

Fabrication and Characterisation of Pt-Carbon Gas Diffusion Electrodes for Polymer Electrolyte Membrane Fuel Cells

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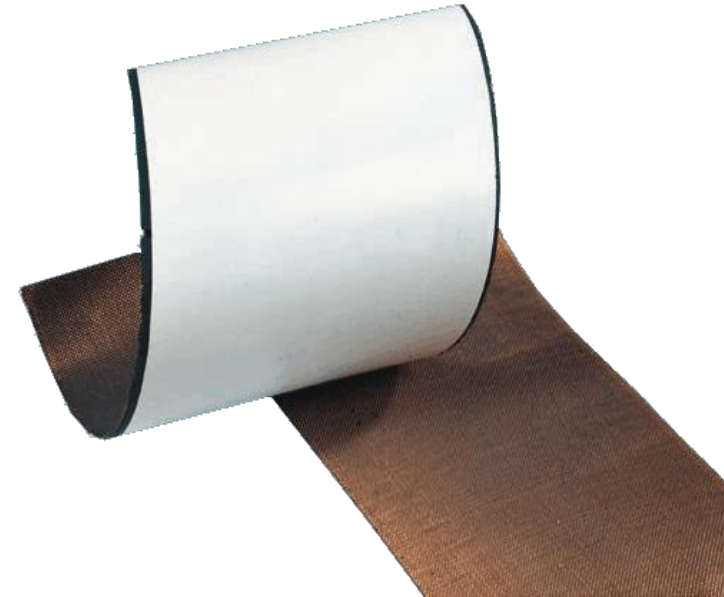
Products



H₂ Reference Electrode
HydroFlex



Alkaline Electrolyser
EloFlux



Gas Diffusion Electrode
BiPlex

BiPlex

Materials

Oxided Nickel

Silver oxide

Different Carbons



Alkaline Fuel Cell

Alkaline Electrolyser

Manganese Dioxide

Zink



Batteries

Silflon®



Chlorine Alkaline Electrolysis

Carbon Materials

Platinum/Carbon



Polymer Electrolyte Fuel Cell

Pretreatment

- Drying of materials
- Milling of materials to reduce particle size

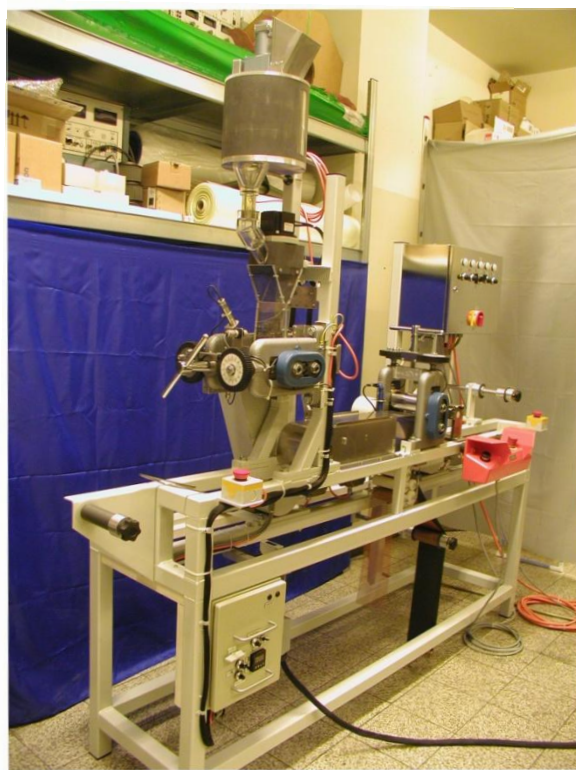
Mixing

- Catalyst is mixed with a hydrophobic binder in a mill.
- Therefore, usually Teflon powder is used.
- Pore forming materials or other additives can be added.

Rolling

- Teflon/Catalyst -Mixture is fed to rolling process to be compacted between two rolls.

Rolling Process



- Rolling Process is a dry process.
- Electrode broadness can be scaled from 10 cm up to 40 cm.
- Allows the continuous production up to several 100 meters.
- Variable speed, pressure, thickness and also temperature can be applied.
- The rolled catalyst layer can be brought on a current collector.
- The current collector is usually a metal mesh.
- But also other reinforcements like Carbon papers or fleeces are thinkable.
- All process data will be saved in a database.

Mechanical and electrical parameters

- Thickness
- Weight
- Electrical resistance (through plane)

Fluid mechanical parameters

- Wettability by weight increase in different fluids (Octane, Water, KOH, H₃PO₄)
- Bubble-Point
- Gas Permeability dry and wet
- Fluid Permeability

Electrochemical Parameters

- Open Circuit Voltage.
- Current-Voltage-Characteristics by Linear or Cyclic Voltammetry.
- Polarization at constant current or constant potential.
- Depending on customer preferences, electrodes can be tested in fuel cell arrangements, too

- **Every electrode with its parameters is recorded in a database.**
 - **This database includes:**
 - Raw material parameters (catalyst loading, density, shape, ...)
 - Production parameters (pressure, temperature, speed,...)
 - Characterization parameters (mechanical, electrical, electrochemical)
 - **Fast graphical correlation between all parameters.**
- ↳ **Management of materials**
- ↳ **Management of data**
- ↳ **Fast optimisation of Gas Diffusion Electrodes**

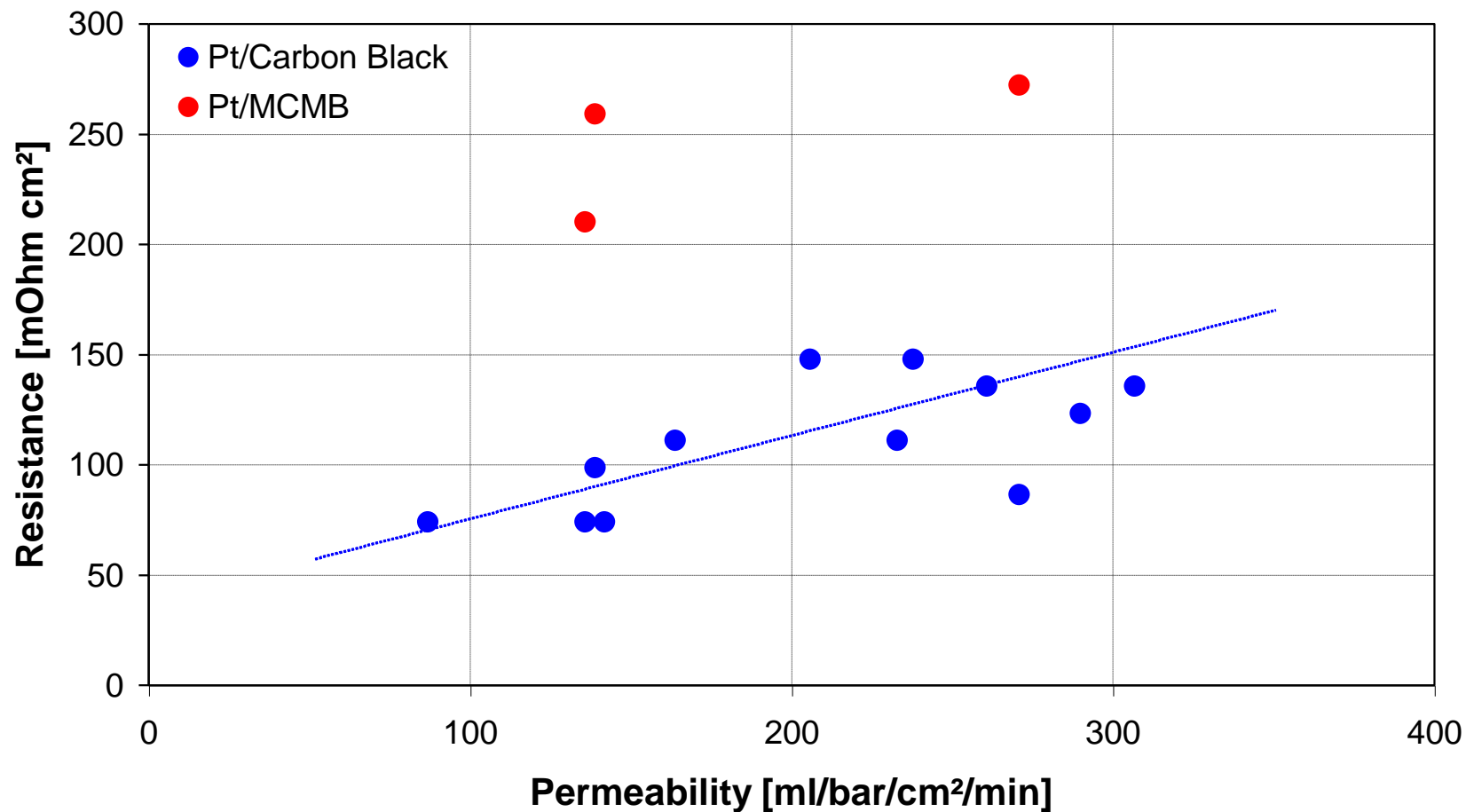
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Characterisation

Mechanical and electrical parameters

No.	Components	Pt [mg/cm ²]	Weight [mg/cm ²]	Thickness [μm]	Air Permeability [ml/bar/cm ² /min]	Resistance [mOhm cm ²]
#156	Pt/XC72 - PFM	2.3	24.3	420	136	73.9
#158	Pt/XC72 - PFM	2.3	24.3	410	139	98.5
#186	Pt/SHB - PFM	2.9	27.6	420	271	86.2
#194	Pt/SHB - PFM	2.7	26.8	400	142	73.9
#311	Pt/SHB - PFM	2.6	25.9	380	164	110.8
#312	Pt/SHB - PFM	2.6	25.8	430	233	110.8
#313	Pt/SHB - PFM	2.4	24.7	396	290	123.1
#374	Pt/SHB - PFM	1.6	19.9	290	497	135.4
#375	Pt/SHB - PFM	2.2	23.6	340	261	135.4
#376	Pt/SHB - PFM	2.3	24.4	350	238	147.7
#377	Pt/SHB - PFM	2.5	25.0	340	307	135.4
#378	Pt/SHB - PFM	2.0	22.0	310	206	147.7
#392	Pt/SHB - PFM	2.3	25.4	350	87	73.9
#27	Pt/AKC & Graphite	1.3	23.4	230	1528	135.4
#71	Pt/AKC & Graphite	2.0	28.8	420	-	-
#389	Pt/MCMB & MCMB	3.0	44.5	360	210	123.1
#390	Pt/MCMB & MCMB	2.0	50.8	435	259	123.1
#434	Pt/MCMB & MCMB	1.8	46.9	436	272	61.6

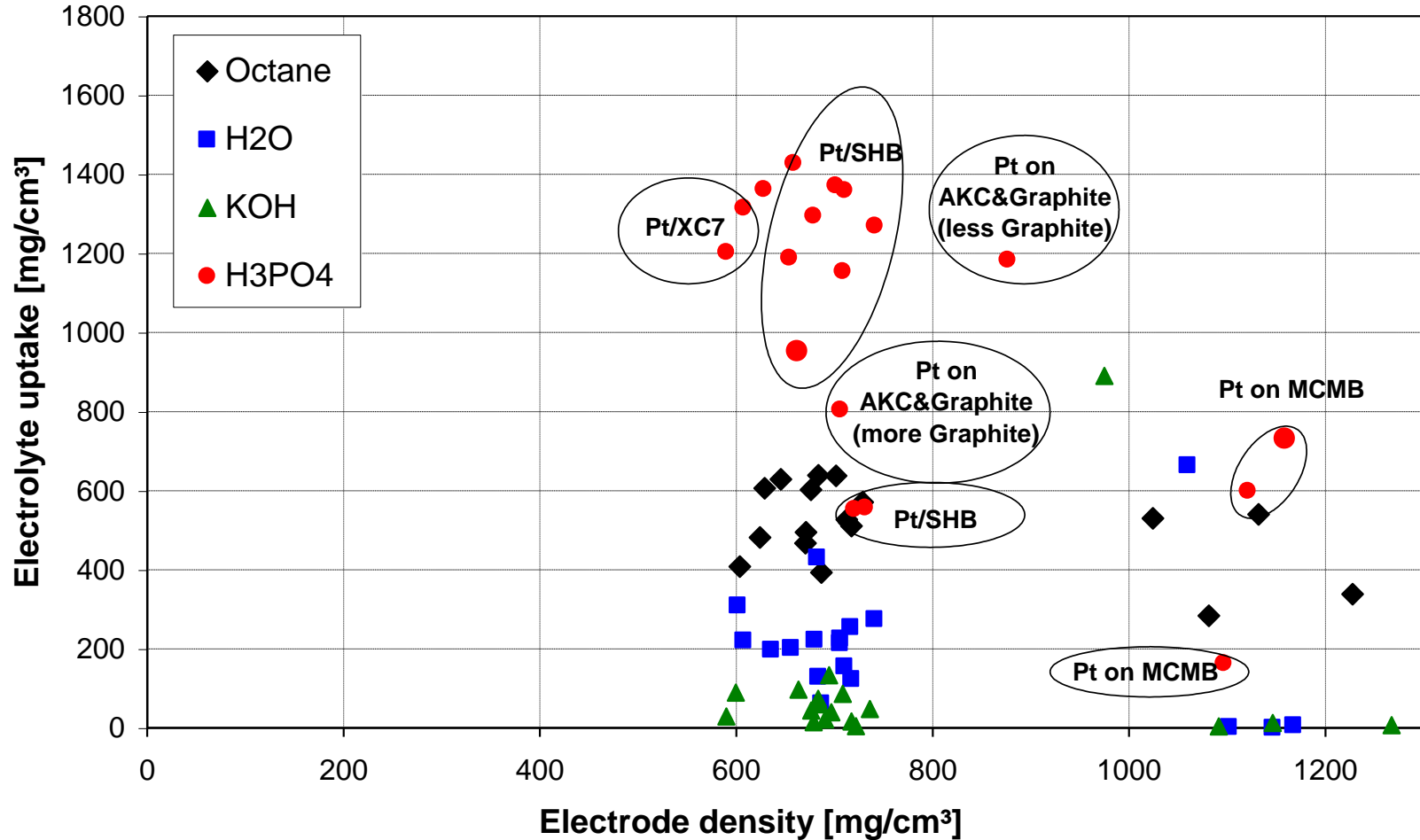
Connection Resistance - Porosity



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Characterisation

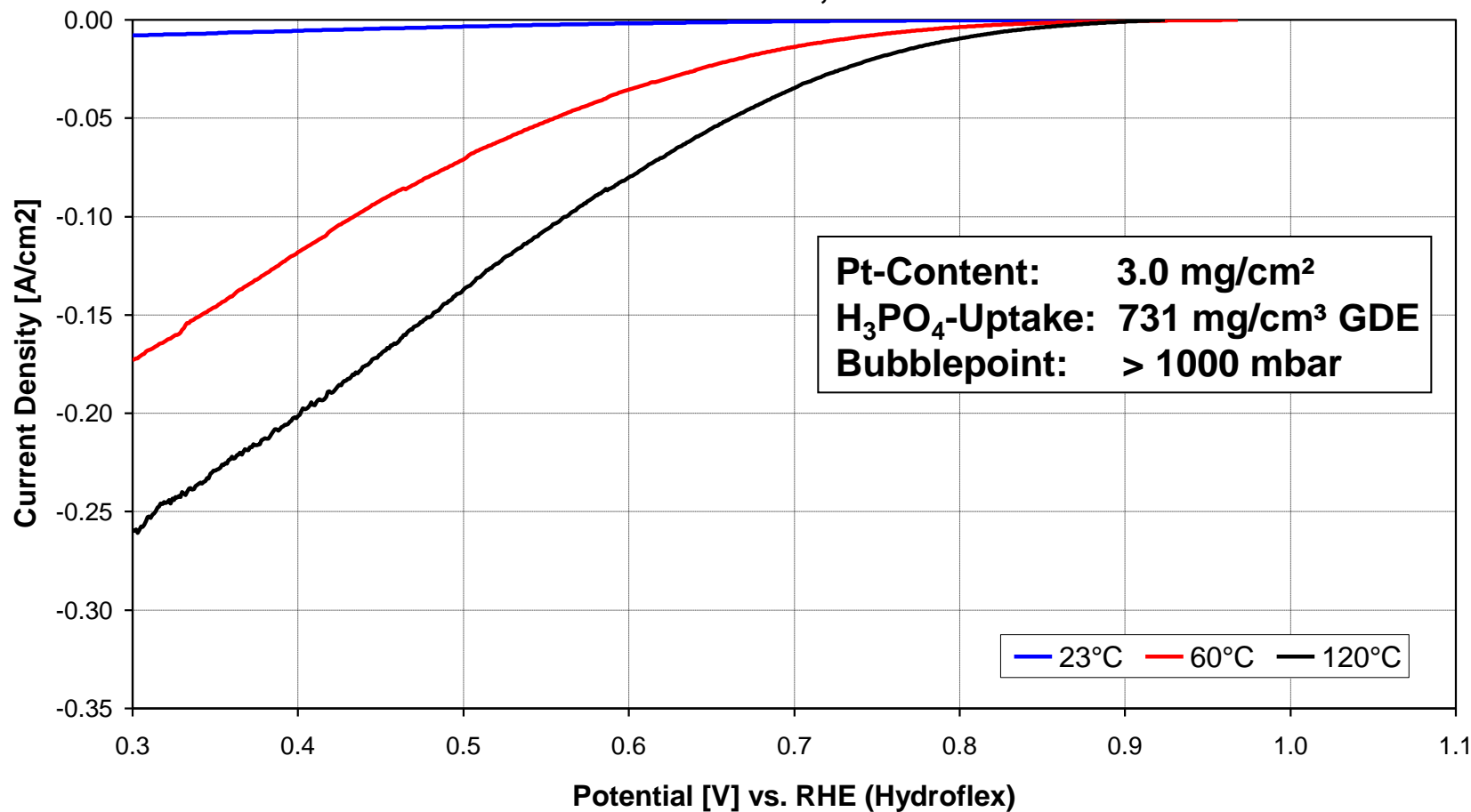
Electrolyte uptake of different Pt/Carbon-electrodes



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Half Cell Set Up

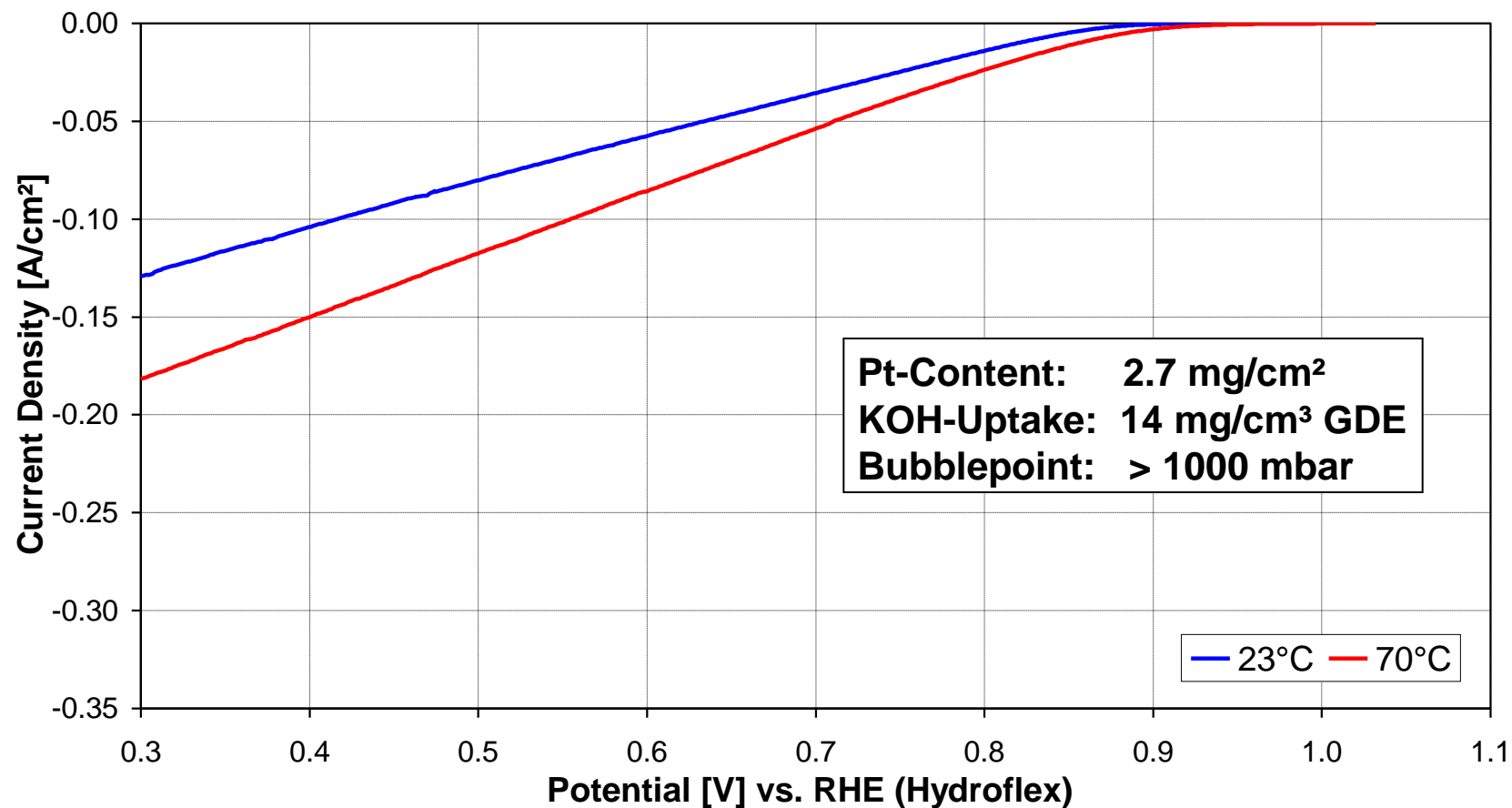
PTFE - Pt/MCMB-MCMB-GDE on carbon fleece
97wt% H₃PO₄, Air



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Half Cell Set Up

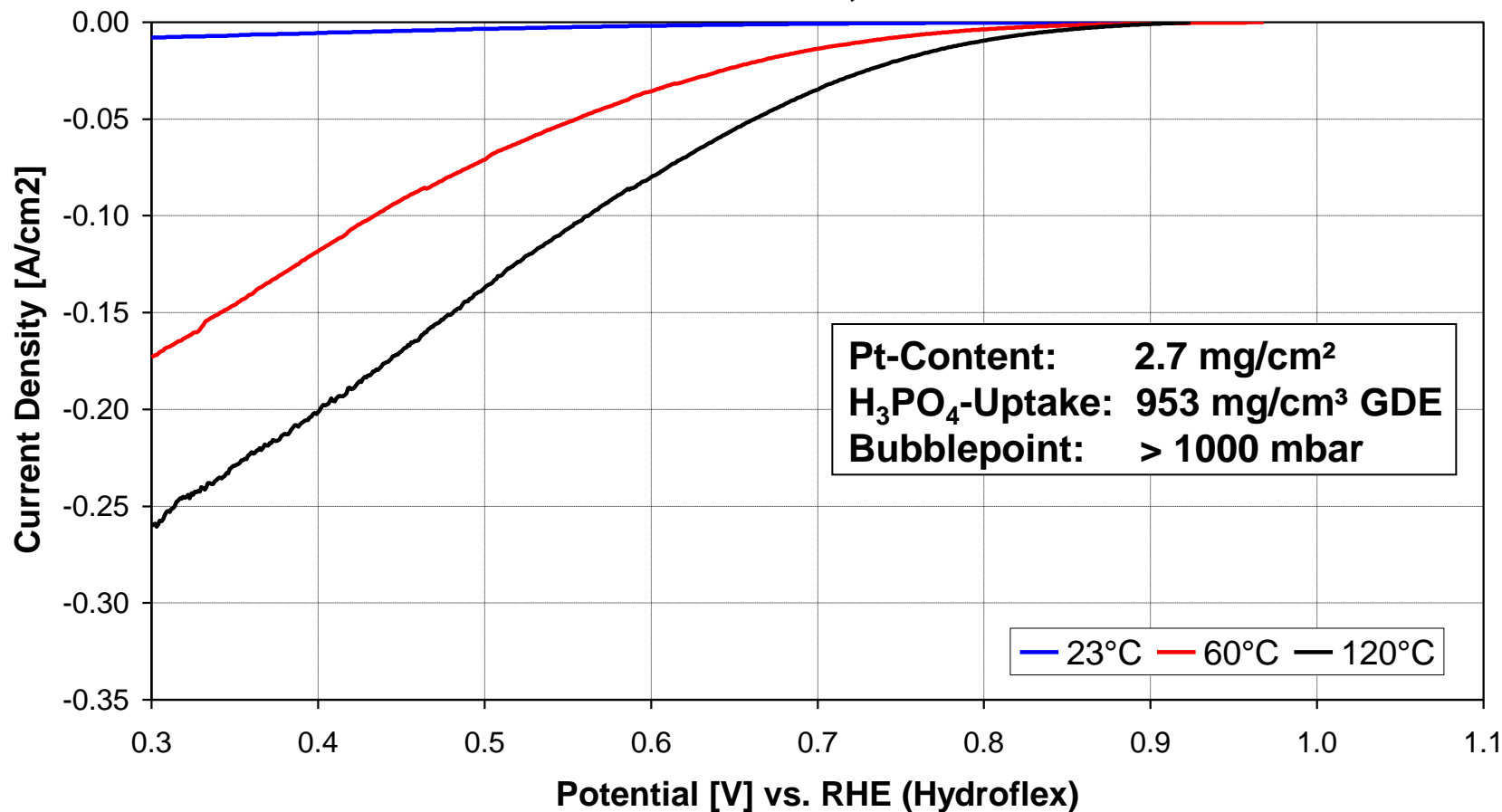
PTFE - Pt/SHB - PFM - GDE on carbon fleece
7 M KOH, Air



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Half Cell Set Up

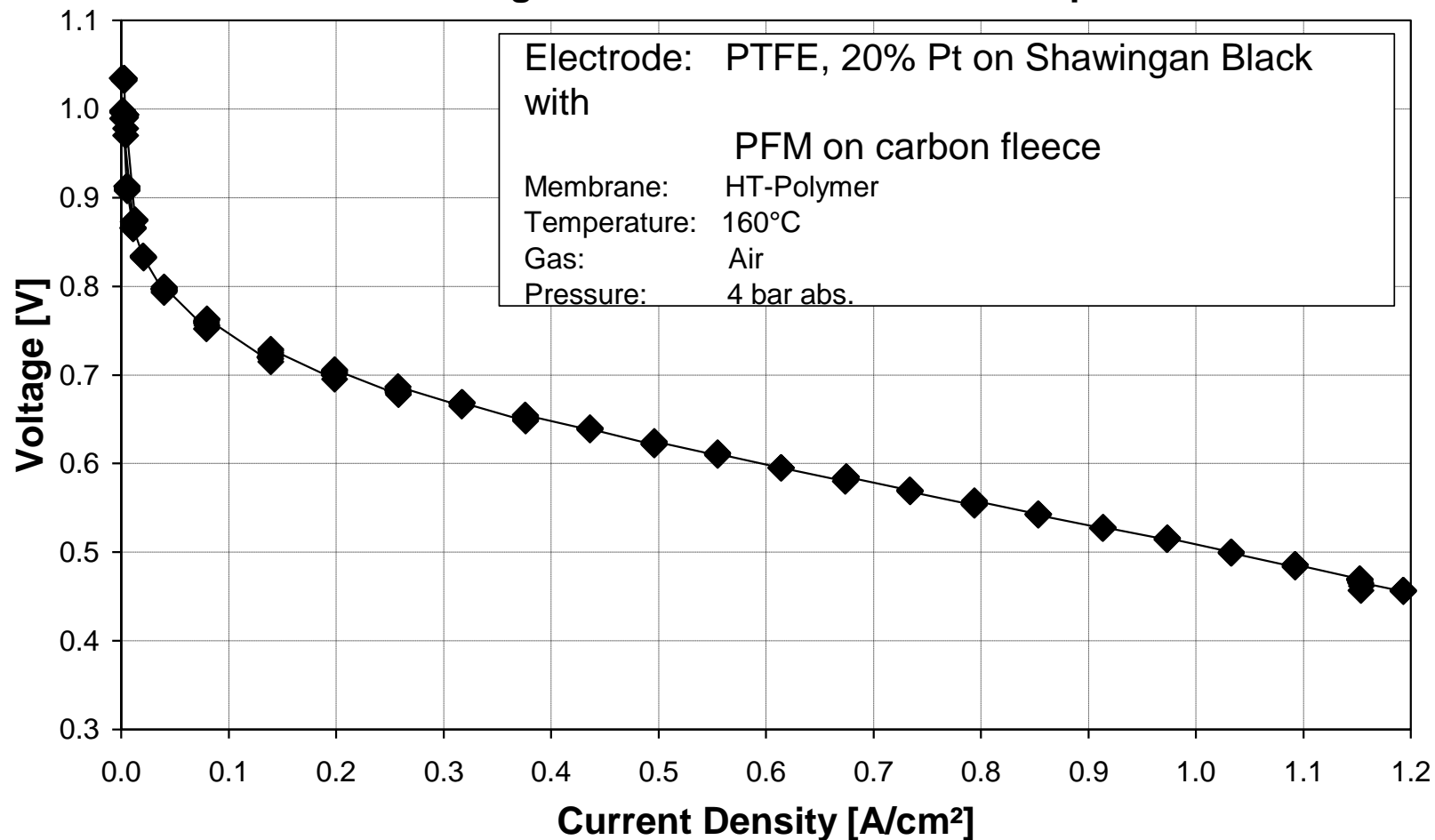
PTFE - Pt/MCMB-MCMB-GDE on carbon fleece
97wt% H₃PO₄, Air



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Fuel Cell Set Up

Testing of electrodes in fuel cell set up



Summary



- One Process for Gas Diffusion Electrodes of different materials.
- Fabrication itself is a simple process.
- Production of GDE's with adjusted properties is difficult.
- Produced electrodes have to be characterised.
- Therefore, special procedures have to be found.
- Database collect all important data of fabrication process and characterisation of produced electrodes.

↪ Production of special electrodes

for special applications

for special customers.