Tunable wavelength terahertz polarization converter

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***Abstract*—We present the results of calculation and experimental testing of the tunable wavelength terahertz polarization converter (TWPC) represented by set of plane-parallel birefringent plates with in-plane birefringence axis. An experimental device has been produced and tested. The calculations show that the effect of interference between the interfaces, including air gaps, may be neglected. Considered device may be used as the simple narrow achromatic waveplate, or Solc band pass filter for the specified wavelength.**

I. INTRODUCTION

THz frequency range (300 GHz - 10 THz) is quite a significant portion of electromagnetic spectrum lying between microwave and infrared ranges. In this work, we have modeled, produced and tested the tunable wavelength THz polarization converter (TWPC). This object consists of the set of parallel-plane birefringent plates made of crystalline quartz, which are transparent in THz wavelength range with optical axes of birefringence lying in plate plane. Unlike monochromatic waveplates, which provides necessary phase retardation for concrete wavelength, TWPC provides tuning the wavelength in wide range.

II. RESULTS

To achieve controlled adjustment of a retardation plate for a specific wavelength and arbitrary retardation, a set of three identical waveplates is sufficient, with outermost plates having parallel birefringence axes. The angle between them and the optical axis of the middle plate must be calculated using a certain method. After that the construction is oriented with the special azimuthal angle relative to the azimuth of electric field vector of the incident beam. This angle can be calculated by the same method as the angle between optical axes of the plates in the assembly. If the assembly allows one to adjust orientation angles (i. e. the plates are not in optical contact and not glued), the set may be fairly well adjusted for a series of arbitrary wavelengths and operate as quarter-wave or half-wave plate (or, generally, waveplate with arbitrary retardation). Rather than being achromatic or superachromatic, the composite retardation plates are controllable waveplates.

There are several papers [1] related to the calculation methods of quartz and sapphire achromatic WPs according to Jones formalism. In Tydex LLC we have applied the methods for real WP calculations [2]. We have seen that in TWPC system the interference effect may be neglected in case if the resolution of the system is 2 cm^{-1} or more. Also we have carried out the measurements of TWPC, produced on the basis of the simulations. These experiments confirm the applicability of the methods described. Thus the production of TWPC is achieved. Experimental approval of the method has been carried out with use of Fourier spectrometer Vertex 70.

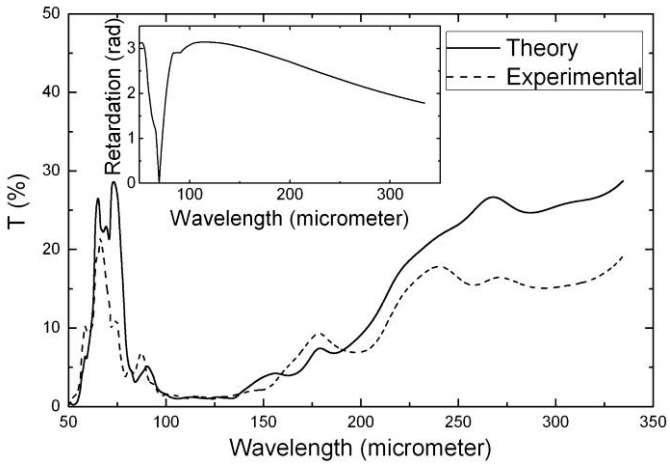

Fig. 1. The theoretical and experimental transmission spectra of the TWPC in half-wave mode situated between two parallel linear polarizers for 120 micrometer wavelengths. Inset: the dependence of the retardation on the wavelength.

The figure 1 depicts the theoretical and experimental transmission spectra of the TWPC situated between two parallel linear polarizers. The theoretical transmission was calculated with the multiplication of Jones matrix of the system on the polarizer matrices. The TWPC is in half-wave mode for 120 micrometer wavelengths. It can be seen that in 105-130 micrometer wavelength ranges the transmission is close to zero, therefore the TWPC really works as half-wave waveplate. The dependence of the retardation on the wavelength is shown in the inset. Here one can see that for the pointed wavelength the value of the retardation is π. The same results were obtained for $\pi/2$ retardation.

III. SUMMARY

We present results of calculations and experimental validation of the tunable wavelength polarization converter for THz spectral range for different (arbitrary) retardations (π and $\pi/2$ in our case). Good agreement with Jones formalism was shown in all the cases. The possibility to use the TWPC as Solc band pass filter and AWP was also demonstrated. Also an experimental device was produced and tested.

REFERENCES

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