Development of diffractive optics for 4.7 THz frequency

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***Abstract*—** Direct laser ablation (DLA) is a mask-less technology used for the research and development of optical components of various materials [1]. The typical fabrication process combines a mask production and many technological steps such as a surface preparation, mask alignment, photoresist development, materials deposition, plasma and chemical treatment [2]. In some cases, such an approach is inefficient and time-consuming, especially in a small volume production. The relevance of the DLA technology is verified in the sub-terahertz frequency range demonstrating the terahertz zone plates with increased frequency selectivity [3], the binary zone plate on-chip with the terahertz detector [4], multilevel phase Fresnel lenses on silicon [5], etc.

In this work, four zone plates were developed: one from a 30-μm thick metal foil and three from a 500-um thick Si wafer for focusing of the 4.7 THz radiation. Processed by the DLA technology, all the lenses were of 25 mm diameter and #f/2 *f*-number but differed in the number of phase-levels. The focusing performance was determined by measuring the Gaussian-shaped beam profile of a 4.745 THz quantum cascade laser along the optical axis with a real-time bolometric camera (pixel size of 25 μm). With the binary optics the focusing gain up to 22 dB and the diffraction efficiency of 41 % was achieved. This was almost independent on whether the lens was developed on an optically thin metal foil or on a thick semiconductor substrate. An increased number of the phase-levels till 8 on the silicon zone plate provided the focusing gain and diffraction efficiency values up to 27 dB and 100 %, respectively.

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