

Research Area Lignocellulose

Objective

Substitution of fossil-based carbonaceous electrode materials by bio-based activated carbon (AC)

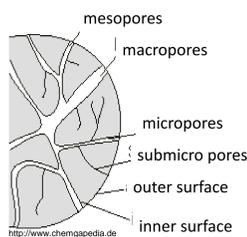
Materials and Methods



Carbonization of Biomass

Hydrothermal carbonization (HTC)
~ 2 - 10 bar
180 - 250 °C
~ 2 - 6 h

Pyrolysis (PY)
~ 500 - 600 °C
30 - 60 min.



KOH activation
KOH/AC ratio 4:1
800 °C



Functionalizing with metall-oxides or heteroatoms



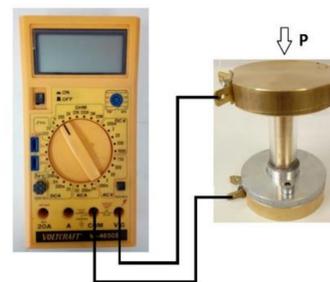
Bio-based electrode materials for Supercaps

Life Cycle Analysis (LCA)

Electrode materials for Supercaps

- good electric conductivity (EC) = low resistance
- high specific surface area (SSA)
- appropriate pore size distribution (PSD)
- surface functionality for redox reactions = high pseudocapacitance

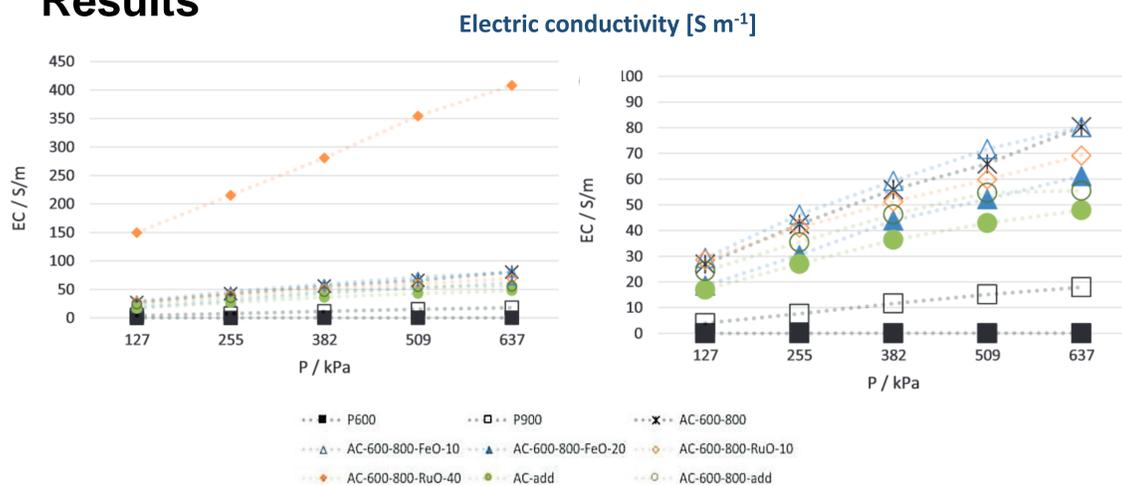
EC measurement



$$\kappa = \frac{h}{R \cdot A}$$

with
 κ = electrical conductivity [S/m]
 h = height of the sample [m]
 R = electrical resistance [Ω]
 A = area of the sample [m²]

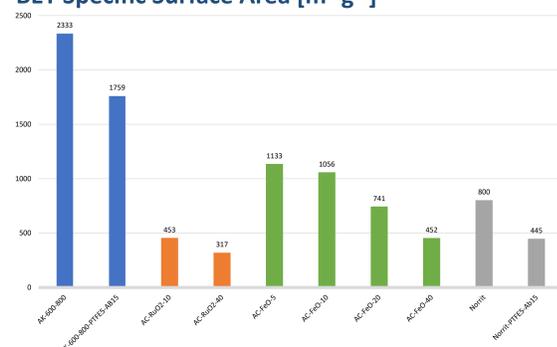
Results



Elementary Analysis

Sample	C (wt.%)	H (wt.%)	N (wt.%)	S (wt.%)	O (wt.%)	Ash (wt.%)
Corncob ¹⁰	46.2	6.2	1.3	N.D.	47.0	0.9
P600	81.7	1.6	0.9	N.D.	7.8	8.2
AC-600-800	95.3	0.1	0.2	N.D.	3.7	0.7

BET Specific Surface Area [m² g⁻¹]



Conclusion and Outlook

- electrode materials for supercapacitors can be produced based on biomass precursors such as corncobs via a carbonization and activation process
- the produced biobased electrode materials show outstanding specific surface areas and good EC values
- the EC increases with the degree of carbonization (C-content)
- EC is positively correlated with the specific surface area in the case of biochar and activated carbon
- After doping the activated carbon with metal oxides, the electric properties of the respective metal oxide dominate the EC property
- Outlook: further analysis regarding the physico-chemical and electrochemical properties (especially capacity of the materials) is necessary

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Biobased electrode materials for sustainable energy storage technologies in the electromobility sector

by Viola Hoffmann (M.Sc.)

Department of Conversion Technologies
of Biobased Resources (440f)





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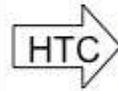
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- 2) Electrode materials for E-Mobility – state of the art
- 3) Biobased electrode materials for E-mobility
- 4) Outlook



1) Introduction

Biomass

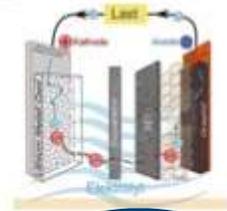


Carbon

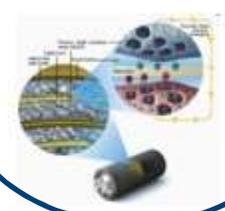


Renewable Energy

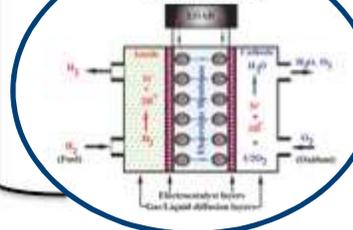
Li⁺/Na⁺ Ion Batteries



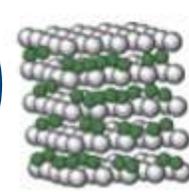
Supercapacitors



Fuel Cells



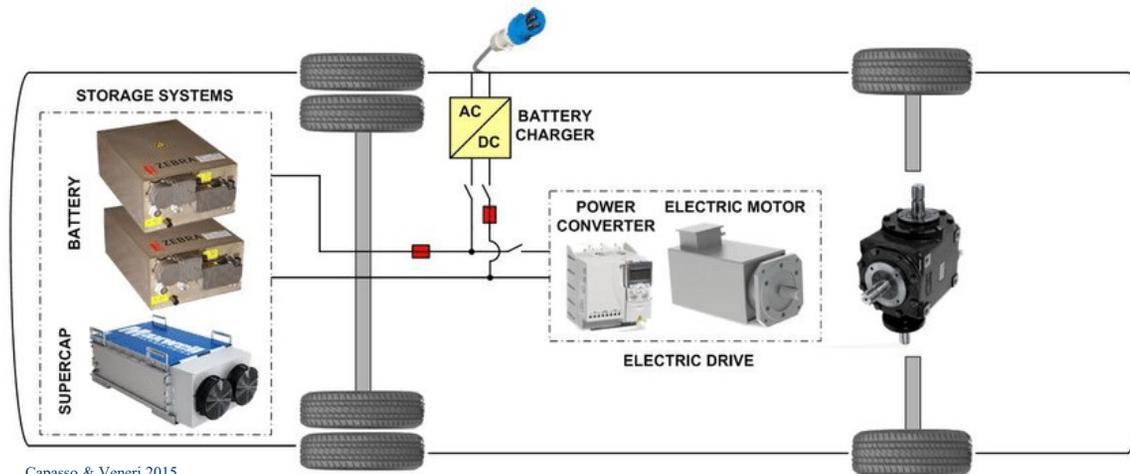
Gas Storage



<http://onlinesize.club/pixie-club.html>

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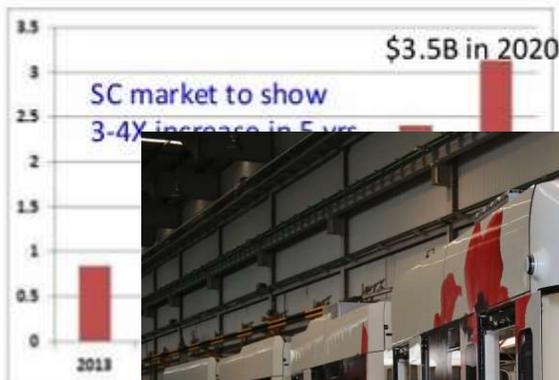
Supercaps



Capasso & Veneri 2015

1) Introduction

Supercaps



<https://www.sli>

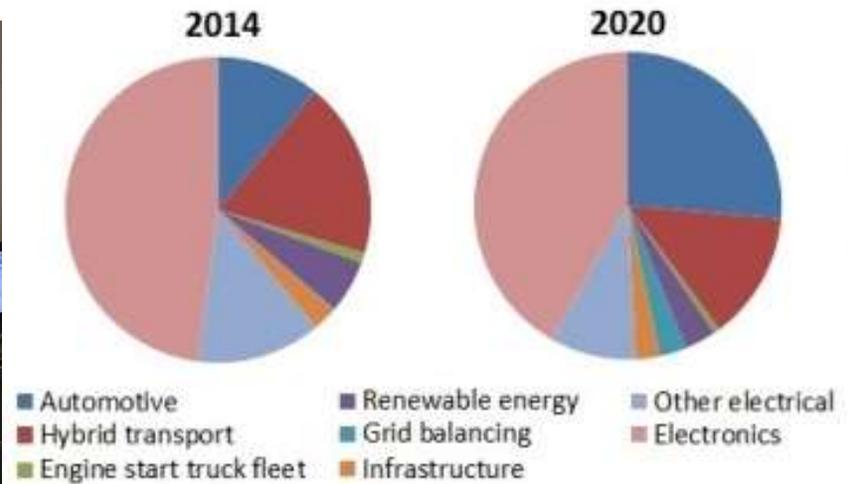


China's CSR ZhuZhou, first tram powered only by Supercaps.

- charged within 10 to 30 sec
- run 4km between charges

<https://www.railwaygazette.com/news/single-view/view/guangzhou-supercapacitor-tram-unveiled.html>

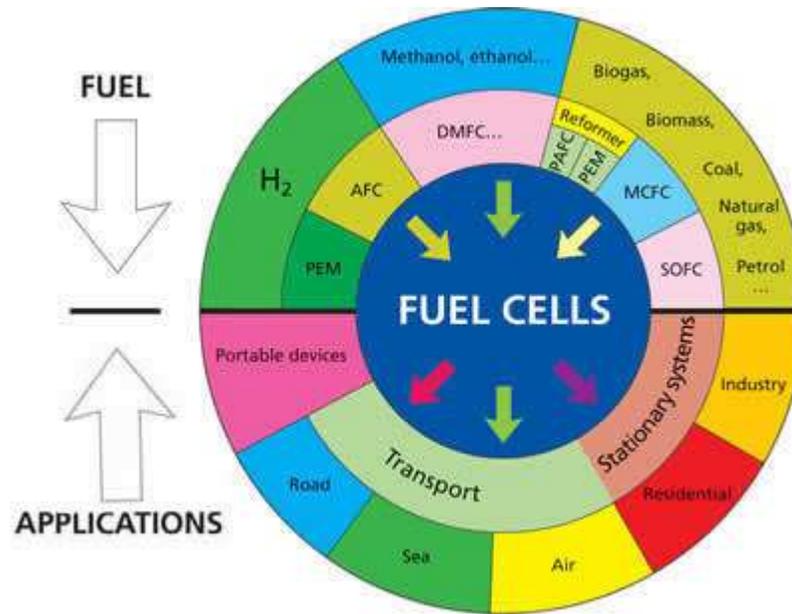
Supercapacitor market shares in 2014 and 2020 by market application



Source: IDTechEx

1) Introduction

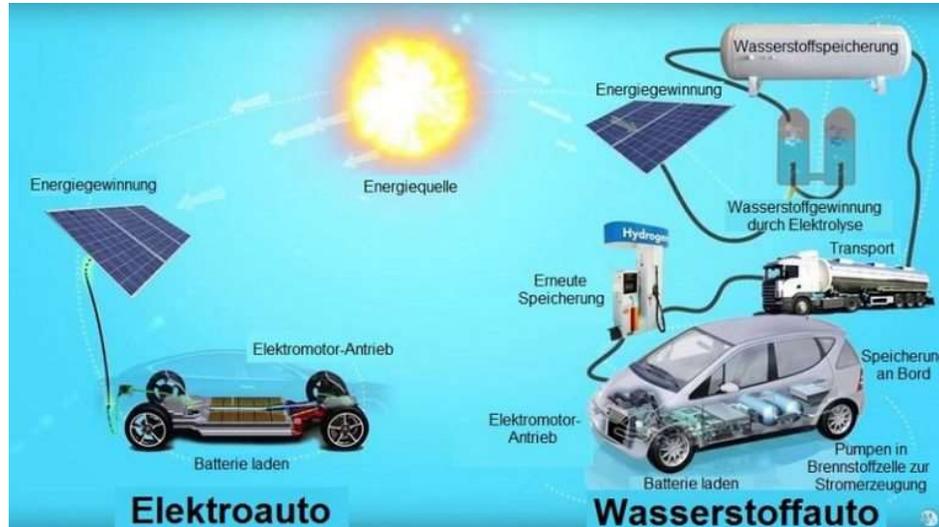
Fuel Cells



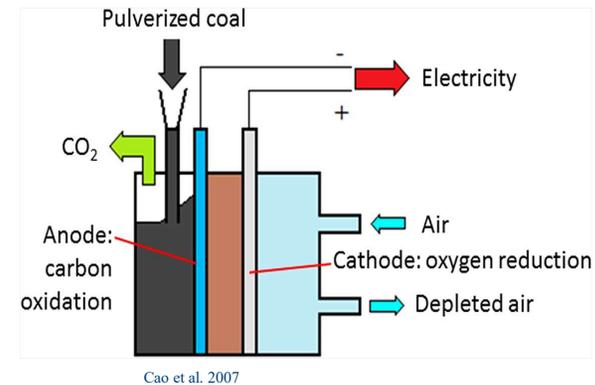
http://www.erevise.com/current-affairs/fuel-cells_art52cfb5437ccb2.html

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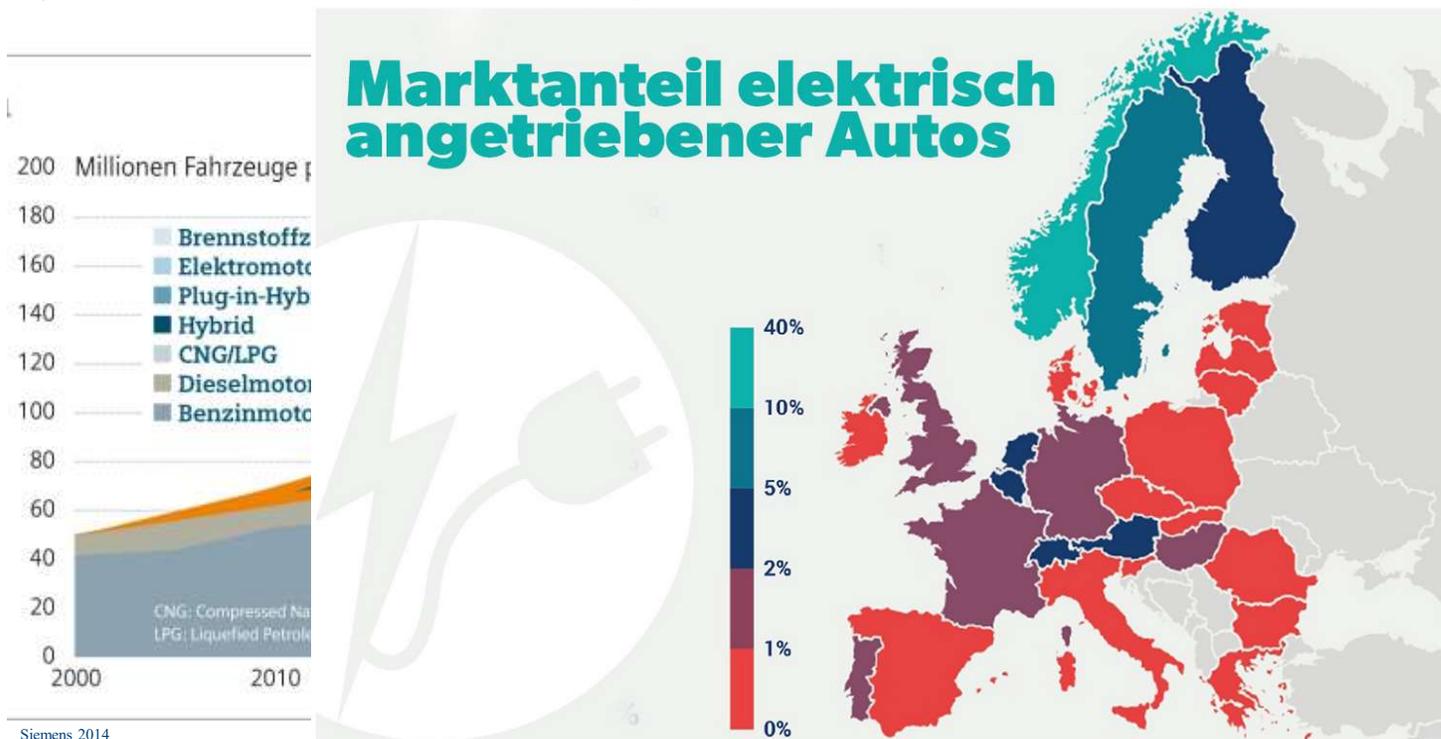
Fuel Cells



<https://wiesoeigentlich.de/alternative-wasserstoffauto/>

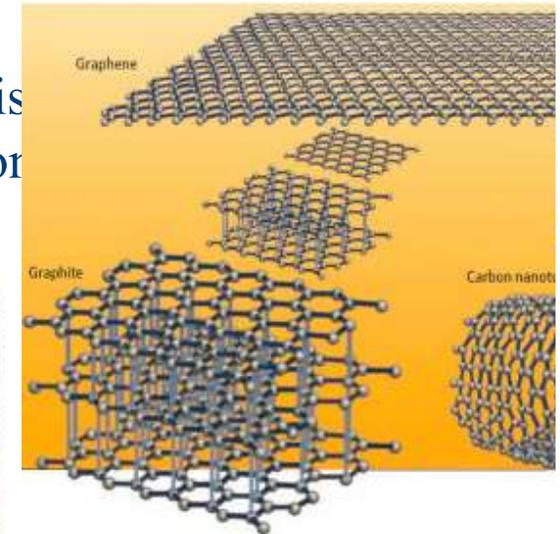
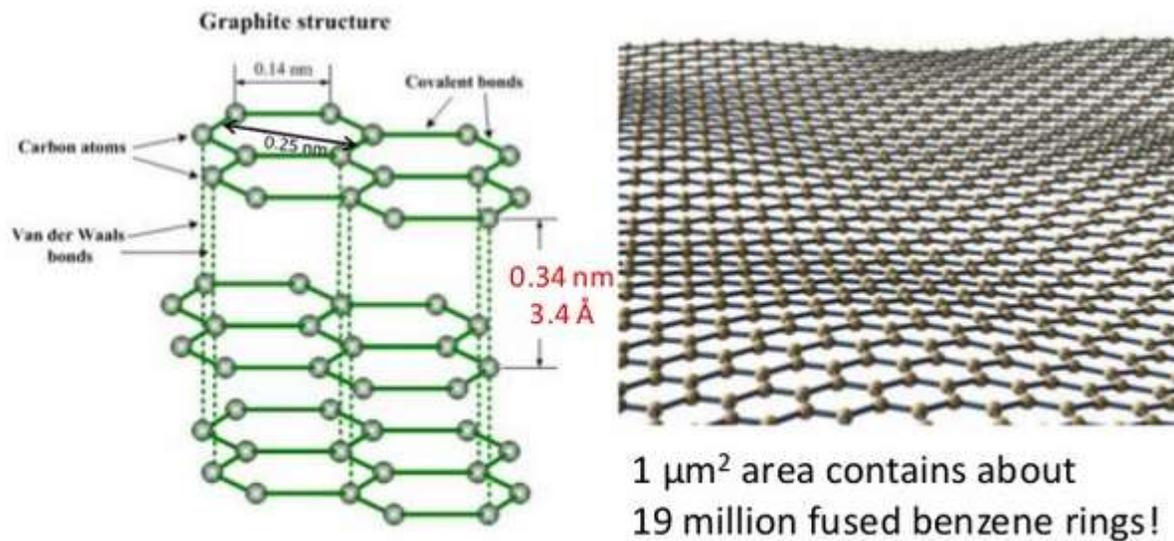


2) Electrode materials for E-Mobility – state of the art

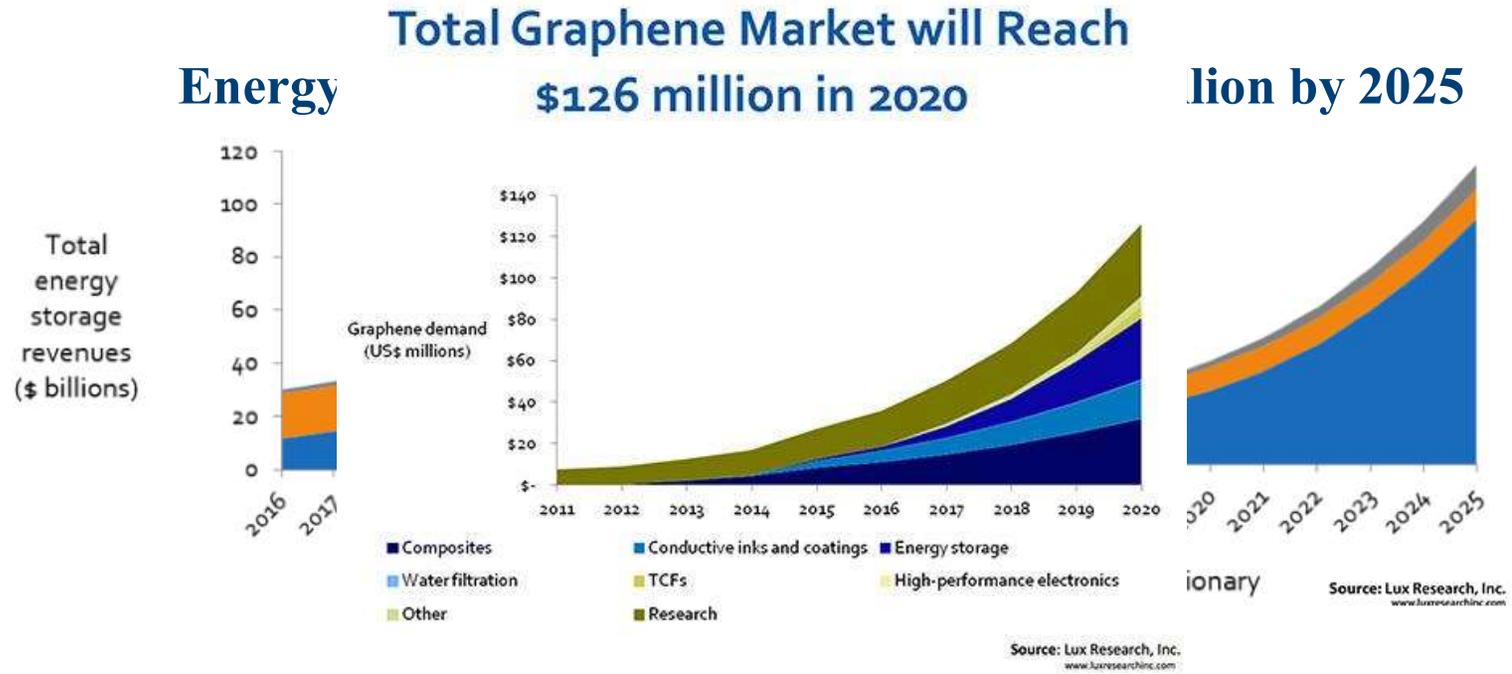


2) Electrode Materials – state of the art

Graphene: the two-dimensional modification of carbon, discovered in 2004 (side note: Al was discovered in 1820, the killer application)

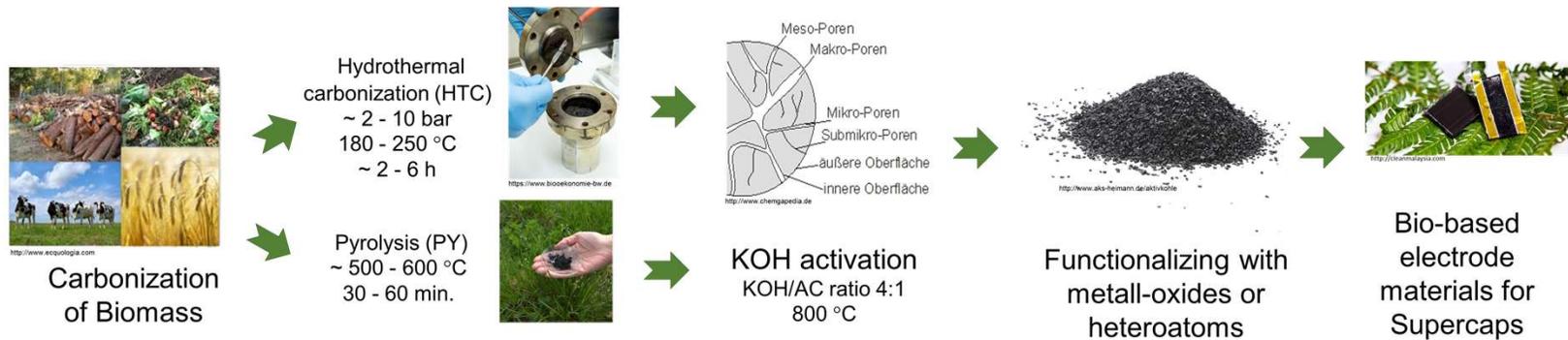


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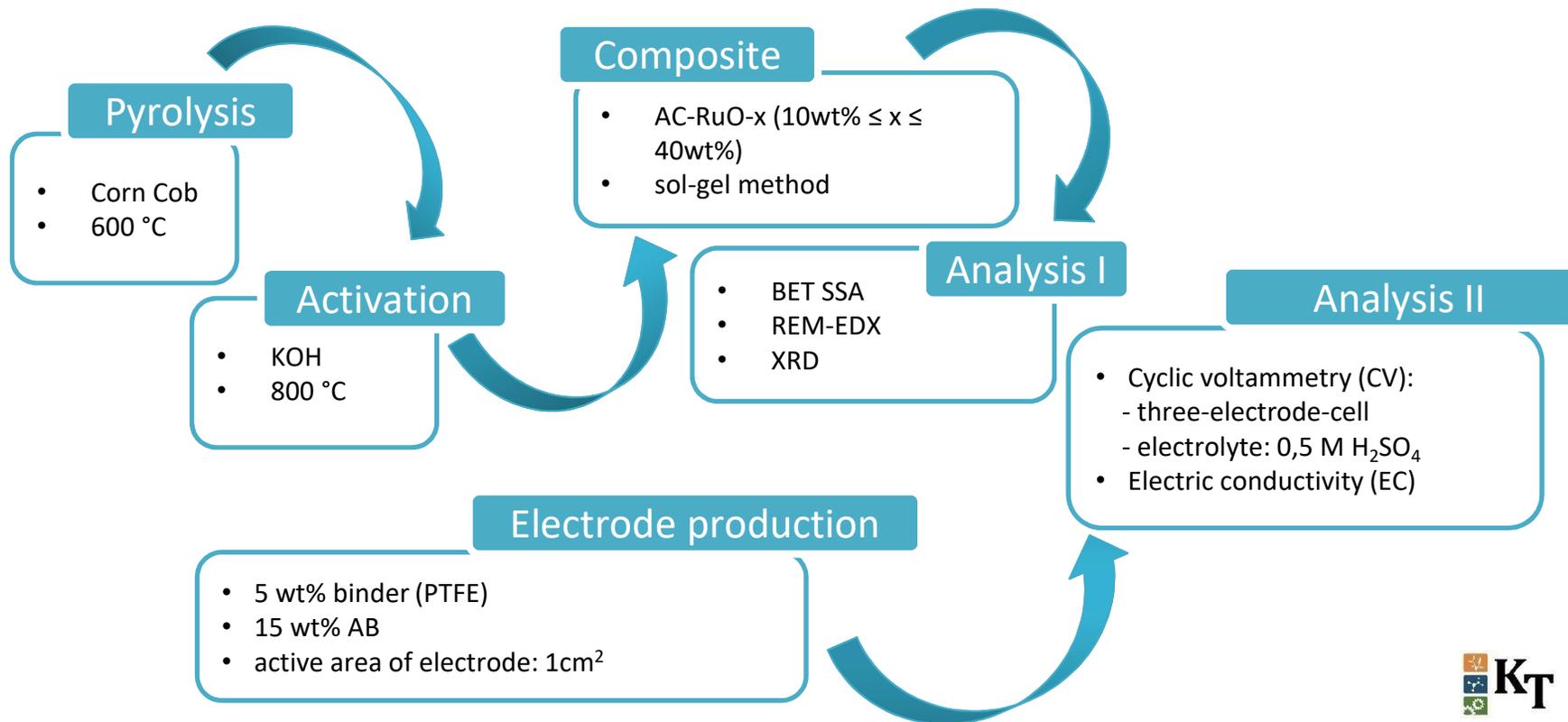


3) Biobased electrode materials for e-mobility

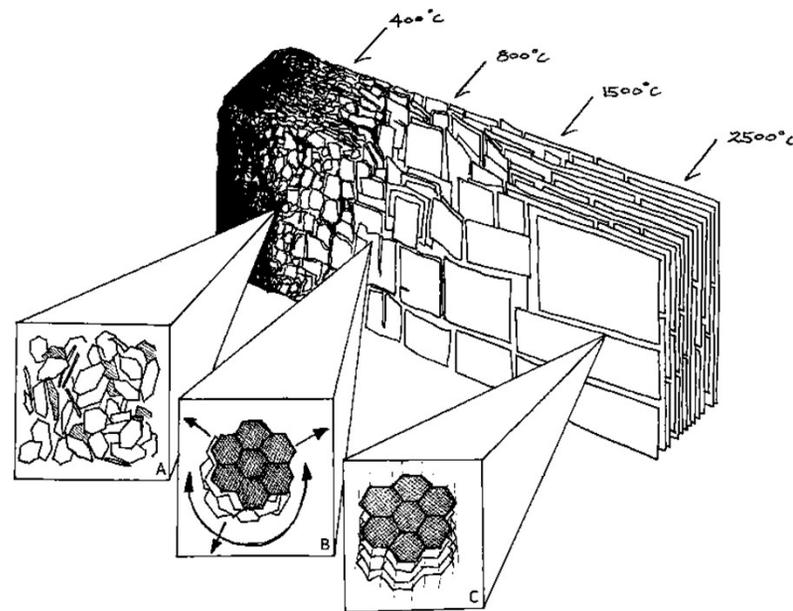
Main Goal: Substitution of fossil-based electrode materials → contribution to biobased resource platform for bioeconomy



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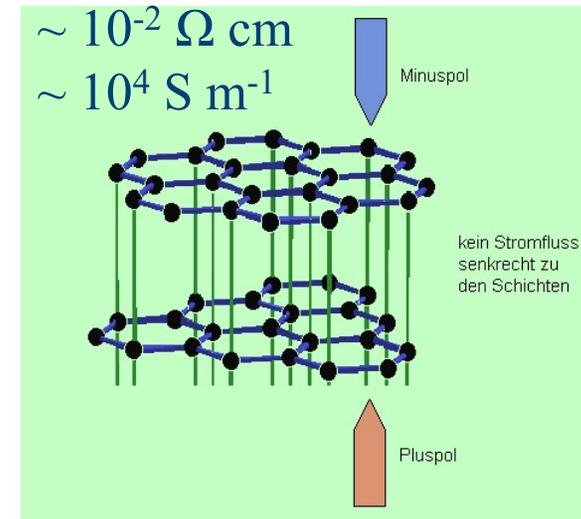
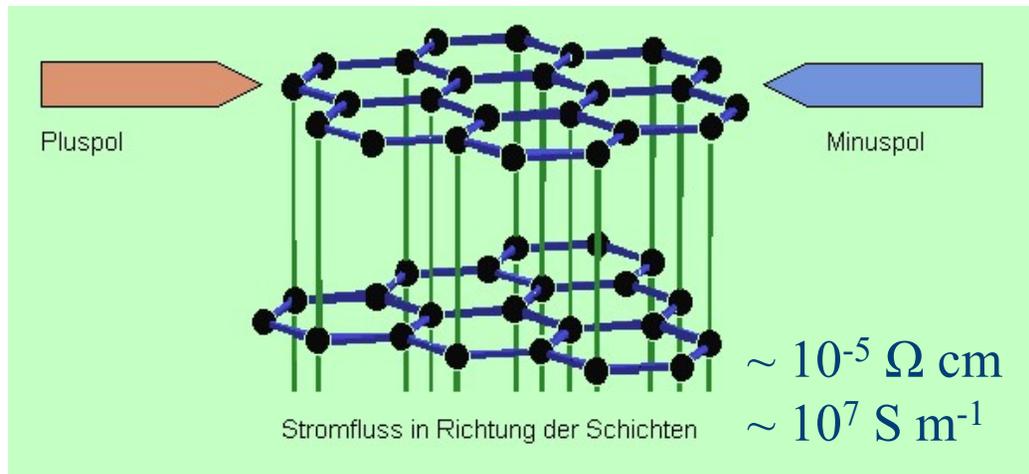


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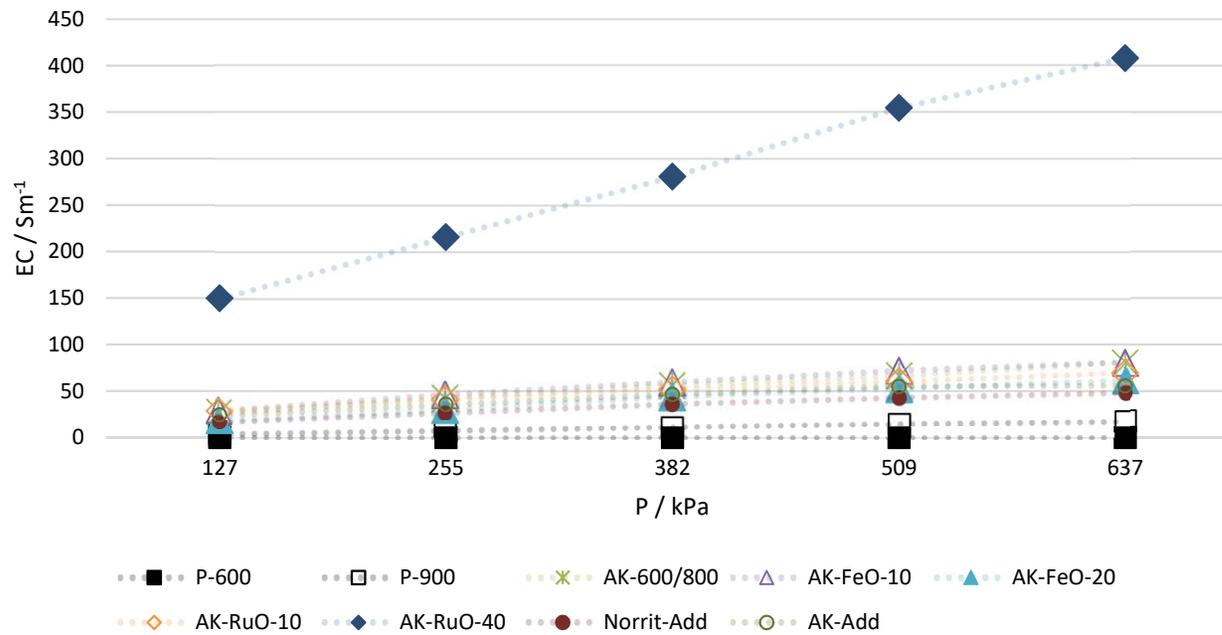


Copyright: Downie, 2011

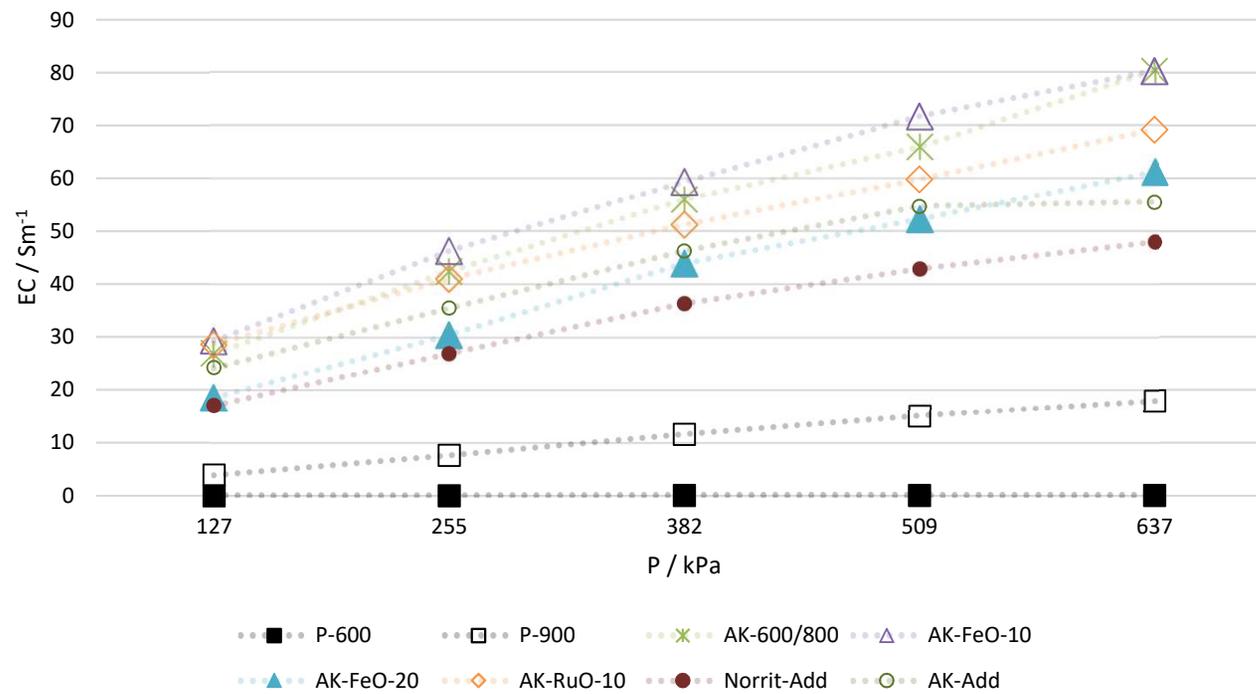
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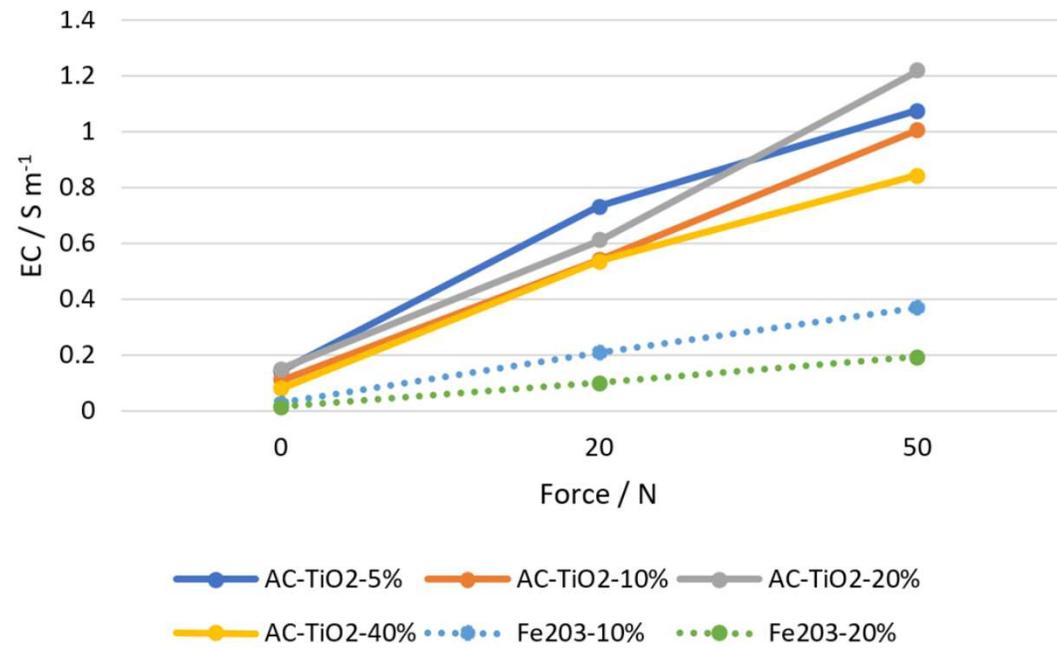
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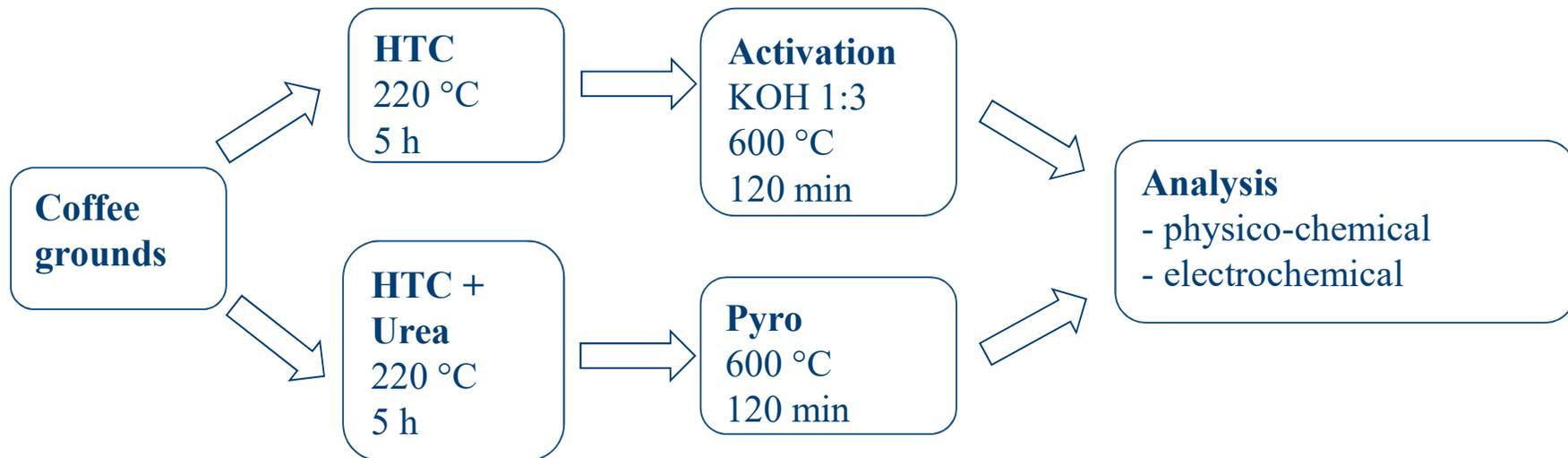
3) Biobased electrode materials for e-mobility



4) Outlook

Process example II

HTC of coffee grounds



4) Outlook

Process example III HTC of bakery waste

