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Corrosion Resistant Metals and Alloys for Alkali-free Glass Melting

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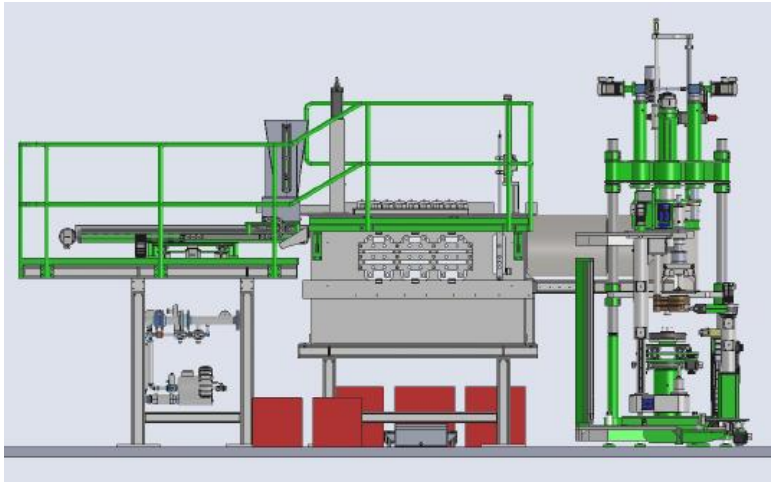
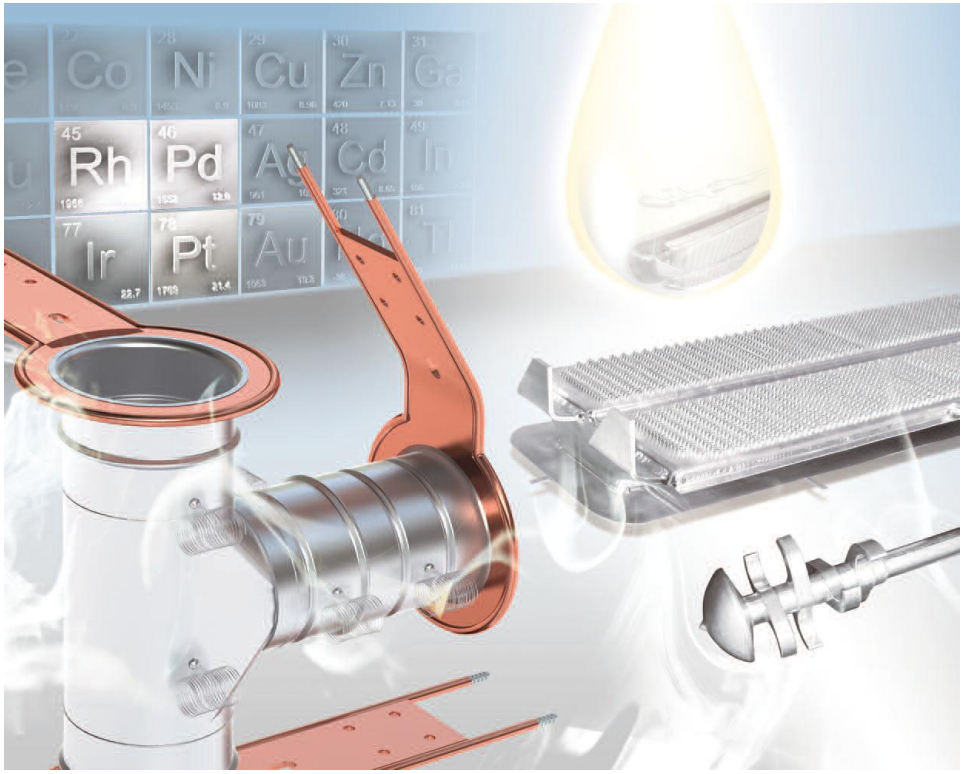




Session:
Refractory Metals
for the Glass Industry

Outline

- **Application of Pt in Glass Processing**
  - **Challenging Glass Compositions**
- **Mini-Melter Technology made by Füller**
  - **Design of Modular Melting Furnace**
- **Platinum-based Materials by Heraeus**
  - **Production and Application in Glass Industry**
- **Research Project FORGLAS**
  - **Corrosion of Material in Contact with Glass**
- **Summary**

FORGLAS

Application of Platinum in Glass Processing

Platinum Components are used in case of….

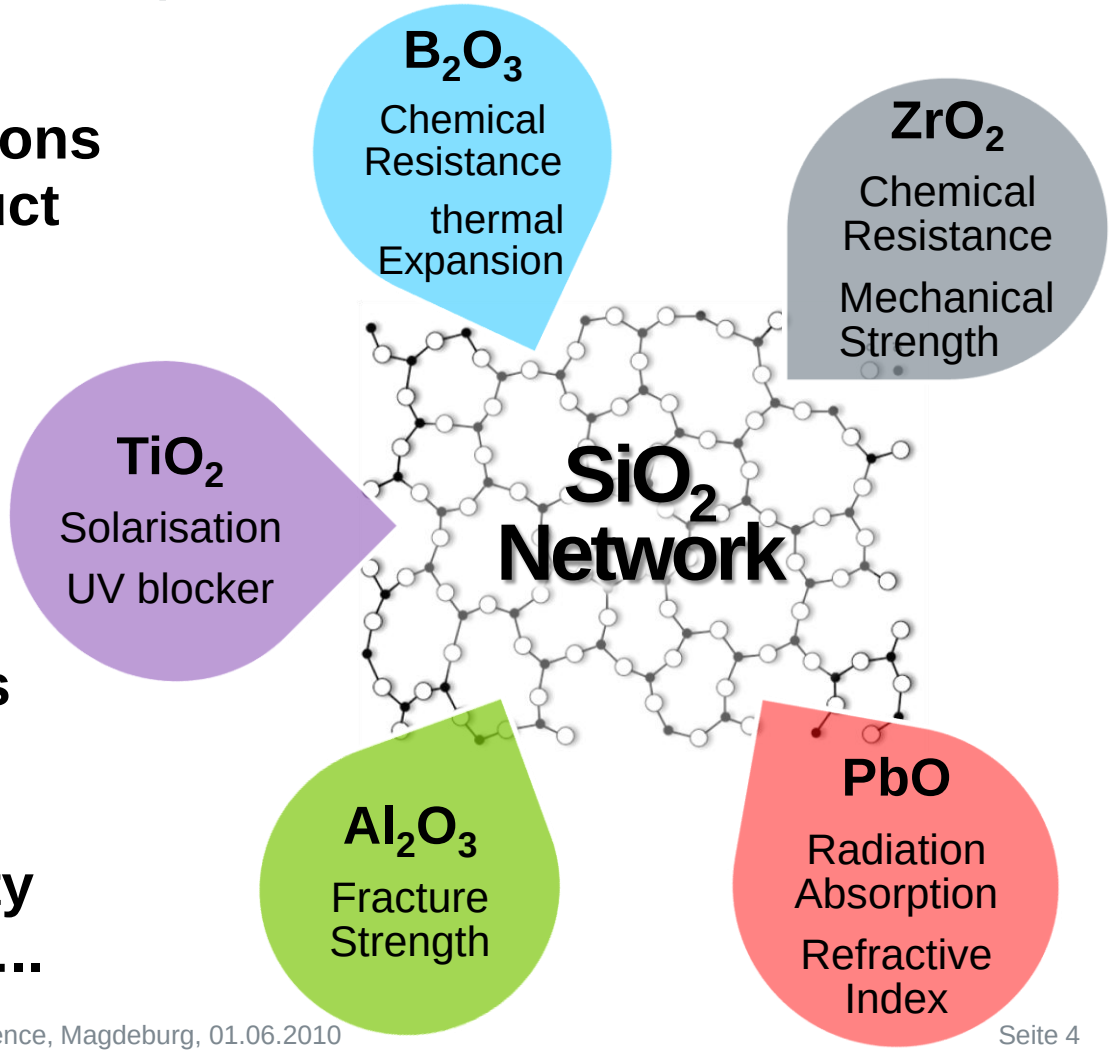
- **High melting and operation temperatures >1250°C**
- **Increased purity requirements on products**
- **Aggressive glass constituents during processing**

Examples are…

- **Crystal glass**
- **Optical glass**
- **Boro-silicate glass**
- **Alkali-free glass**
- **Basalt glass**
- **Glass for fibres (E-Glass, etc.)**

Challenging Glass Compositions

- **Complex compositions for increased product specifications**
- **Especially low amounts of alkali oxides result in demanding process conditions:**
  - high temperature
  - increased viscosity
  - low conductivity…..



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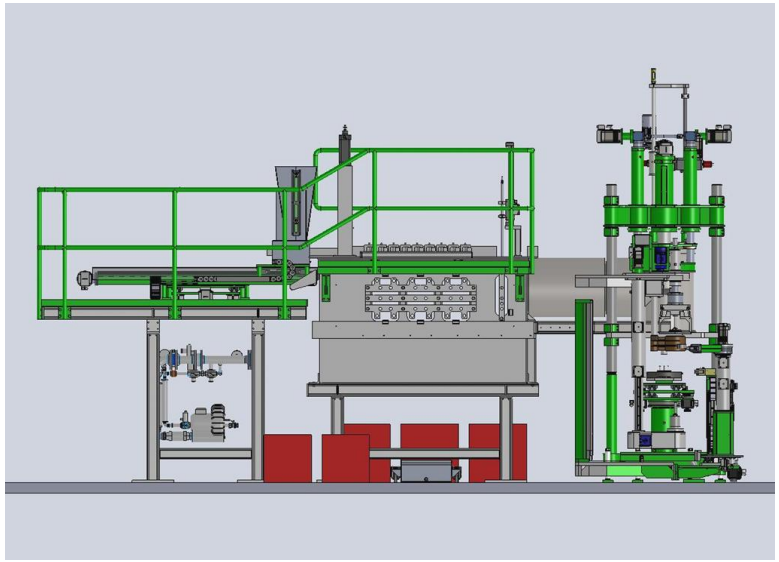
Mini-Melter made by Füller Glastechnologie

Füller Glastechnologie …

PRODUCTION SUPPORT

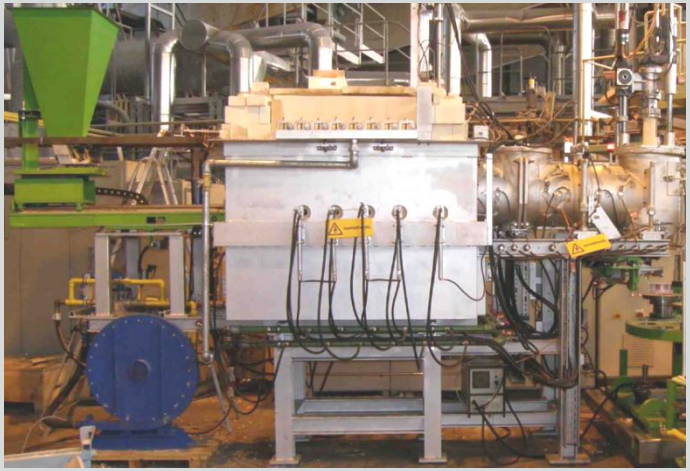
- **mini-melting**
- **feeding**
- **feeder channel colouring**



.. is developing innovative production systems for crystal glasses and high-precision manufacturing systems for technical as well as optical glassware.
Füller glass technology reflects 30 years of experience in glass manufacturing.

Production Systems for
High Quality
Glasses

Melting Systems Containing Platinum

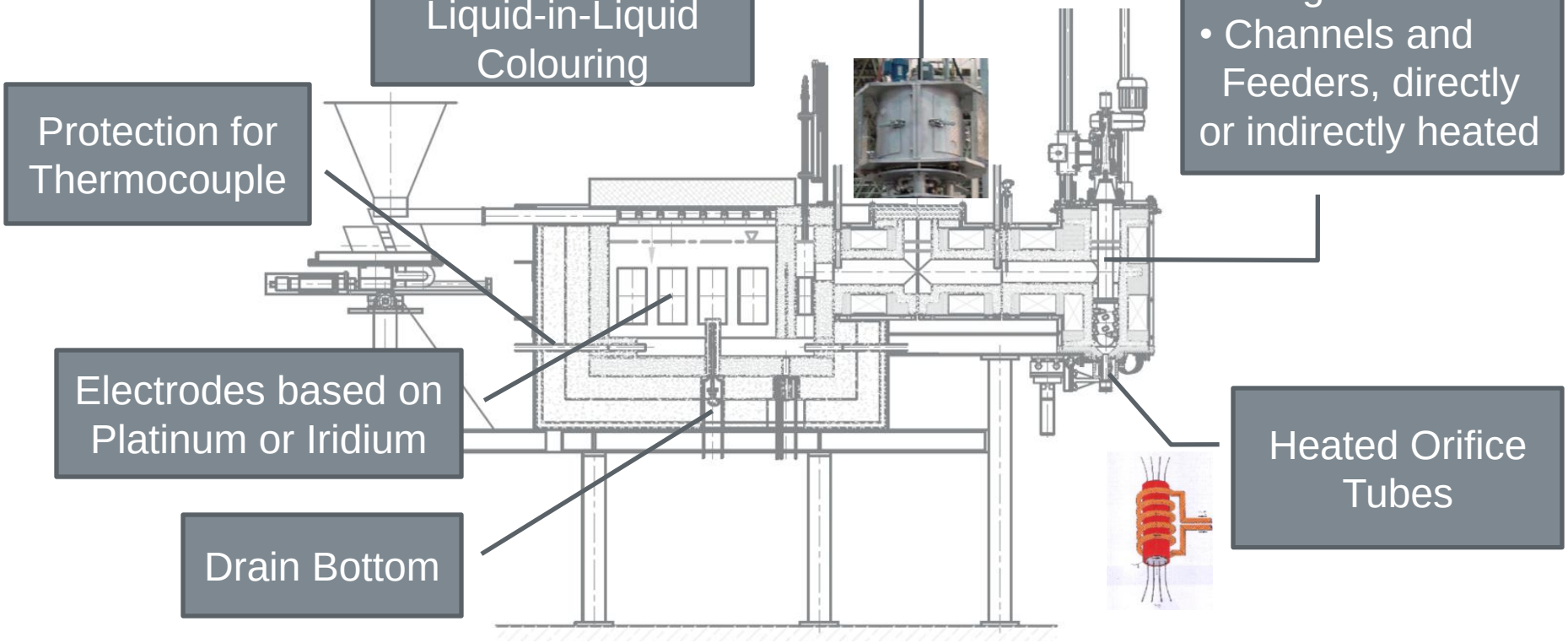
Micro-Melter (Platinum Crucible)	Mini-Melter	Feeder
Melting system: Discontinuous, vertical	Melting system: Continuous, modular	Feeding system
Capacity: max. 75 kg in 24 h	Capacity: 150 kg in 24 h, up to max. 2 t in 24 h	Capacity: max. 30 t in 24 h
		

Platinum-Application in the Mini-Melter, Feeder and Orifice

Platinum or Iridium Crucibles for Liquid-in-Liquid Colouring

Platinum for
- Stirrers and Plungers
- Channels and Feeders, directly or indirectly heated

Protection for Thermocouple



Electrodes based on Platinum or Iridium

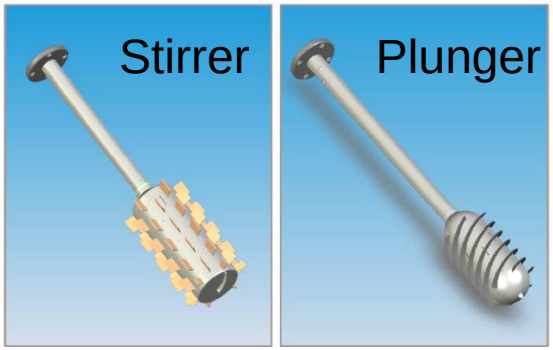
Heated Orifice Tubes

Drain Bottom

Platinum-based Materials by Heraeus

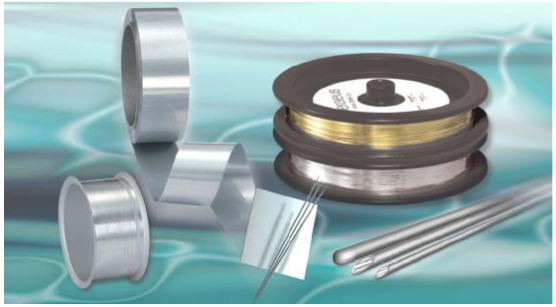
Platinum Components

- **The company offers the full range of platinum materials and platinum group metals as pure unprocessed metals, semi-finished products and fabricated components.**



Feeder Cell

Gob Feeder

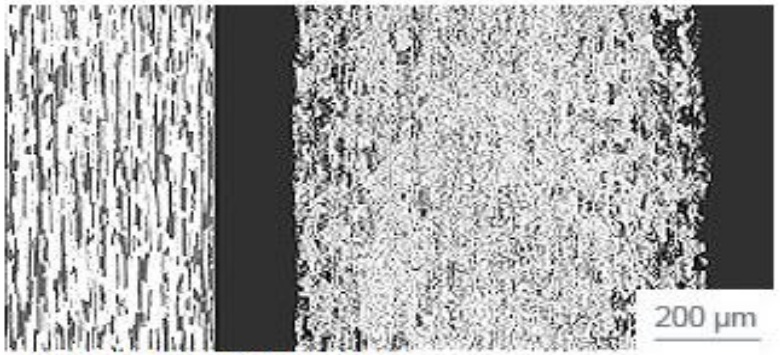


Semi-finished Products (sheet, tube and wire)

Platinum for High Thermal and Mechanical Load

- **With dispersion hardening (DPH) Heraeus succeeded in creating a new class of materials in precious metal technology whose resistance to thermal loadings and corrosion resistance is even greater than that of pure platinum and the solid solution hardened platinum alloys.**

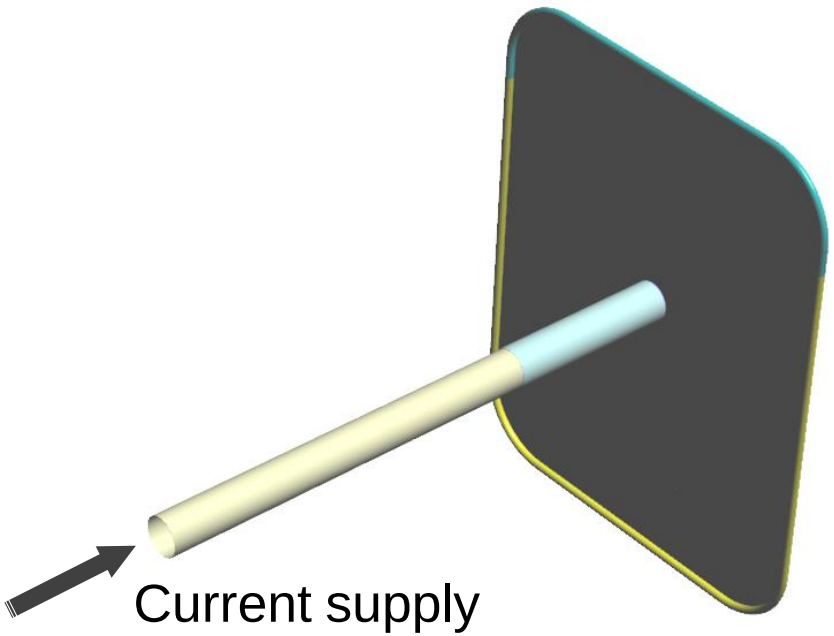
Pt90Rh10 after 30 h at 1600°C



Pt90Rh10 DPH after 30 h at 1600°C

Platinum Electrodes in Glass Melting

Plate-like electrode



Current supply

- **Electrodes used for melting special glass by direct heating can be made of precious metal if limits for molybdenum are exceeded.**
- **To ensure an adequate life time and to minimise losses, parameters like current and frequency have to be managed and controlled properly.**

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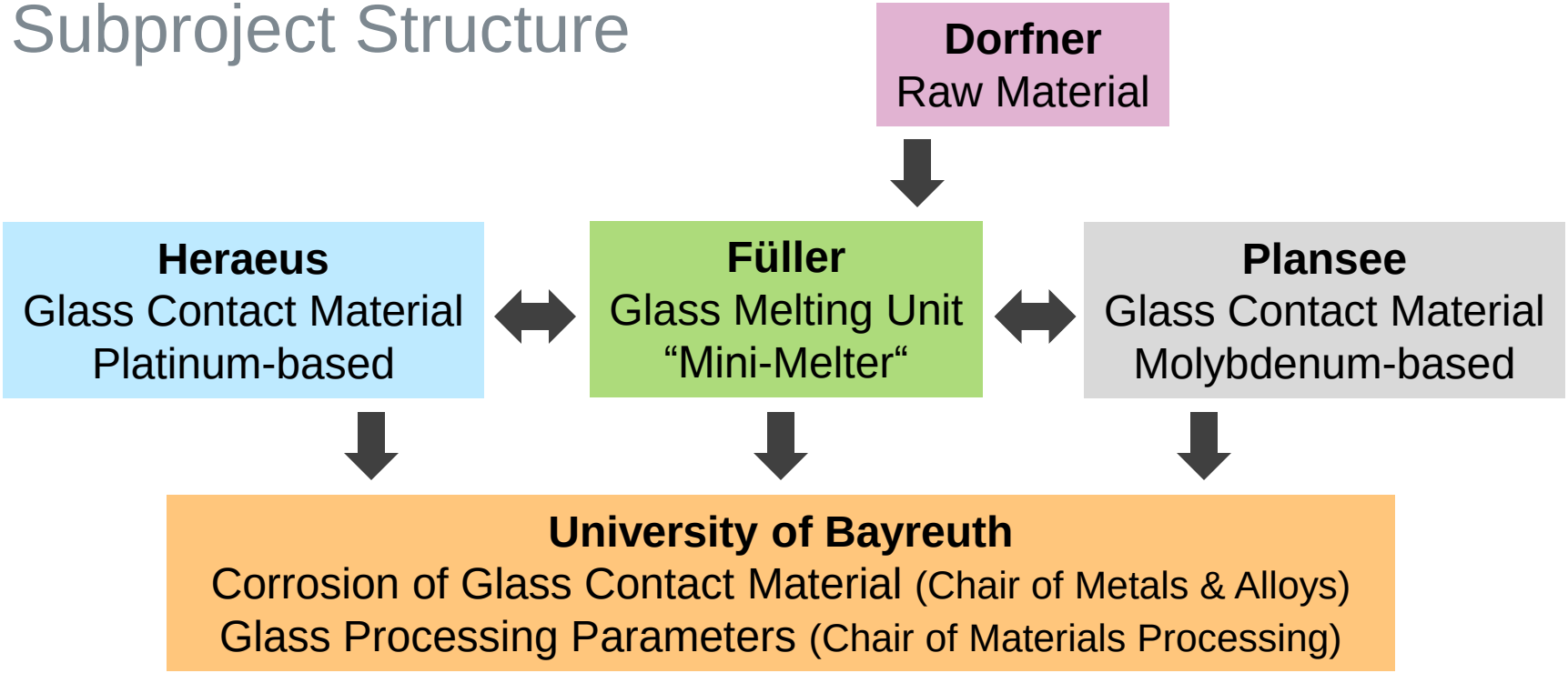
Research Project FORGLAS

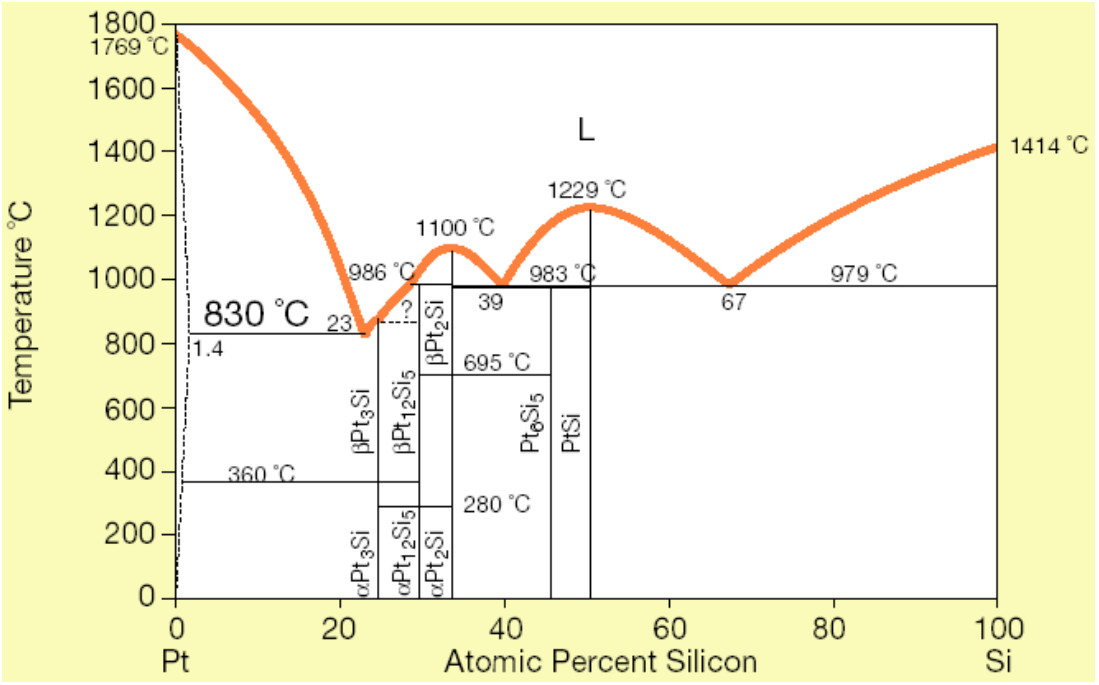
Subproject Structure

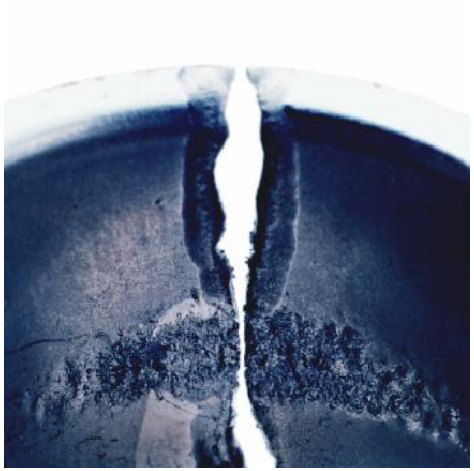


- **Knowledge about corrosion reactions between platinum and molybdenum in contact with glass melt**
- **Evaluation of optimised operating parameters, e.g. AC current frequency, current density, glass composition, temperature, time**

Corrosion of Material in Contact with Glass

- **Platinum corrosion is reaction with other elements to form compounds or alloys with lower melting points.**
- **Critical elements: P, Bi, Si, S, Pb, Zn, Sn, Sb, As, Fe and C**





Example of eutectic formation in Pt - Si system

Influencing Parameters

- **Corrosion occurs when reducible elements and/or reducing atmosphere are present**
- **Diffusion of elements along grain boundaries results in brittle failure and disintegration, favored by thermal shock conditions**
- **Higher current frequencies >1 kHz can improve resistance**
- **Platinum alloys stabilised with oxide particles (DPH) exhibit negligible grain growth, increased creep strength and higher corrosion resistance.**

➤ ***Qualified data necessary for customer-specific design***

Summary

- **Platinum-based components manufactured by HERAEUS are suitable for extreme conditions in contact with molten glass.**
- **Modular, continuous melting system by FÜLLER Glastechnologie (“Mini-Melter”) enables a flexible production of high quality glass in small quantities.**
- **Research project FORGLAS at Univ. Bayreuth will investigate corrosion reactions between metal and glass and the influence of process parameters.**
- **The aim of this project is to obtain reliable data for specific and qualified consultation in customer applications.**

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Acknowledgement

- Bayerische Forschungsstiftung (AZ-882-09)
- Project Partners at University of Bayreuth