing to commercial Pt/C.
7. Degradation tests of organic pollutants.
8. Degradation tests of organic pollutants in fuel cells.

Characterization techniques

TEM (JEOL JEM 2100)
- EDX analysis

XRD (PANalytical X'Pert PRO MRD diffractometer)

Surface specific BET and porosimmetry

XPS (PHI ESCA-5500 photoelectron spectroscope)

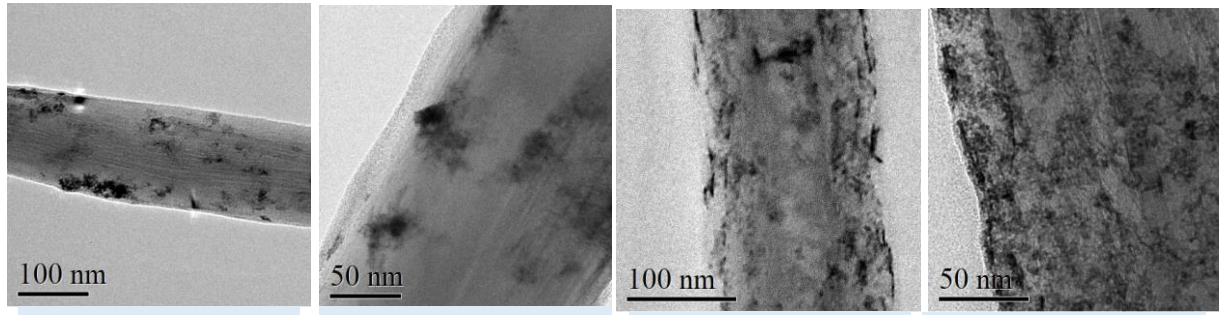
Electrochemical analysis (AUTOLAB, PGSTAT 100)

Working Plan

Activity	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1. Development of methods and techniques	x															
2. Objective 1	x	x	x	x												
3. Objective 2		x	x	x	x	x	x	x	x							
4. Objective 3				x	x	x	x	x	x							
5. Objective 4				x	x	x	x	x	x							
6. Stay in a foreign centre										x	x					
7. Objective 5					x				x	x	x	x				
8. Objective 6									x	x	x	x				
9. Objective 7											x	x	x	x		
10. Attendance to congresses				x				x				x				x
11. Writing and defense of Thesis														x	x	x

Results

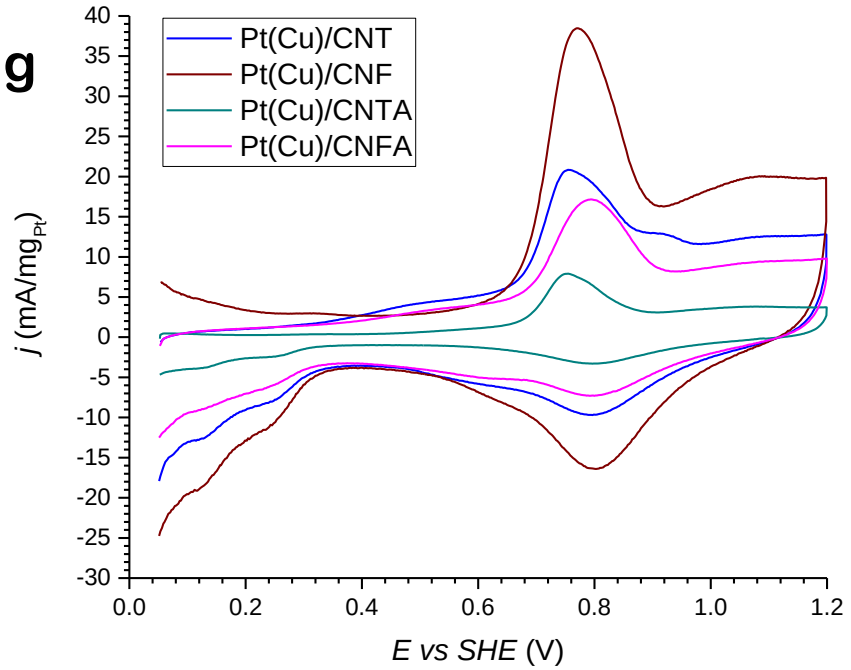
TEM



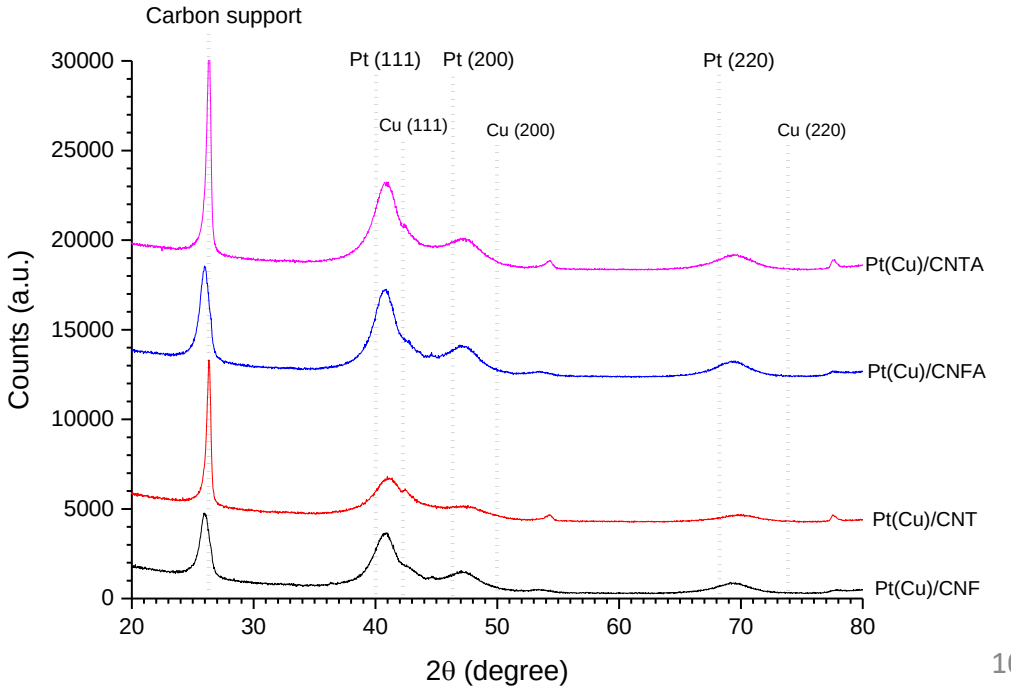
Pt(Cu)/CNT | Pt(Cu)/CNTA | Pt(Cu)/CNF | Pt(Cu)/CNFA

Catalyst sample	Crystallite size XRD (nm)	wt% Pt (EDX)	ECSA CO stripping (m^2/g_{Pt})
Pt(Cu)/CNT	20.4	7.4 %	27.5
Pt(Cu)/CNTA	16.4	22.2 %	10.1
Pt(Cu)/CNF	14.1	5.0%	58.0
Pt(Cu)/CNFA	10.9	7.4 %	20.8

CO Stripping



XRD



Acknowledgements

LEMMA

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