Karlsruhe Institute of Technology

Institute for Applied Materials
Energy Storage Systems (IAM-ESS)

Redox-flow batteries with robust 3D-structured carbon based electrodes

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Motivation:

- 2D-Phase boundaries result in an inhomogeneous electrochemical reaction area with poor space utilization
- Activity of electrode material has to be improved
- Long term stability of electrode material and its surface is poorly evaluated

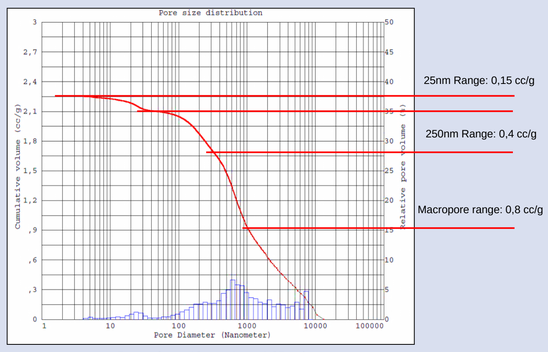
Aim of the FLOW 3D project:

- **Material and structural design**: Optimization of space utilization through distinct porosity and the distribution of the carbon material
- **Method development:** Systematic characterization and 2D/3D imaging
- **Understanding**: Influence of morphology and surface properties on the activity and stability

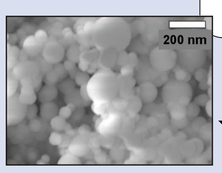
Template based porous Carbon

Aim:

- Distinct adjustment of the pore size distribution for RFB-applications
- Graphitized carbon containing meso- and macropores and (optionally micropores)



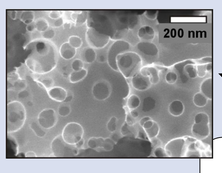
Porevolume 10nm - 1µm: 1,35 cc/g



Silica Template

Infiltration with Carbon precursor

Carbonization



Removal of the Carbon precursor

Porocarb

Production of electrodes with 3D-structure

PAN-Fiber

Production of the non-woven fabric

Carbonization

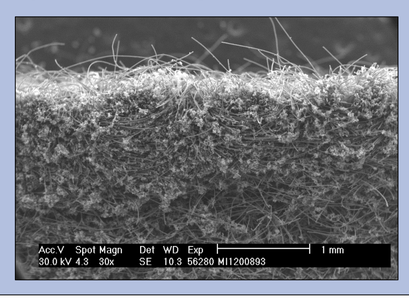
Carbon non-woven

Aim:

- Homogenous distribution of the Porocarb and good adhesion towards the nonwoven

1 Results

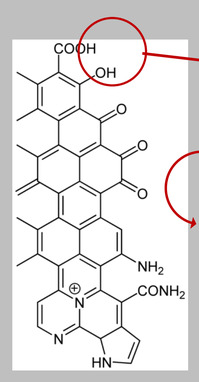
- TP-conductivity under compression are in the same range as reference materials
- With higher porosity leading to a better permeability at the same conductivity



Composite Electrode

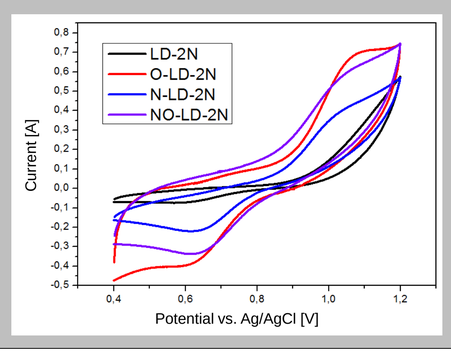
Modification of the Carbon materials and their characterization

Treatment



- Generating functional surface groups
- Analysis (EC, Raman, XPS, TEM,...)
- Activity determination
- In situ-Diagnostic/Aging

Results:
Improvement of the carbon materials redox-properties with N/O-surface groups



Electrochemical and structural Analysis

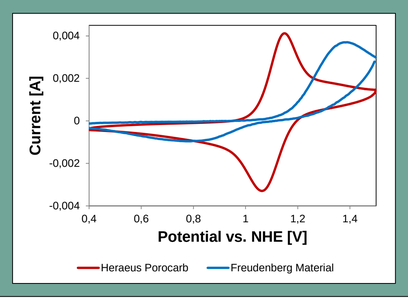
Test bench

Single cell test and characterization

- Testbench (pH, pressure, half-cell potential)
- Imaging (SEM, TEM, FIB-SEM)
- Analysis (ZV, Raman, NEXAFS, XRD/PDF, XPS)

Results:

- Non-woven fabric reaches performance comparable to literature
- Porocarb shows a very good el.chem. behaviour



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