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Using the jiggled bed reactor to develop activated carbons from biomass residues

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Using the Jiggle Bed Reactor to Produce Activated Carbons from Biomass Residues

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Biomass pyrolysis

BIOMASS → PYROLYSIS

PYROLYSIS → GAS (10-20%)

PYROLYSIS → CONDENSABLE VAPORS (BIO-OIL) (50-70%)

PYROLYSIS → BIOCHAR (20-30%)

BIO-CHAR production

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Objectives of our Research

- **Bio-Char production** from a variety of **biomass residues and wastes** using different technologies and under different operating conditions followed by **activation**

- **Characterization**

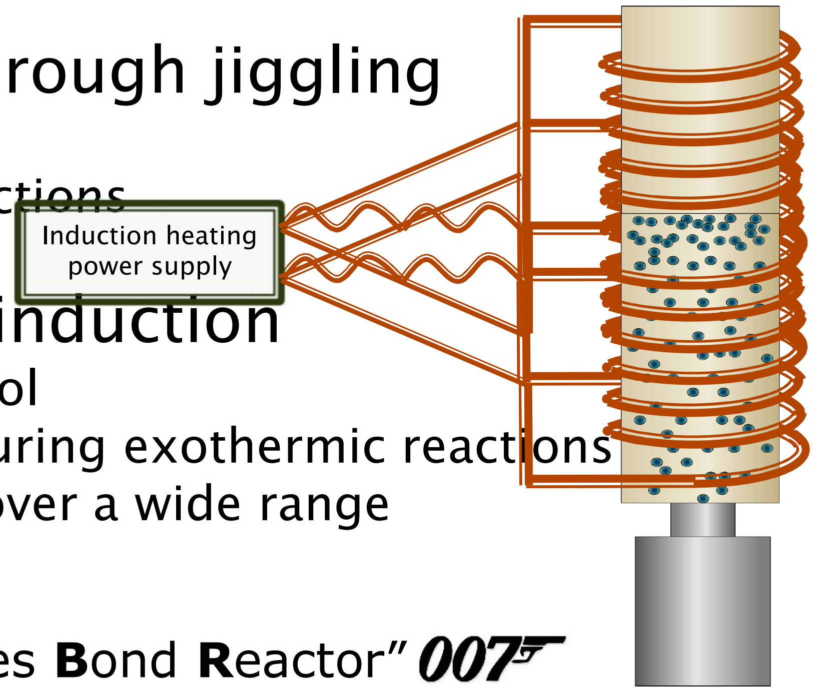
- Studies on the **potential use for adsorption of selected pollutants**

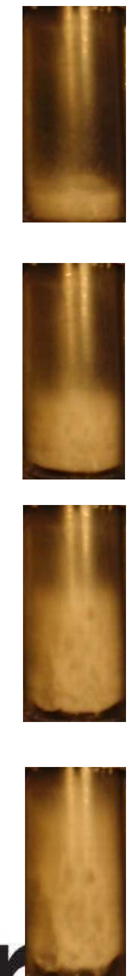
Biomass selection: 13 biomasses

Energy crops	Crop residues	Seeds	Milling residues
Willow	Wheat Straw	Sorghum	Olive Residue
Miscanthus	Corn Stover	Sunflower Husks	Bagasse
	Canola Straw		Birch Bark
Switchgrass			
			Lignin
			Maple wood

The "Jiggle Bed" Reactor (JBR)*

- Micro-reactor developed for catalyst screening
- Fluidization achieved through jiggling
  - No fluidization gas
  - Ideal to study gas-solid reactions
- Heat provided through induction
  - Excellent temperature control
  - Fast response to changes during exothermic reactions
  - Heating rate can be varied over a wide range





*…also designated as the "**J**ames **B**ond **R**eactor" 007

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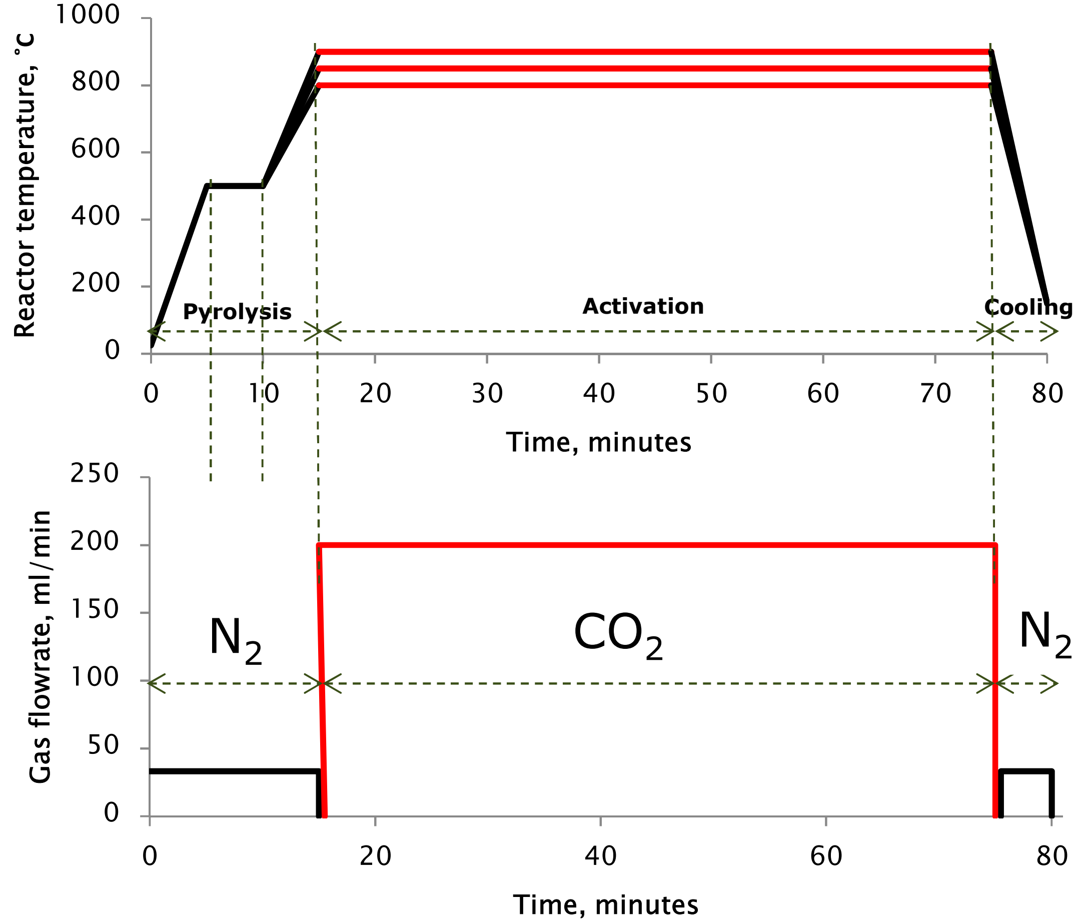
Experimental procedure: PYROLYSIS and ACTIVATION



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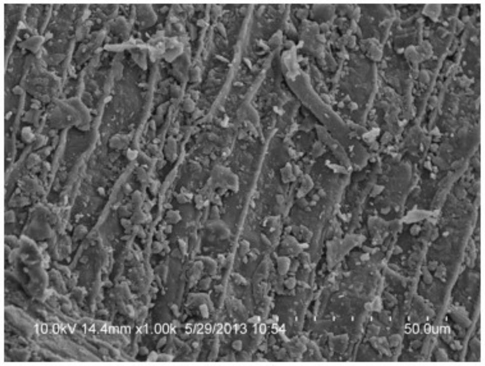
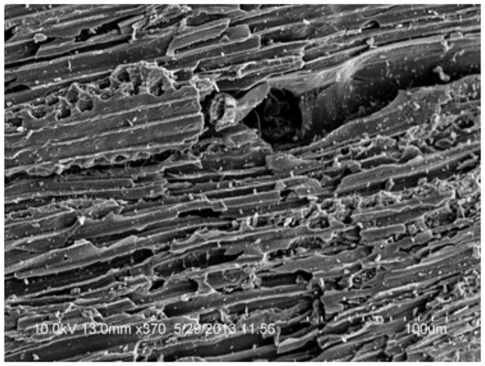
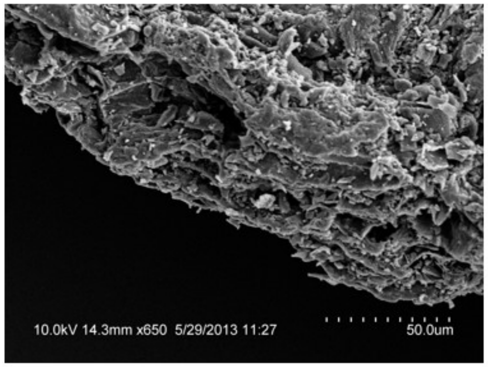
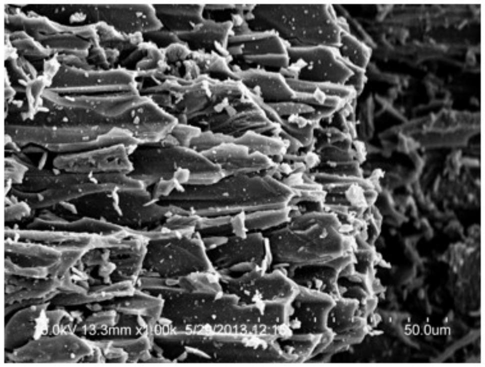
Bio-Char Activation





Surface overview for non activated and activated biochar from birchwood





Surface detail for non activated and activated biochar from birchwood

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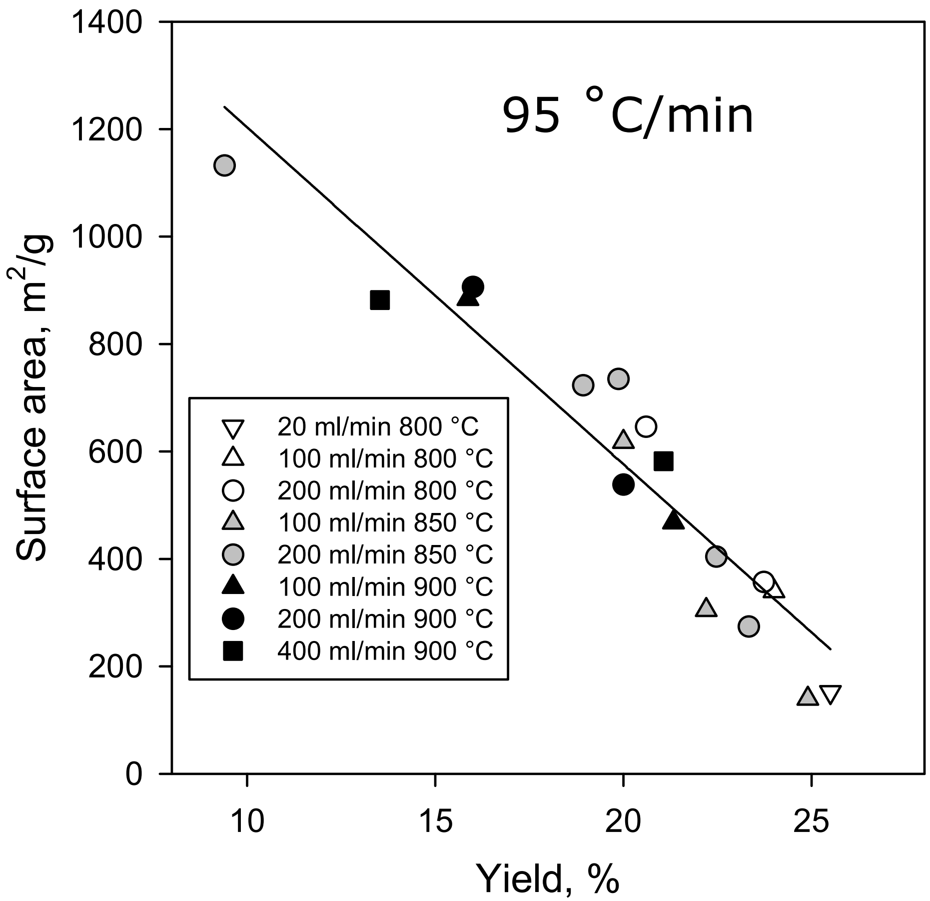
Slow Pyrolysis + Activation
(olive residue)



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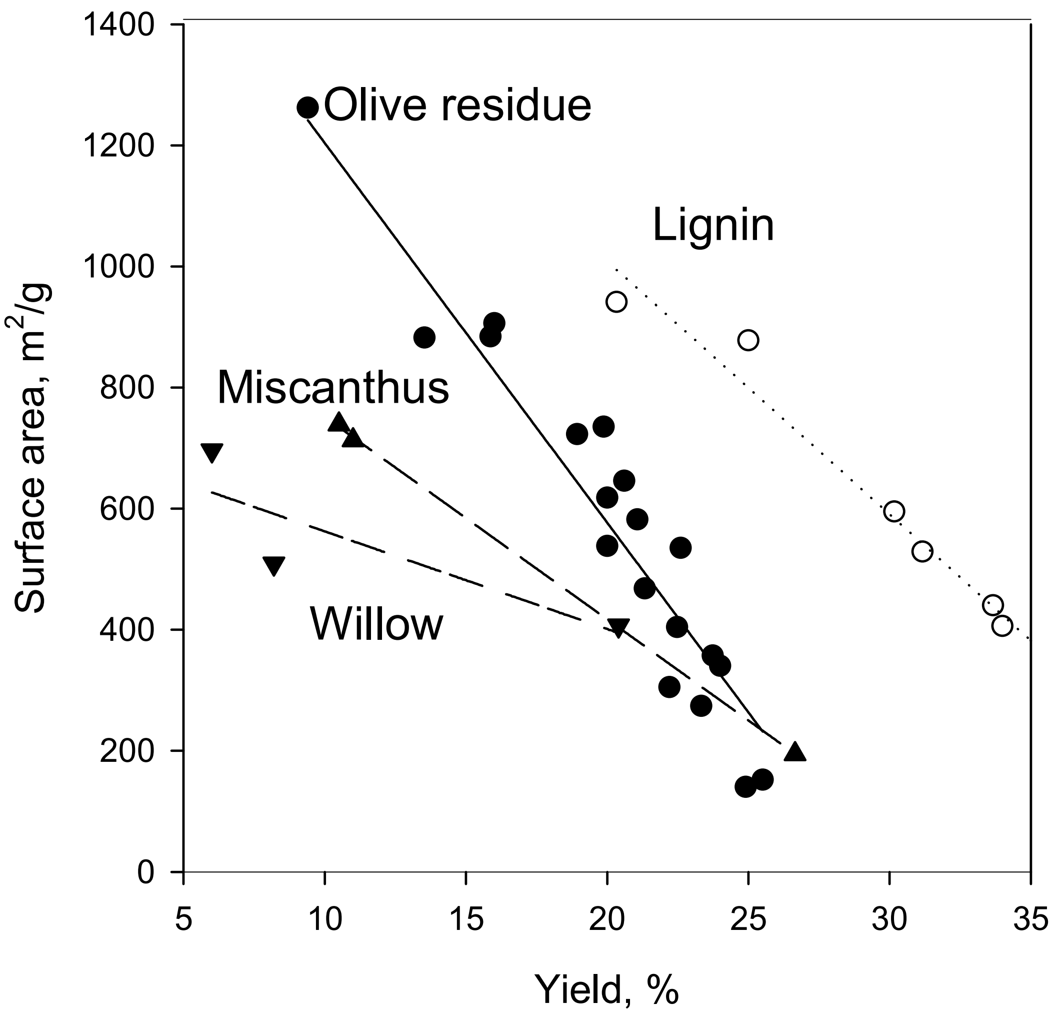
Feedstocks comparison



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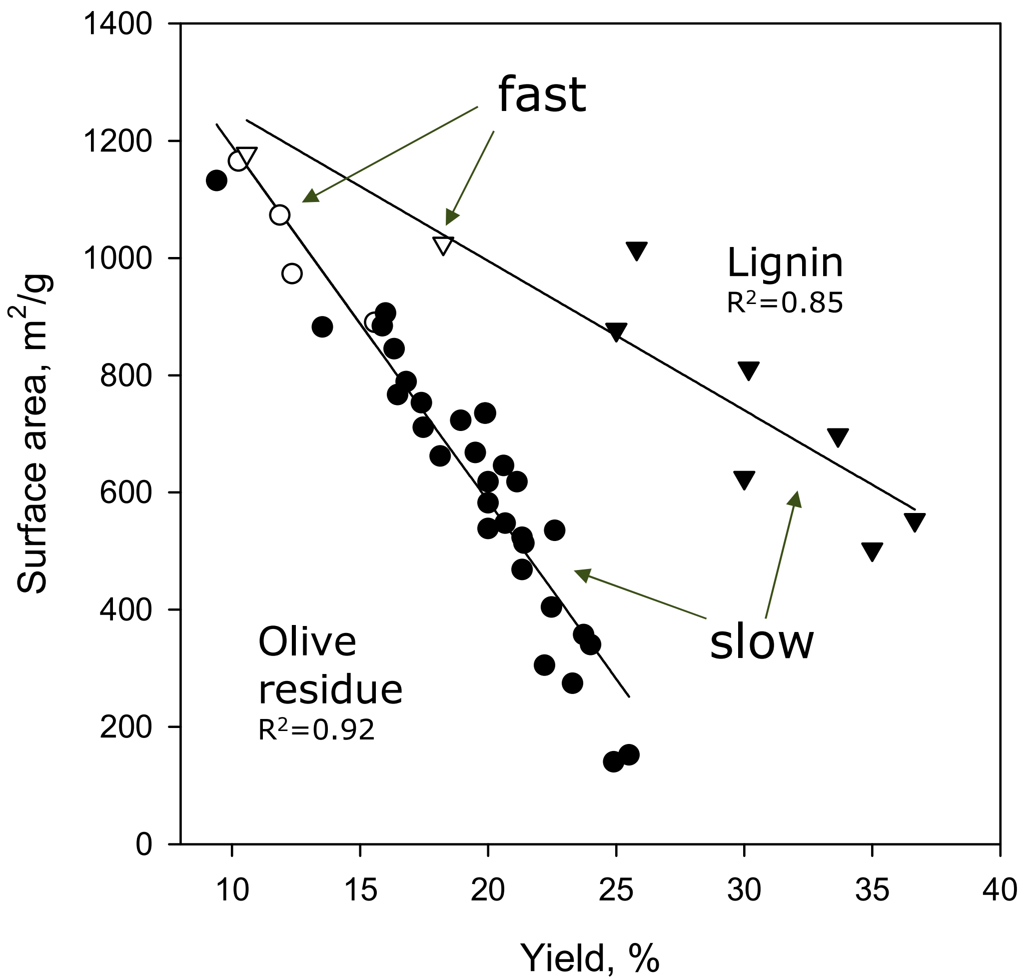
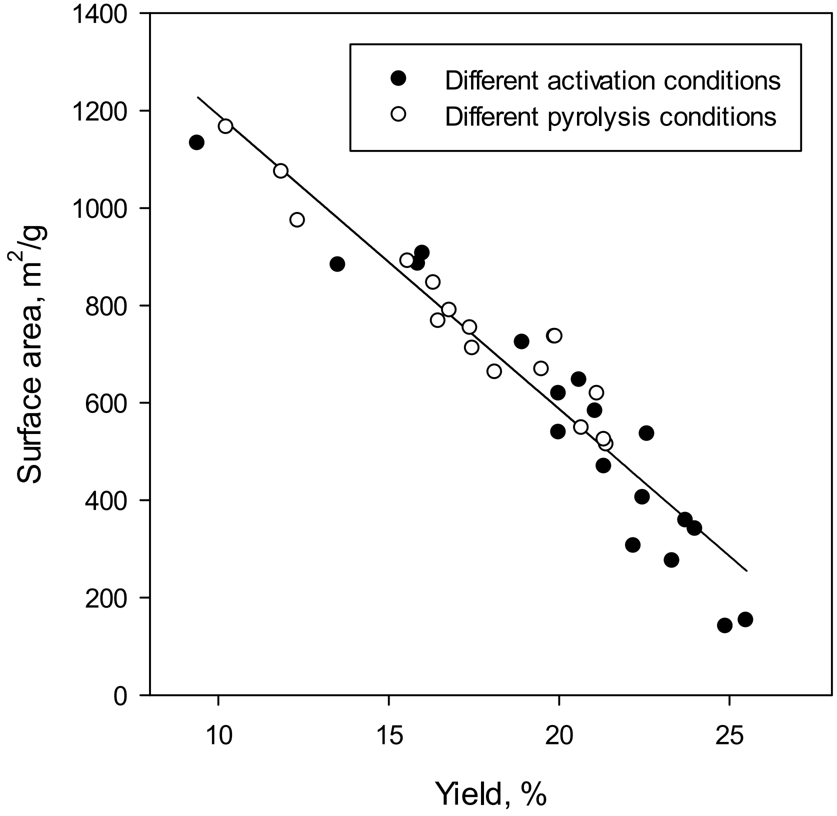
Slow and fast pyrolysis



Universal relationship (olive residue)



For every feedstock, a unique relationship exists between total surface area and yield!

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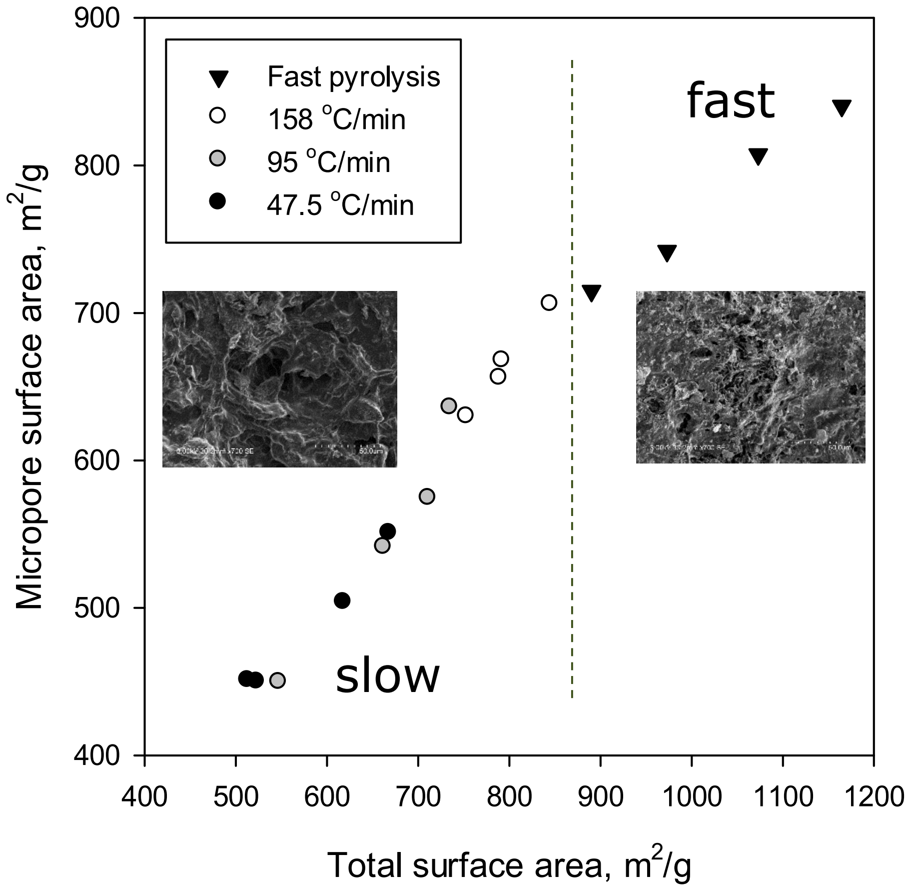
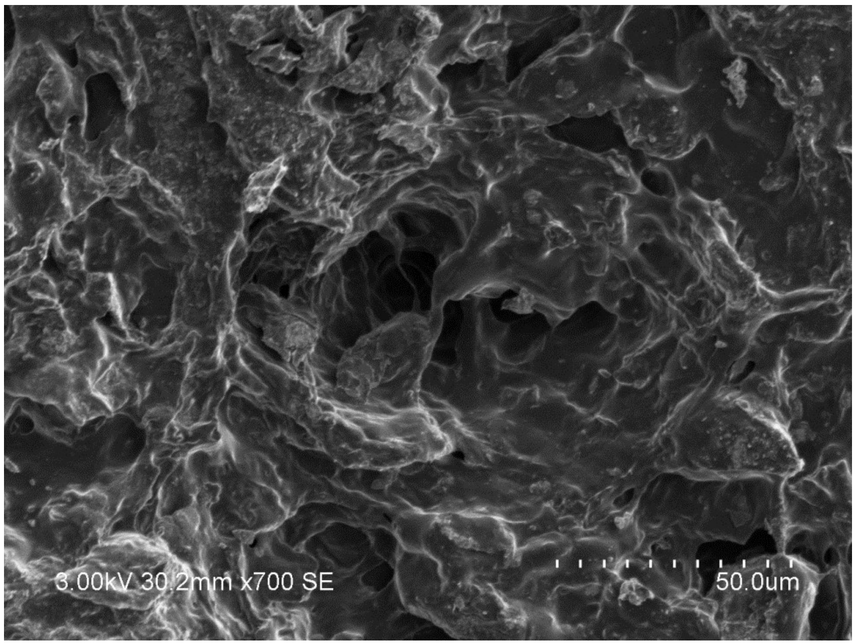
Impact of pyrolysis conditions on the porous structure (olive residue)

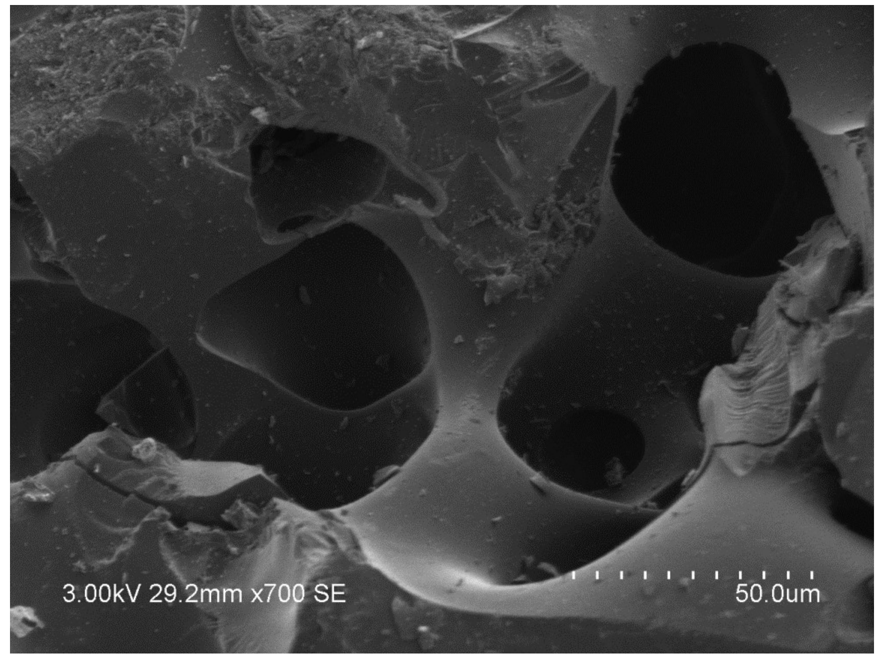


However, the distribution of micropores and mesopores depends on the pyrolysis conditions

Comparison of activated charcoal from different feedstocks

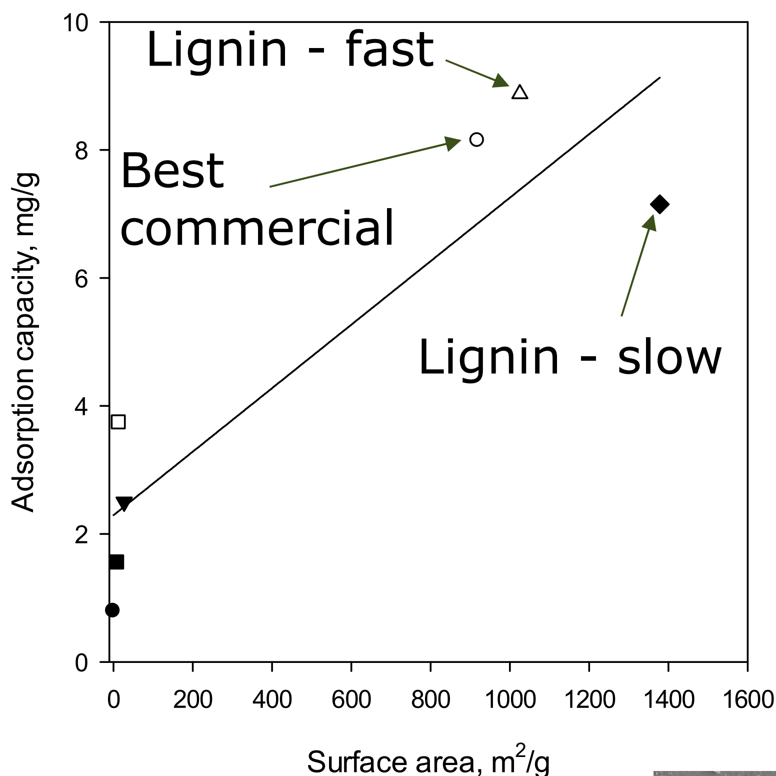


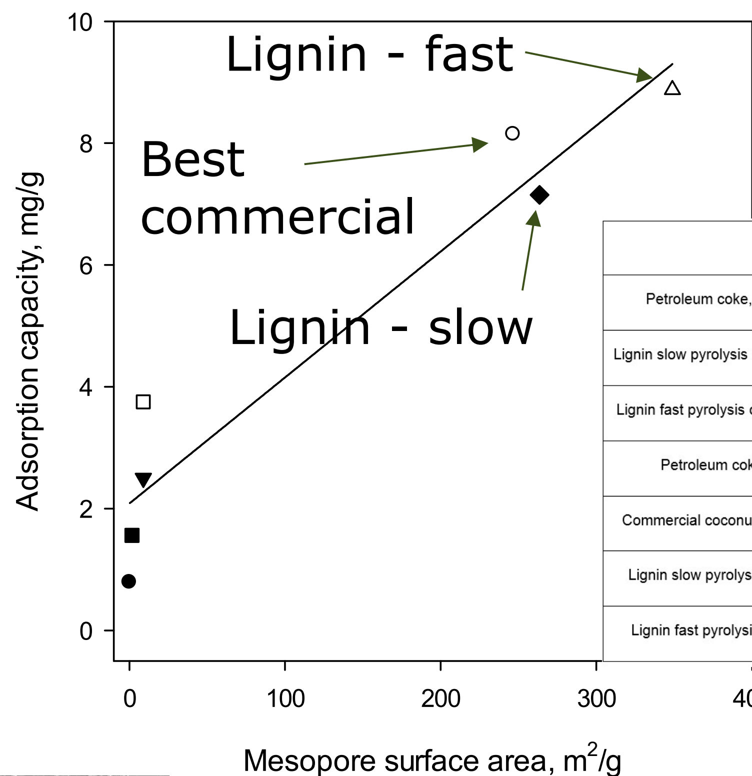
Olive residue
(more **micropores**)



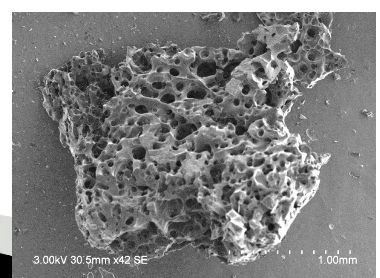
Lignin
(more **mesopores**)

Adsorption of Naphthenic Acids





	Symbol
Petroleum coke, non-activated	■
Lignin slow pyrolysis char, non-activated	●
Lignin fast pyrolysis char, non-activated	▼
Petroleum coke, activated	□
Commercial coconut activated carbon	○
Lignin slow pyrolysis char, activated	◆
Lignin fast pyrolysis char, activated	△



Activated lignin bio-char

Key conclusions

- Bio-Char is a valuable co-product of pyrolysis of residual biomasses and wastes
- In order to increase its value, it can be successfully be activated
- Activation can reduce significantly the mass and increase significantly the porosity: for every feedstock a unique relationship exists between yield and surface area
- Activated Bio-char is an effective adsorbent

Acknowledgments

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