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INTEGRATED OPTICAL CHIP FOR FIBER OPTICAL GYROSCOPE FABRICATED BY HIGH TEMPERATURE PROTON EXCHANGE

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Abstract -- *Multifunctional integrated optical chip (MIOC) for fiber optical gyroscope with linear digital output is developed. The technology is based on recently proposed High-Temperature Proton Exchange method. MIOC is used for industrial closed-loop fiber optic gyro.*

One of the main fiber optical gyroscope's components is a multifunctional integrated optical chip (MIOC). Optolink's MIOC is a solid state waveguide device on X-cut $LiNbO_3$ substrate fabricated by High-Temperature Proton Exchange method (HTPE) [1]. It includes a linear polarizer, Y-junction coupler and two pairs of electro-optic phase modulators. Light coming from the optical fiber coupler is linearly polarized within the MIOC to greater than 60 dB. This high degree of polarization minimizes bias uncertainty due to polarization non-reciprocity. The Y-junction coupler within the MIOC splits the light into equal amplitude waves, each directed along a separate waveguide within the MIOC. Each of the resulting waves pass through an electro-optical phase modulator and after two waves counterpropagate around the optical PM optical fiber sensor coil. To achieve the low random walk and bias a 1070 m coil is used.

Wide used technology for fabrication of MIOC is based on annealing proton exchange method (APE) [2] applies a two-level process, which consists of a PE (melting pure or diluted by lithium benzoate benzoic acid as a rule) and subsequent annealing. It was recently obtained, that different defects are formed in the surface area of waveguide due to different phase transitions [3]. These defects are sources of additional scattering of light. In paper [1] we reported the fabrication and characterization of $LiNbO_3$ optical waveguides prepared by HTPE process with a new proton exchange source, i.e., the mixture of stearic acid and lithium stearate. HTPE process, in contrast to APE, is a one step process and does not allow any phase transitions, and, therefore, allows one to achieve the smaller optical losses and higher electro-optical coefficients.

The HTPE processes are held in the specially developed containers [1]. The specially developed metal and dielectric films used as masks to provide locality proton exchange diffusion. Then by vacuum deposition of electrodes, the integrated electro-optical phase modulators are formed on both arms of Y- splitter. After the end surfaces are cut (the angle is 10 degree to the Z axis), polished, and finally they are coupled with one input and two output anisotropic polarization maintaining (PANDA) fibers. The final steps are packaging and welding of electrodes.

The light propagation in MIOC was simulated as following. Firstly, the ion-exchange nonlinear equation was solved for any cross-section of structure to obtain refractive index distribution. Then, the beam propagation method was used for simulation of light propagation in Y-splitter.

MIOC is a monoblock hermetic product, which is connected to the optical block of FOG by means of fiber waveguide welding and soldering phase modulator electrical outputs to the electronic blocks (Fig.1).

Main parameters of OPTOLINK MIOC with operating wavelength 830±30 nm are following:

- optical power loss (at depolarized light) <7 dB;
- polarizer extinction ratio > 60 dB;
- division coefficient - 0.5± 0.05;
- phase sensitivity of each of modulator >1 rad/V

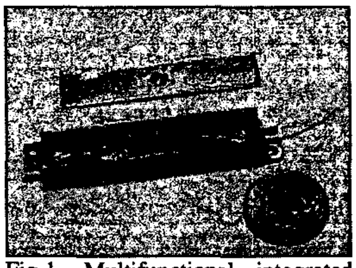

Fig.1. Multifunctional integrated optical chip.

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