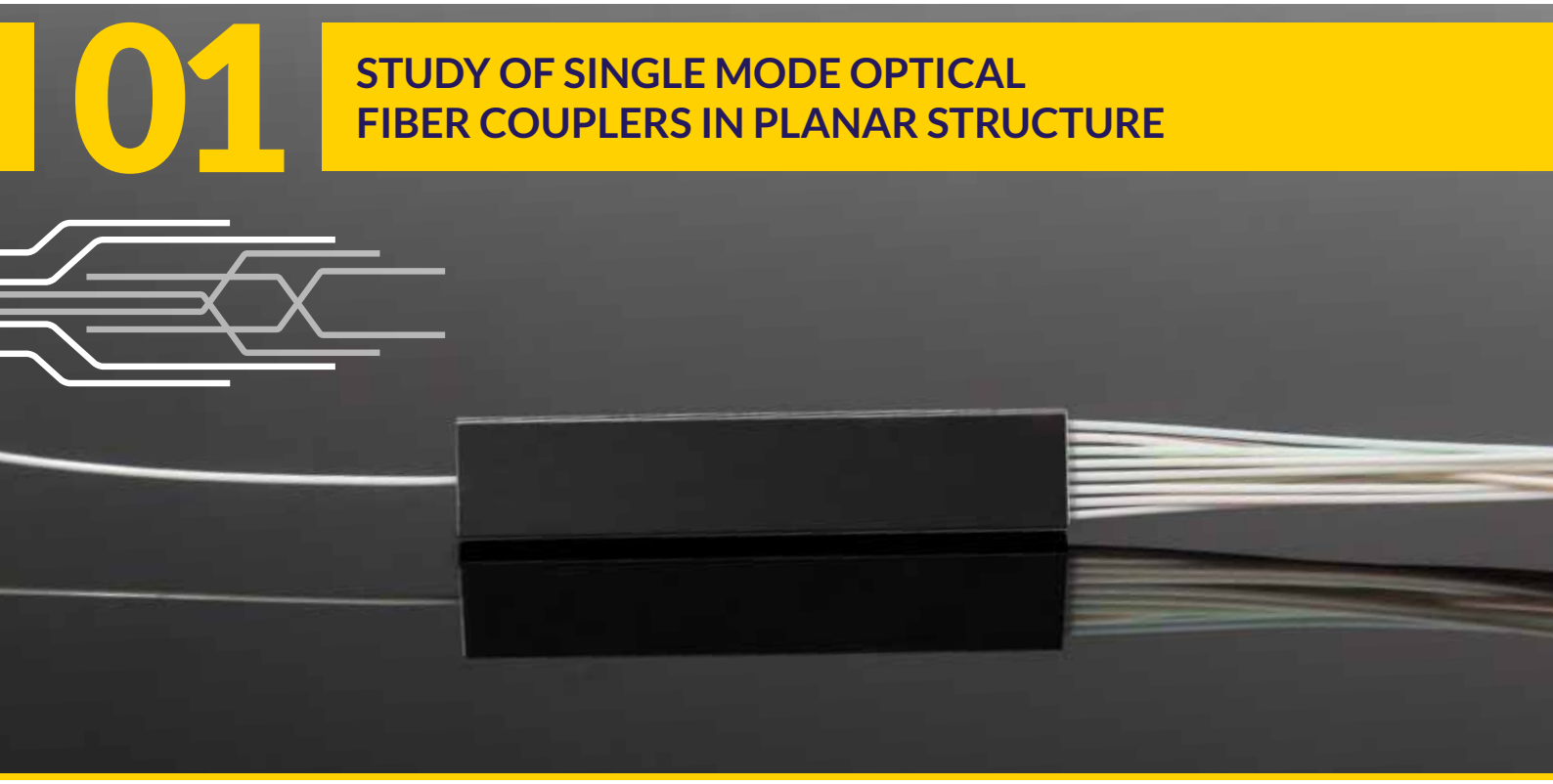
01 STUDY OF SINGLE MODE OPTICAL FIBER COUPLERS IN PLANAR STRUCTURE



Abstract

PLC (Planar Lightwave Circuit) technology is currently the most developed method among optical fiber couplers, as it provides even and asymmetrical division of the input signal power between multiple outputs. In order to analyze optical splitters, research in the scope of Insertion Loss - IL, Reflectance - RL, as well as Wavelength Dependent Loss - DL is carried out. Optical fiber couplers are manufactured taking into account a number of standards (Bellcore GR 1202 and GR 1209, PN-EN 60793-1-40:2005), to facilitate the creation of data transmission systems. The application of these passive elements is common in ICT networks, in GPON networks, FTTx systems and CATV cable TV.

PLC technology

The company Cellco Communications produces optical fiber couplers in the PLC planar technology. They are fully passive optical devices that are characterized by a uniform, as well as asymmetric distribution of the signal. PLC technology provides better transmission parameters, as well as high temperature stability. An additional advantage is stable operation within the whole range of bandwidth from 1260 – 1650 nm. It is possible to make different types of PLC 1xN splitters, while N occurs in the following configurations: 2, 3, 4, 6, 8, 12, 16, 24, 32, 64, 128. An additional advantage of this technology is the production of 2xM couplers, where M is the following number of outputs: 4, 8, 16, 32, 64, 128.

The PLC technology is based on the separation of the optical beam and guiding it through special waveguide channels, and then the insertion of this beam into the individual outputs of the coupler. The use of a flat structure is aimed at removing light splitting signals at the point of branching. To build a coupler in this technology, there are three elements necessary: pigtail, chip and output consisting of multiple optical fibers. Fig. 1 shows the planar structure of the optical fiber coupler.

PLC technology uses special technologies for the manufacture of the chip. It consists of the so-called quartz wafers arranged in such a way, so that they create optical paths for the light beam. The density of the arrangement of the paths in the chip can be 127 um or 250 um. In addition, every chip is marked by an individual serial number.

Measurement
of insertion loss

Measurement of insertion loss is carried out according to the standard Bellcore GR 1202 and GR 1209 based on FOTP180 procedure in accordance with the criterion adopted for digital transmission elements.

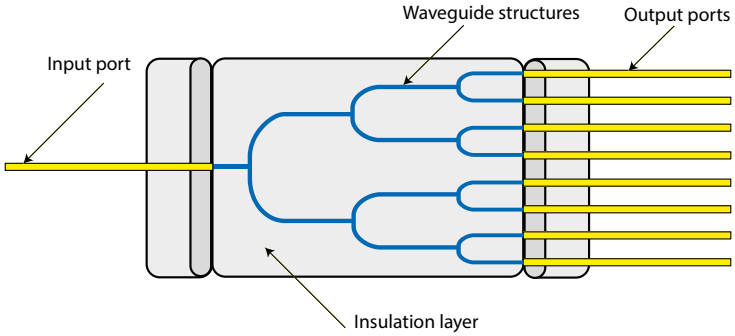


Fig.1 Planar structure of coupler

For the test, a laser source was used (IQ2123 ORL) with two wavelengths: 1310 nm and 1550 nm with temperature stability 0.03 dB (t=8h T=0.....50 °C) and InGaAs detector with the measuring range from 800 to 1700nm). This study involves sealing the light source with the coupler input and then measuring individual outputs.

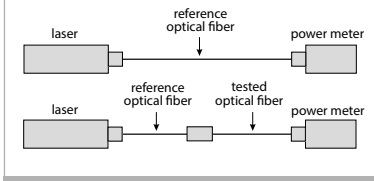


Fig.2 System for measurement of insertion loss.

Measurement
of reflectance

Measurement of reflectance allows to read information related to the optical track heterogeneity, and also provides data on accidental folds and fissures. Analysis of the measurement results shows the difference in the diameters of fibers' modes fields, the individual segments, as well as the level of back reflection from connectors. The principle of measurement is based on the transmission of impulses to the measured fiber with the selected wavelength, then the detection of the reflected part of them. The test was performed according to the standard Bellcore GR 1202 and GR 1209.

Results

For an example splitter PLC 1x8, the results of measurement of insertion loss have been presented

- the average value of insertion loss IL for the wavelength of 1310nm amounts to 10.01dB

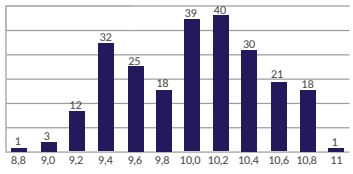


Fig.3 Distribution of insertion loss for 1310 nm

- the average value of insertion loss IL for the wavelength of 1550 nm amounts to 10.26dB

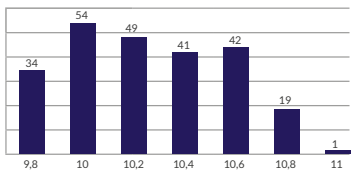


Fig.4 Distribution of insertion loss for 1550 nm

Results for reflectance have been presented in Table 1.

	RL [dB] for 1310 nm	RL [dB] for 1550 nm
Average value of RL	62,9	69,5
Min. value of RL	58,5	61,4
Max. value of RL	66,0	79,5

Tab. 1 Reflectance values

Application

This technology has found wide application in:

- telecommunications and ICT networks,
- PON (Passive Optical Network) networks, GPON,
- RfoG (RF over Glass) network,
- FTTX (FTTH, FTTB) type networks,
- CATV cable TV,
- hybrid networks,
- optical fiber.

Conclusions

Studies have shown that PLC technology allows to manufacture optical fiber couplers of repeatable optical parameters, i.e. insertion loss or reflectance. In addition, the tested splitters are characterized by high temperature stability and a wide range of bandwidth from 1260 – 1650 nm. The tested couplers show high repeatability of the results. The average value of insertion loss for 1x8 splitters for the wavelength of 1310 nm amounts to 10.01dB, and for the wavelength of 1550 nm - 10.26 dB. The average value of reflectance RL of PLC couplers for measurements on wavelength 1310 nm amounts to 62.9 dB, and for 1550 nm - 69.5 dB. The obtained values meet the criteria set out in the standard GR 1221.

Literature

[1] G. Żegliński, A. Niesterowicz, *Badania sprzęgaczy światłowodowych SM PLC typu 1x8 na zgodność z normą GR 1221/1209,* West Pomeranian University of Technology in Szczecin, 2014
[2] G. Żegliński, A. Niesterowicz, *Optical Splitters – PLC 1x8,* West Pomeranian University of Technology Szczecin, 2014
[3] http://www.wooriro.com
[4] http://ppitek.com
[5] Training materials on reflectometry measurements

SCIENTIFIC STUDY

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