

Influence of H₂ purity on stack life

Further Improvement and System Integration
of High Temperature
Polymer Electrolyte Membrane Fuel Cells

FURIM

SES6-CT-2004-502782

April 2004 - April 2008

List of participants

Participant name	Country
Technical University of Denmark (coordinator)	Denmark
Volvo Technology Corp.	Sweden
Norwegian University of Science and Technology	Norway
University of Newcastle upon Tyne	UK
Elsam A/S	Denmark
Danish Power Systems ApS	Denmark
Case West Reserve University	USA
University of Stuttgart	Germany
Hexion B.V.	Netherlands
Freudenberg FCCT	Germany
IRD Fuel Cell A/S	Denmark
Foundation of Research and Technology	Greece
Between Lizenz GmbH	Germany

Project main goals

- **A 2kW_{el} HT-PEMFC stack**
 - operating 120-220°C
 - single cell performance 0.7 A/cm^2 @ 0.6V
 - more than 5,000 hours
- **A hydrocarbon reformer**
- **A catalytic burner**
- **An integrated system**

Key issues

- **Polymer membranes**
- **Electro-catalysts**
- **Gas diffusion electrodes**
- **Stack materials and construction**
- **A diesel reformer, a burner and integration with HT-PEMFC stack**

Lifetime test

Achieved in AMFC

Electrode, 0.4-0.5 mg Pt/cm²

PBI / H₃PO₄ membrane

H₂/O₂, 1 bar/ 1 bar

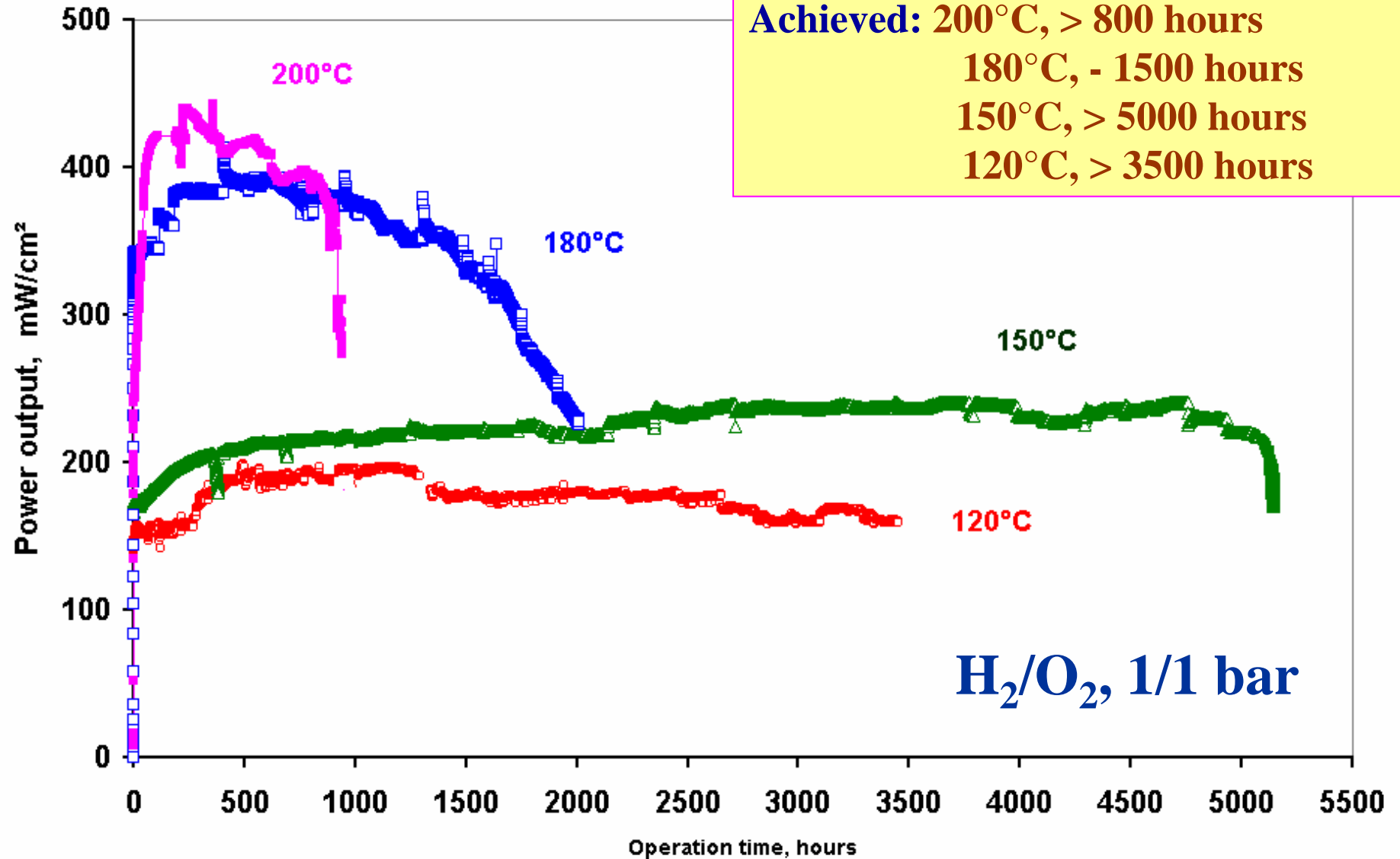
Operation at constant voltage 0.5V

Achieved: 200°C, > 800 hours

180°C, - 1500 hours

150°C, > 5000 hours

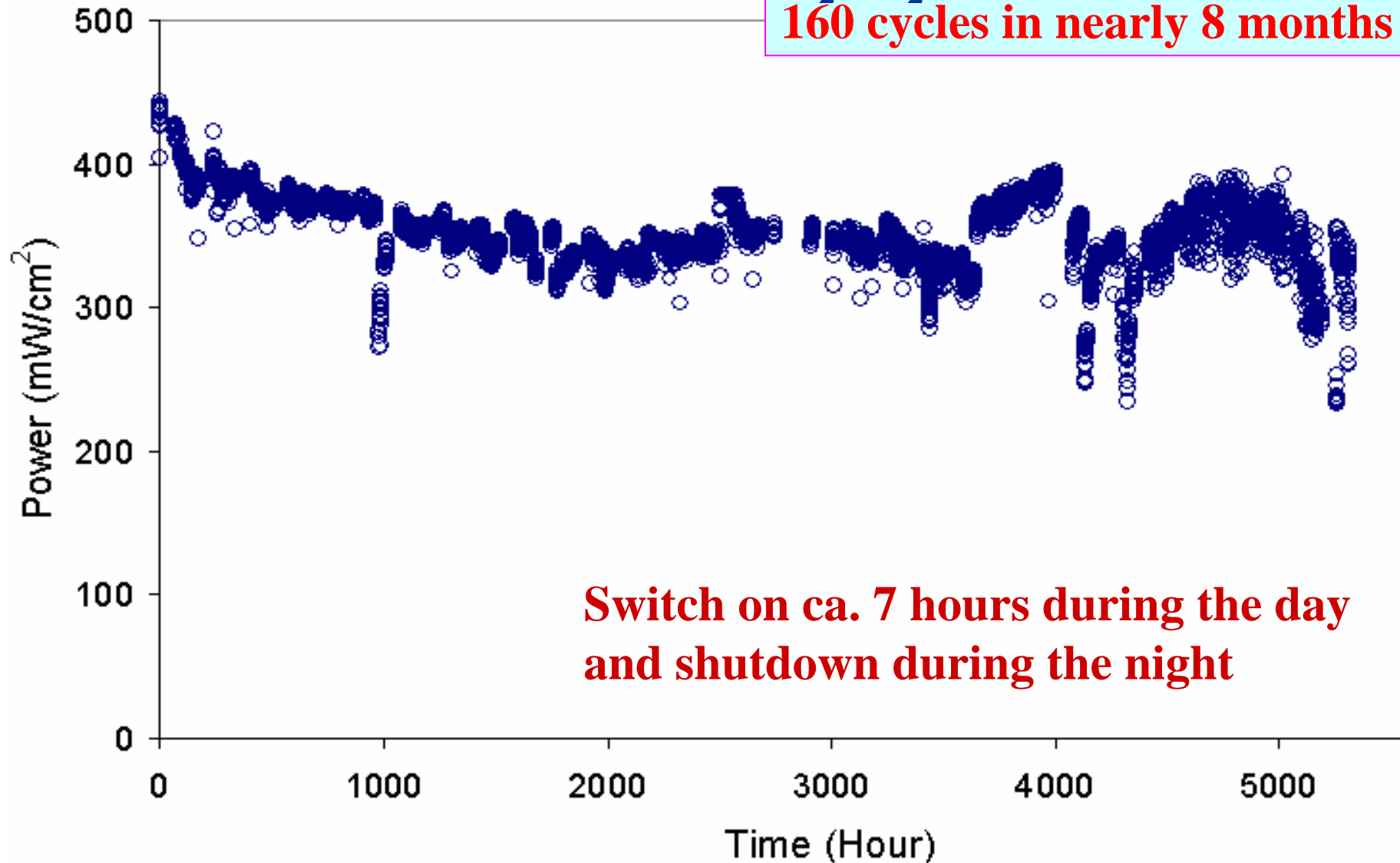
120°C, > 3500 hours



Lifetime – thermal cycling

Achieved in AMFC

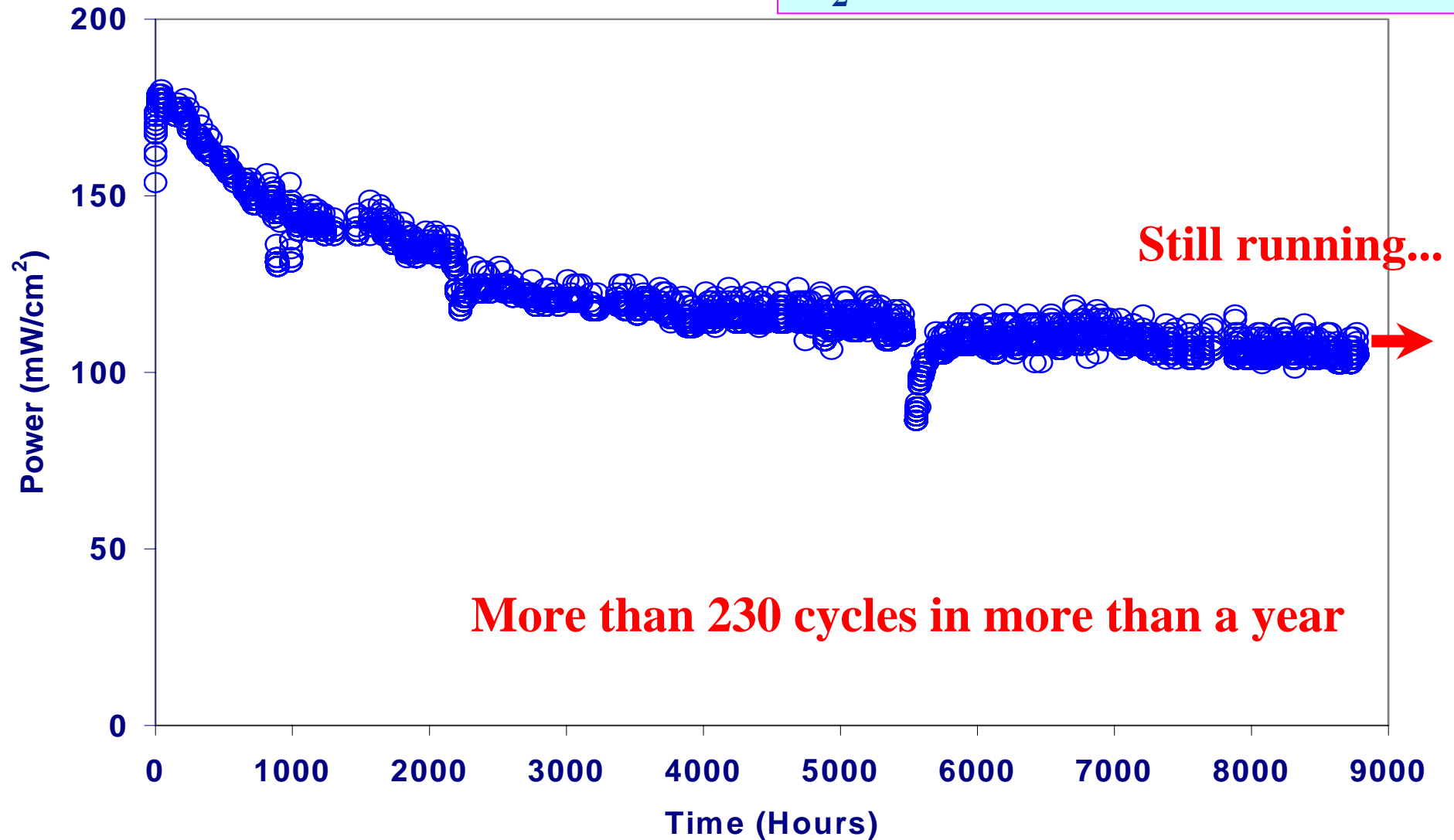
Temperature: 150°C
Catalysts: 0.61 mg Pt/cm²
PBI: doping level 5.6
H₂ / O₂ 1/1 bar
160 cycles in nearly 8 months



Lifetime – thermal cycling

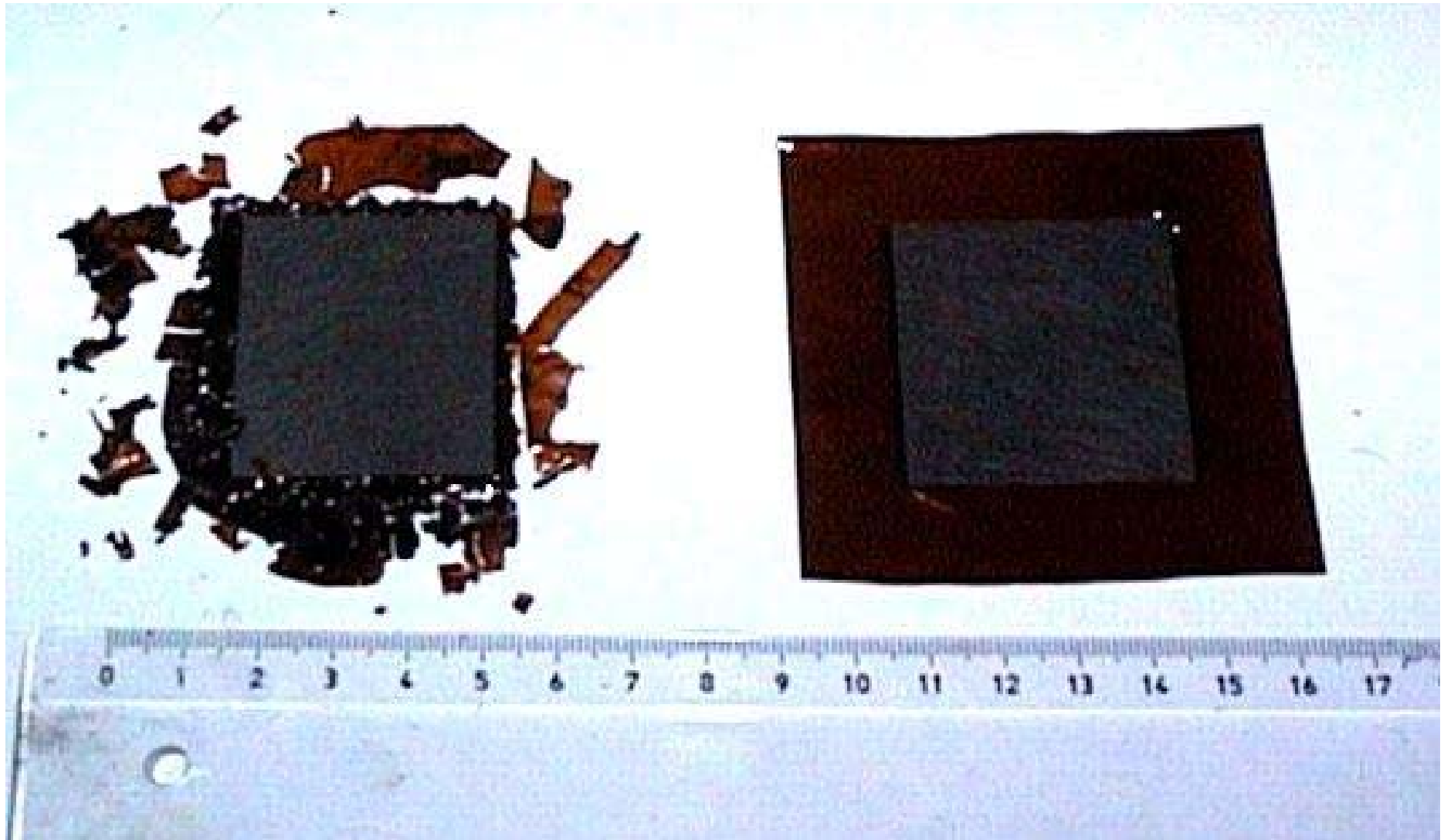
- Started in AMFC
- Continues in FURIM

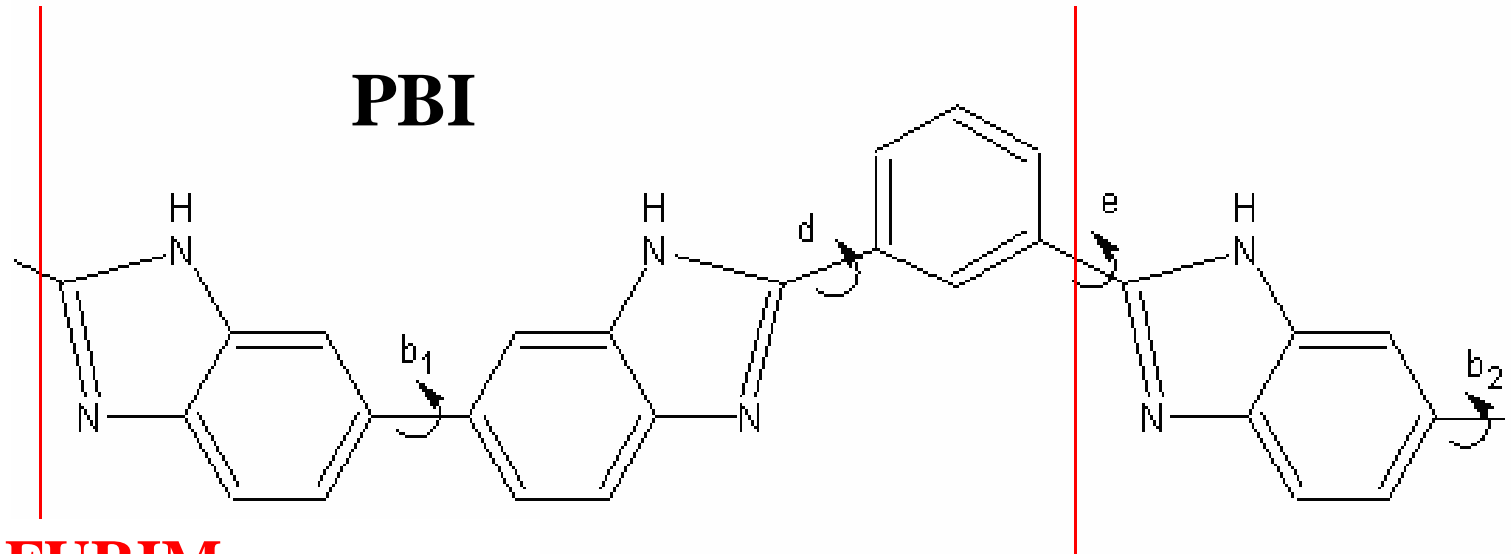
Temperature: 150°C
Catalysts: 0.61 mg Pt/cm²
PBI: doping level 5.6
H₂ / Air 1/1 bar



Lifetime of HT-PEMFC

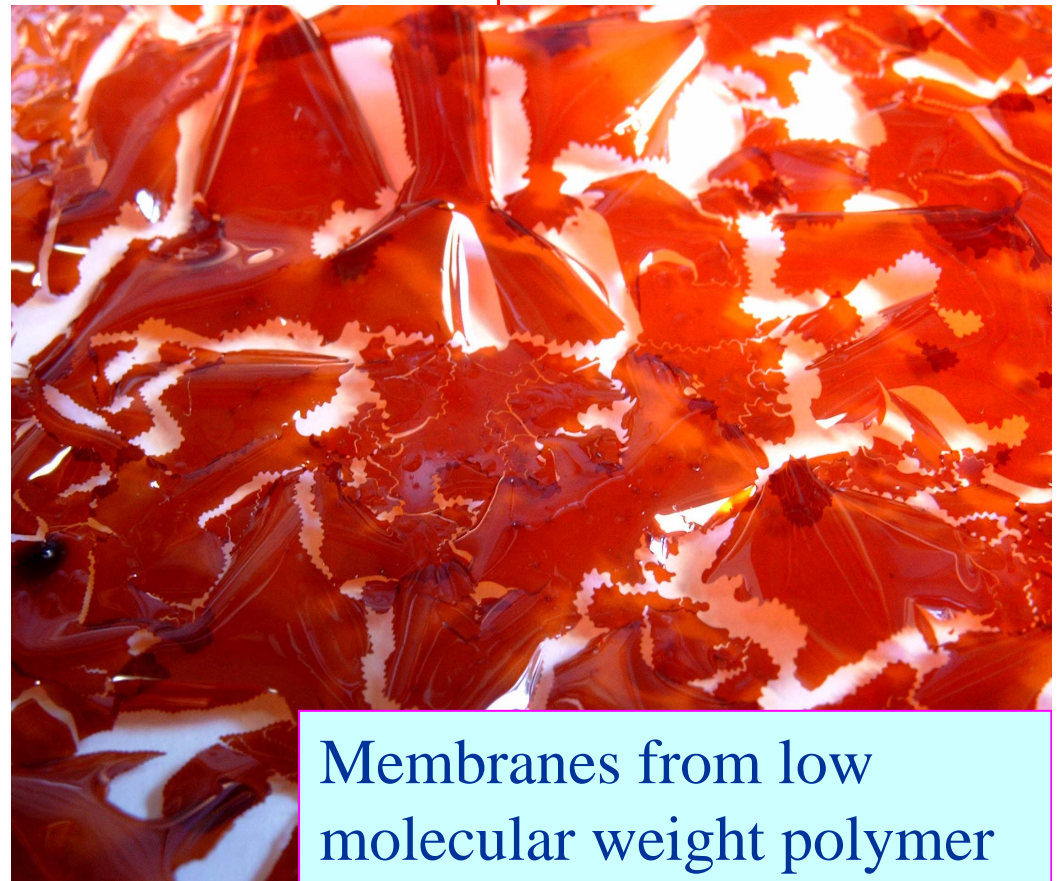
- Degradation of polymer membranes





Efforts in FURIM

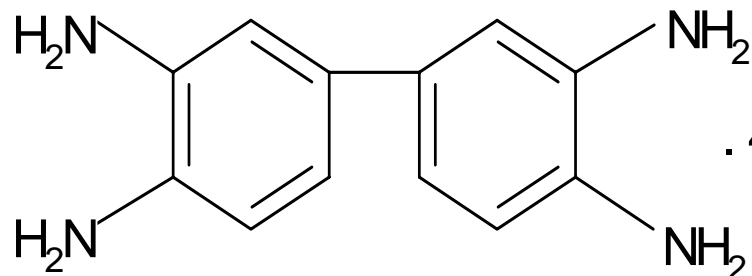
- **Synthesis of high molecular polymer**
- **Modified structure (branched polymers)**
- **Membranes from cross-linking, blending**
- **Membranes of inorganic-organic composites**



Membranes from low molecular weight polymer

Synthesis of PBI

diaminobenzidine

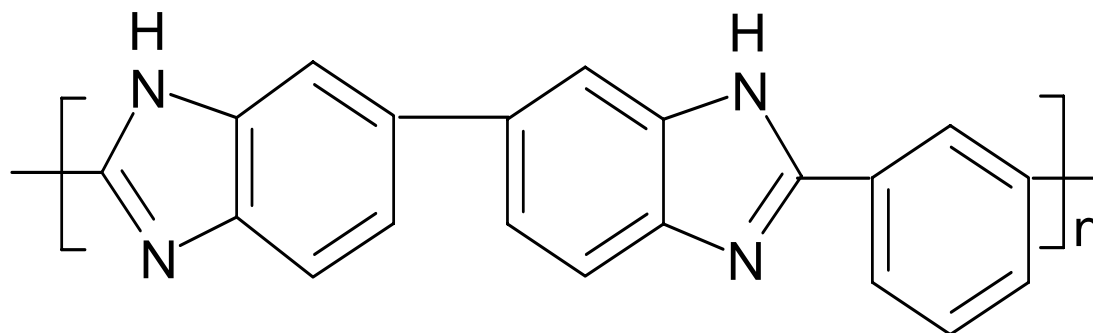


isophthalic acid



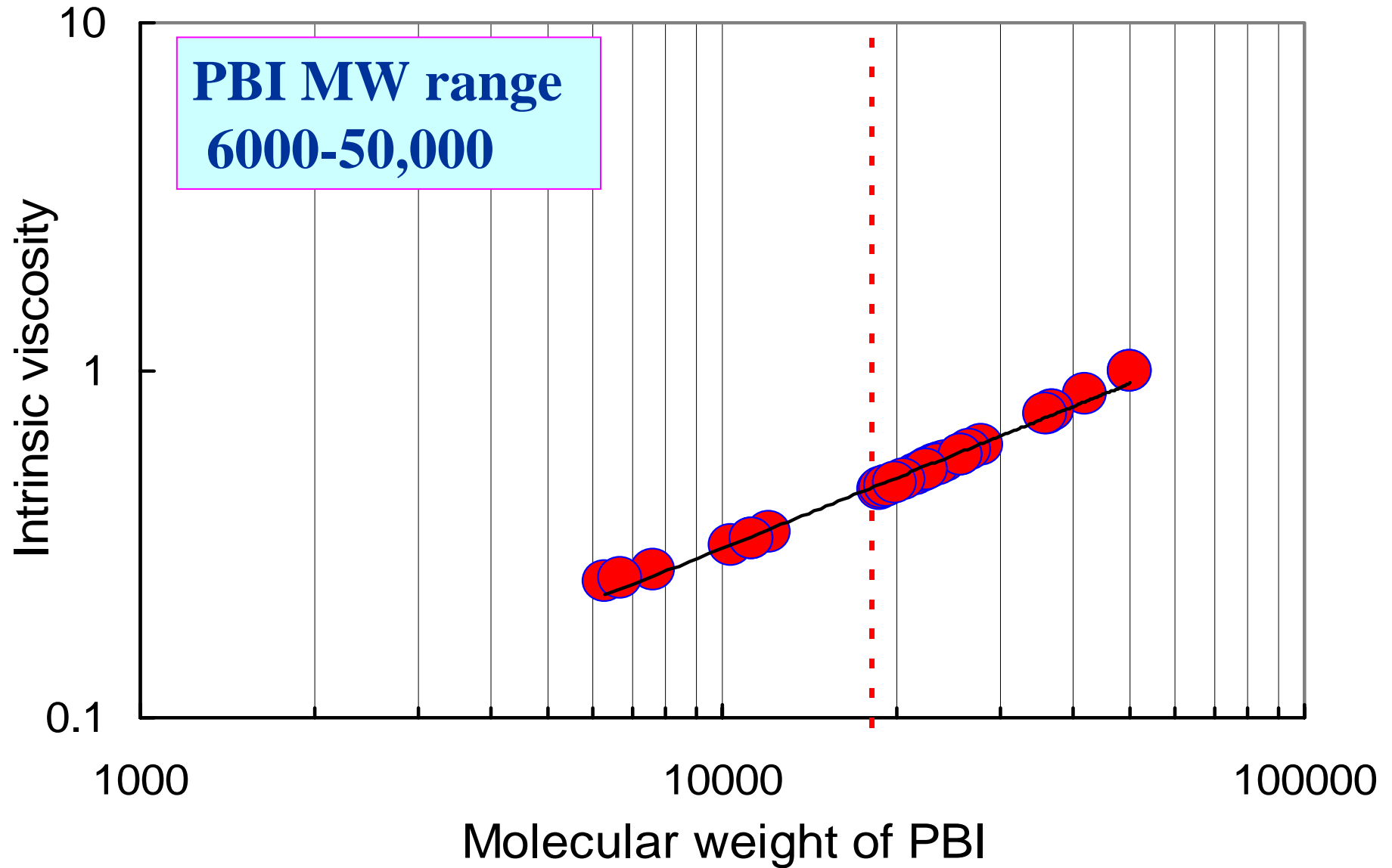
in PPA

170-200°C



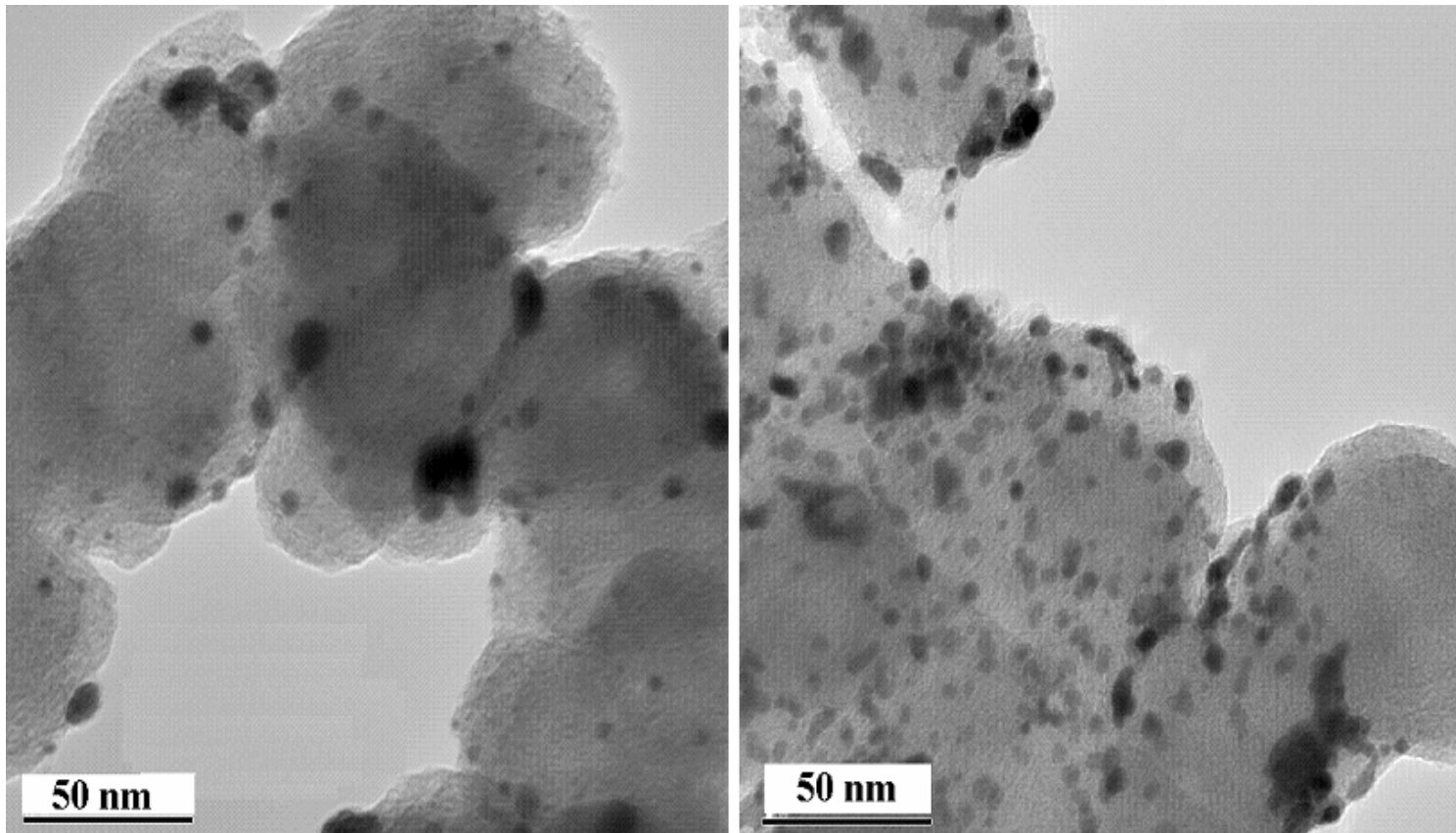
Synthesized PBI

with increased molecular weight

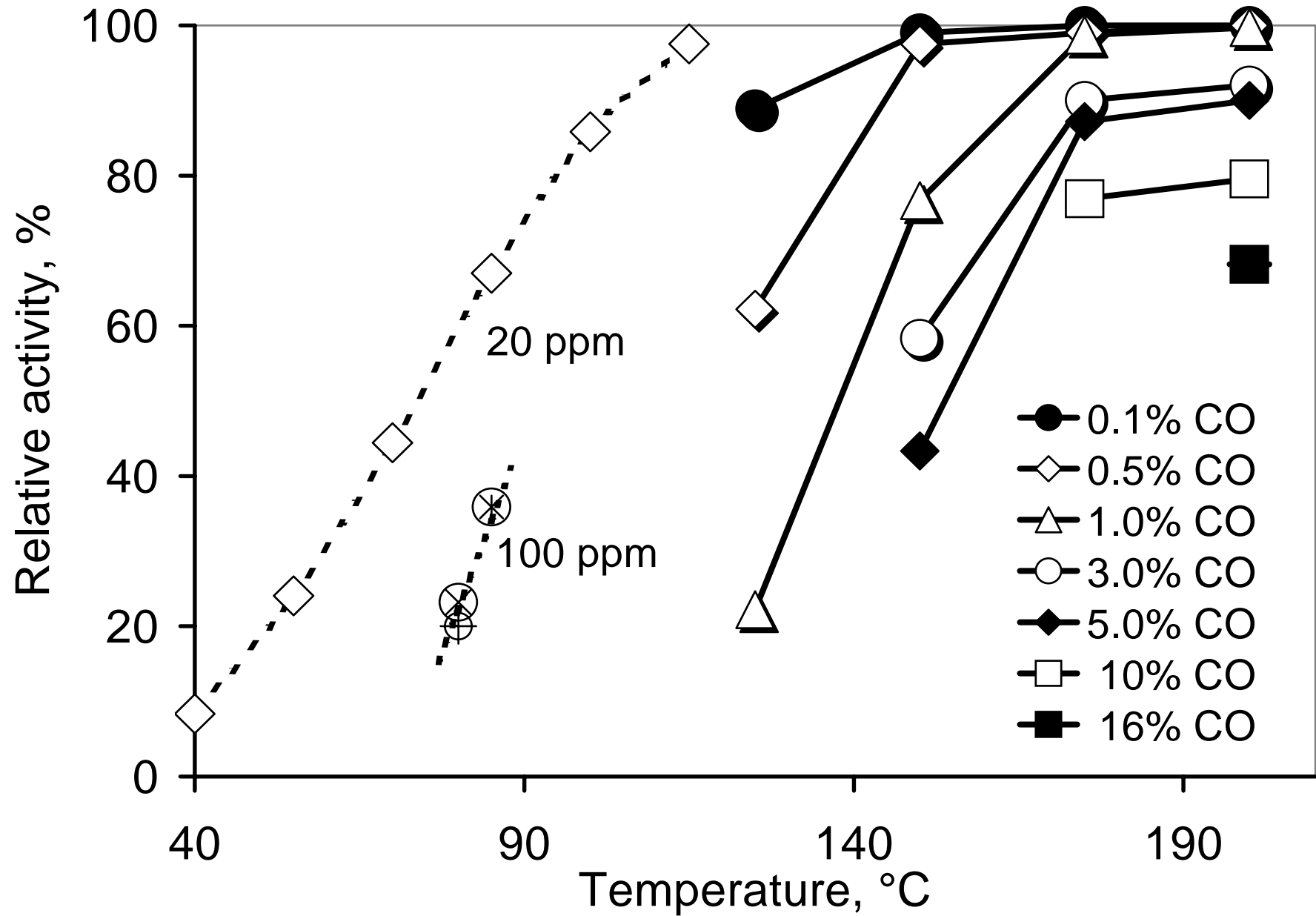


Lifetime of HT-PEMFC

- **Deterioration of catalysts**
 - **growth of particle size**
 - **corrosion of support carbon**



CO Poisoning – in temperature range up to 200°C



Influence on fuel impurities

to be evaluated in FURIM

- **Poisoning effect**
- **Reversibility**
- **Long term effect**