Gaussian apodized volume grating for a holographic demultiplexer

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Abstract

In this paper, Gaussian apodized volume grating for demultiplexer is implemented. A 22-channel demultiplexer based on that grating is optically demonstrated. The channel spacing, the interchannel cross-talk level and the channel uniformity of 0.8 nm, -30 dB and 1.5 dB, respectively, are obtained.

In recent years, there has been an advance in high-density transmission through DWDM, which can simultaneously transmit numerous signals with different wavelengths. When the channel spacing is narrower, the crosstalk between channels, which guarantees to the high performance of a whole system, is more important. Apodization technique is one of the solutions to reduce the crosstalk.

In this paper, a Gaussian function is chosen as an apodization profile because a Gaussian intensity distribution of laser beam can be obtained easily by a laser source. The output laser beam is expanded by a spatial filter, a lens, and cylindrical lenses, so that it has the intensity of uniform distribution in vertical direction but Gaussian one in horizontal direction. To fabricate the Gaussian apodized grating, two beams with that distribution and the intensity ratio of 1:1 illuminate a photopolymer to make the interference. The DuPont HRF-150-38 photopolymer is used because of its stability and popularity. By moving the grating horizontally through the red beam, we can check the profile of the grating. The Gaussian probe beam is focused on the grating, so it has a small spot size to distinguish a little change of gratings profile along the apodizing direction. The Gaussian apodized grating is fabricated by the recording and checking system shown in Fig. 1(a) and its profile is drawn in Fig. 1(b).

In the demultiplexer scheme[2)] shown in Fig. 2, by using a lens, output beams are focused into different points on the back focal plane where the output fibers are located. For a uniform grating, the spectrum of a channel, which is closely similar to sinc^2 function, is simulated by using coupled wave theory as shown in Fig. 3. It is evident to realize that the sidelobe of the spectrum is large. This leads to high crosstalk between the adjacent channels. If the uniform function is replaced by one that vanishes smoothly at the edges of the grating, the slowly decaying sidelobes of the sinc2 curve is eliminated, i.e. the crosstalk will be significantly reduced.

By using the Gaussian apodized grating, the crosstalk level between two channels of 0.8-nm channel spacing is reduced down to 35 dB as shown in Fig. 4(a). The spectral response of created grating working as a demultiplexer is also shown in Fig. 4(b). The bandwidth of a channel was 0.18 nm. The two adjacent fibers were separated by 245-μm horizontal distance providing the wavelength spacing between each channel of 0.8 nm. Especially, the interchannel crosstalk level was less than -30 dB. Besides, for all 22 channels, the interchannel uniformity of 1.5 dB was also obtained. Although the result of the experiment is just worked on 0.8-nm channel spacing, however, by choosing properly parameters of grating size, output focus lens, readout beam size, we believe that apodization technique could be a good solution to suppress the sidelobe and reducing the channel cross-talk in the DWDM demultiplexer.

Acknowledgement:
This work was supported by grant No. (R01-2001-000-00324-0(2002)) from the Basic Research Program of the Korea Science & Engineering Foundation.

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[2] J.W. An, N. Kim, and K. Y. Lee, Japanese Journal of Applied Physics, vol. 41, no. 6B, 2002.

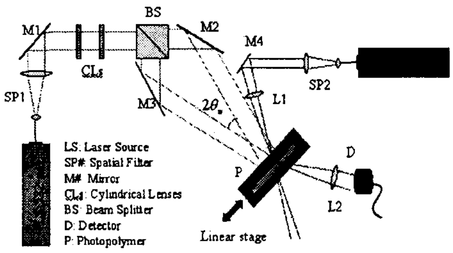
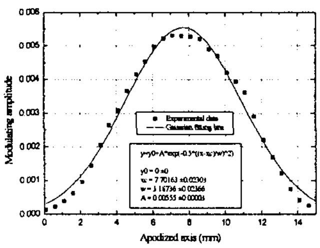


Fig. 1: (a) Recording and checking system



(b) Gratings profile and its Gaussian fitting data

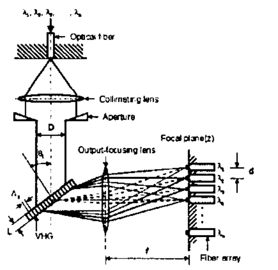


Fig. 2: Basic structure of a demultiplexer based on the photopolymer volume grating.

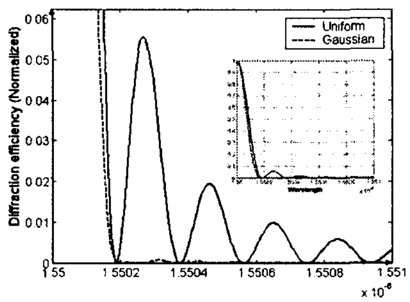


Fig. 3: Normalized diffraction efficiency versus wavelength for a uniform grating and Gaussian grating.

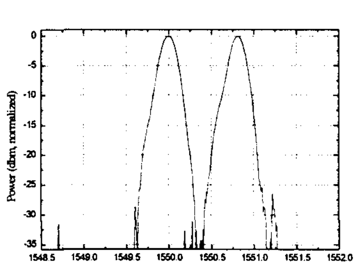
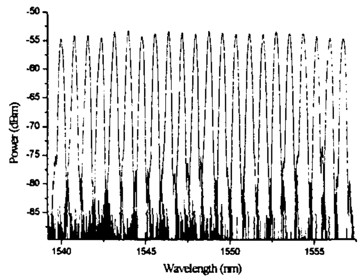


Fig. 4: (a) 2-channel spectral response of the Gaussian grating



(b) 22-channel demultiplexer