Abstract

The rapid development of terahertz technologies is evident not only in the field of radiation emission and detection but also in their applications. Terahertz radiation finds use in areas ranging from non-destructive testing, telecommunications, astronomical observation, security systems, and medical imaging, to studies of molecular properties. Due to its non-ionizing nature, it is also employed for examining biological samples, which, owing to their high water content, exhibit strong attenuation. Applications include imaging of cancerous tissues in the skin and breast, studies of tissue hydration, and even analyses of biomolecular dynamics. Because of the high absorption of terahertz radiation in many types of samples, particularly biological ones, reflective systems are often required. One of the most widely used measurement devices in the field of terahertz technology is the terahertz time-domain spectroscopy system, which typically requires costly components and significant amount of space. To enable faster and more widespread use of terahertz technologies, it is necessary to develop potentially specialized systems that reduce both the cost and size of the setup. Diffractive optics in the terahertz range offers a way to meet these requirements. This work therefore presents a reflective terahertz system based on diffractive structures. The system enables scanning and imaging of various materials, including strongly attenuating samples. Two approaches to building a scanning setup were analyzed: point illumination and uniform illumination of a larger sample area. After evaluating the performance of the designed structures, a demonstrator based on point illumination structures was developed. The selected structures produced off-axis point illumination at a short distance, which, after reflecting from the sample, was redirected and focused onto the detector plane. Experimental results obtained with the demonstrator for samples with different optical properties are presented in this work.

Keywords: terahertz radiation, diffractive optical elements, reflective scanning setup, examination of highly attenuating materials, terahertz skin phantom