# Introduction to Department of Energy Conversion and Storage

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# Introduction to

# Department of Energy Conversion

# and Storage

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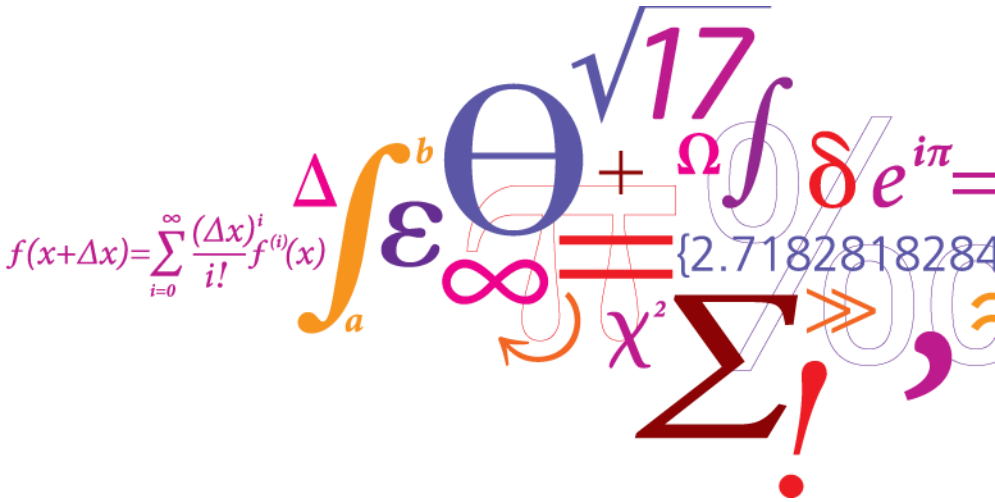


# Technical University of Denmark (DTU)

Founded in 1829 (by H.C. Ørsted)

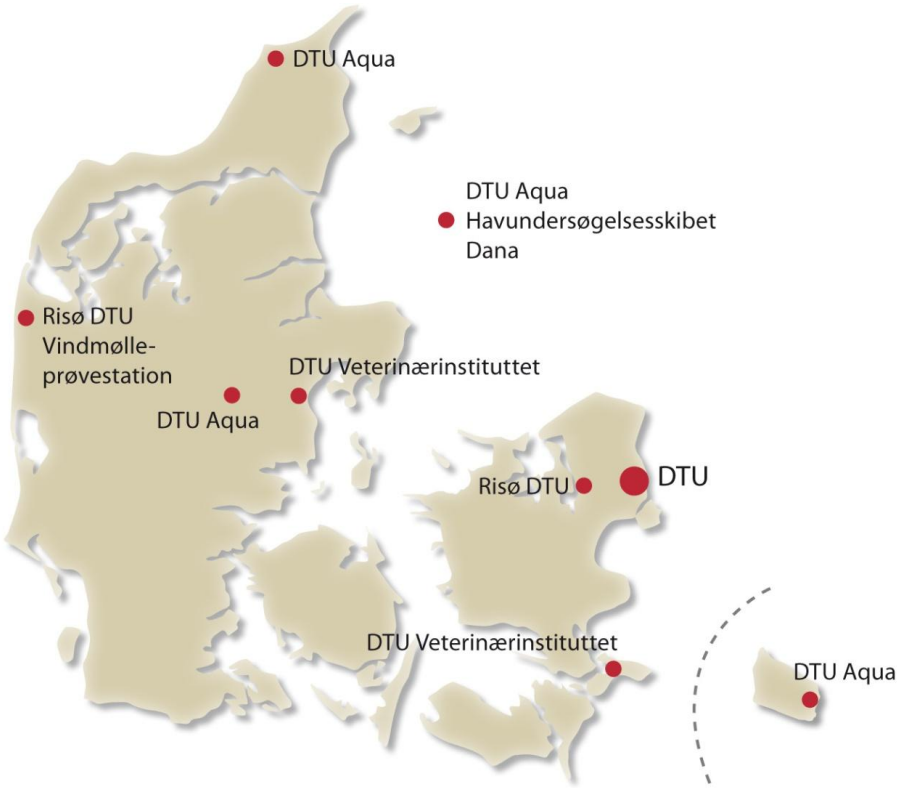
From 1962 to 1974, DTU moved to its current location in Lyngby

- Employees ca. 4800
- Students ca. 8500
- PhD-students ca. 1200
- International students ca. 650/year

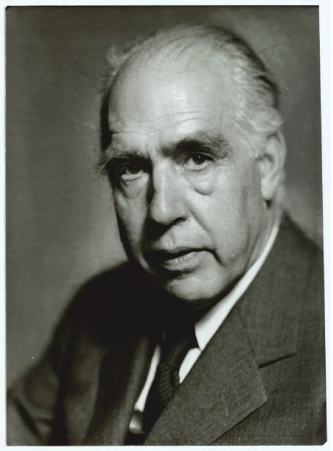
(2010)

# Technical University of Denmark





# Risø



**1958** Founded in by Niels Bohr and others as a nuclear research institution.

**1985** Nuclear power officially given up
Risø becomes *Research Centre Risø*

**2007** Risø becomes part of DTU
*Risø DTU National Laboratory for Sustainable Energy*
ca. 700 employees

**2012** DTU energy Conversion is formed:

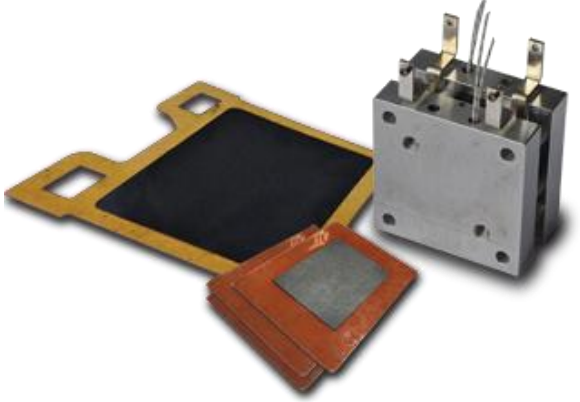
<u>From Risø DTU:</u>
- Fuel Cells and Solid State Chemistry Division
- The Solar Energy Programme
- Parts of the Materials Research Division

<u>From DTU Chemistry:</u>
- Energy and Materials Science Group.

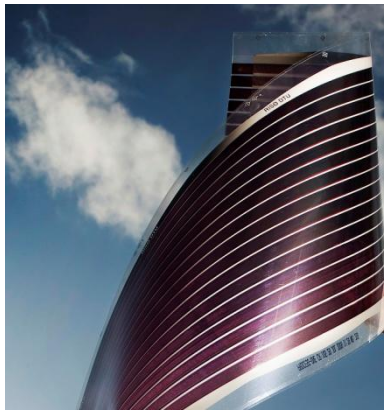
# Overview of the department

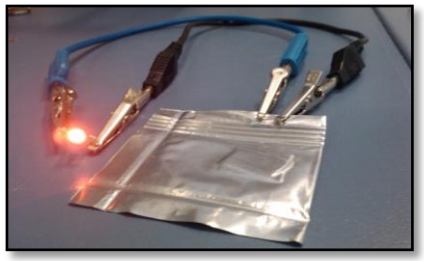
- Sustainable technologies for energy conversion and storage
- ~230 people
- Research span from fundamental investigations to component manufacture
- Focus on industrial collaboration and industrially relevant processes
- Head: Professor Søren Linderoth
- Located on two campuses: Risø and Lyngby

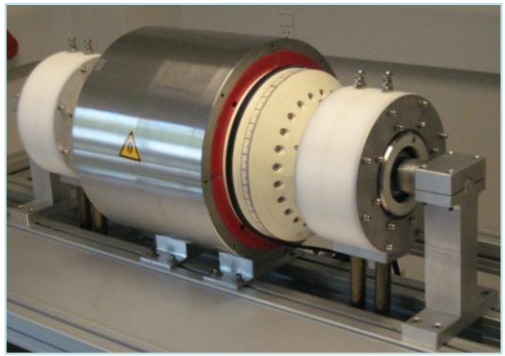
# Technologies



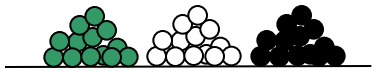
- Solid oxide fuel cells
- High-temperature PEM fuel cells
- Electrolysis
- Polymer solar cells
- Batteries
- Solid state storage of hydrogen and ammonia
- Membranes for oxygen or hydrogen separation
- Magnetic refrigeration
- Thermoelectric components
- Flue gas purification using electrochemical cells
- Superconducting components



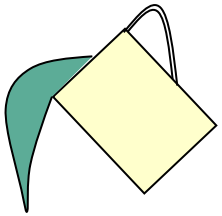




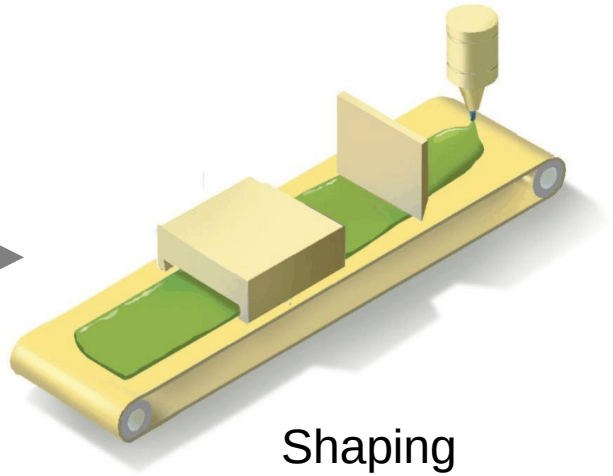
# Solid Oxide Fuel Cells



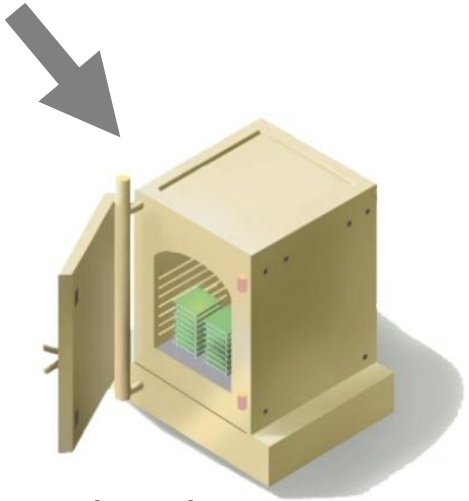
Raw materials



Slurries



Shaping



Sintering

# Solid Oxide Fuel Cells

## Pre-pilot facility



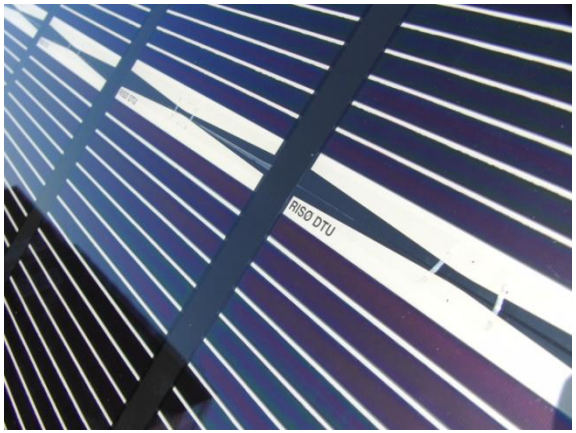

Capacity of 10,000s of units per year

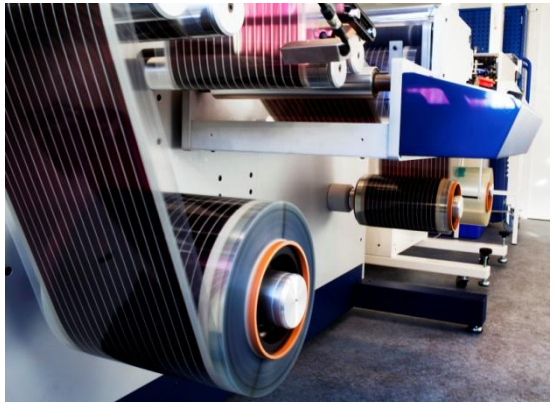
# SOFC: Topsoe Fuel Cell pilot plant

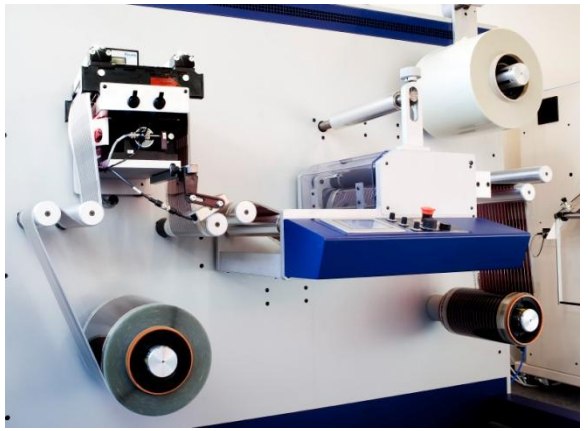

TOPSOE FUEL CELL
RETHINKING ENERGY

# Polymer solar cells

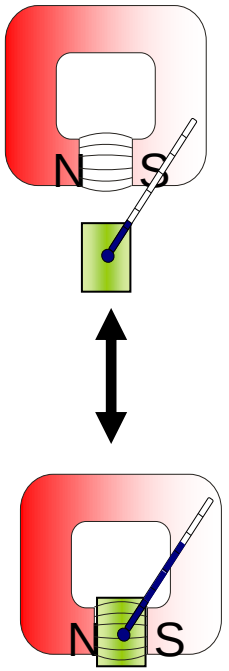
- Promising alternative to traditional Si-based photovoltaics
- Organic photovoltaics printed on flexible plastic substrates
- High-speed roll-to-roll processing
- Research focus on increased efficiency and lifetime



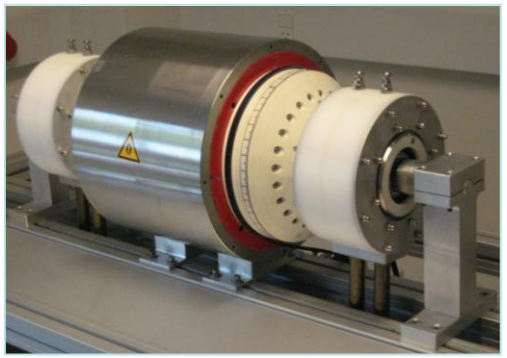





# Magnetic refrigeration

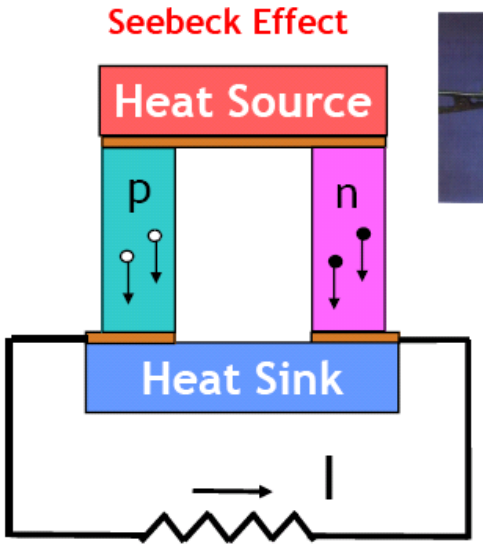



- Uses the magnetocaloric effect
- Ceramic materials with tunable transition temperature
- Advantages
  - high efficiency
  - low-noise operation
  - environmentally friendly (no volatile gases)
- Both for refrigeration and heat pumps
- Prototype designed and constructed at DTU
  - 200 W cooling power @ 18 °C span
  - further optimization under way

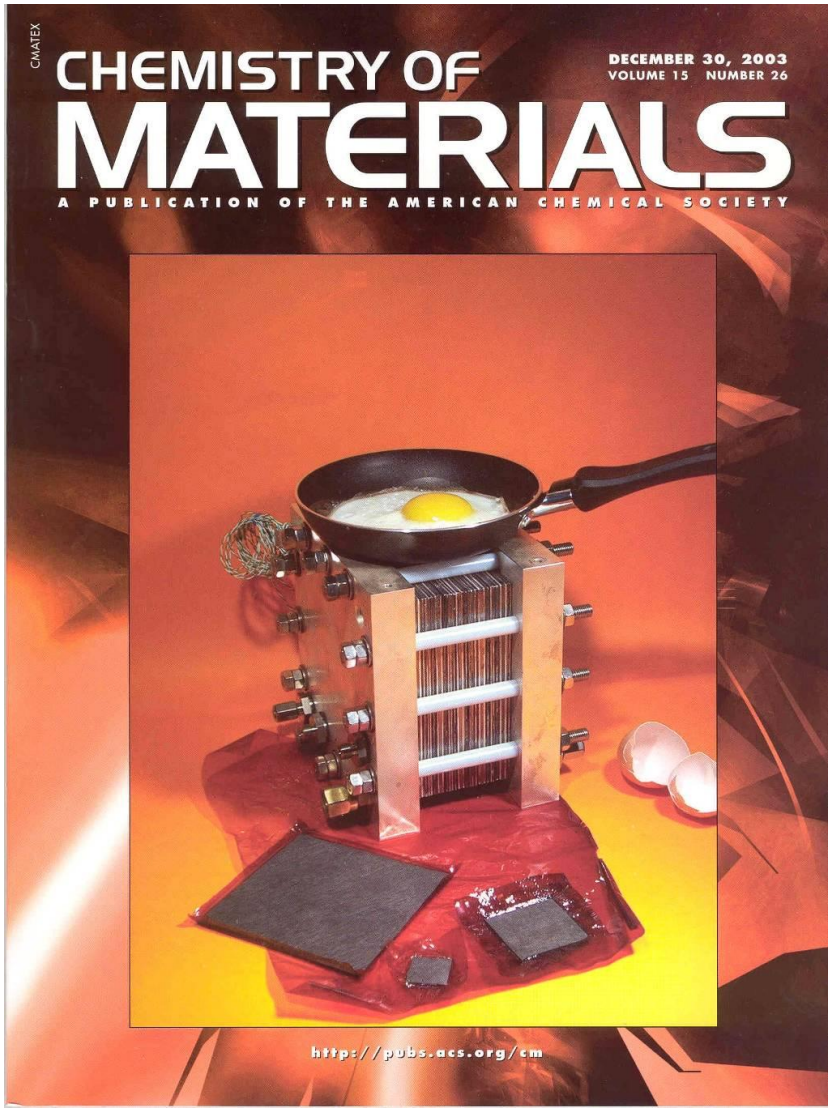


# Thermoelectrics

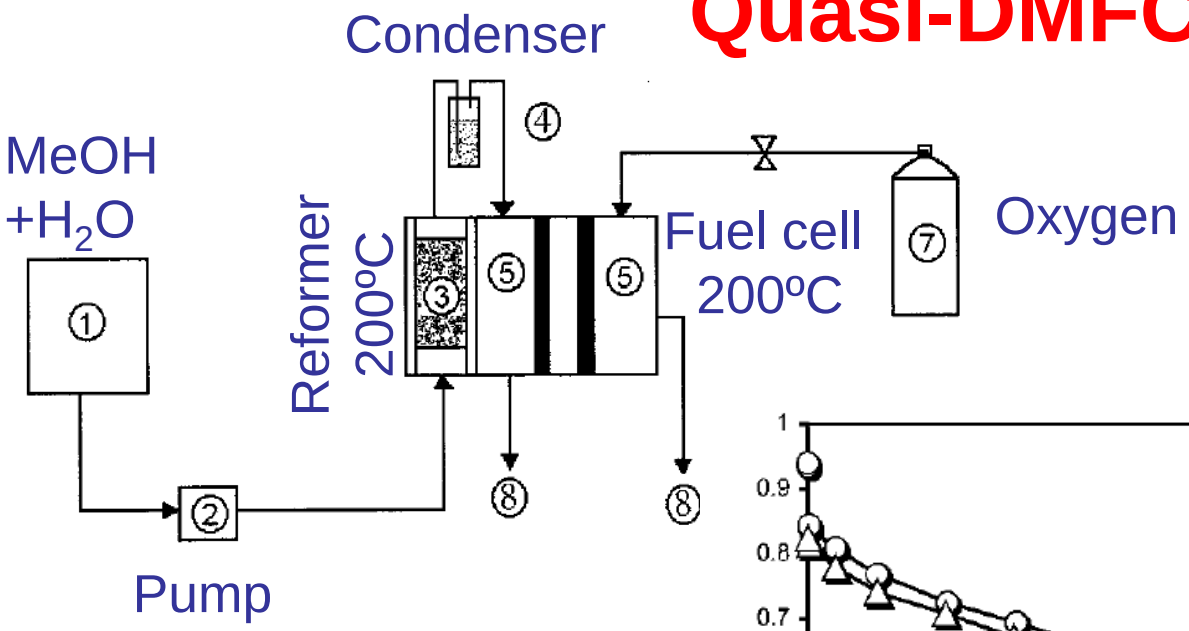
- Use of the Seebeck effect to generate electricity
- Conversion of waste heat from, e.g., solid oxide fuel cells
- Oxide materials for operation at 400-1000 °C
- Aim is to demonstrate a device with a conversion efficiency approaching 15-20%

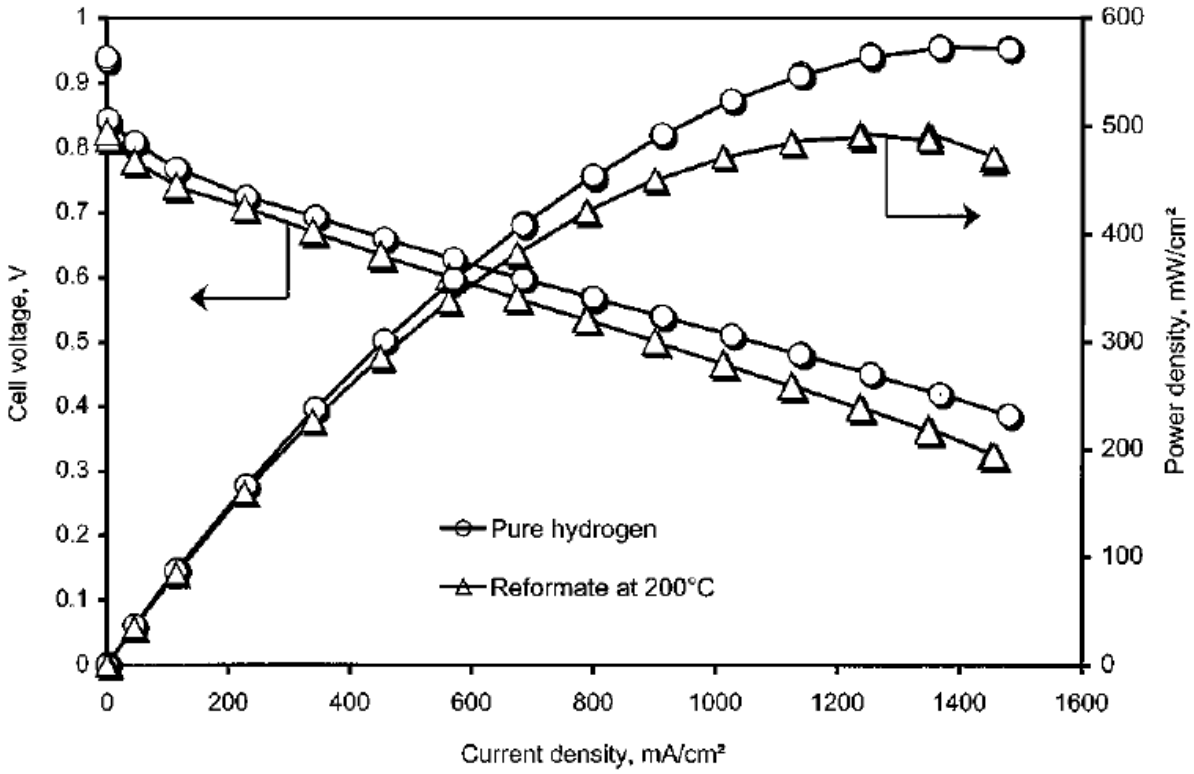


# High temperature PEM fuel cells



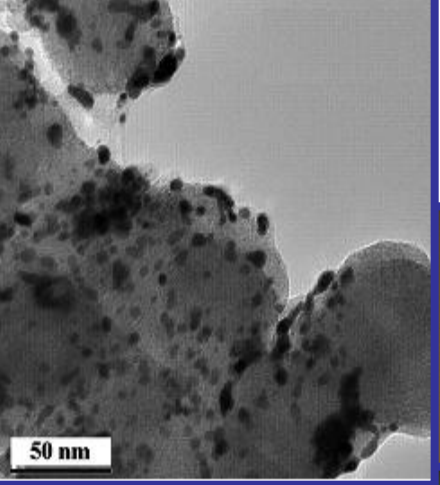
# Quasi-DMFC

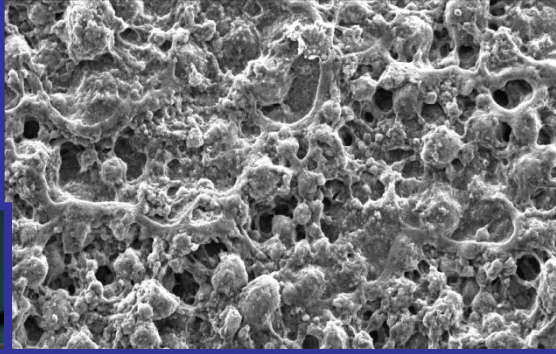


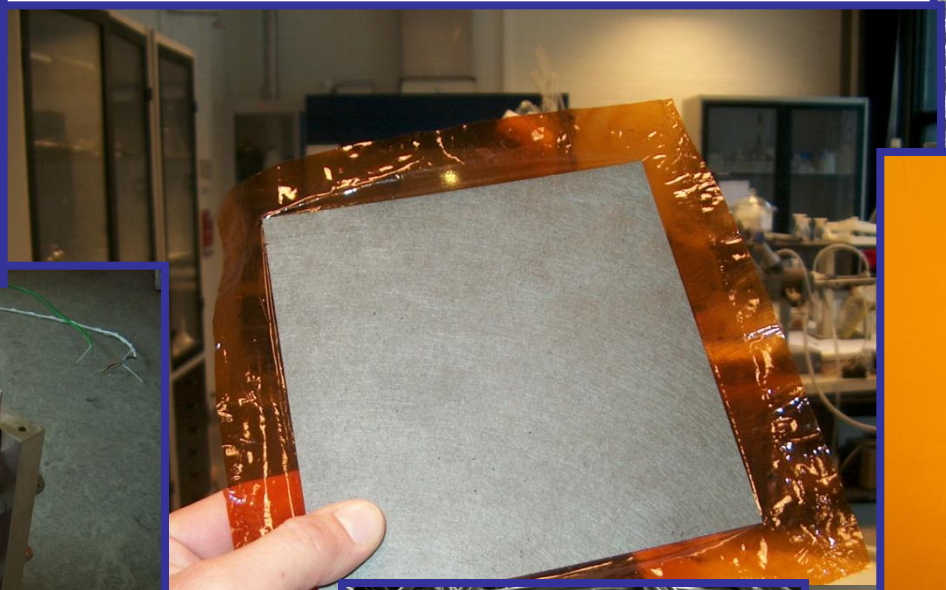



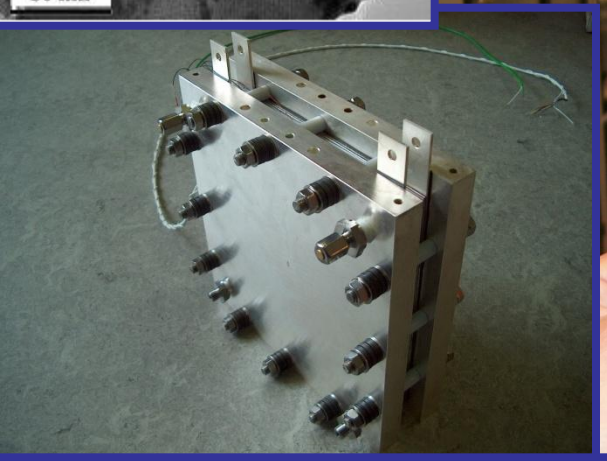

Li Qingfeng et al.
Electrochemical and
Solid-State Letters, **5** (6)
A125-A128 (2002)

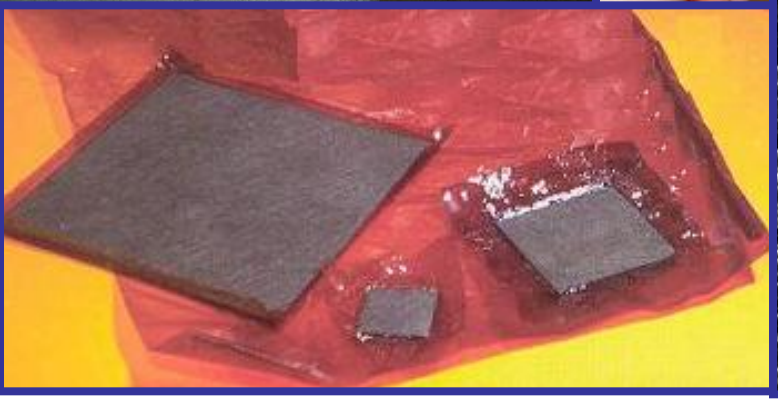
# Activities at DTU



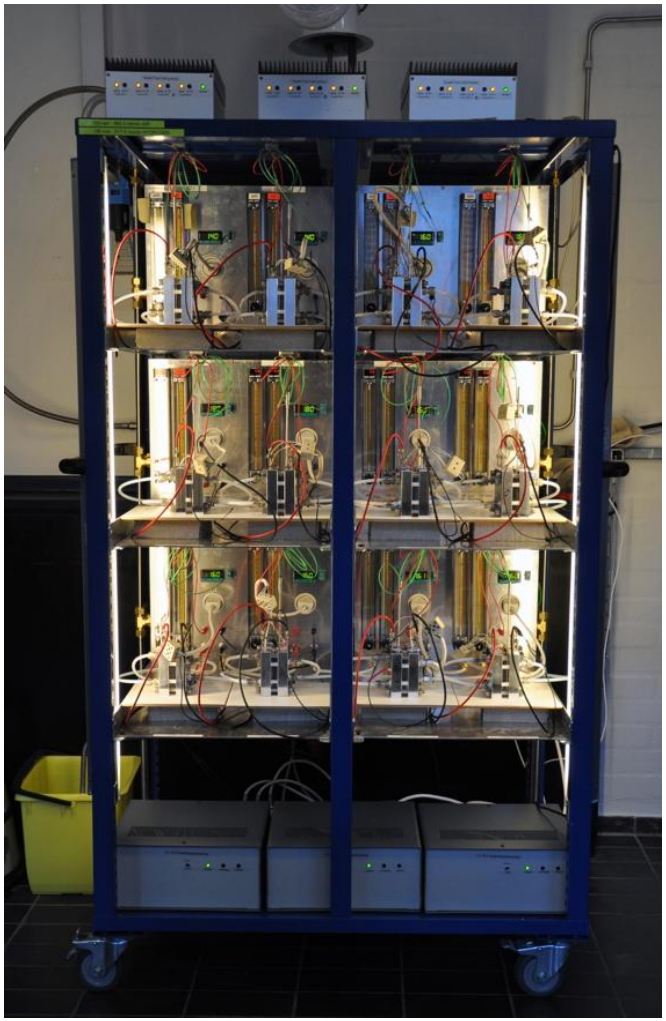



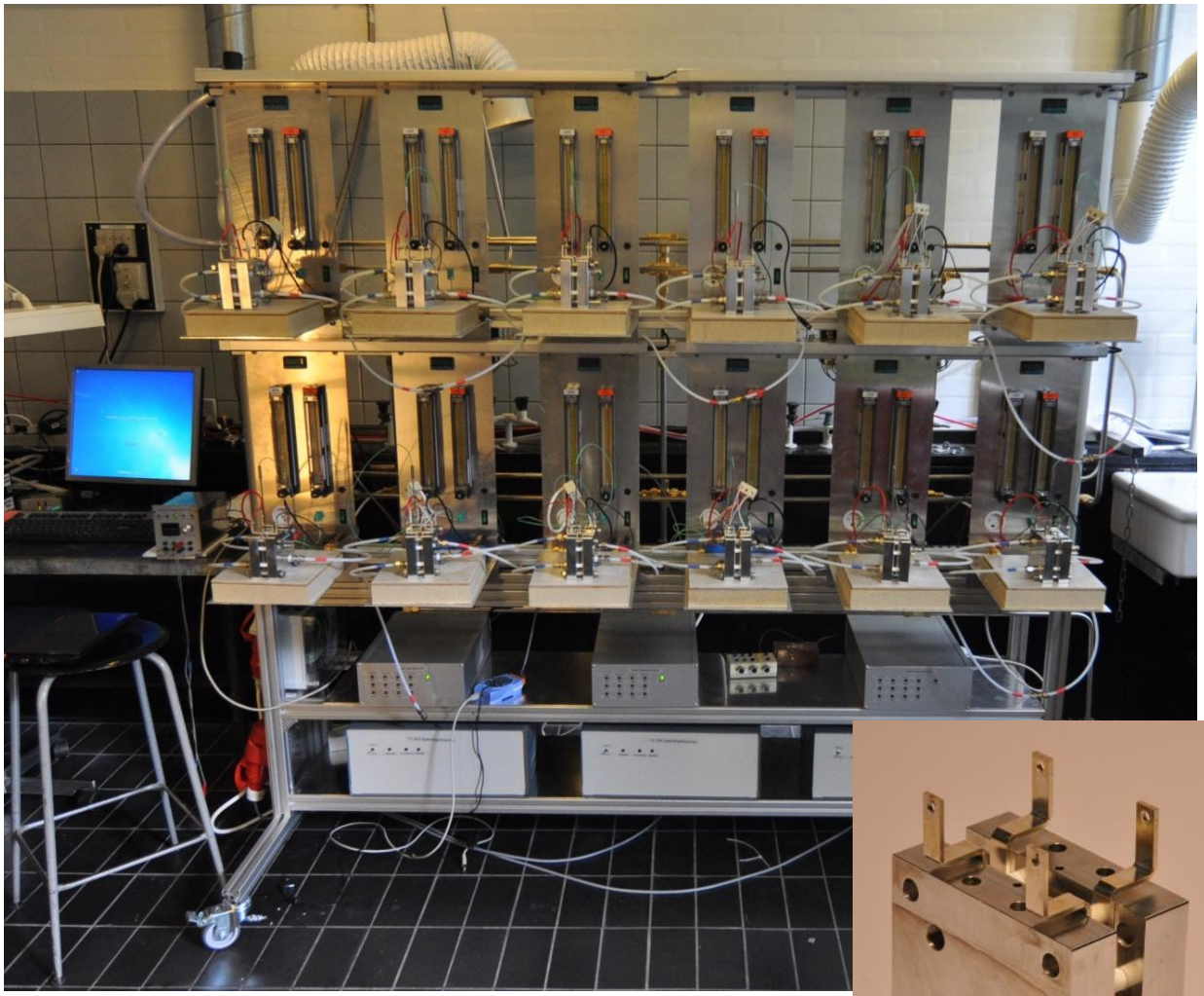







# Single cell durability

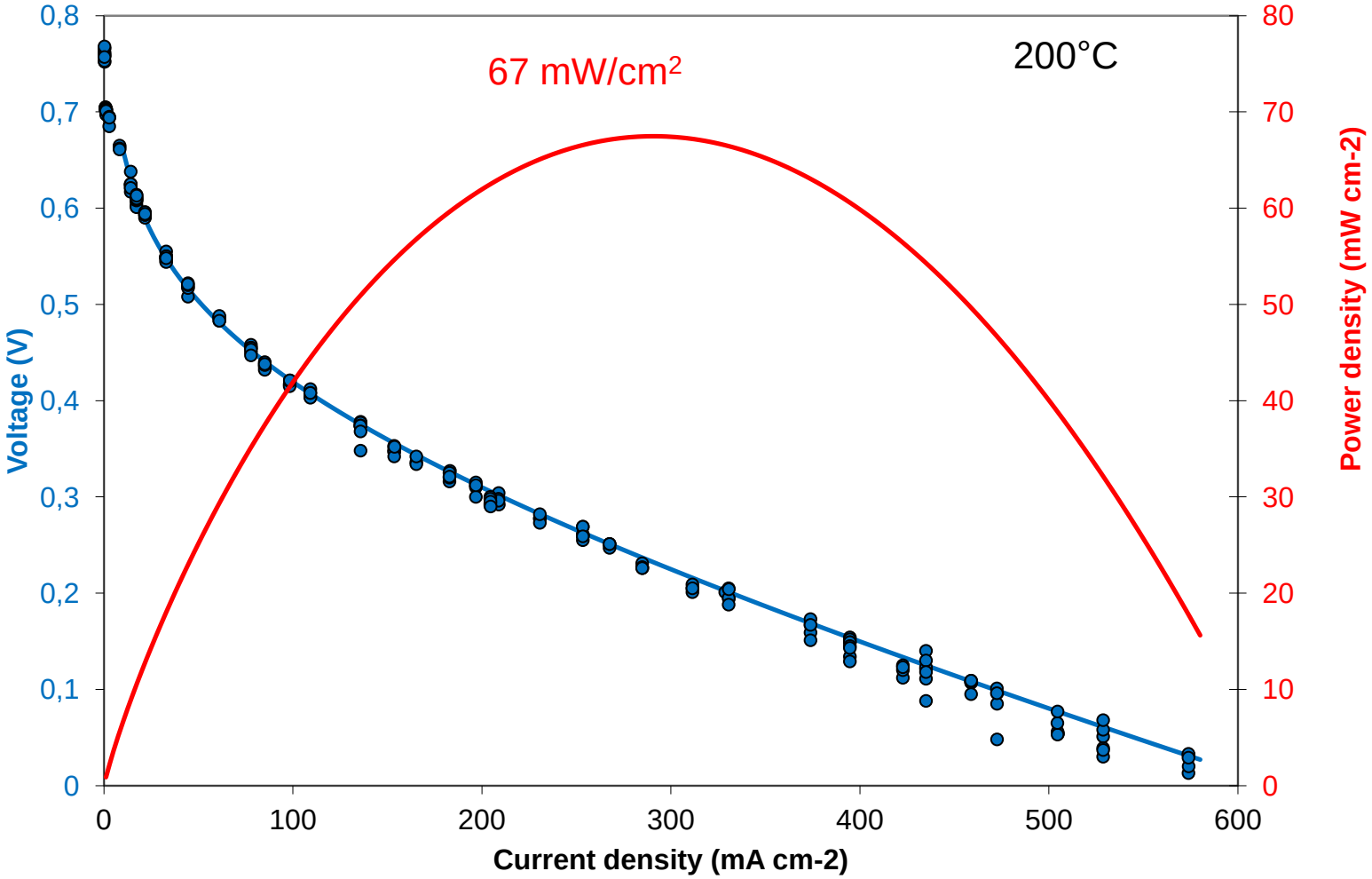






2 X 12 channel test bench (cells 10 $cm^2$)

# Direct DME in HT-PEMFC



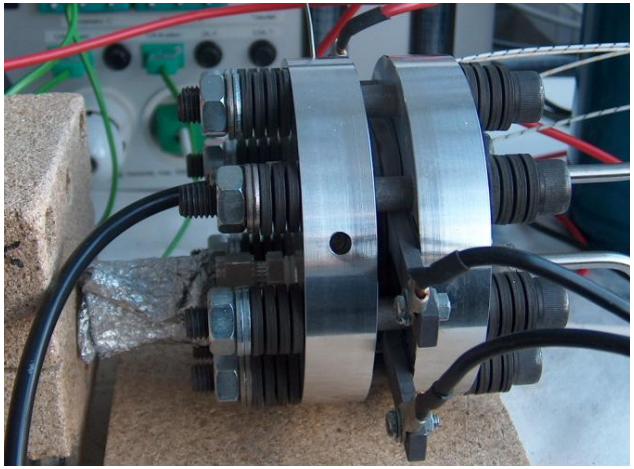

J. O. Jensen, A. Vassiliev, et al.
*J. Power Sources* **211** 173-176 (2012)

Polarization curves of a direct DME fuel cell based on acid doped PBI at 200°C. Ambient pressure, air as oxidant.

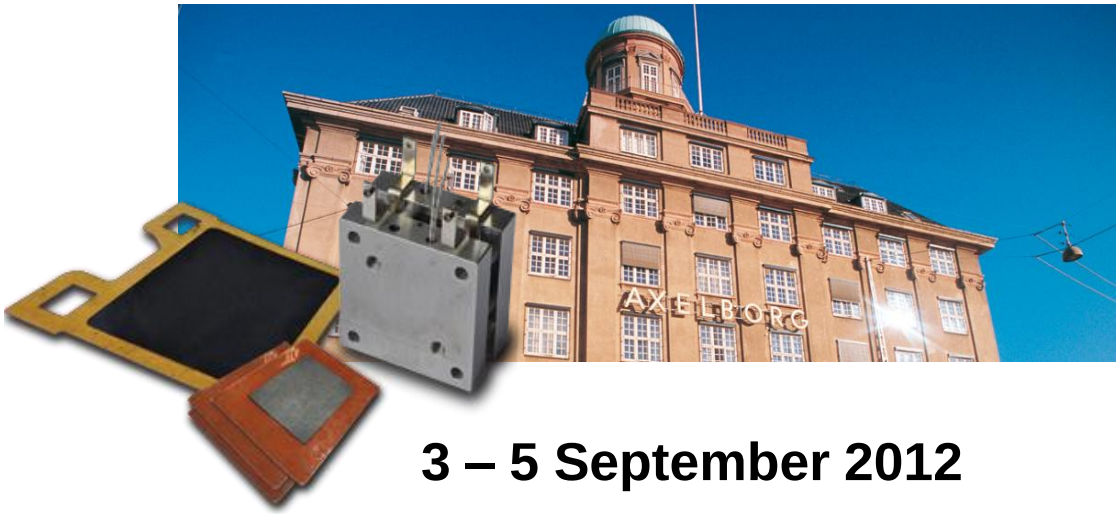
# Electrolysis

- SOEC + $CO_2$ electrolysis
- HT-PEMEC >100ºC
- AEC
- Inorg. proton conductors

  200-400ºC



CARISMA 2012




**3 – 5 September 2012**

# 3rd CARISMA International Conference on Medium and High Temperature Proton Exchange Membrane Fuel Cells

**Venue: Axelborg, Copenhagen, Denmark**

**http://carisma2012.com/**