

1 Glass paste for screen printing

© Fraunhofer ISC

2 Sealing of two glass plates for the application in photovoltaics.

© Fraunhofer ISE

Fraunhofer Institute for Silicate Research ISC

Neunerplatz 2
97082 Würzburg, Germany

Glass and Mineral Materials

Dr. Bernhard Durschang
Phone +49 931 4100-304
bernhard.durschang@isc.fraunhofer.de

Stefanie Hauber
Phone +49 931 4100-316
stefanie.hauber@isc-extern.fraunhofer.de

www.isc.fraunhofer.de

GLASS AS SEALING MATERIAL

The task

Sealing materials are mostly known as (polymeric) adhesives, ceramic high temperature adhesives or metallic solders. But for a variety of applications these materials are not suitable. Plastics, for example, are inapplicable for temperatures above 400° C. In addition, alternating temperatures result in tensions due to the high thermal expansion coefficient of plastics. Metals, on the other hand, don't have electric insulating properties and are not suited for materials that can't be heated above their operating temperature, and ceramics usually don't provide gastight bonds.

Stable glass as sealing material

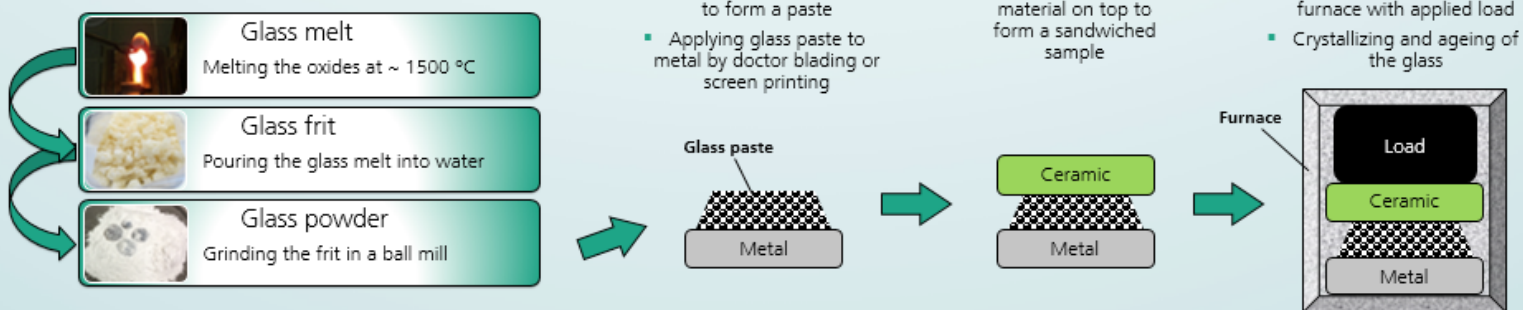
When other sealing materials approach their limits, glass solders show their full potential. Glass as sealing material shows the following advantages:

- Application temperatures up to the transformation range (T_g) of glass, where T_g can vary over a wide range from 400 °C far above 1000 °C by selection of the appropriate glass composition
- Gastight bonds due to viscous flow above T_g
- Adjustable thermal expansion coefficient (CTE) in the range of many ceramics and metals
- Good chemical and mechanical durability up to T_g

Crystallizing glass

Especially for high temperature application, crystallizing glass seals have further advantages. These advantages are gained by the formation of crystal phases induced by a thermal treatment. Regarding structure and properties the resulting material is a mixture of glass and ceramics.

Production of the glass-ceramic sealant



Depending on the phase components the properties of glass or ceramic can be adapted and combined:

- Temperature stability up to 1200 °C
- Viscous flow prior to or during use
- Dense material without extensive sintering processes
- High thermal stability
- Mechanical and chemical durability far above T_g of the starting glass
- Application temperature even above sealing temperature possible
- Large range of adjustable CTE starting from $-1 \cdot 10^{-6} \text{ K}^{-1}$ to $16 \cdot 10^{-6} \text{ K}^{-1}$
- Tunable electrical properties (conductivity, permittivity)

Current applications

- Hermetic glass/metal compounds for electrical and lighting technology, optoelectronics, telecommunications, automotive technology, sensors, high-performance electronics
- Materials almost without thermal expansion e. g. for ceramic hobs, reflecting telescopes
- Bioactive glass ceramics e. g. for medical devices
- Automatic producible glass ceramics for precision engineering
- Fuel cells e.g. gas-tight, electrically insulating
- Photovoltaics

We offer

Consulting service

- Selecting suitable glass solders for your application/product
- Advice in getting commercial glass seals and assistance in contacting suppliers

Development

Glass seals fitted to your individual process and product with respect to:

- Thermal expansion coefficient
- Application temperatures
- Structuring and crystallization program (heat-up rate, maximum temperature, necessary temperatures or holding times fitted to contact material)
- Contact materials and operation atmosphere
- Type of application (powder, paste, molding) and formulation of a suitable composition for application of the glass solder
- Crystallizing glass solders with adapted flow behaviour for your production process, optimized crystallization program, according to your other specifications
- Long term thermal stability and thermal shock stability
- Multi-layered glass solders for complex applications

Production

- Of up to 50 kg solder glass per month
- Form: glass powders, thermally pulled glass moldings, glass frits

For higher amounts we can arrange contacts to glass manufacturers.

Analysing and testing of

- Application methods
- Interface between glass and contact materials (SEM and EDS)
- Tightness to gas
- Integration possibilities in your production chain
- Long-term effects at application temperature
- Viscosity due to crystallization rate
- Determination of crystal phases
- Soldering experiments
- Thermal expansions (dilatometry)
- Sintering and viscous flow behaviour (thermo-optical measurements)
- Chemical stability (for various requirements)