



New Pt DPH-materials for the glass industry

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Requirements from the glass industry

■ Manufacturing of high quality glasses requires use of equipment with

- High melting point
- Good mechanical properties
- High corrosion resistance
- Good wetting behavior and no glass coloring effects for optical glasses
- Complex geometry
- Long service life

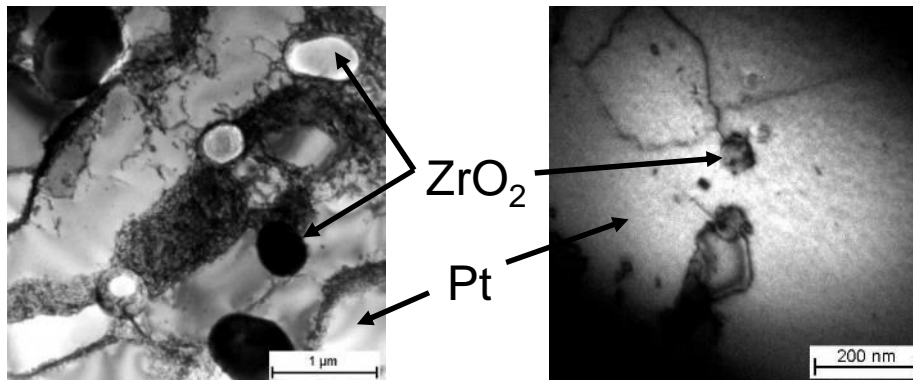


■ Suitable materials are

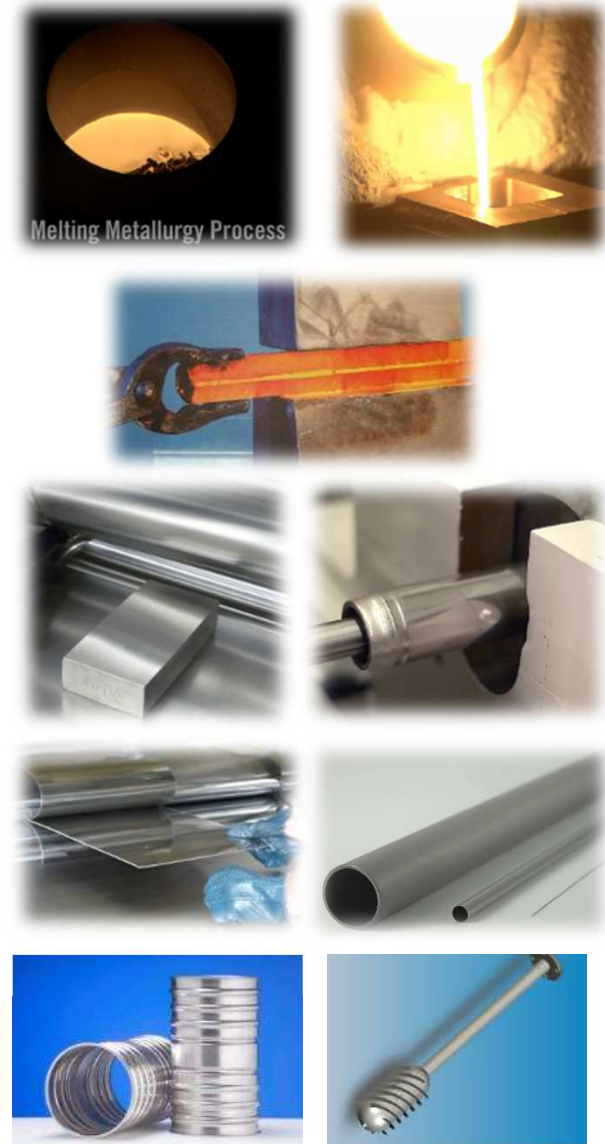
- Conventional Pt- and Pt-Rh-alloys
- Oxide dispersion hardened Pt- and Pt-Rh-alloys
 - ODS: powder metallurgical manufacturing route
 - DPH: casting metallurgical manufacturing route only from Heraeus

DPH and DPH-A: Casting metallurgical route

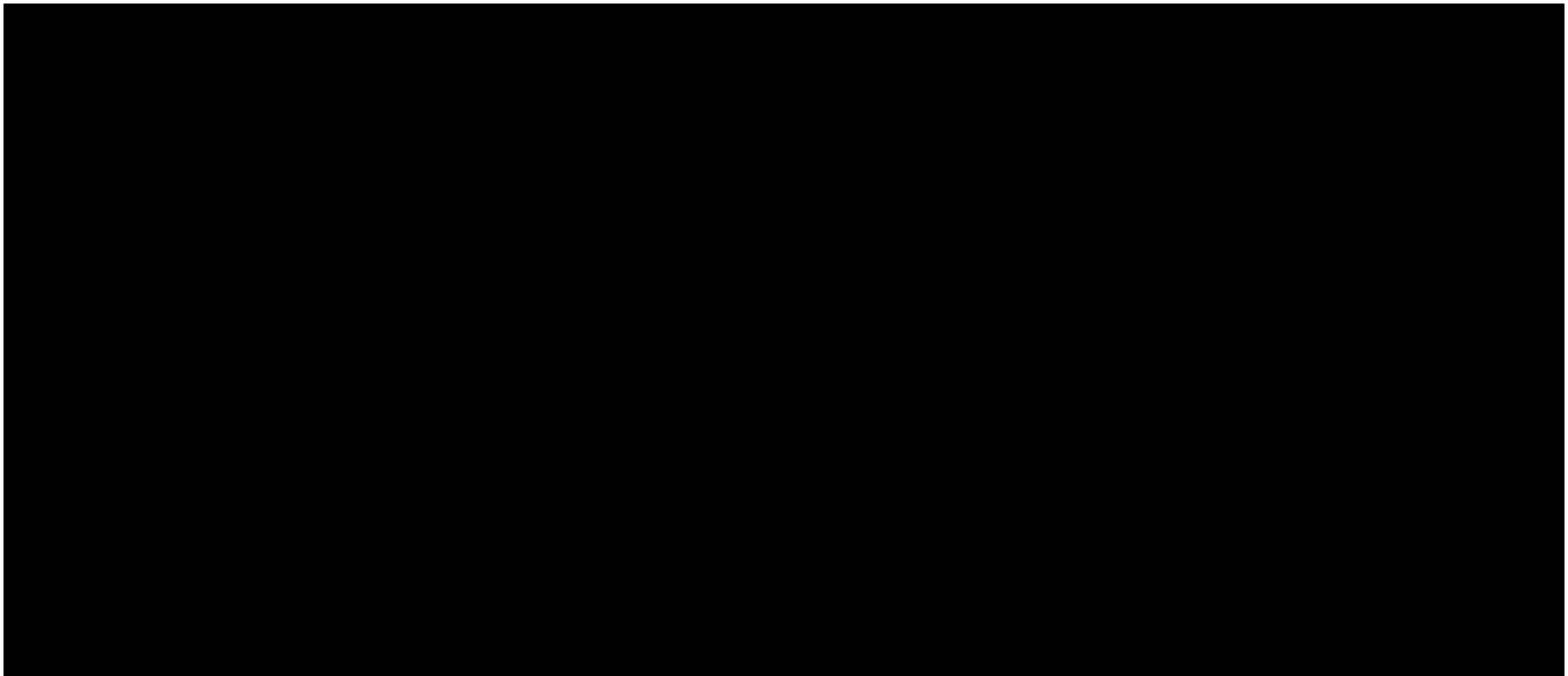
- Casting (Pt $T_m=1769^\circ\text{C}$) + Forging + Rolling
- Oxy-Annealing of sheets / tubes
 - No powder production necessary
 - No air porosity and no impurities during powder production
 - Internal oxidation of the sheet / tube
 - formation of ZrO_2 -particles and even distribution inside the grains and at the grain boundaries
- ➔ Platinum hardened by ZrO_2 -particles at high temperatures



■ Rolling + Forming of „Platinum components“



“Platinum components” for the glass industry

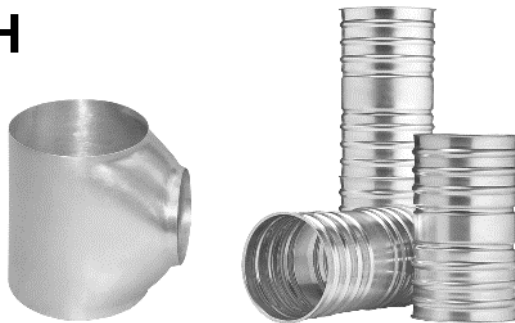


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➔ Materials with different properties are required for different components

Properties of DPH and DPH-A materials

DPH



Materials for tubes and it's components

- High elasticity in the heating-up phase
- Robustness to changes in temperature
- High form stability of the components, even in the weld joints

- High ductility
- Good workability
- Excelent weldability

DPH-A



Materials for active parts like stirrers & plungers

- Excellent combination of strength and ductility
- High torsional rigidity for stirrers and plungers

- Very high strength
- High stiffness
- Excelent weldability

Properties of DPH and DPH-A materials

DPH



- Same chemical composition
- Different thermo mechanical treatments for DPH and DPH-A
 - Different microstructure (grains)
 - Different nanostructure (particles)

DPH-A



Materials for tubes and it's components

- $ZrO_2 = 1800 \text{ ppm}$
- ZrO_2 -particle size 100–450 nm
- Round shape grains
- Grain size 60 – 90 μm

Materials for active parts like stirrers & plungers

- $ZrO_2 = 1800 \text{ ppm}$
- Smaller ZrO_2 -particles than in DPH
- Stretched grains
- Grain size 70 – 120 μm

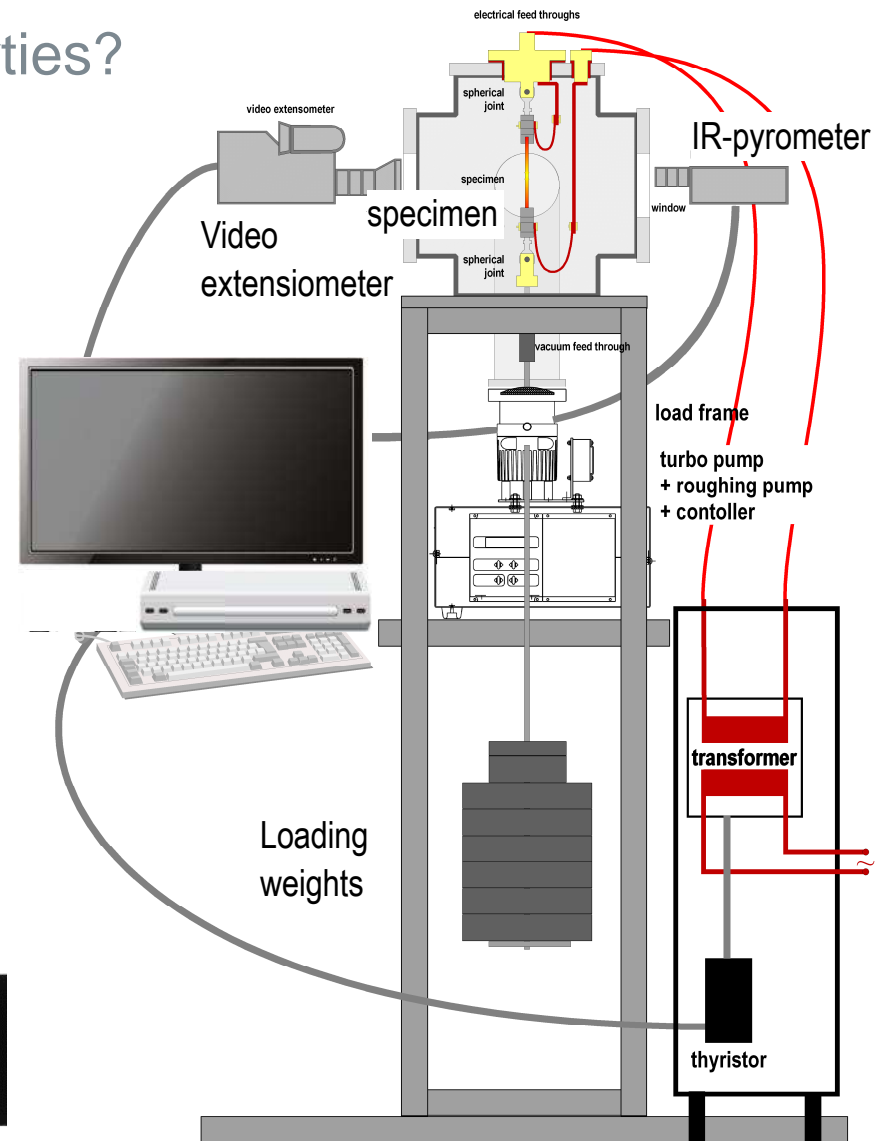
How to measure mechanical properties?

Creep rupture test

Stress-rupture and creep tests

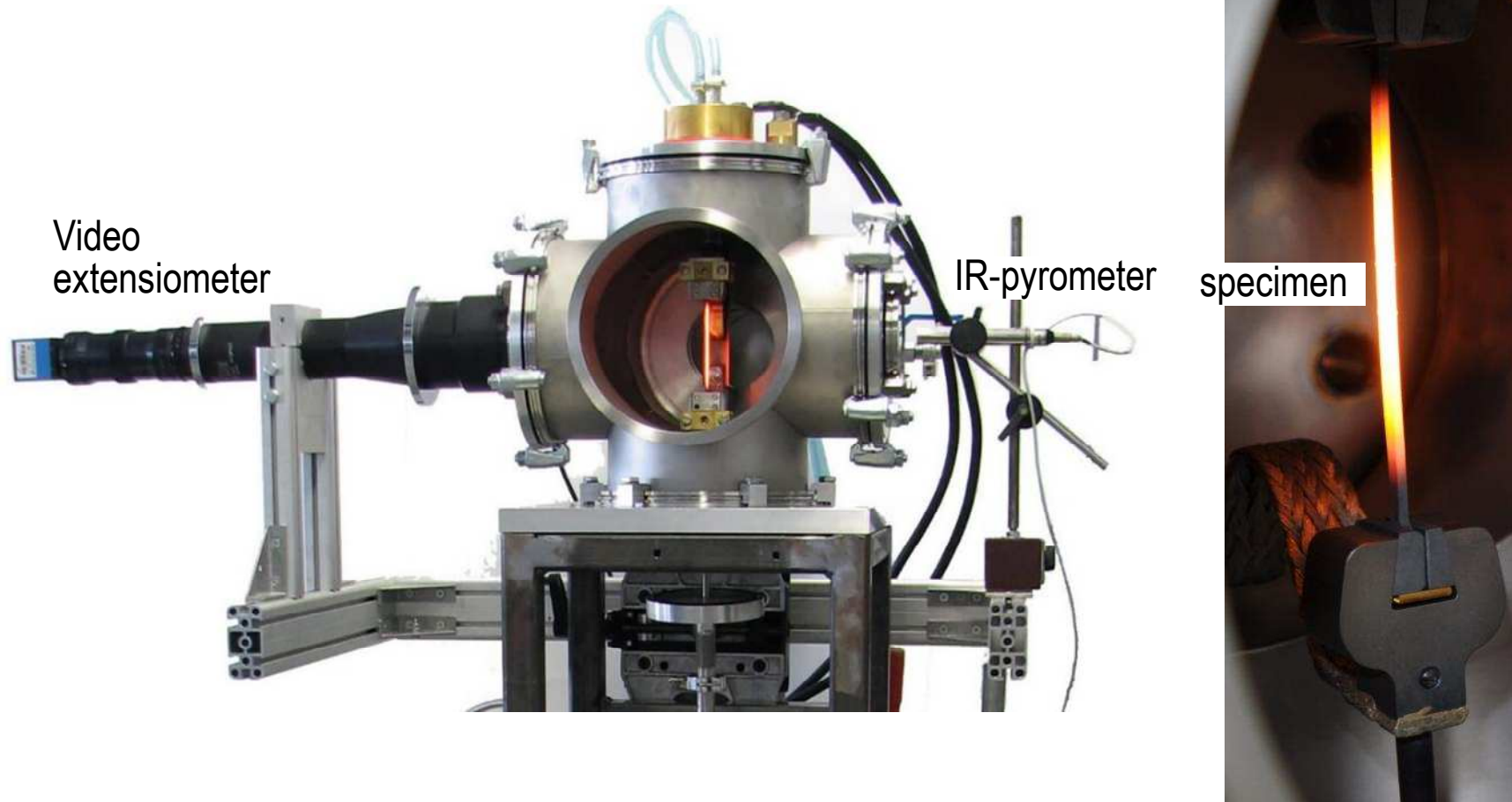
- Direct electric current heating
- IR-pyrometer
- Temperature controlled by computer Temperature range: 750 - 3000°C
- Creep curve determination by high resolution camera and the SuperCreep software

Specimen: Strips $120 \times 4 \times 0.8$ mm
4 shoulders laser cut

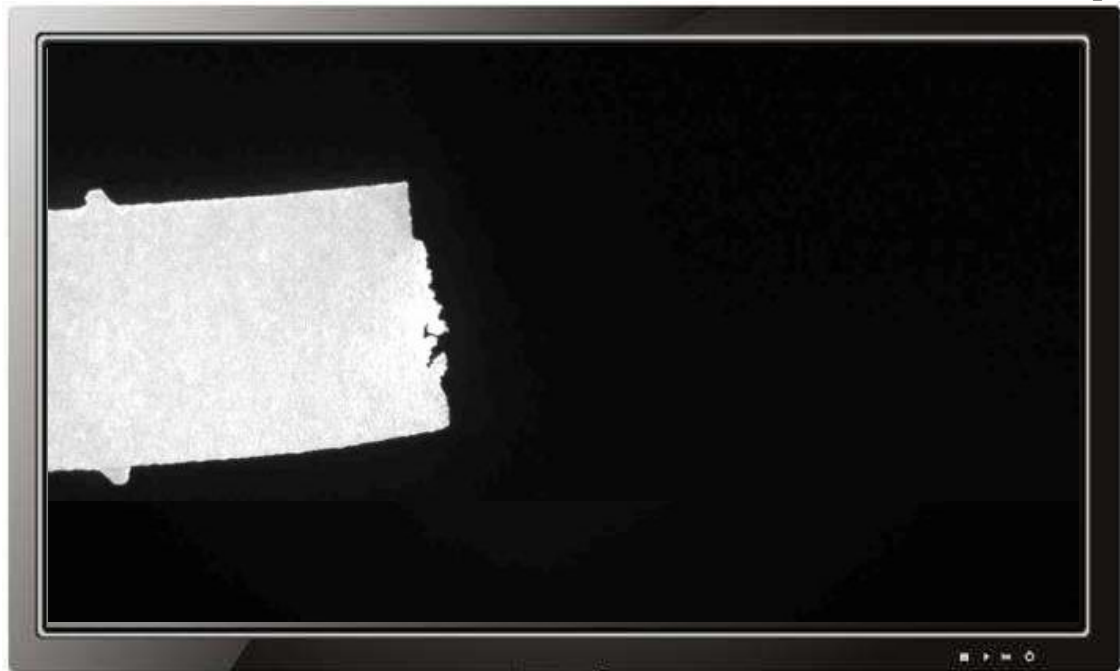


How to measure mechanical properties?

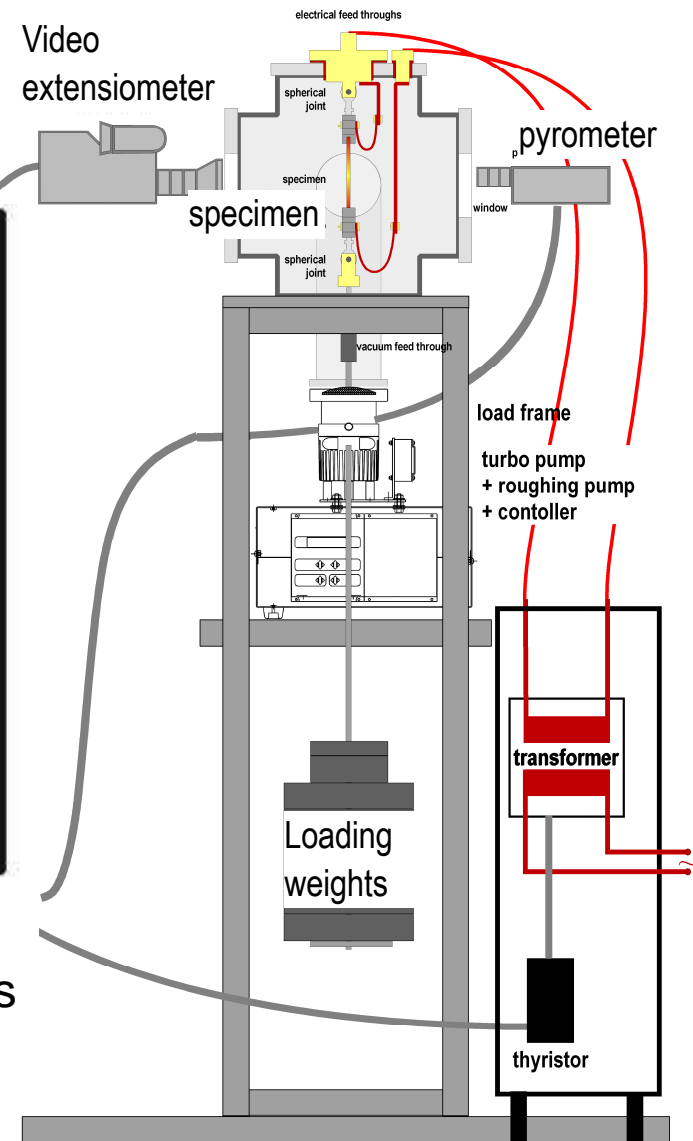
Creep rupture test



Mechanical properties of DPH and DPH-A
Creep rupture test

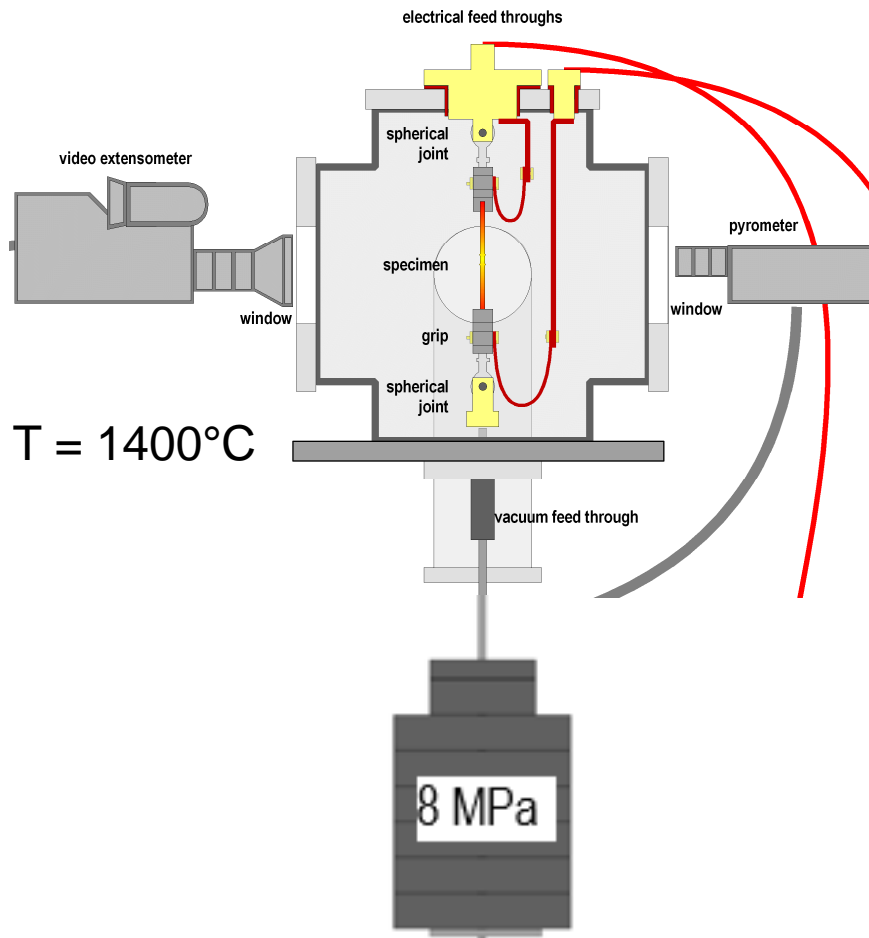


High strength and ductile fracture of DPH-materials



Mechanical properties of DPH and DPH-A

Creep rupture test

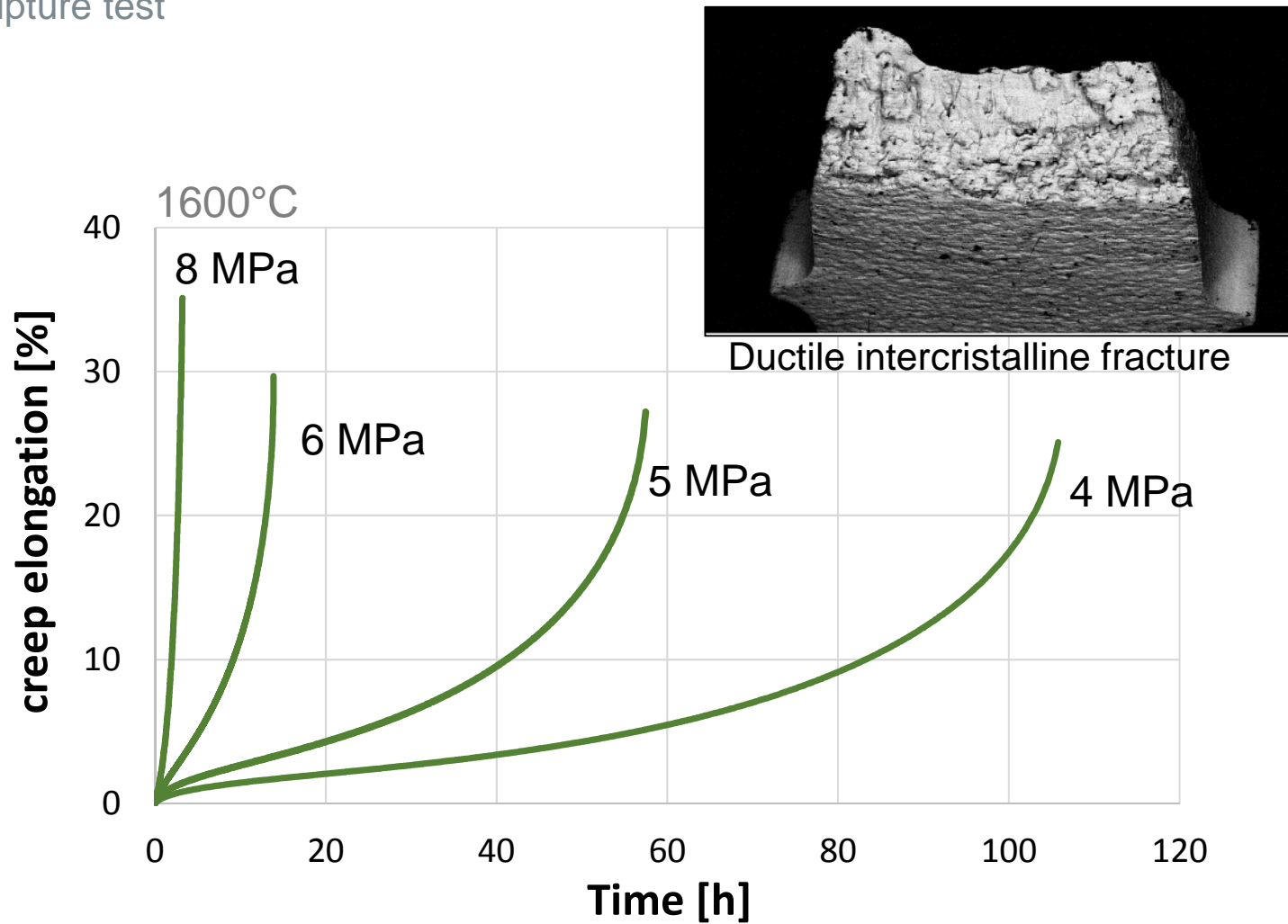


— Different time to rupture for different materials

- Pt-10%Rh 10 sec.
- Pt DPH 1 h
- Pt DPH-A 30 h
- Pt-10%Rh DPH 100 h
- Pt-10%Rh DPH-A 4000 h

Mechanical properties of DPH and DPH-A

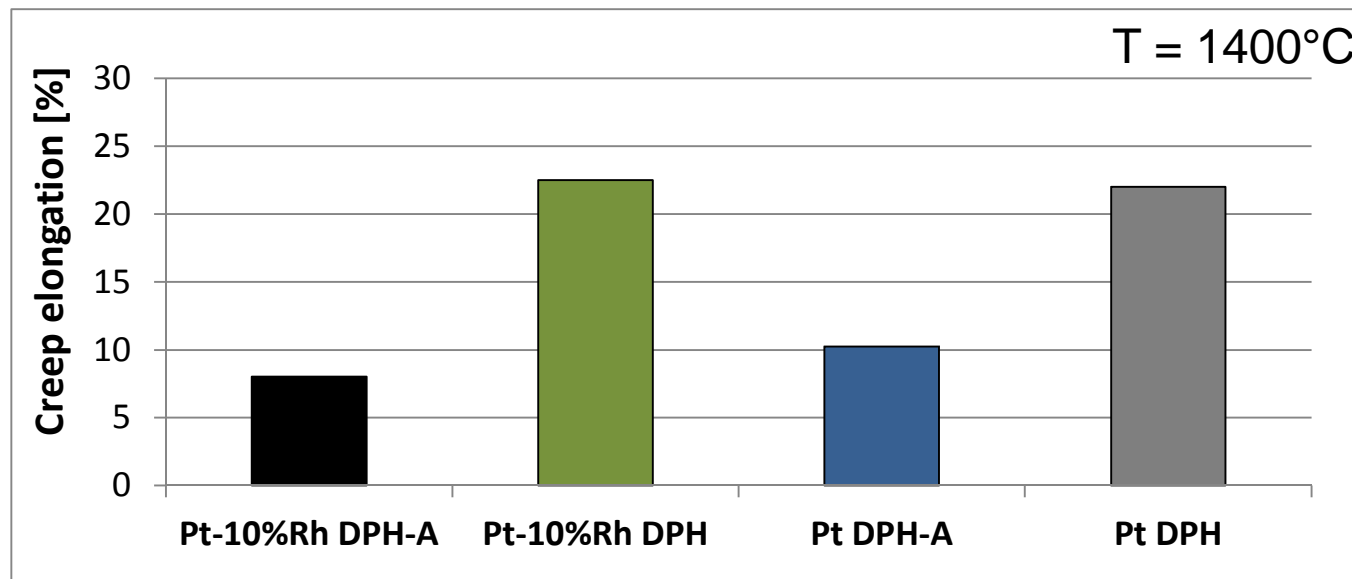
Creep rupture test



Mechanical properties of DPH and DPH-A

Creep rupture test

■ DPH-materials show high creep elongation



- Pt DPH ≈ Pt-10%Rh DPH > 20%
- Pt DPH-A ≈ Pt-10%Rh DPH-A ≈ 8 - 10%
- DPH > DPH-A materials

Equipment with complex geometry

Welding of DPH and DPH-A materials



Equipment with complex geometry

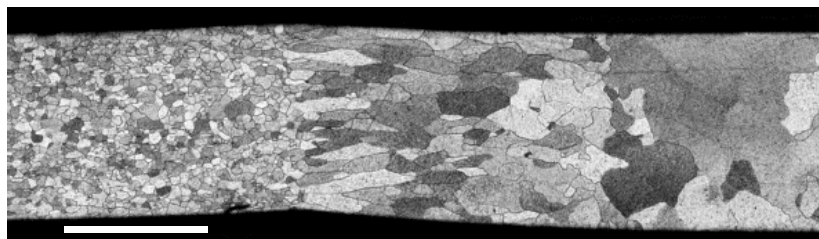
Welding of DPH and DPH-A materials

- Excellent weldability by all welding processes

- TIG, Laser, EB, Plasma ...

- Fine grained microstructure in welding zone

- Large amounts of ZrO_2 remain in the material

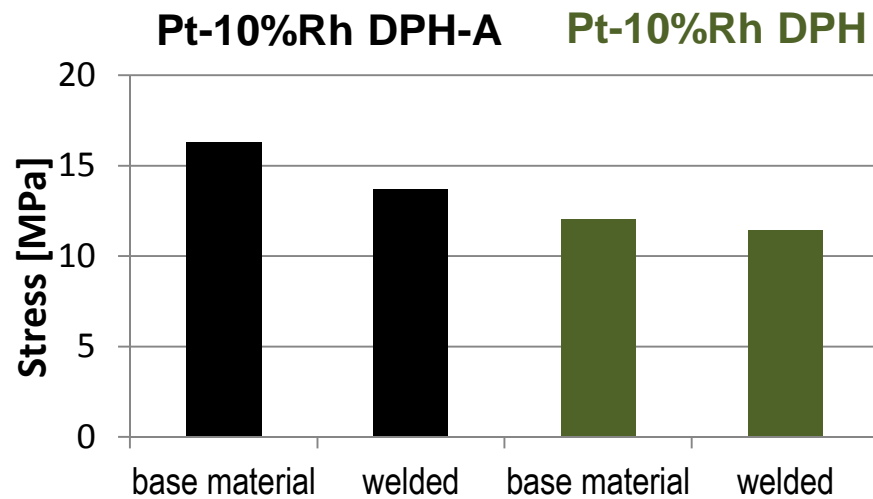


- High ductility > 20% of welded material



Equipment with complex geometry

Welding of DPH and DPH-A materials



Base material

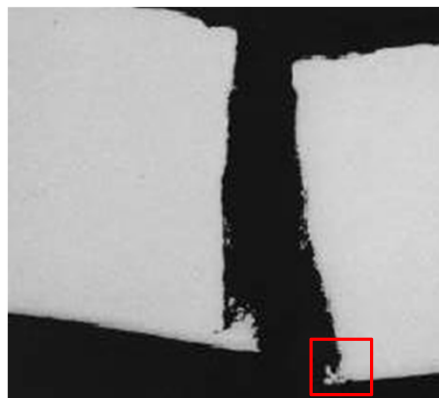
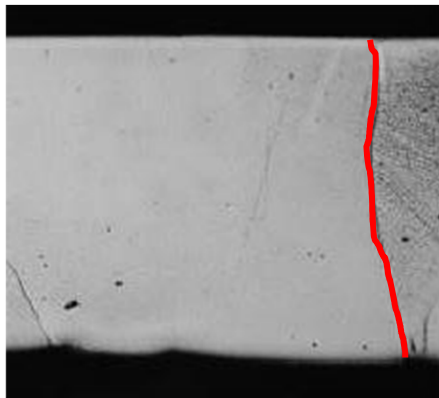


Welded

- Mechanical properties of weld's are similar to the base metal
 - > 80% creep rupture strength maintained
- Welded DPH-A has similar strength than DPH base material

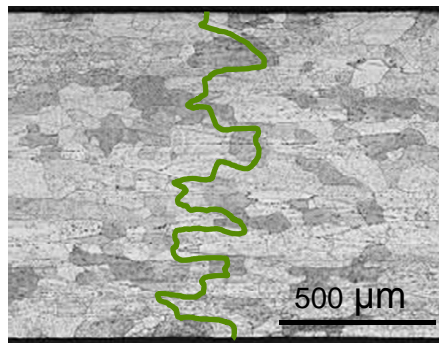
Corrosion resistance of DPH and DPH-A materials

- Pt-10%Rh show low corrosion resistance due to fast grain coarsening



Short diffusion paths and easy formation of corrosion cracks along grain boundaries

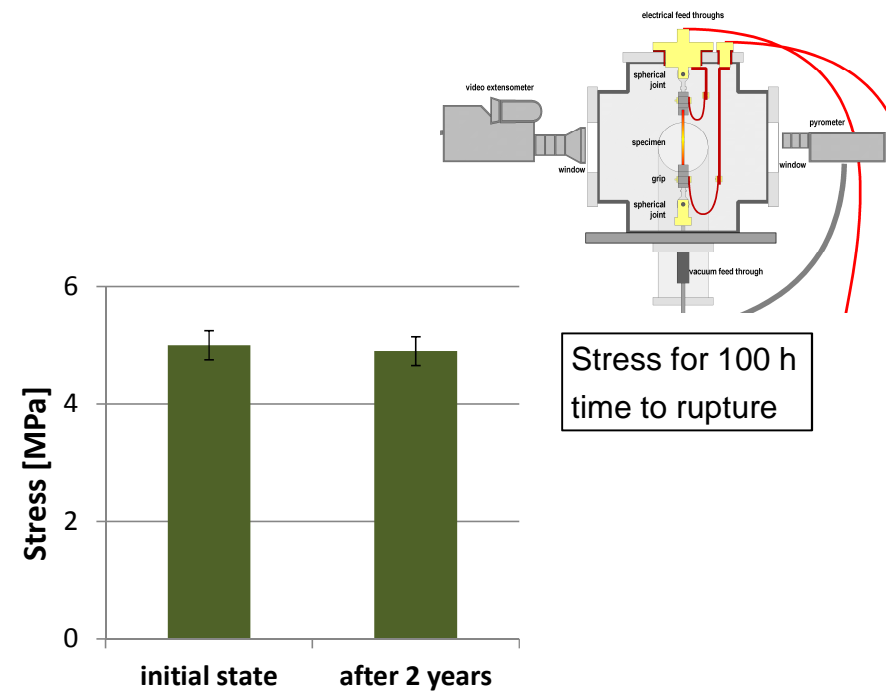
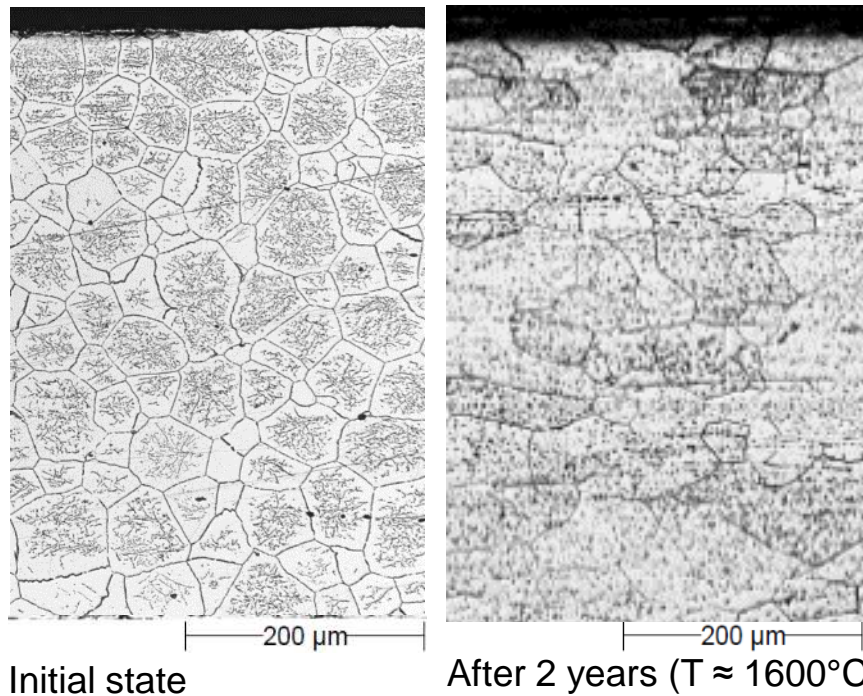
- DPH and DPH-A show high corrosion resistance due to small grain sizes



- ➔ DPH and DPH-A shows no grain coarsening
- ➔ long diffusion paths lead to high corrosion resistance
- ➔ No material and Pt-part failure

Long term stability of DPH and DPH-A materials

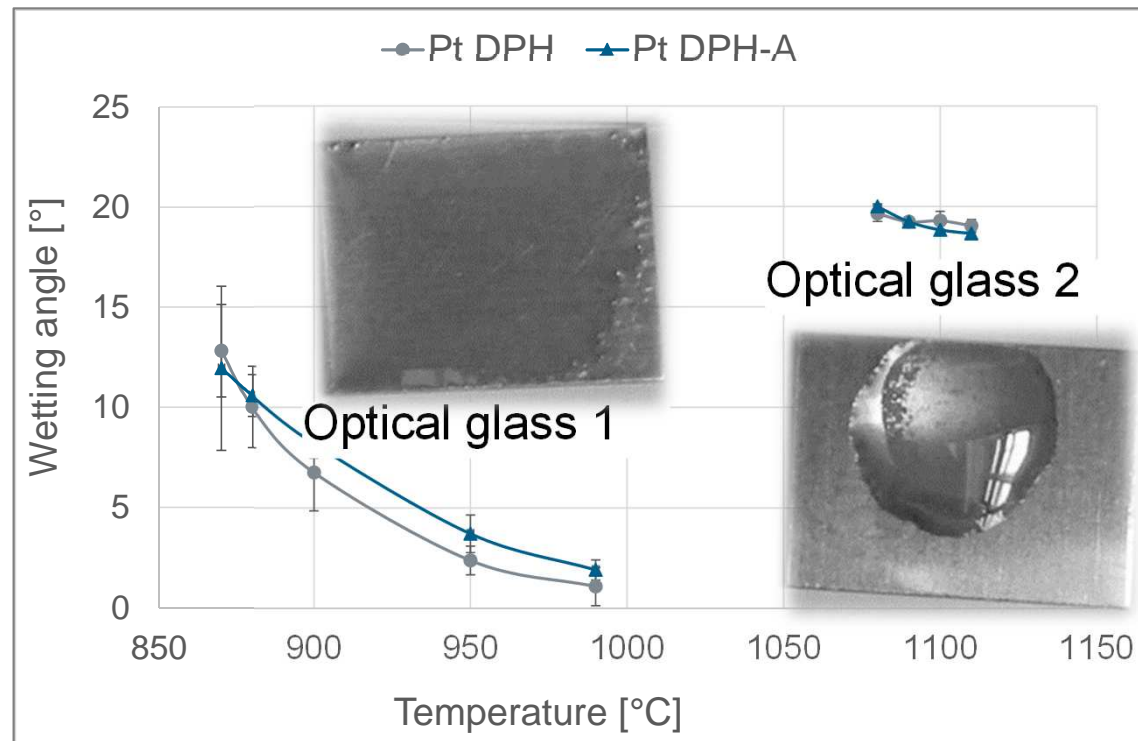
- High microstructure stability during long term operation at high temperatures



- No noticeable grain coarsening
- Mechanical properties after operation similar to initial state

Wetting behaviour of DPH and DPH-A materials

- DPH and DPH-A grade shows similar wetting behaviour
- No risk to combine DPH and DPH-A in one glass melting system
- No coloring effect for optical glasses



Your benefits

Combine the **established DPH** and **new DPH-A** grade in your systems for



— **Longer service life**

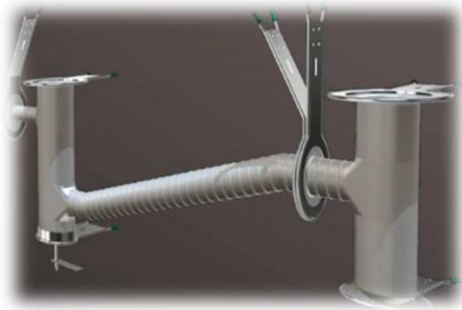
— **Less shut-downs of glass production lines**

— **Heraeus as full service provider**

- **Support in precious metals handling**
- **Technical support**
- **Optimization of your Pt-systems**
- **Recycling of used parts**

— **Best overall cost-benefit-ratio**

New Pt DPH-materials for the glass industry



Thank you very much for your attention



Acknowledgement

■ Prof. Bernd Fischer

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■ Prof. Uwe Glatzel and Dr. Rainer Völkl

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