

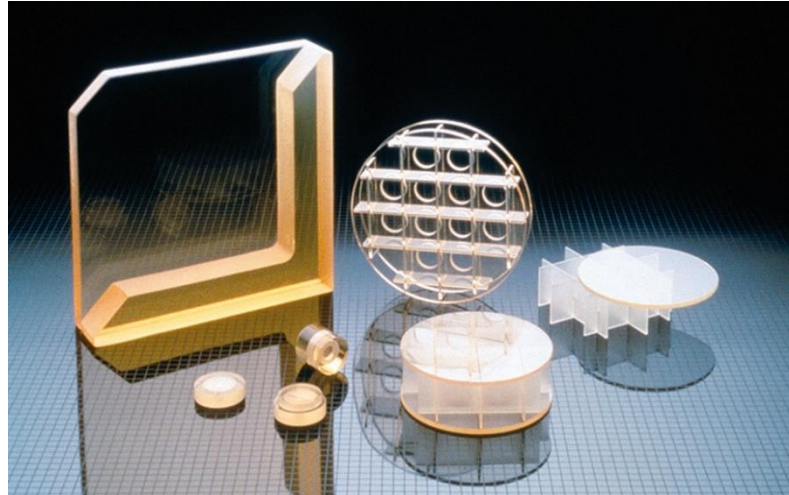
Category: Sensors & Measurement Techniques

Reference: TD-DE-1039

High-temperature resistant glass-ceramics with low thermal expansion

The segmented X-ray mirrors of the planned giant space telescope XEUS (X-Ray Evolving Uni-verse Spectroscopy) are no longer to be individually polished, but manufactured using an automated molding process. The challenges here lie in the required significant increase in impression accuracy. For the die, this means that it must maintain its shape and surface quality extremely accurately over a wide temperature range and that its thermal expansion must be well matched to that of the glass to be formed with it. A new mold material for high-temperature processes was therefore needed for the production of several thousand precision glass substrates.

The new glass ceramic developed for this purpose is produced by thermal conversion of a semi-transparent starting material. Over 90% of the material is then in the crystalline phase with a keatite crystal structure.



As a result of the conversion process, the material is thermally stable and does not change even over many heating cycles. In long-term use, the glass-ceramic is characterized by a temperature resistance of up to 850°C. The thermal expansion is a low $2.0 \cdot 10^{-6} \text{ K}^{-1}$ in the range 20 - 700°C, and at room temperature even a value of only $1.5 \cdot 10^{-6} \text{ K}^{-1}$ is achieved.

Innovative Aspects:

The novel glass-ceramic can be characterized by the following main features:

- The material has low thermal expansion and high temperature resistance up to 850°C.
- The coefficient of thermal expansion of $1.5 \cdot 10^{-6} \text{ K}^{-1}$ at room temperature allows combinations of the glass-ceramic with other materials of similar low thermal expansion, e.g. with Invar® alloys.
- The excellent homogeneity and internal quality of the material can be visually inspected in the semi-transparent state before conversion.
- The converted material has a high reflectance of $> 90\%$ in the visible range, it is no longer transparent but brilliant white.
- The glass ceramic is free of pores and can be excellently polished.
- Components can be produced in almost any geometry up to dimensions of several meters.

Application Areas:

The presented glass ceramic is the material of choice for optical and mechanical applications that require the following:

- Use at high temperatures
- High precision of the components to be manufactured
- Low thermal expansion
- Resistance to high thermal loads
- Non-porous and highly precise polishable surface.

The following specific areas of application are conceivable, for example:

- Mechanical and optical components in high-power lasers
- Mold material for use in hot molding (glass, plastics)
- Ceramic motor components
- Calibration standards for optical and probing measurement systems.

Cooperation:

There is interest in contract manufacturing of components and joint development of components for various applications. In addition to series production, the manufacture of prototypes and small series is also possible.