Optimized terahertz diffractive optical element for skin cancer diagnosis

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Every year in Europe thousands of people die from diagnosed melanoma and therefore quick and early detection becomes crucial [1]. The aim of the T-SKIN project (Project financed by the National Center for Research and Development under the Lider programme) is to create diffraction based optical structures for examination of reflection from healthy skin and cancer tissues for effective detection of skin cancer. We assume using narrowband illumination having 0.48 mm wavelength corresponding to 0.52 THz.

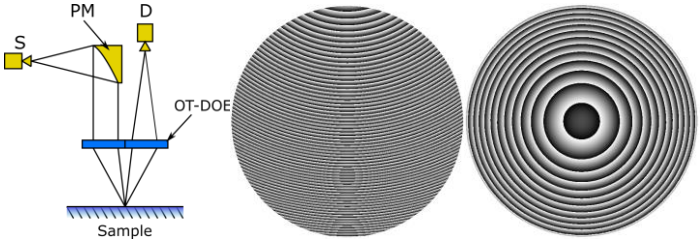

Fig. 1 The schematic representation of described setup (S – source, D – detector, OT-DOE – Optimized THz DOE) (left). Phase maps corresponding to structure focusing incident radiation on the sample (middle) and structure gathering reflection from the sample on the detector (right). White color corresponds to 2π phase shift and black to 0.

This work describes combined THz diffractive optical structures designed for scanning systems detecting cancer tissues on human skin. The first part of the project concerns focusing the radiation into focal spot and further analysis of possible penetration depth of THz wave into skin layer. Thus, a diffractive optical element consisting of two parts – half focusing on and half collecting the radiation reflected from the sample – as shown in Fig. 1. The configuration assures small angle between incident and reflected waves along the normal to the sample. The structure (Fig. 1) was designed and optimized assuming plane wave illumination, thus, an optical setup with additional parabolic mirror is used. Optimization was performed using iterative algorithm to suppress the influence of asymmetrical phase distribution.

Optimized diffractive structure having two functions and consisting of two halves combined into one element were designed and experimentally verified. Our next goal is to create imaging setup using diffractive elements to make it compact and assure fast determination of registered image.

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