Development of mid Infrared optics with ZBLAN glass using hot embossing technique

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We present the successful thermal molding of the ZBLAN fluoride glass into the refractive plain-convex lens with good imaging properties proving that this material is suitable for the fabrication of cost-effective passive optical elements with broadband transmission window range covers from 200 nm to around 7.8 μm.

We have synthesized thermally stable fluoride $53ZrF_4$-$20BaF_2$-$4LaF_3$-$3AlF_3$-20NaF (ZBLAN) glass in-house in the sealed glove box with a controlled nitrogen atmosphere [1]. The glass transition temperature and the onset of the crystallization measured by the DSC are equal to 258 °C and 332 °C, respectively.

To obtain a plano-convex lens, we used an in-house built molding device composed of the cylindrical resistance furnace inside which there was a mold connected to the piston. As a starting substrate, we used ZBLAN glass in the form of polished disks of 10 mm in diameter. The optimum results were obtained for the brass mold, and the molding process was performed at 450 °C for 3-5 s with a force of 34 N. A series of plano-convex lenses with the curvature radius of R=11 mm are developed (Fig. 1). We have obtained the surface roughness as low as 77 nm for the entire lens surface directly after molding without post processing. The test lens has a diameter of 10 mm and a focal length of 30.0 mm. A resolution of 23 lp/mm is achieved for near infrared and 8 lp/mm for broadband thermal source emitting in the range of 3-5 μm.

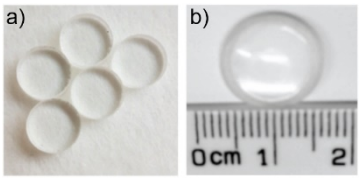

Fig. 1. Substrate ZBLAN disks (a) and lens after molding process (b)

Fluoride based optics is attractive for mid infrared systems due to its simultaneous high transmission in the visible range, which makes optical systems easy to alignment. On the other hand it has limited chemical and mechanical durability [2]. The use of thermal molding for ZBLAN glass allows for the development of free-form optical components with reduced material costs and no post processing.

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