Devices to guide and manipulate THz waves

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Abstract: In this presentation, we will discuss a whole range of quasi-optical components that have been developed over the last 15 years by the Marburg Semiconductor Photonics Group.

Spectroscopy using terahertz waves and THz communication technology have developed significantly in recent decades. Considerable progress has been made. This applies in particular to the development of powerful THz sources and THz detectors. Since THz radiation can be regarded as long-waved light, THz systems also require a whole range of quasi-optical components. This includes lenses, prisms, diffraction gratings, polarizers, and so on. These components are commercially available in the optical spectral range from many companies. In the THz range, they had to be or still have to be developed. Over the past 15 years, the working group in Marburg has presented several such components that can be used to guide or manipulate THz beams. In the talk we will present several of these components.

First, we will discuss low-cost THz lenses and transmission blaze gratings. These devices can be easily produced by compression molding [1,2]. Alternatively, these optical components can also be fabricated by 3D printing [3,4]. As 3D printing is a very powerful technique it also allows for the fabrication of waveguides or even couplers for THz frequencies [5,6]. Moreover, we will present a prism. Nearly all dielectric materials do not show dispersion in the THz range. Hence, the concept for prisms, which is based on the dispersion of glass in the visible spectral range, cannot be used for THz frequencies. We therefore use a different physical principle: our prisms are based the well known waveguide dispersion [7]. Often, one wants to manipulate the state of the polarization of THz waves. Wave plates are ideal components for this purpose. We will present a wave plate easily made of a stack of ordinary white copy paper [8]. The working mechanism of this component is form birefringence. Its design frequency can be adjusted by varying the thickness of paper stripes. Of course, there are alternative ways to produce components based on form birefringence, for example waveplates can be fabricated out of fused silica using a process known as selective laser-induced etching [9]. Finally, we present a THz lens with a variable focus containing a terahertz-transparent liquid [10]. By injecting and draining an oil, which is transparent at THz frequencies into the lens one can vary the lens curvature. This in turn leads to a shorter or longer focal length.

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