Micro-Lenses Fabrication by Solvent-Casting of Chalcogenide Glass

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Quantum Cascade Lasers (QCLs) have emerged as a leading method to produce mid-infrared (Mid-IR) laser light for sensing applications for health and the environment. Due to the small size of QCLs, they have the potential to significantly reduce overall device size and even to be directly integrated for on-chip sensing. However, in order to successfully implement this technology, corresponding optics must be scaled down creating a need for micro-lenses and waveguides at these frequencies. Chalcogenide glasses have become an important material for Mid-IR technology due to their favorable physical and optical properties [1]. Through novel processing approaches, these materials promise a path for developing micro-lenses for Mid-IR technology.

In developing micro-lenses, the method used plays a critical role due to the small size of the desired lenses. In this presentation, we describe a solution-based method for the fabrication of chalcogenide glass micro-lenses. This particular method consists of two components: micro-syringe dispensing and heat treatment. As an initial test, paraffin is used as a hydrophobic substrate in order to provide a spherical shaped droplet. However, due to the low melting temperature of paraffin we also use Polydimethylsiloxane (PDMS), a silicon-based organic polymer, as a substrate for the lenses. The As_2S_3 solution is deposited on this hydrophobic surface at 9 psi for 1µs. Then, the drops are baked at a temperature of 50 °C for 60 minutes in a vacuum oven under vacuum. The results show 57% yield in the total amount of drops that maintain the shape of the lenses. The curvature appears to be uniform in all the good lenses.

The micro-lenses sizes are in a range of about 970-µm in diameter and 120-µm height with focal length of about 1mm. For further study, the use of InP as a substrate is planned due to the fact that is one of the Mid-IR technology semiconductor materials used.

A B

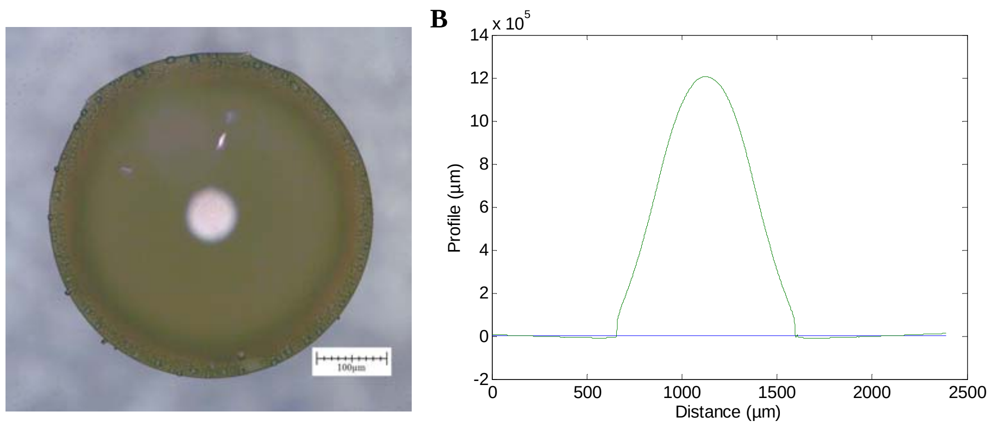

Fig. 1 **(A)** Microscopic image of a micro-lens at 10x magnification. **(B)** Plot of data obtained through superficial profiling. The lens is 121 µm high, 944 µm wide and has a focal length of 981 µm.

[1] H. Hisakuni and K. Tanaka "Optical fabrication of microlenses in chalcogenide glasses" *Optics letters.* Vol. 20, No. 9 (1995).