

A little more about lens molding

Arrange by Michael Hausner* (November 2025)

Material of the molds for molding:

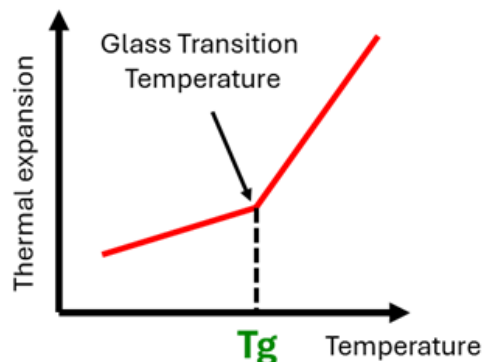
- For very low T_g , up to 400°C , Electroless nickel-phosphor, Stainless steel or Optical-grade Aluminum alloy are used. (Mold life, up to 1000 moldings).
- For high T_g , $400^\circ\text{C} < T_g < 620^\circ\text{C}$, Tungsten Carbide or ceramic materials are used. (Mold life, up to 10000 moldings).
- For very high T_g , $T_g > 620^\circ\text{C}$, Tungsten carbide or ceramic materials (Silicon Carbide - SiC) are used. (Mold life, up to 10000 moldings).

To extend the life of the molds, coating on the appropriate surfaces can be applied, probably not on diffractive surfaces): Ceramic coating (TiAlN, CrN, TiBCN or TiBC), noble metal coating (Pt/Ir and Re/Ir, and carbon coating (diamond like coating, amorphous carbon coating)

Tungsten Carbide - Tungsten carbide is a compound of tungsten and carbon, renowned in industry for its superior durability and high melting point ($2,870^\circ\text{C}$). It is widely used in applications that require superior wear or impact resistance, such as abrasives, cutters, dies and punches.

Tungsten carbide (chemical formula: WC) is a chemical compound (specifically, a carbide) containing equal parts of tungsten and carbon atoms.

Tg - T_g in glass stands for **glass transition temperature**, which is the temperature at which an amorphous solid, like a polymer or glass, transitions from a hard, rigid state to a soft, rubbery state. This transition point is crucial because it determines the material's mechanical properties and how it will perform in a specific temperature range.



Glass – all those advertised by the manufacturers of the materials – can be molded

The typical temperature range for the molding process is between 500°C and 700°C, enabling the extension of the operating lifetime of the mold material and a significant time reduction of the press process.

SCHOTT ~ 27 types**

HOYA ~ 31 types**

OHARA ~ 23 types**

CDGM ~ 16 types**

The normal molding temperature is 10% above T_g. For example, the moldable optical glass L-BSL7 (Ohara) has a transition temperature T_g=498°C, and the normal molding temperature is 10% above T_g, ~548°C.

Some of the main concerns around glass during molding are

- devitrification (crystallization) of the glass upon cooling
- adhesion between the glass and tooling
- formation of internal stress in the glass
- change in refractive index
- smooth flow of material during pressing

Chalcogenide (exotic) materials - Molding of Infrared Materials - Chalcogenide Glasses (ChG)

Chalcogenide (exotic) materials (IG6, GAZIR) are glasses by definition for the infrared (IR) region and can be molded.

Chalcogenide glass optics can be produced by all the methods used for crystals, but because of their vitreous nature, optical surfaces **can also be molded** to produce finished lenses. This can greatly reduce production costs, and since molding is not a subtractive process, no measurable subsurface damage is created, which results in a finer surface than one created by conventional processing.

Crystalline materials - lenses cannot be molded from crystalline materials

However, PLM (Precision Lens Molding) processes cannot be used to manufacture lenses from crystalline materials since they would lose their crystal properties through the process.

Crystalline materials for our purposes: CaF₂, Al₂O₃, ZnS, ZnSe, Si, Ge.

** For more information, see manufacturers' publications.

References

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- “Recent advancements in optical microstructure fabrication through glass molding process” by Tianfeng ZHOU, Xiaohua LIU, Zhiqiang LIANG, Yang LIU, Jiaqing XIE and Xibin WANG. Front. Mech. Eng. 2017, 12(1): 46–65. ©The Author(s) 2017. This article is published with open access at link.springer.com and journal.hep.com.cn.

Remark

There are many publications, books and articles referring to the process of molding optical elements, some researchers and some manufacturers but very few referring to the molds, maybe due to confidentiality, commercial and professional secret and its o.k. The article above is based on many publications I looked at and found something I was looking for some kind of interest, and I thank all for referring to this mold issue.



***Michael Hausner** has about 40 years’ experience in inspection and tests of optical elements: incoming and at the source of production, review of optical elements suppliers, writing procedures for optics inspection, handling of nonconformance optical elements and corrective actions, consulting, and training for Quality Assurance and Inspection of Optical Elements.

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