Design of Concave Holographic Grating for WDM Multi/Demultiplexer for PMMA-based POF systems

Lyubomyr Bartkiv

Abstract – **In this paper the results of calculations and optimization of a concave holographic grating for use in multi/demultiplexer for wavelength-division-multiplexing in data transmission systems with polymer optical fibers made of polymethylmethacrylate are given.**

Keywords – **polymer optical fiber, wavelength-division-multiplexing, concave holographic grating.**

I. INTRODUCTION

To increase the transmission capacity of data links with a standard polymer optical fiber (POF) made of polymethylmethacrylate (PMMA) usually the different techniques are used, among of which the wavelength-division-multiplexing (WDM) technique is most effective [1]. This technique allows increasing of the total transmission capacity of data link by simultaneous transmission of many signals over a one single optical fiber using optical carriers of different wavelengths. For spatial combining/separation of different optical carriers the special optical devices – multi/demultiplexers – are used. Different types of multi/demultiplexers using interference filters and plane diffraction gratings have been designed and manufactured for use in POF-systems. One of disadvantages of such devices is a need in the use of additional collimating and focusing optics that complicate an alignment of device components and makes it bulky. In systems with silica single-mode optical fibers this disadvantage is corrected with the use of a concave diffraction grating. A concave grating has diffraction and focusing properties and therefore can simultaneously separate and focus light of different wavelengths without the help of additional optical elements [2]. Multi/demultiplexer with concave diffraction grating consists of only a one concave grating. Until now such devices were not yet realized practically for use in POF-systems. In this work the design of a concave diffraction grating for the use in WDM mutli/demultiplexer which can be applied in data transmission systems with PMMA-based POF will be presented.

II. CALCULATION OF BASIC PARAMETERS OF CONCAVE DIFFRACTION GRATING

For calculating of basic parameters of concave grating for use in multi/demultiplexer usually a well-known schematic layout with a classical concave grating is used [3]. A standard POF based on PMMA has its transmission windows in the visible spectrum range from 400 nm up to 700 nm. Light emitting diodes are commonly used with such fibers as light sources. Available today at the market light emitting diodes almost completely cover a full visible range. Their emission spectrum varies from 15 nm to 50 nm. Thus, taking all these into account the number of wavelength channels was selected equal to 8 with channel spacing approx. 30 nm. A linear dispersion in the image plane of the concave grating was calculated and equal to 4×10^4. For this value the radius and groove spacing of the grating from practical considerations should be equal to 50 mm and 1200 nm, respectively.

Diameter of concave grating depends on the type of input fiber and its location relatively to the grating. Taking that into account from practical considerations the grating diameter has been selected equal to 30 mm.

Lyubomyr Bartkiv – Department of Photonics, Lviv Polytechnic National University, S. Bandery Str., 12, Lviv, 79013, UKRAINE, E-mail: lbartkiv@polynet.lviv.ua

III. OPTIMIZATION OF CONCAVE GRATING FOR USE IN MULTI/DEMULTIPLEXER

A holographic concave grating has been selected for use in multi/demultiplexer because it has better transmission performances in comparison with ruled concave grating. To improve the transmission characteristics of multi/demultiplexer the concave grating has to be optimized. Aberrations of grating should be minimized to make better channel isolation and diffraction efficiency of the grating should be maximized to decrease insertion losses in wavelength channels. Minimization of aberrations of the concave holographic grating was carried out by optimal location of point recording sources and improving of diffraction efficiency of the grating was done by optimization of its groove depth. The received parameters of the concave holographic grating are shown in Table 1.

TABLE 1

PARAMETERS OF CONCAVE HOLOGRAPHIC GRATING

Ø, mm	30	r_D, mm	46.87
R, mm	50	δ, deg	22.03
Δ_0, nm	460	r_C, mm	50.21
λ_0, nm	632.8	γ, deg	–7.54

IV. CONCLUSION

In this paper the parameters of the concave holographic grating for the use in multi/demultiplexer for POF-systems were obtained. Aberrations of concave grating were minimized and diffraction efficiency of the grating was optimized.

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