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Multichannel transmission for the future wireless THz telecommunication links

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Terahertz (THz) radiation brings the attention of researchers and entrepreneurs for at least a few decades and has already found numerous applications in various areas, such as medical diagnostics, nondestructive testing, detection of dangerous materials and objects, security or telecommunication. This work focuses on the latter area of potential applications and aims at the development of the multiplexing methods for the future THz data transmission links. We propose the utilization of the properly designed THz diffractive optical elements (THz-DOEs) for manipulation of the THz waves on both sides of the data transmission link to, respectively, multiplex and demultiplex signals.

DOEs introduce defined attenuation and phase retardation distributions to the illuminating optical field. Clever adjustment of these parameters allows to reshape incoming radiation into almost arbitrarily chosen patterns. Moreover, the size of the crucial elements of such structures depends linearly on the wavelength, which in case of THz and sub-THz bands is in order of single millimeters or its fractions. Therefore, in many cases, THz-DOEs can be manufactured using relatively simple and cheap techniques, such as extrusion-based 3D printing.

In this work, we present methods of separation of THz beams propagating in the single optical channel, also with the frequency division. We have designed, optimized and manufactured THz-DOEs redirecting the incoming radiation into several focal spots. Two approaches have been investigated – single-frequency and multi-frequency operation. In the first case, a monochromatic THz beam is divided into three separate focal spots, while in the second one a polychromatic beam is redirected at an angle dependent on the frequency. All structures have been successfully verified experimentally and the obtained results comply with the theoretical simulations. Moreover, a setup demonstrating simultaneous dual-channel transmission at 300 GHz and 330 GHz has been demonstrated.

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