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Low-cost soft-glass diffractive and refractive lenses for efficient mid-IR fiber coupling systems

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Abstract: In this paper we present results of measurements of fiber coupling efficiency for optical mini lenses fabricated from multi-component soft glasses by using low-cost hot embossing technique. We show that soft glasses prove to be a suitable material for fabricating various types of mini lenses to be used in the compact optical system in broadband range from visible up to infrared at around 5 μm. The fabricated elements are biconvex refractive lenses and Fresnel lenses. We discuss soft glass properties, the fabrication process and the results of quality measurements of the fabricated lenses by means of the modulation transfer function. Finally, we report on the use of these diffractive and refractive elements for light coupling to various types of multimode optical fibers from a laser diode.

Keywords: hot embossing, soft glass, micro-optics fabrication, refractive lenses, diffractive lenses, fiber coupling systems,

1. Introduction

There is a broad range of potential applications for optics in the mid infrared (midIR) spectral range. First of all, there are all kinds of spectrographic setups based on the absorption of narrow spectral bands resulting from vibration-resonance of molecules [1]. Apart from these, midIR optics can be applied in meteorology, communication, biology and medicine [1]. Recently, we have observed intensification of work on such new light sources as heterostructure LEDs, super luminescent light emitting diodes (SLED), interband (ICL) and quantum (QCL) cascade lasers, and detectors [2]. A practical, commercial and massive use of such devices is often limited by the high cost of passive optical elements. This necessitates development of better materials and more cost-effective methods of fabricating optical components.

Most of the commonly used optical materials, such as fused silica glass, cannot be used in the midIR wavelength range due to their high attenuation beyond 2 μm. There are three groups of materials especially suitable for making refractive components in this spectral range. First, there are such materials as single crystalline germanium (GE), or zinc selenide (ZnSe) [3]. However, they are too expensive to be applied in

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