THz Achromatic Polarization Converter

THz monochromatic waveplates can be used only at single wavelength since phase retardation strongly depends on the wavelength. Sometimes it's necessary to have nearly constant retardation at the specified wavelength range. For that case we have developed THz achromatic polarization converter (APC) that is a special case of THz broad-band phase transformer.

Basic methods of broad-band phase transformers calculation are well-known. However, they are not suitable for the case if measuring system has high resolution. So we have modified the methods to take into account interference effect. Broad-band phase transformers consist of several specially oriented crystal quartz plates. The plates are stacked together at visible optical contact. The stack of plates is fixed into a holder. According to Jones formalism system of several retardation plates is optically equal to system containing only two elements: so called “retarder” and “rotator” (please see Fig.1). Retarder provides required phase shift (usually π or π/2). Rotator turns the polarization plane at angle ω.

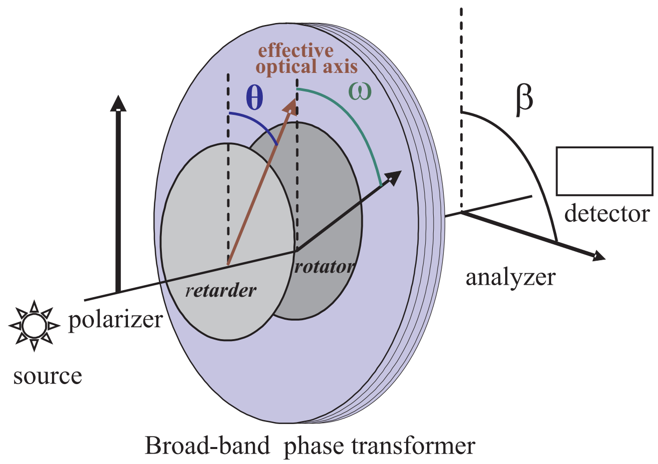

Fig.1. Broad-band phase transformer in terms of Jones formalism and its position relative to polarizer and analyzer.

There are two types of broad-band phase transformers depending on ω value.

1) ω is not 0° and it depends on the wavelength. We call it “achromatic polarization converter”.
Example ω of behavior is below.

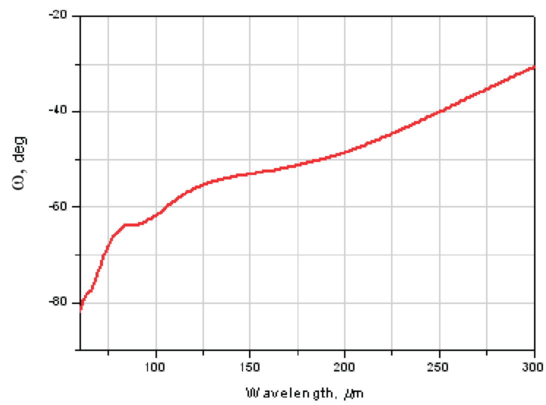

Fig.2. Angle ω of the APC L/4@60-300 μm.

2) ω is about 0° and it is constant within the operating wavelength range. In this case it is “usual achromatic waveplate” and its operating principle is the same as of monochromatic waveplate.

Currently quarter-wave achromatic polarization converter has been developed.

There are some features of APC position relative to polarizer and analyzer (please see Fig.1).

APC should be oriented to polarizer at angle θ (angle of effective optical axis of APC). Angle θ slightly depends on the wavelength (please see example below).

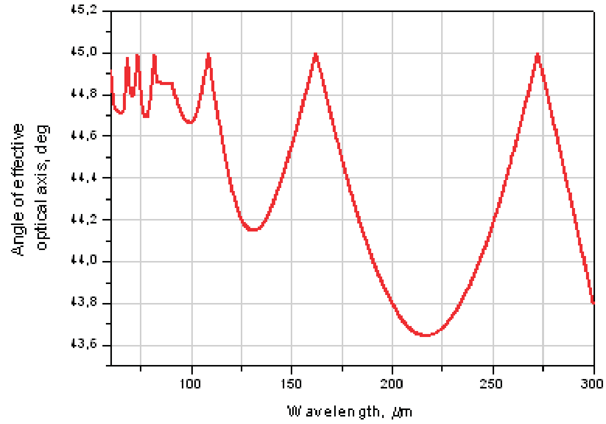

Fig.3. Angle θ of effective optical axis of the APC L/4@60-300 μm.

Analyzer is oriented to polarizer axis at angle β (please see Fig. 1). If linear polarized radiation is transformed to circle polarized one analyzer should be adjusted according to ω(λ) dependence (please see Fig. 2). In the case of the transformation of circular polarization to linear one β=ω±45°. Negative sign of ω means that it's necessary to rotate analyzer in opposite direction to θ, i.e. counterclockwise, if to look from the polarizer side.

Actually we are able to design L/4 APC for the following ranges within the wide interval from 60 μm to 3000 μm: 60-300 μm, 300-900 μm, 900-3000 μm. Also it's possible to divide this wide interval into other sub ranges depending on the concrete demands.

Retardation tolerance for mentioned ranges is ±3% (example is below). Tolerance increasing (for example, up to ±10%) will allow widening the operating ranges.

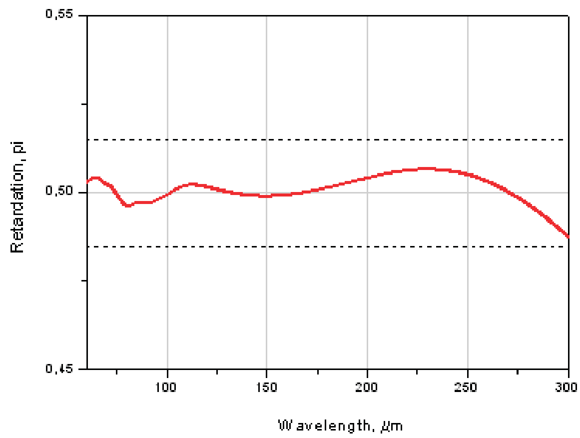

Fig. 4. Calculated retardation of the APC L/4@60-300 μm. Retardation tolerance is ±3%.

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The APC L/4@60-300 μm has been tested using the scheme shown at Fig.1. The APC was situated relative to polarizer axis taking into account θ(λ) dependence (please see Fig.3). Analyzer has been adjusted relative to polarizer according to dependence at Fig.2.

APC transmission spectra at different positions of analyzer have been measured using FTIR spectrometer Bruker Vertex 70 (please see Fig.5).

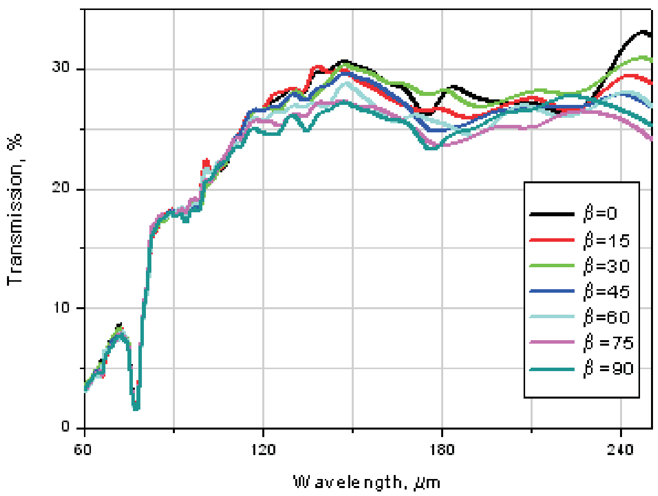

Fig. 5. Measured transmission spectra of the APC L/4@60-300 μm at different analyzer positions.

We have chosen several wavelengths and made graph that shows dependence of APC transmission on analyzer angle for these wavelengths (please see Fig.6).

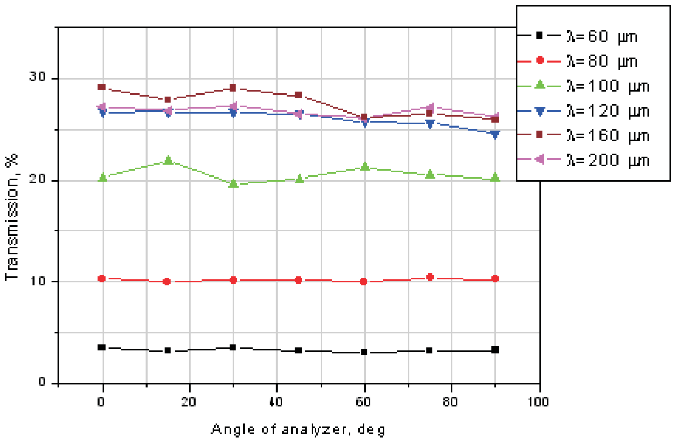

Fig. 6. Measured transmission of the APC L/4@60-300 μm as a function of analyzer angle β.

As follows from the graph transmission doesn't depend on the angle (small data spread is due to features of our Fourier measurements). It means that radiation passed through the APC has circular polarization that confirms correct operation of the APC.

Common specification:

Type	achromatic polarization converter
Retardation	L/4
Operating wavelength range, μm	60-300 or specified by customer
Retardation tolerance, %	+/-3 or specified by customer
Clear aperture, mm	25 (standard) or <25 (upon request)
Holder	conventional optical component mount or rotator

Achromatic polarization converters are manufactured upon request.

Please specify resolution of your measuring system and type of polarization conversion (linear polarization should be changed to circular one or vice versa) in your RFQ.

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