Thanks to researches and the development of integrated optics devices for optical applications in the telecommunications, relatively cheap sources and detectors of optical radiation that can be used in the design of planar optical sensors [1, 2]. One of the commonly used sensor systems is the differential interferometer, based on planar waveguides [3]. In the analyzed system propagates a mode for wavelengths from 450 nm to 600 nm. This type of arrangement is shown in [4-6] and called “frequency-resolved”, “broad-band” or “wavelength interrogation” Mach-Zehnder interferometer. This abstract presents the idea of a spectropolarimetric differential interferometer in which the recorded signal indicates the spectral distribution recorded at the output of the structure. Any change in the condition of propagation results in a change of the recorded spectral distribution. In the case of an interference of the modes TE\(_0\) and TM\(_0\) and the same optical power density I\(_0\) is transmitted in both modes, the signal recorded by the detector I(t) can be expressed by the formula [3]:

\[
I(\lambda, t) = I_0 \{1 + \cos[\Delta \phi(\lambda, t)]\}
\]

where \(\Delta \phi(\lambda, t)\) is the phase difference between the modes at the output of waveguide.

In the course of propagation the difference of the phases between the modes is attained, which is a function of the length of the path of propagation L, the difference of the effective refractive index (N\(_{TM}\)-N\(_{TE}\)) and the wavelength.

\[
\Delta \phi(\lambda) = \frac{2\pi}{\lambda} L (N(\lambda)_{TM} - N(\lambda)_{TE})
\]

The second polarizer placed before the spectrometer at the same angle (45°), provides light from both orthogonal modes to one plane of polarization, permitting the recording of the signal of interference (Fig. 1).

According to the relation (2) the phase shift \(\Delta \phi\) between the orthogonal fundamental modes is directly proportional to the product of the difference of the effective indices and the length of the propagation path and inversely proportional to the wavelength. The differences of the phase between the modes \(\Delta \phi(\lambda)\) after passing the length L have been determined concerning the whole spectral range (from 450nm to 600nm). Basing on relation (1) and assuming the same intensity of light I\(_0\)(\(\lambda\)) in the orthogonal modes, a normalized light intensity \(I_n(\lambda)\) could be defined as:

\[
I_n(\lambda) = \frac{I(\lambda, t)}{I_0}
\]
\[ I_n(\lambda) = \frac{I_o(\lambda)(1+\cos[\Delta\phi(\lambda)]\sqrt{n^2-1}}{I_o(\lambda)} \]  

(3)

Figure 2 presents the normalized light intensity distribution concerning the refractive indices of the cover \( n_C = n_{H2O} \) and \( n_{Ci} = n_{H2O} + i \times 0.001 \) (i=1,2,3) for the length of the propagation path \( L = 1\text{mm} \).

A change of the refractive index of the cover of the waveguide in a spectropolarimetric interferometer results in a change of the distribution of power in the spectrum transmitted by the considered system.

References