Terahertz achromatic polarization conversion with quartz waveplate set

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We have applied modified Jones formalism for some cases of achromatic polarization converter (λ/4 and λ/2) for THz wavelength range. The experiments which approve these calculations were carried out with Fourier spectrometer for the quarter-wave converter for 60-300 micron wavelength range.

I. Introduction And Background

In this work we have calculated, produced and tested the wide wavelength-range THz polarization converter. In particular, it is well-known achromatic waveplate (WP) [1]. This object represents the set of parallel-plane birefringent plates, which are transparent in THz wavelength range with optical axes of birefringence lying in plate plane. Unlike monochromatic WP, which provides necessary phase retardation for concrete wavelength, achromatic WP provides it in wide wavelength range. Varying azimuth angles and plate thicknesses, one may achieve achromatic effect in different wavelength ranges and also for different retardations (for example, λ/4 and λ/2).

II. Results

There are some papers [2, 3, 4] related to the calculation methods of quartz and sapphire achromatic WPs. Some corrections were described in basic methods of WP calculations, because they are not suitable for the case when the measuring system has high resolution (in compare to FWHM of interference peaks). So there were some modifications of methods which take into account interference effect. In Tydex we have applied the methods for real achromatic WP calculations. Also we have carried out the measurements of WP, produced on the basis of the simulations. These experiments confirm the applicability of the methods described. Thus in Tydex commercial realization of these objects is achieved.

According to Jones formalism [5] the system of several retardation plates is optically equal to system containing only two elements – so called “retarder” and “rotator” (Fig.1). Retarder provides required phase shift (for example, π or π/2). Rotator turns polarization plane at angle ω. There are two types of the polarization converter depending on ω value: 1) ω is close to constant within operating wavelength range. In this case it’s common “AWP” and its operating principle is the same as of monochromatic WP. Polarization plane of transmitted through AWP radiation is situated at 2θ to polarizer axis, where θ is an angle of “effective optical axis” of AWP; 2) ω depends on wavelength. In this case the object is not common “AWP” and may be called broad-band polarization converter (BBPC) - a special case of AWP. Radiation transmitted through converter has polarization plane oriented at angle β=ω±45º to polarizer axis. In this work we have calculated AWPs and BBPCs for λ/4 and λ/2 cases in different THz ranges. Taking into account an interference effect, we have used [3] modified Jones matrix 4×4, written for each plate.

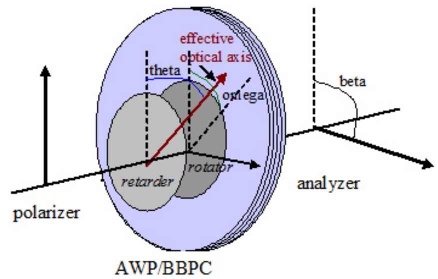

Fig.1. Schematics of the polarization converter.

Experimental approval of the method has been carried out with use of Fourier spectrometer Vertex 70. We have used quarter-wave BBPC fo 60-300 micron wavelength range. The results are shown in Fig. 2.

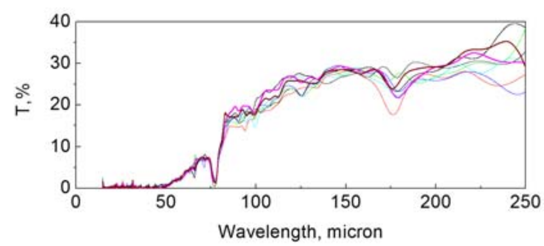

Fig. 2. The dependence of linearly polarized light transmission for λ/4 BBPC on wavelength for different angles of analyzer (rotated linear polarizer). The curves are very similar. Small misfit of the curves is related to relatively low SNR of spectrometer.

In summary, we have applied modified Jones formalism, for different THz wavelength ranges from 30 to 3000 micron. The experiments which approve these calculations were carried out for produced in Tydex quarter-wave BBPC for 60-300 micron wavelength range.

References

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