

DEPARTMENT OF CHEMICAL ENGINEERING

NCE – ELECTROCHEMICAL ENGINEERING

Electrochemical applications – from materials to devices

Context

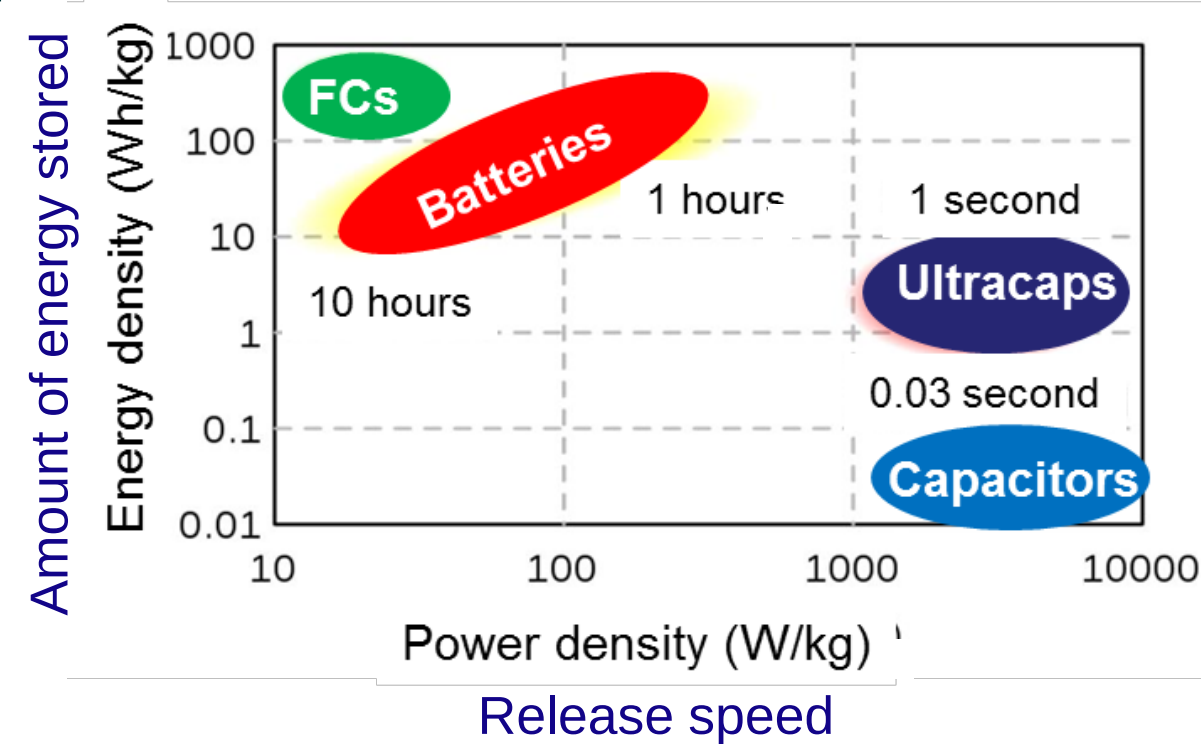
Electrochemical storage and restoration of energy for stationary, mobile and portable applications:

- Demand/offer match (energy management)
- Disconnected/decentralized use of energy



Electrochemical production/storage of electricity for homes, cars, portable and ultraportable devices.

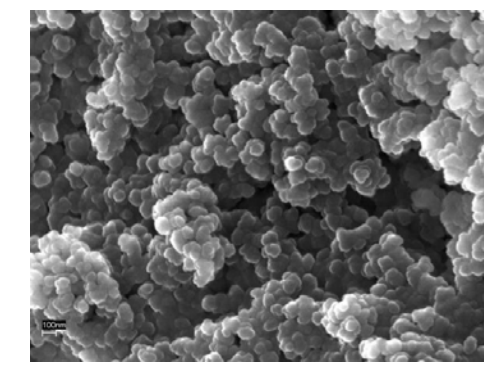
Type of devices



Fuel cells, batteries and supercapacitors are used for quite different applications, depending on the amount of energy stored (Energy density) and the speed of energy release (Power density). Yet their inner structure is very similar

Methodology – from materials to devices

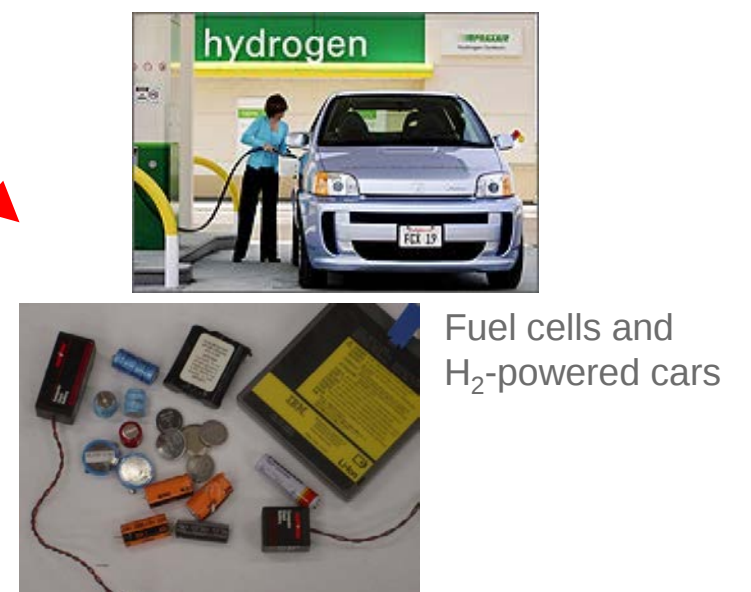
(nano)Structured Material



Goal: links between the materials properties at the nanoscale and their behavior in assemblies and devices

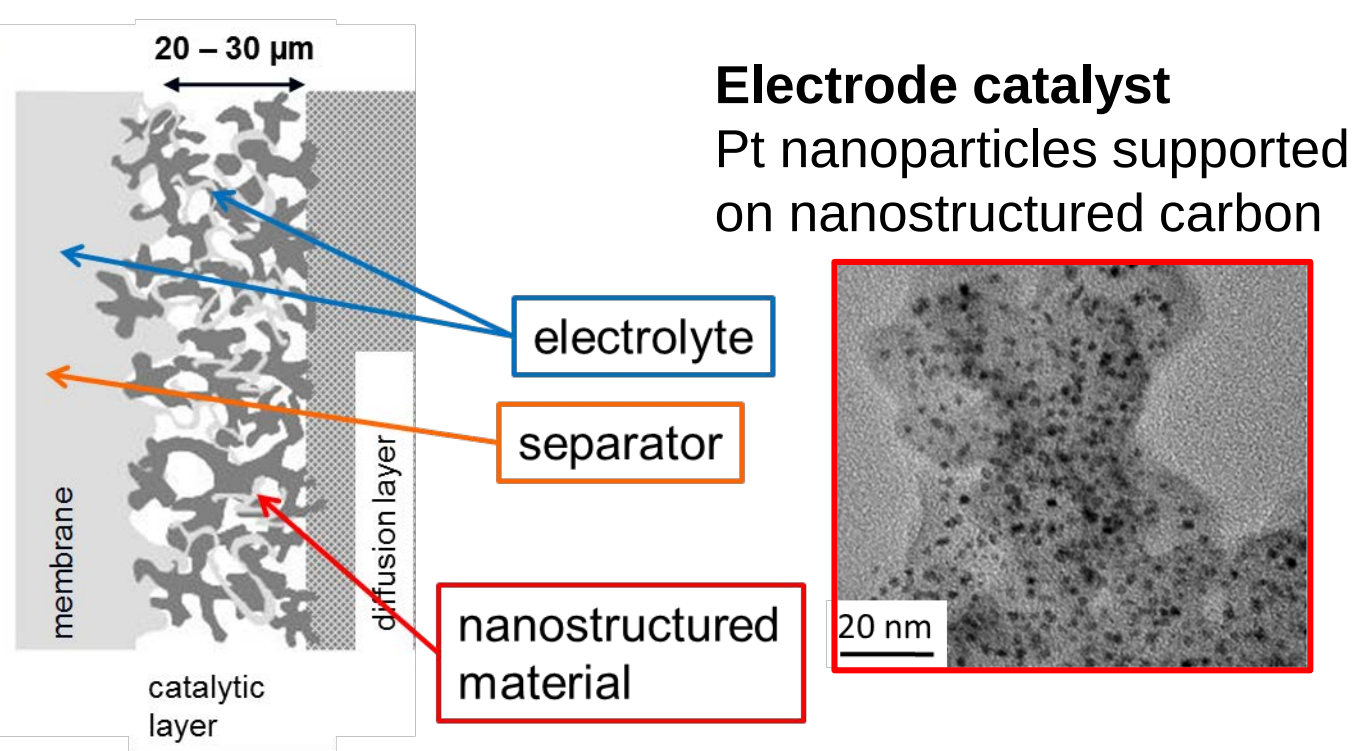
Application

Batteries and supercapacitors

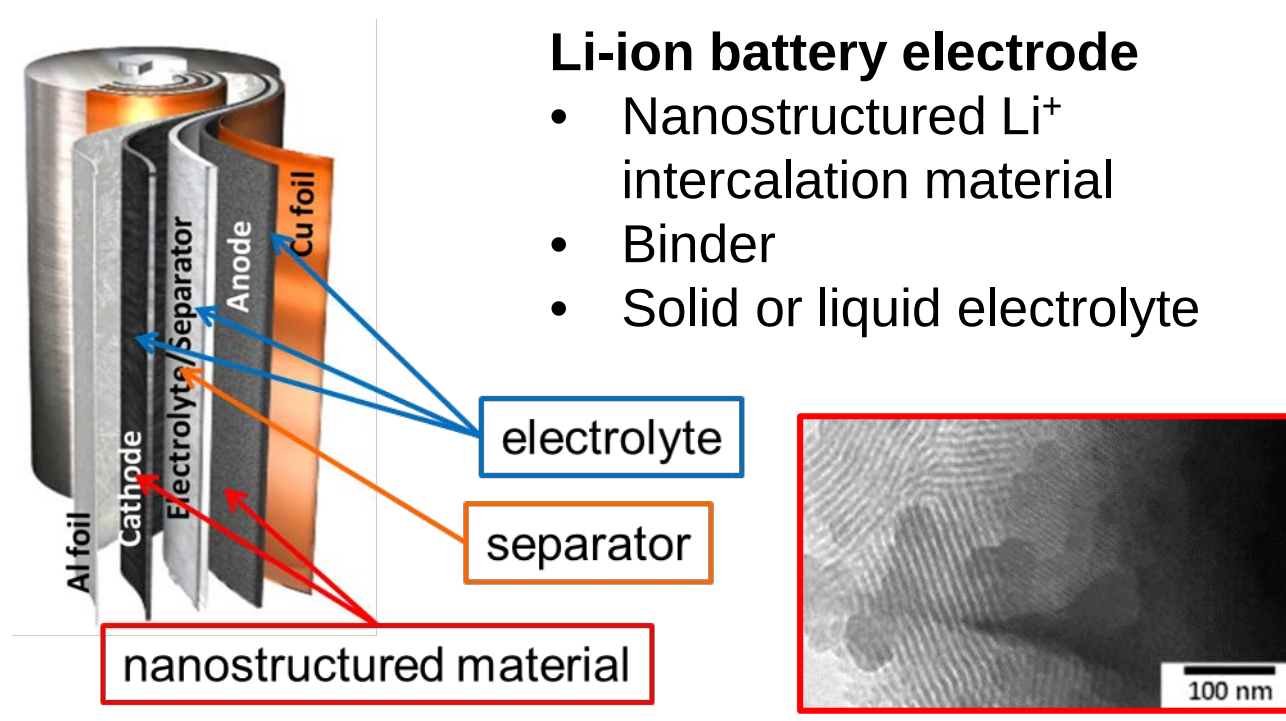


Electrochemical devices are made of three components: anode, cathode and electrolyte. These components are intertwined nanostructured materials so as to maximize the electron exchange surface. How to design nanostructured compounds so that the final device works the best?

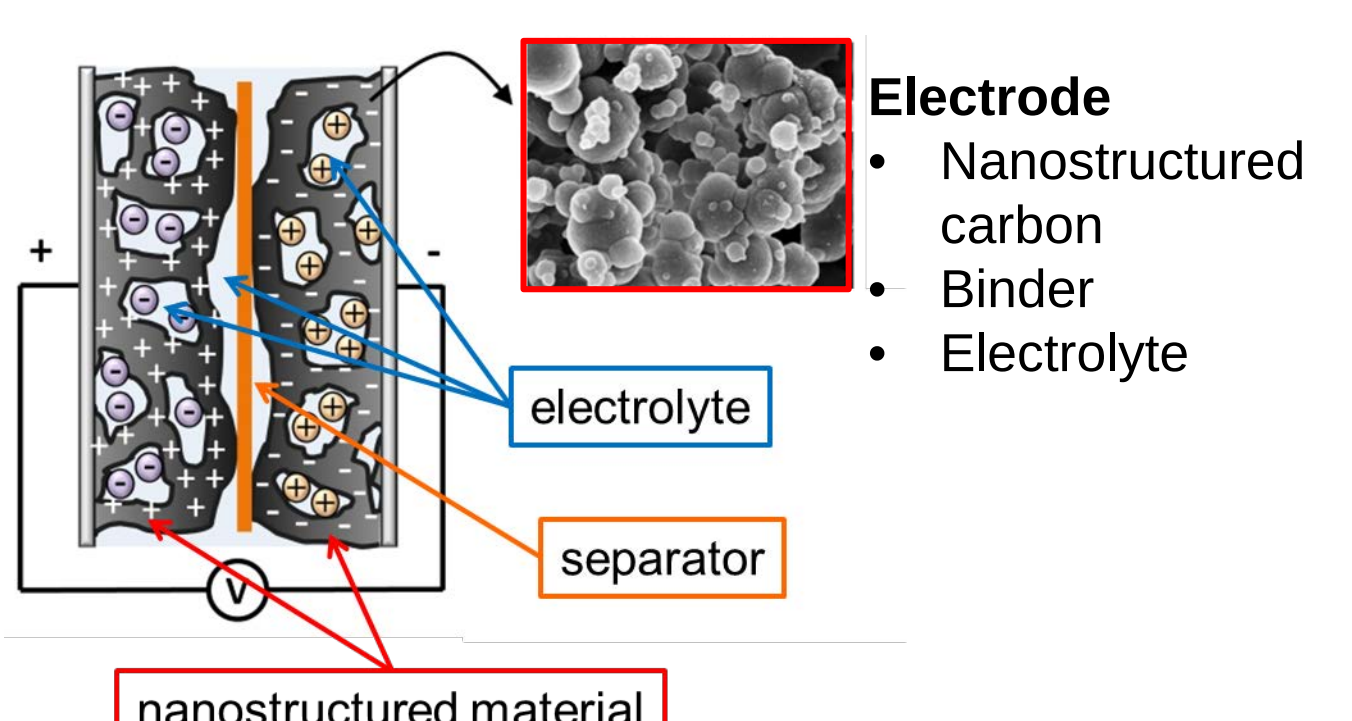
Fuel cells



Batteries



Supercapacitors



Challenge: assembly of nanostructured materials into (i) compound electrodes (ii) monocell and (iii) complete stack or battery

Assembly

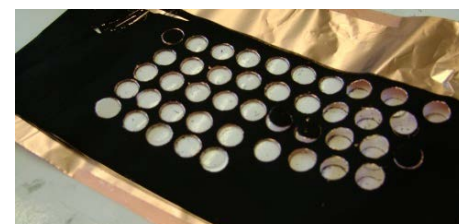


Testing

- On lab-designed test benches
- Monocells (material characterization)
 - Stacks (behavior vs. working mode)

Assembly

- Electrode processing
- Battery assembly

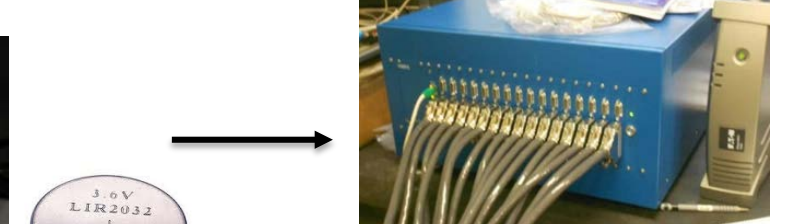


Testing

- Material characterization
- Assembly validation
- Charge/discharge performance
- Ageing

Assembly

- Electrode processing
- Supercap assembly



Testing

- Material characterization
- Assembly validation
- Charge/discharge capacity

Possible PhD thesis topics

Fuel cells

- Synthesis/manufacture and characterization of new materials (catalysts, membranes, bipolar plates)
- Implementation in mono and multi-cells
- Design of FC components
- Study of component behavior vs. time and use profile

Batteries

- New nanostructured materials for batteries
- Assembly in half and complete cells
- Assembly testing and validation
- Charge/discharge performance

Supercaps

- New electrode materials / new electrolytes
- Assembly testing and validation
- Capacity vs. materials

Systems

- Assembly into complete multi-cell batteries or stacks (FCs)
- Monitoring of complete devices
- Long-term behavior
- Modelling

... and more if you are interested in materials and devices for energy storage from an experimental viewpoint!