Porous structure evaluation and application to analysis of battery technology

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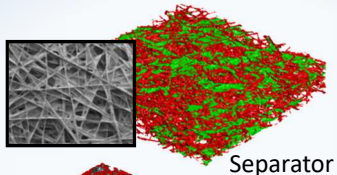
Porous electrode science

Improvement of cell performance by focusing on heterogeneous real porous electrode structure

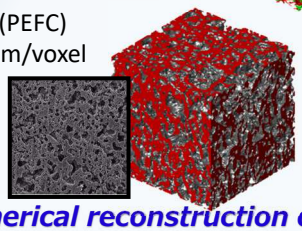
Lithium ion batteries (LiBs), Polymer Electrolyte Fuel Cells (PEFCs), Vanadium Redox Flow Batteries (VRFB), All-solid state batteries, air batteries, various electrochemical devices and systems

GDL (PEFC)
1 μm/voxel

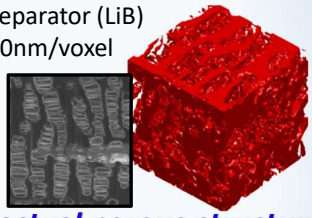


JPS, 347 (2017) 108
JPS, 342 (2017) 476
JPS, 327 (2016) 610
JPS, 327 (2016) 1

CL (PEFC)
4 nm/voxel

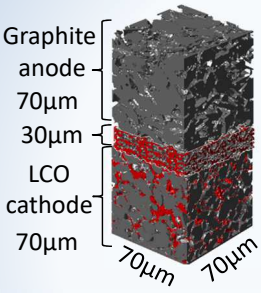


Separator (LiB)
10nm/voxel

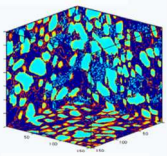


Numerical reconstruction of actual porous structure

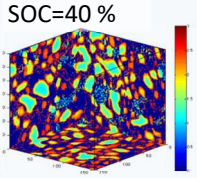
LiB Discharge sim.



SOC=80 %

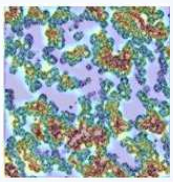


SOC=40 %



Electrochem. Acta submit
ECST, 75 (2017) 165
ECST, 75 (2016) 385

Reaction distribution in PEFC catalyst layer



Reaction and mass transport simulation in electrode

- ***Nano,micro X-ray CT***
- ***FIB-SEM***
- ***3D tomography***
- ***Image processing***

Structure Observation

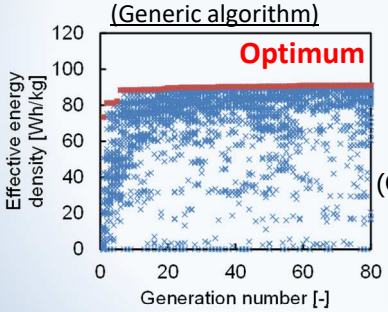
Numerical Simulation

- ***Reaction and mass***
- ***Pore-network model***
- ***LBM, DNS***
- ***Multi-block method***

- ***Material informatics***
- ***Machine learning***
- ***Theory building***

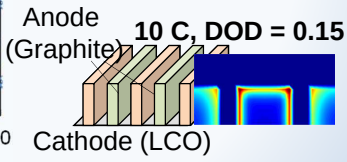
Structure design

Automatic optimization of LiB electrode structure (Generic algorithm)



AICHE J, 63 (2017) 249
ECST, 75 (2016) 147
ECST, 69 (2015) 83

Design of 3D electrode structure



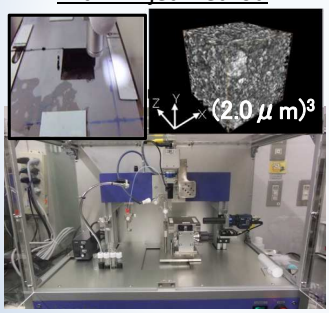
Optimal structure design by exp. & sim. results

Cell fabrication In-situ Exp.

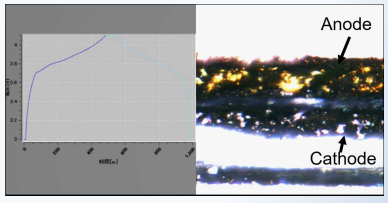
- ***Inkjet, 3D printer***
- ***Particle control***
- ***Direct visualization***

IJHE, 41 (2016) 21352
JPS, 327 (2016) 1

Fabrication of CL with Ink jet method



Comparison with exp. for LiB sim. (volume expansion, charge curve)



Fabrication of optimal structure and check with exp.

Academic fields: Electrochemistry, Chemical reaction engineering, Process systems engineering, Transport phenomena, Fluid dynamics, Separation Engineering, Powder Engineering

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