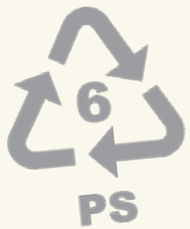
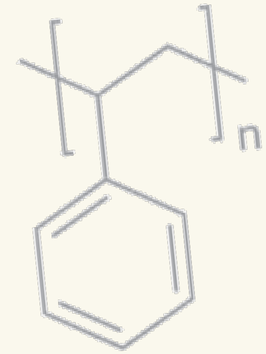
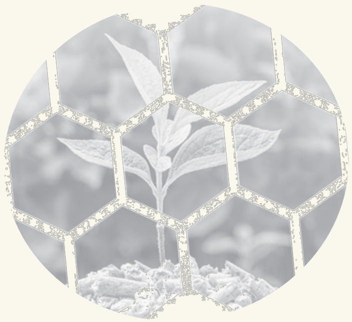
CORFU2022

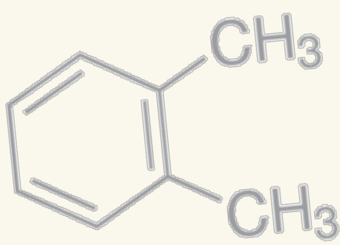
Hydrocarbon selectivity enhancement through catalytic fast co-pyrolysis of almond shell and plastic wastes blends

A. Alcazar-Ruiz, L. Sanchez-Silva, F. Dorado
Department of Chemical Engineering, University of Castilla-La Mancha, Ciudad Real, 13071, Spain





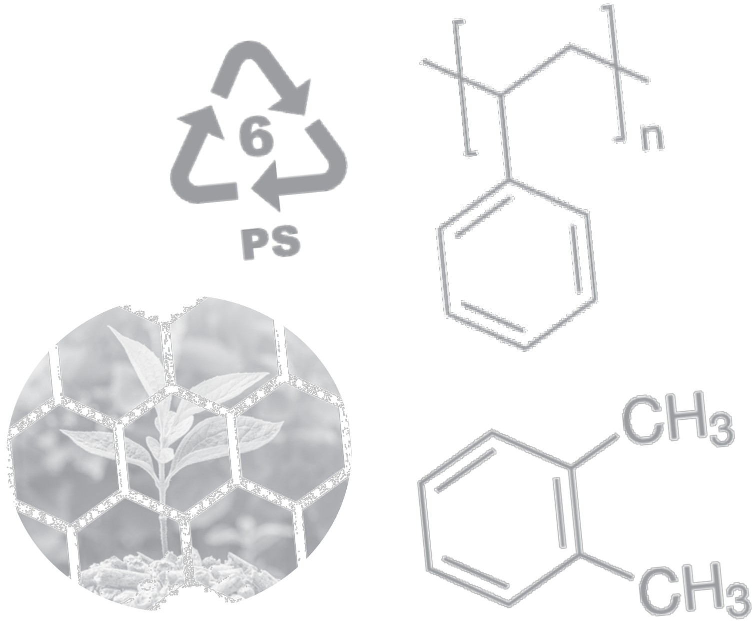


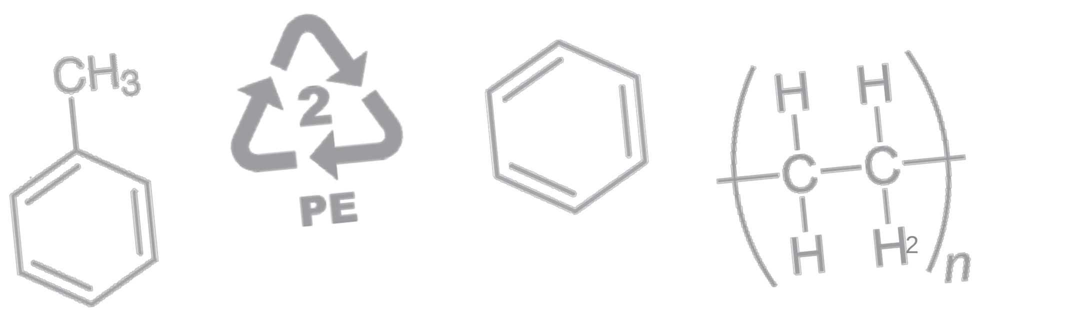


Angel.Alcazar@uclm.es
@AAlcazarRuiz

UCLM
Angel.Alcazar@uclm.es
@AAlcazarRuiz

INDEX





Angel.Alcazar@uclm.es
@AAlcazarRuiz

1 INTRODUCTION

BIOMASS

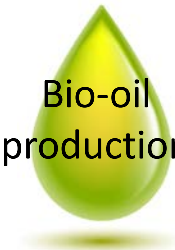
PYROLYSIS

RENEWABLE ENERGY POTENTIAL OPTION

Hydrogen deficient nature

FAST PYROLYSIS

- ↑ Heating rates (ºC/ms)
- Moderates temperaturas (400-600 ºC)
- ↓ Residence time (0.5-15 s)



Bio-oil production

Secondary cracking reaction

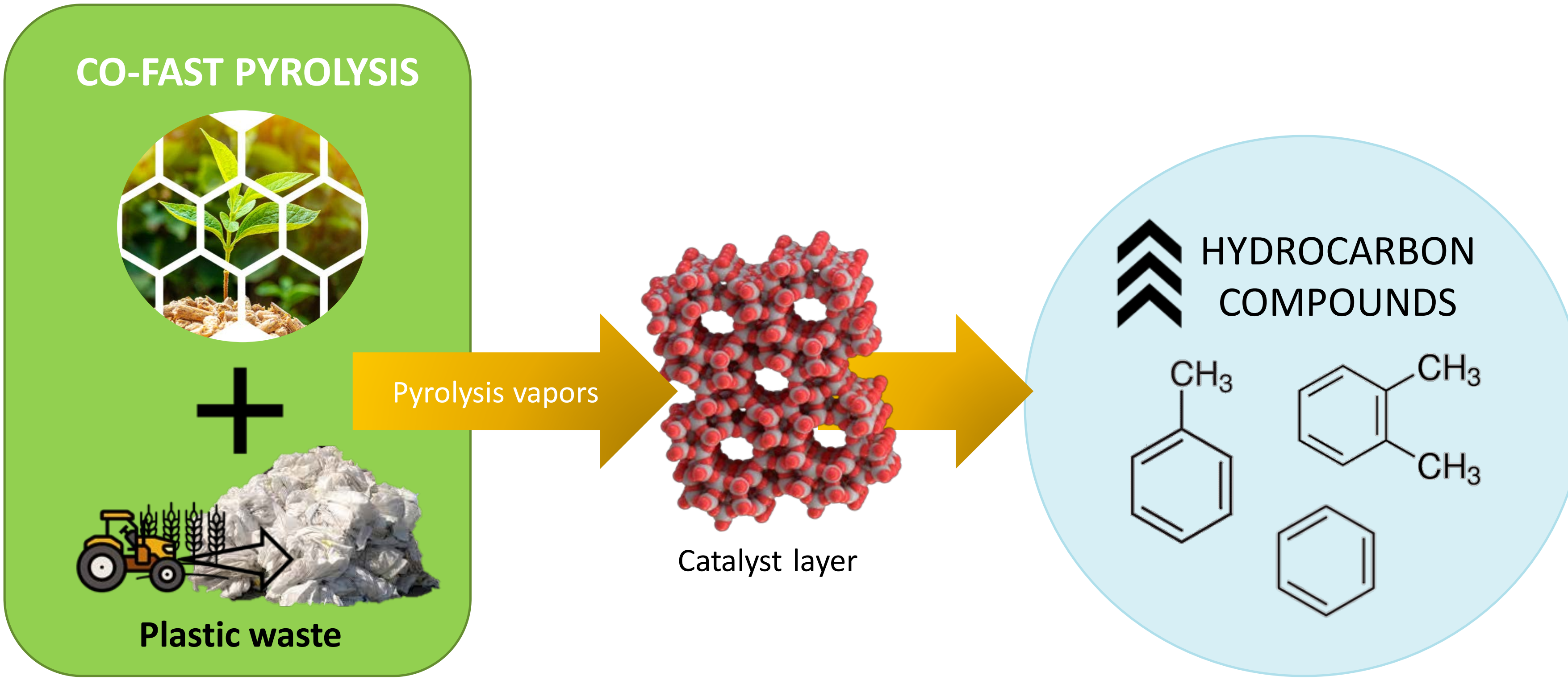
Undesiderable BIO-OIL properties

↓HHV (MJ/kg)

↑ Viscosity

↑Oxygen composition

Angel.Alcazar@uclm.es
@AAlcazarRuiz



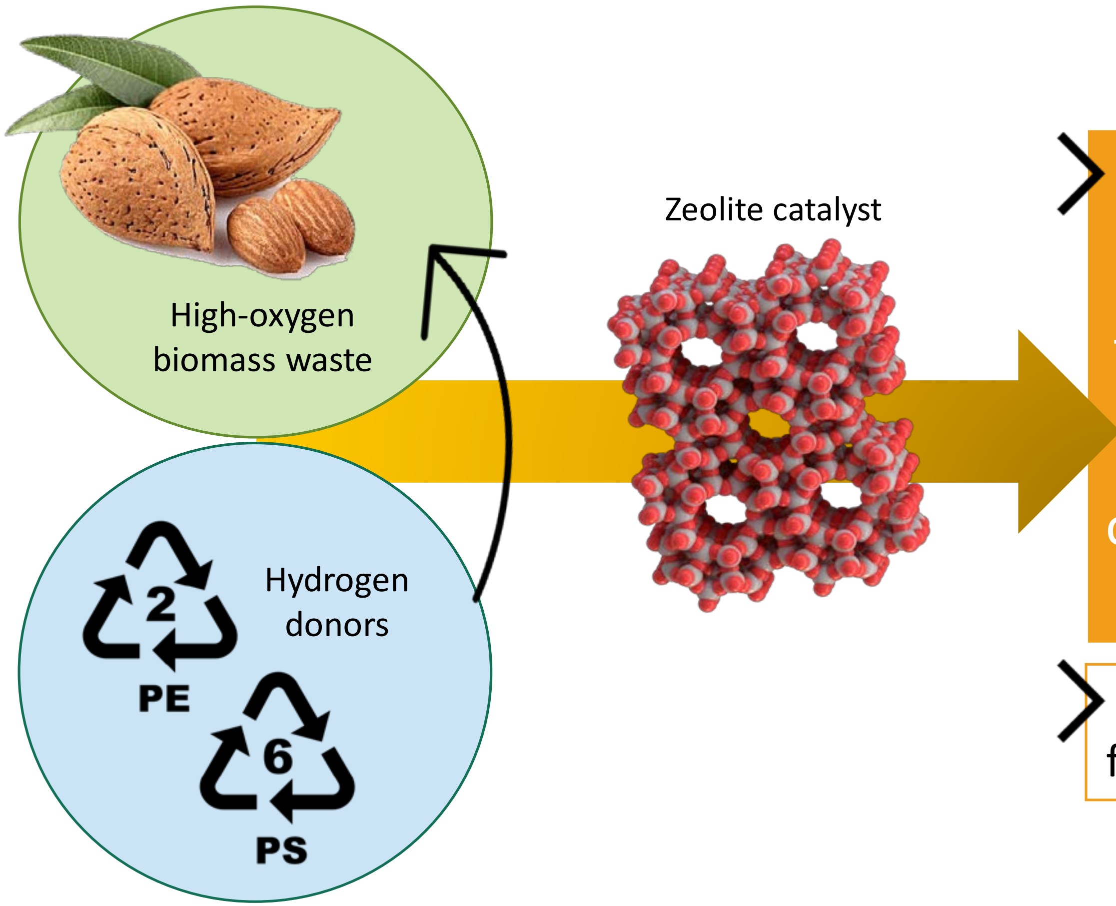
↑Decarboxylation

↑Decarbonylation

↑HHV

UCLM
Angel.Alcazar@uclm.es
@AAlcazarRuiz

2 OBJETIVE



- Investigate the effect of **CATALYTIC CO-FAST PYROLYSIS** on hydrocarbon selectivity, looking for enhancing the production of value-added compounds, such as BTX.
- The coupling effect of AAEMs from biomass and zeolite addition

UCLM
Angel.Alcazar@uclm.es
@AAlcazarRuiz

3 METHODOLOGY

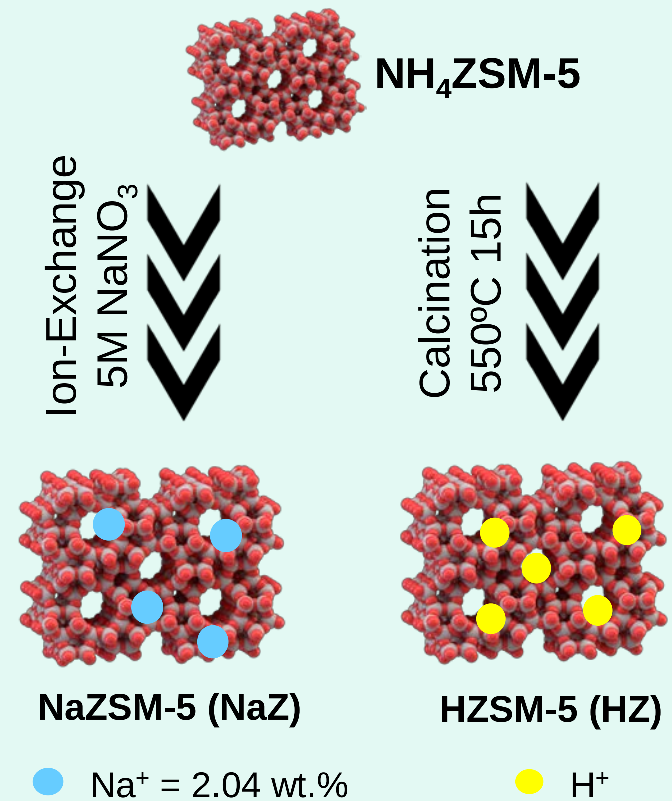
Feedstock samples

Almond Shell (AS)

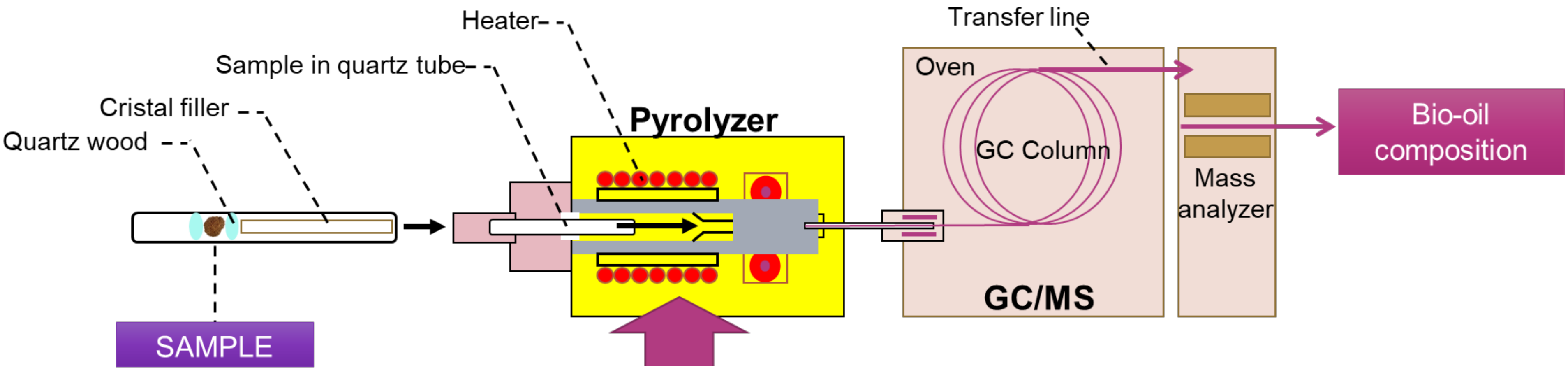
Polyethylene (PE)

Polystyrene (PS)

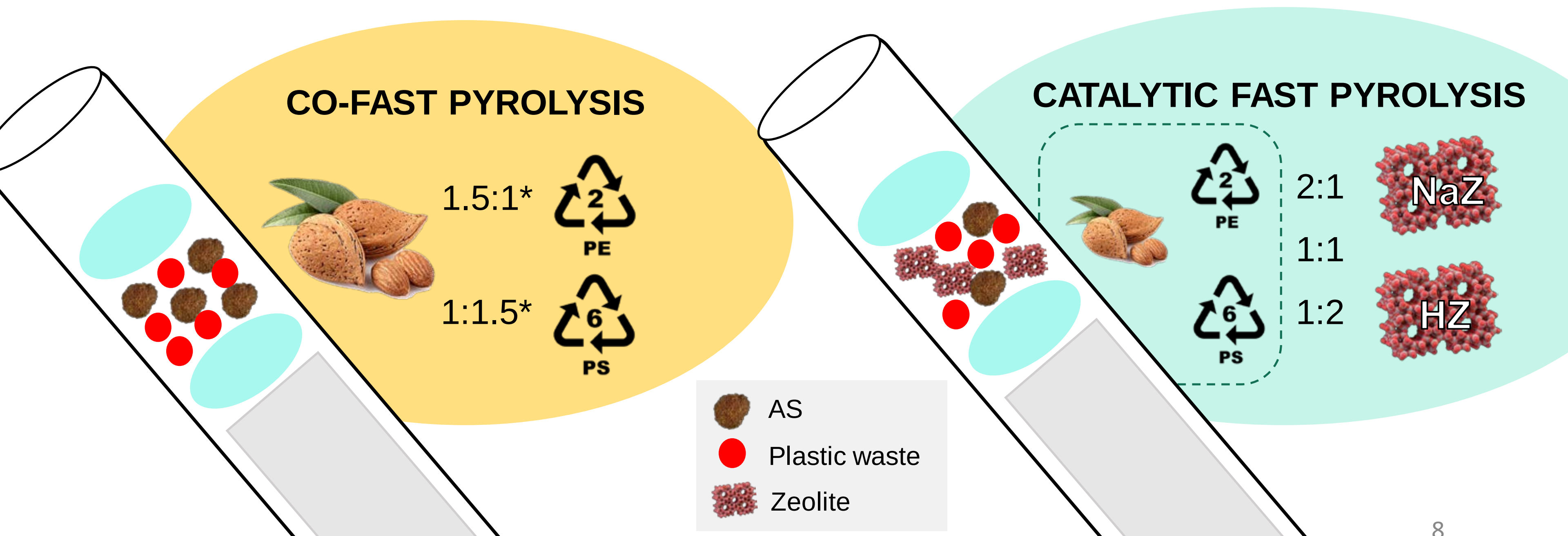
Catalyst preparation



Angel.Alcazar@uclm.es
@AAlcazarRuiz



Fast pyrolysis (650ºC, 20ºC/ms, 20s)



*Alcazar-Ruiz A, Dorado F, Sanchez-Silva L. Fast pyrolysis of agroindustrial wastes blends: Hydrocarbon production enhancement. J Anal Appl Pyrolysis 2021;157:105242. https://doi.org/10.1016/j.jaap.2021.105242.

UCLM
Angel.Alcazar@uclm.es
@AAlcazarRuiz

4 RESULTS

Sample characterisation

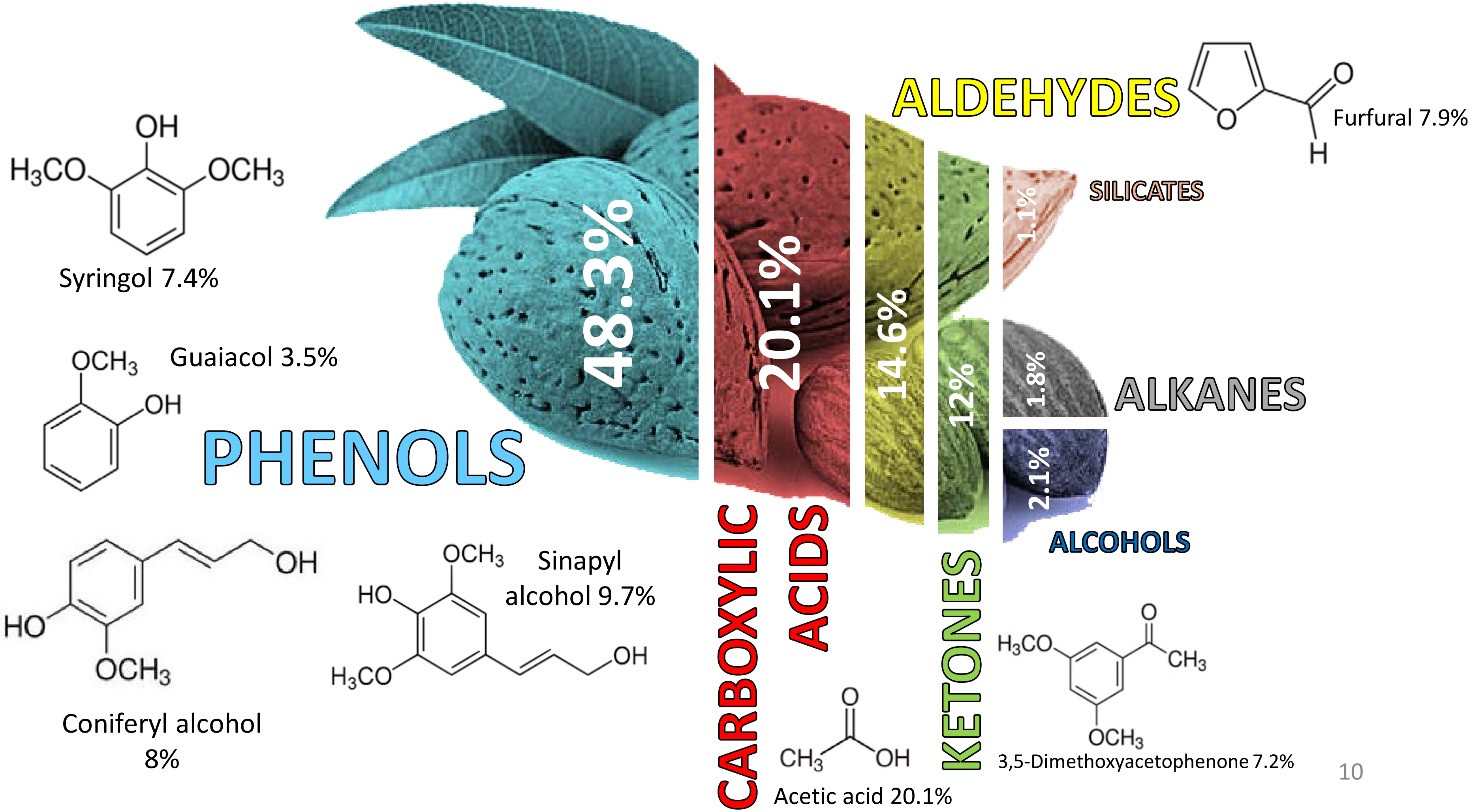
Sample	Proximate analysis (wt.%)^{*daf}				Ultimate analysis (wt.%)^{*daf}				HHV (MJ/kg)	H/C_{eff}
	Moisture	Ash	Volatile matter	Fixed carbon^{*diff}	C	H	N	O^{*diff}		
	3.11	4.24	78.48	14.16	47.21	5.71	0.45	46.6	18.3	0.3
PE	0.45	0.22	99.27	0.06	85.70	14.20	0.05	0.05	46.63	1.98
PS	0.26	2.39	97.30	0.04	92.31	7.72	0	0	41.27	1.01

	Mineral content (wt.%)			
	Ca	K	Mg	Na
	0.29	1.16	0.032	0.058

	Chemical composition (wt.%)^{db}		
	Lignin	Cellulose	Hemicellulose
	13.4	28.1	39.7

Angel.Alcazar@uclm.es
@AAlcazarRuiz

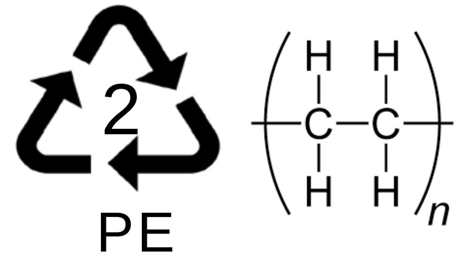
AS Fast pyrolysis

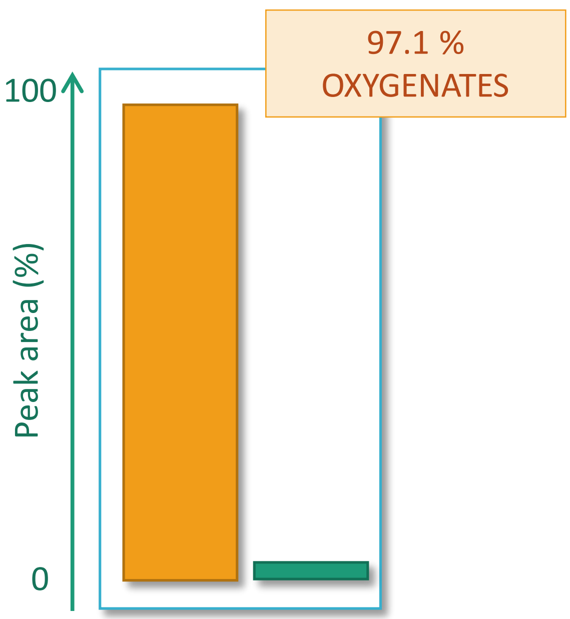


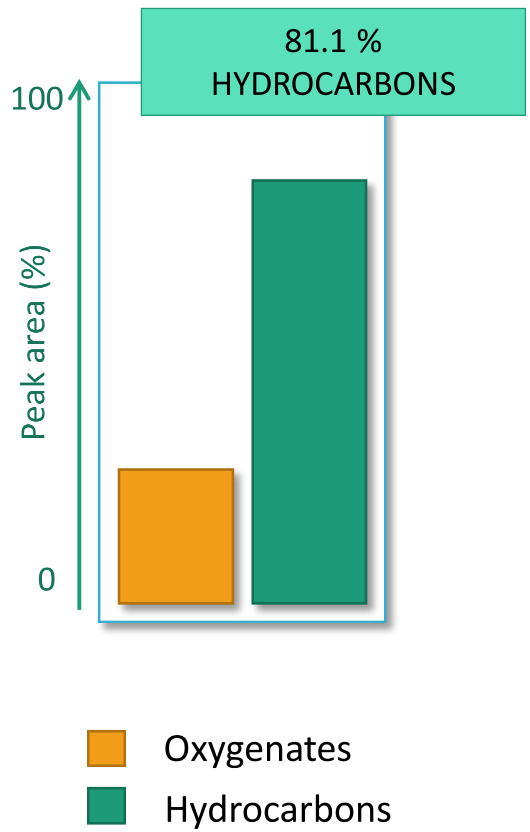
UCLM
Angel.Alcazar@uclm.es
@AAlcazarRuiz

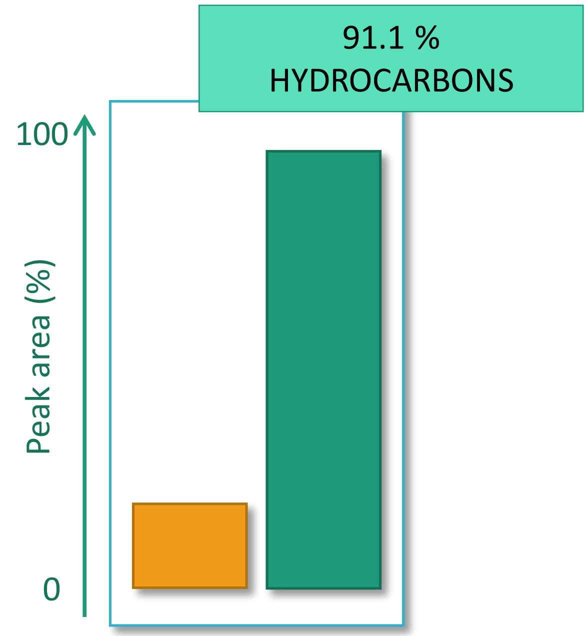
Co-fast pyrolysis of AS/PE

1.5:1 AS/PE



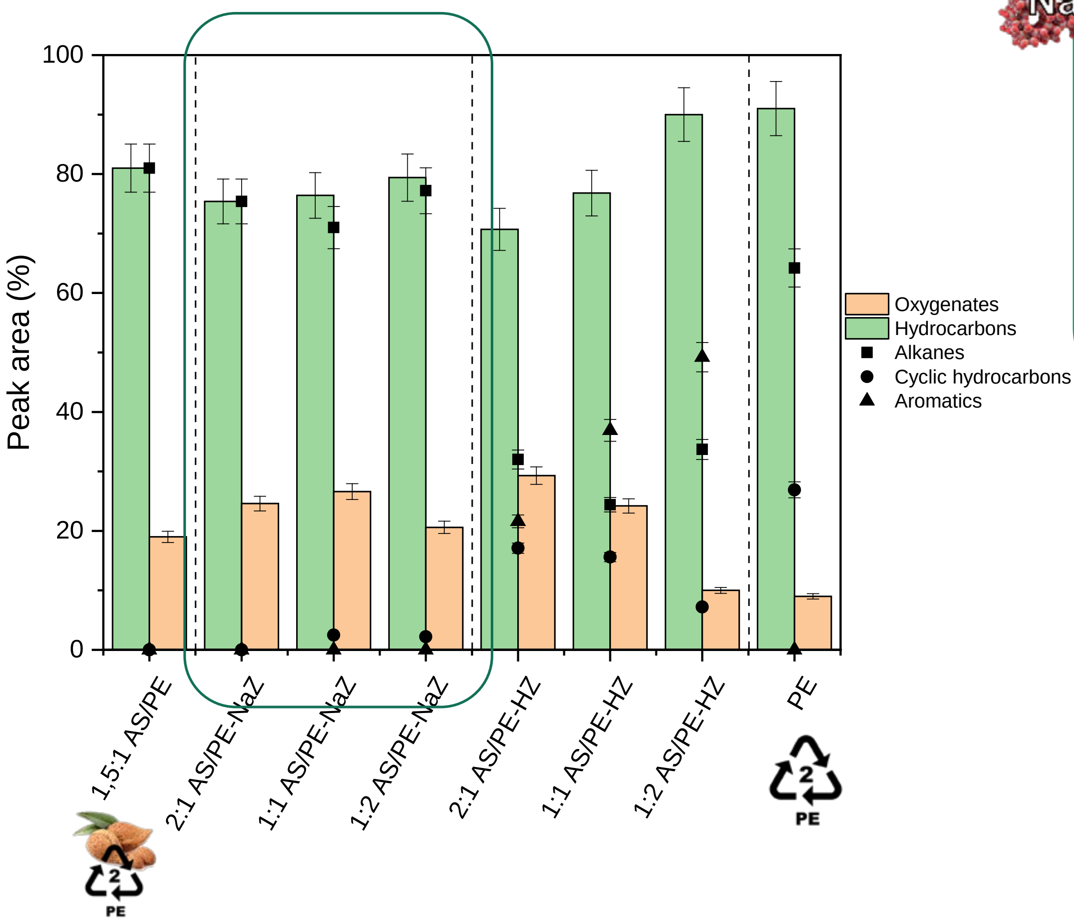






UCLM
Angel.Alcazar@uclm.es
@AAlcazarRuiz

Catalytic fast pyrolysis of AS/PE



- Slightly enhancement of OXYGENATES

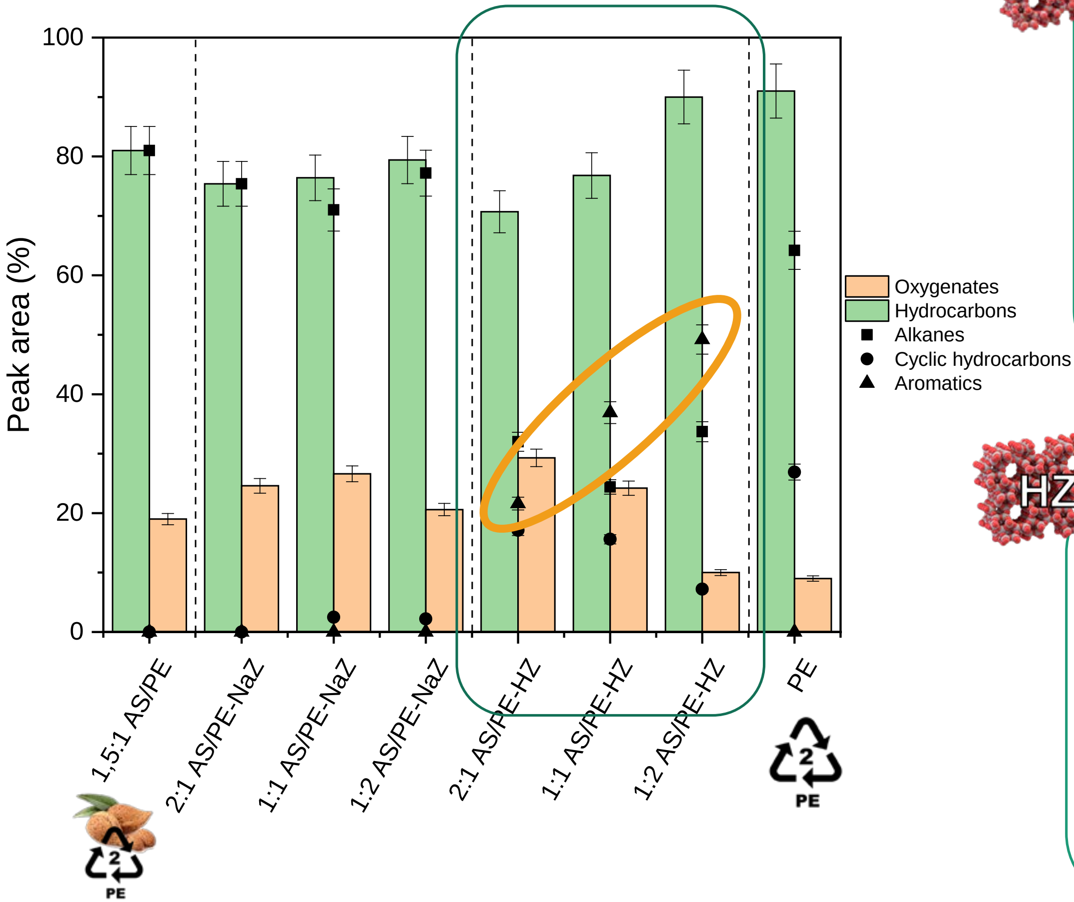
→ PHENOL AND ACIDS

- Combined Catalytic effect

Inherent AAEMs + extra Na^{+} (NaZ)

Angel.Alcazar@uclm.es
@AAlcazarRuiz

Catalytic fast pyrolysis of AS/PE



- Slightly enhancement of OXYGENATES

→ PHENOL AND ACIDS

- Combined Catalytic effect

Inherent AAEMs + extra Na^{+} (NaZ)

HZ

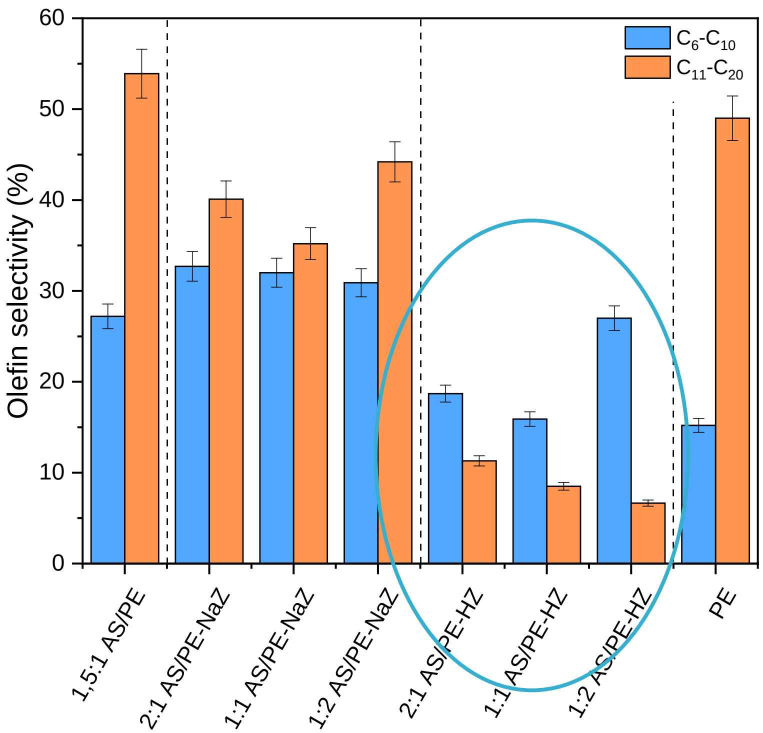
↑ HYDROCARBON production

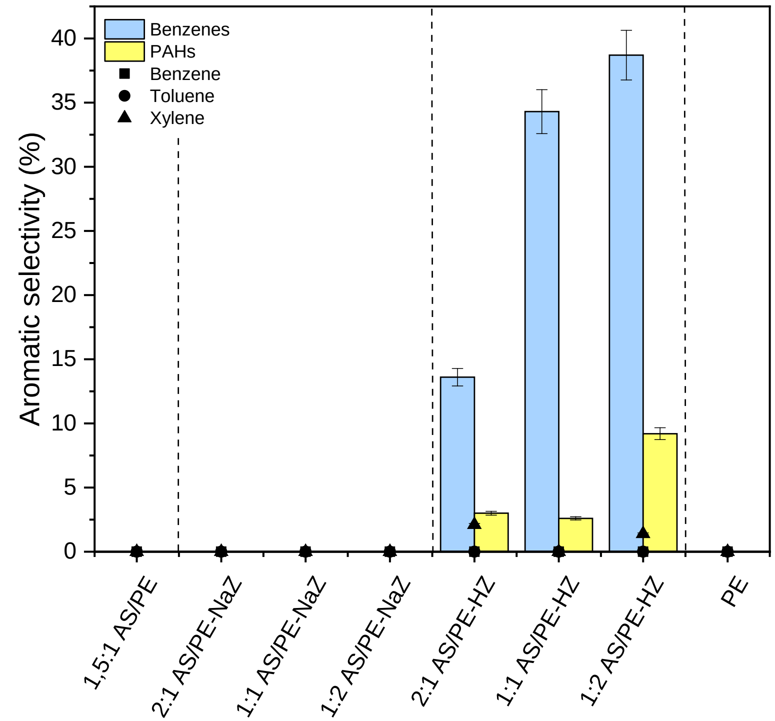
70.7 to 90% yield as HZ ↑

Diversity of hydrocarbon compounds:

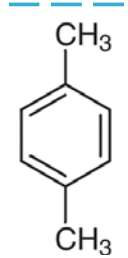
AROMATICS ✓

UCLM
Angel.Alcazar@uclm.es
@AAlcazarRuiz





AROMATICS (%) increase in detriment of ALIPHATIC fraction



↑ p-xylene

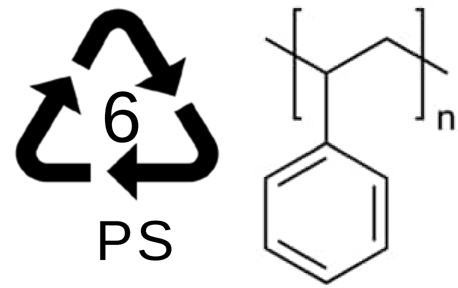
- 2.1% (2:1 AS/PE-HZ)
- 1.4% (1:2 AS/PE-HZ)

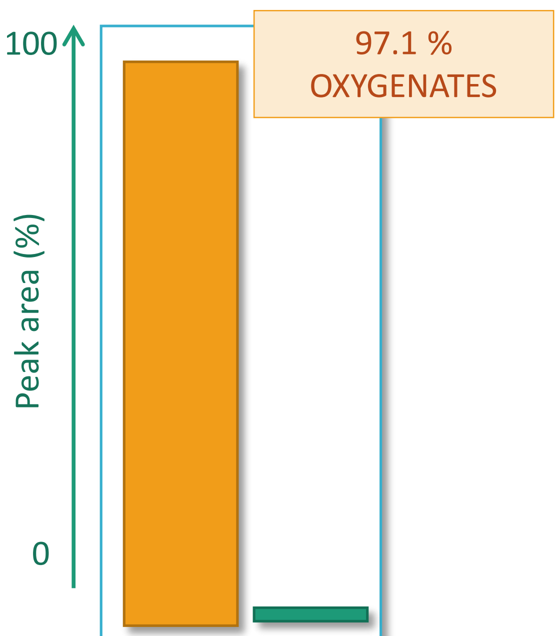
MAHs > PAHs

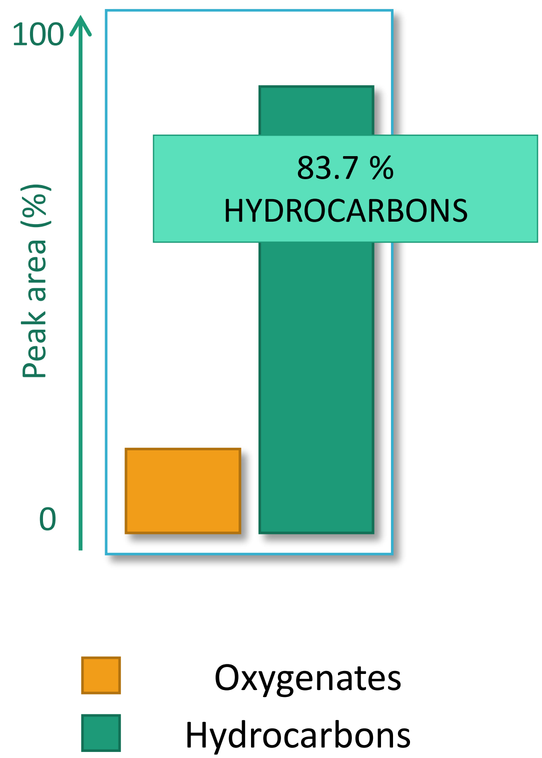
Angel.Alcazar@uclm.es
@AAlcazarRuiz

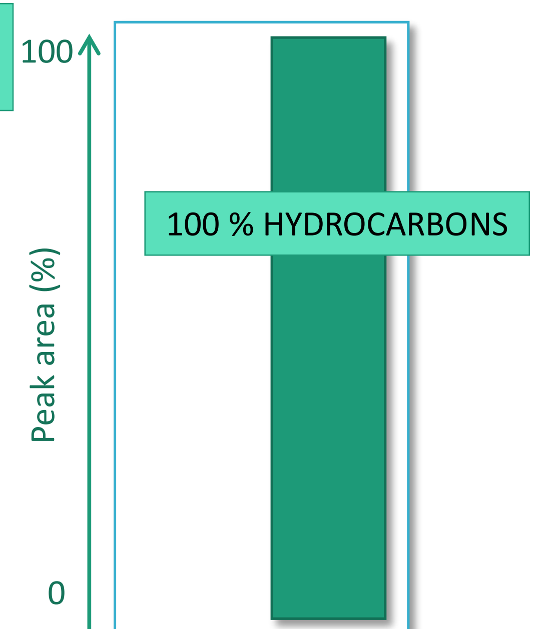
Co-fast pyrolysis of AS/PS

1:1.5 AS/PS



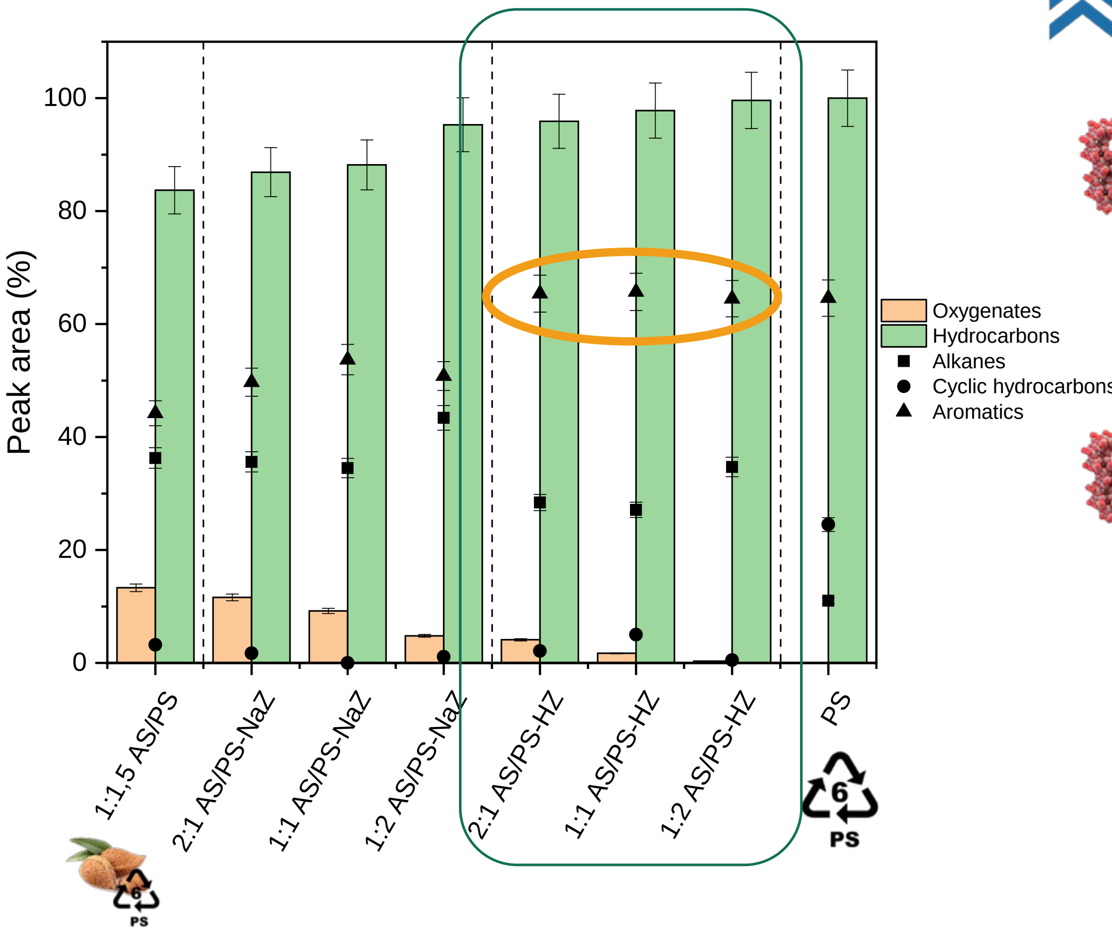






Angel.Alcazar@uclm.es
@AAlcazarRuiz

Catalytic fast pyrolysis of AS/PS



HYDROCARBON COMPOUNDS (%)

Inherent AAEMs + extra Na^+ (NaZ)

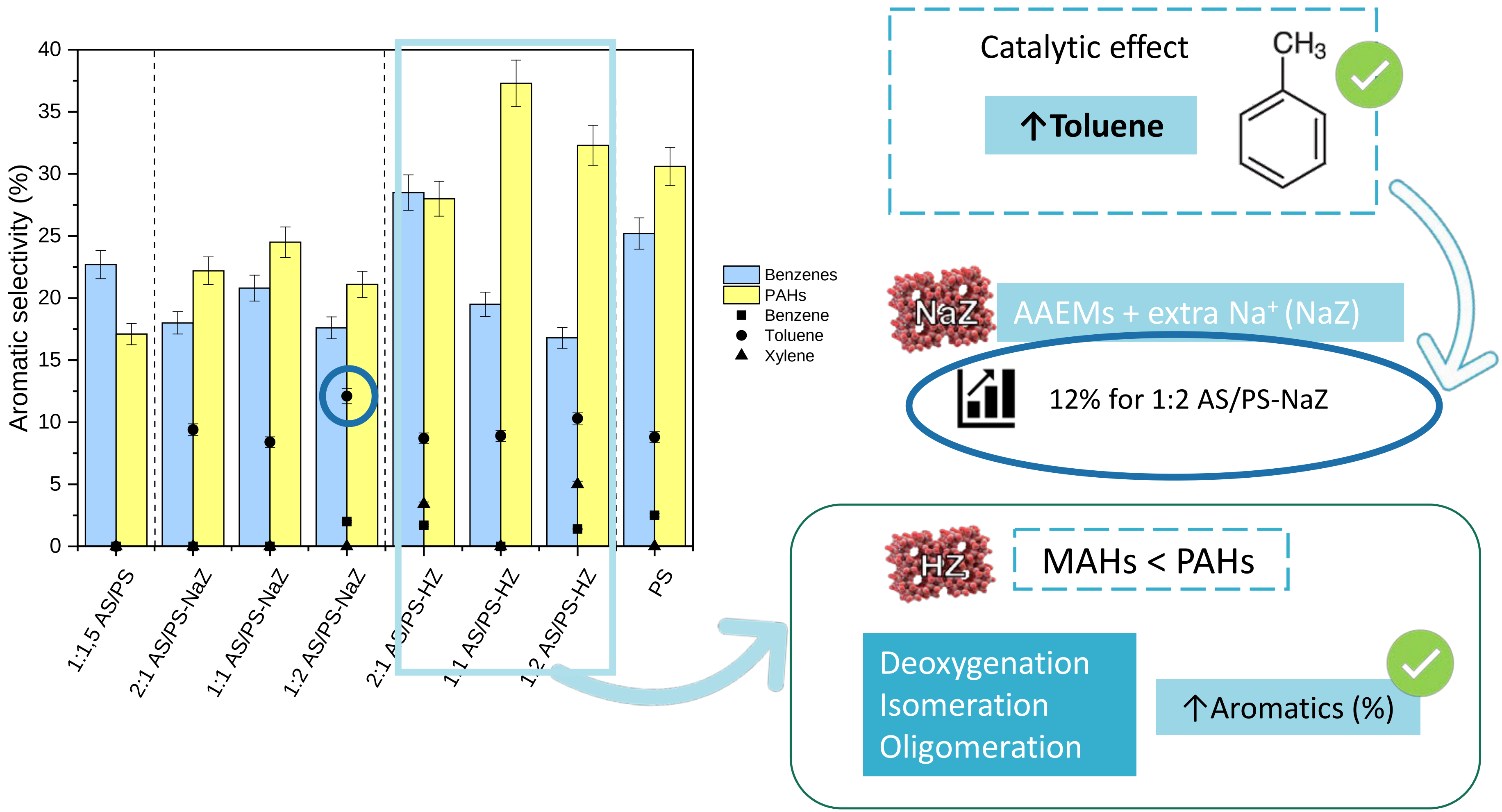
↑MAHs > ↓PAHs

↑ HYDROCARBON production

100% for 1:2 AS/PS-HZ

↑Aromatic compounds

UCLM
Angel.Alcazar@uclm.es
@AAlcazarRuiz

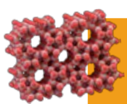


UCLM
Angel.Alcazar@uclm.es
@AAlcazarRuiz

5 CONCLUSIONS

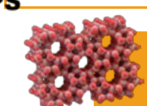
Catalytic co-fast pyrolysis of AS/PE and AS/PS blends enhanced hydrocarbon selectivity due to the catalytic action of zeolites.

In 1.5:1 AS/PE hydrocarbon fraction rose to 81 % yields: aliphatic compounds distributed 27.2 % in light olefins (C_6-C_{11}) and 54 % of long chains olefins (C_{11}-C_{20}).



AS/PE-HZ Zeolite action (HZSM-5): fomented the formation of AROMATICS up to 45 % yield.

In AS/PS hydrocarbon selectivity reached the 84 % yield.



AS/PS-HZ produced 100% hydrocarbon compounds, being toluene enhanced.

CORFU2022

THANKS FOR YOUR ATTENTION!

Hydrocarbon selectivity enhancement through catalytic fast co-pyrolysis of almond shell and plastic wastes blends

A. Alcazar-Ruiz, L. Sanchez-Silva, F. Dorado
Department of Chemical Engineering, University of Castilla-La Mancha, Ciudad Real, 13071, Spain

Angel.Alcazar@uclm.es
@AAlcazarRuiz

Junta de Comunidades de Castilla-La Mancha
Proyect SBPLY/17/180501/000238