Design of Long Period Waveguide Gratings for Broad Band Polarization Filters

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Abstract: We present long period waveguide grating based broadband polarization filters. Our numerically simulated results show TE-pass and TM-pass filters with polarization extinction ratio in excess of 20 dB over a wavelength band wider than 90 nm.

Introduction

Long-period waveguide gratings (LPWG) have been proposed to overcome the geometry and material limitations of long period fiber grating (LPFG). [1, 2] LPWG devices have become popular for their applications as integrated-optic devices and components for optical telecommunications and sensing technologies. [3, 4] A polarizer is one of the important components in the area of telecommunication and fiber optics gyro to reduce the interference between TE and TM modes. LPWGs presented in Ref. [1] showed the possibility of obtaining very wide rejection band. We utilize this characteristic of LPWG to design broad-band polarization filters. We have optimized waveguide and grating parameters by using the particle swarm optimization (PSO) algorithm to obtain TE-pass and TM-pass polarization filters with polarization extinction ratio (PER) in excess of 20 dB over a wavelength band broader than 80 dB. The design would be useful for applications as integrated optic polarization filters for WDM telecommunication systems.

Numerical Results

A 4-layer planar waveguide structure with finite over cladding proposed in Ref. [1] has been employed to design polarization filters. The waveguide consists of a guiding film deposited on a substrate and a finite over cladding deposited on the guiding film. We have used long period corrugated grating embedded in the guiding film of the waveguide to couple unwanted polarization to one of the cladding modes and to obtain band rejection. We have considered the following values of various waveguide parameters in our calculations:

Substrate index $n_s = 1.5$, guiding film index $n_f = 1.52$, over cladding index $n_{cl} = 1.51$, cover index $n_c = 1$, guiding film thickness $d_f = 2$ μm, and over cladding thickness $d_{cl} = 5.5$ μm.

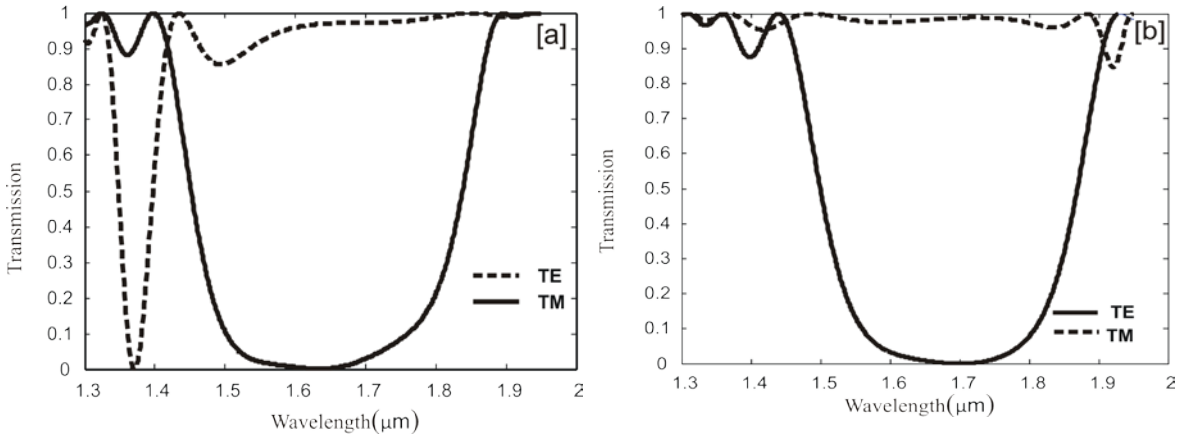

Fig. 1: Transmission spectra of designed polarization filters (a) TE-pass, (b) TM-pass.

Grating length L, grating period Λ, and corrugation height h have been optimized by PSO algorithm to obtain the desired transmission spectrum of the grating. The transmission spectra of the designed TE-pass and TM-pass filters are shown in Fig.1.

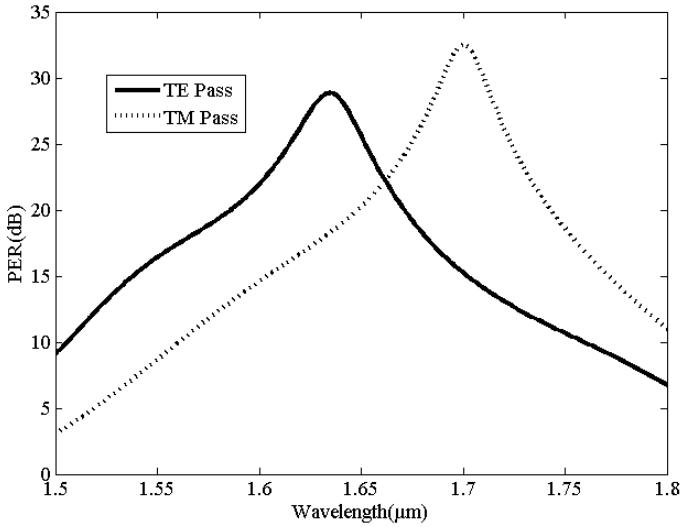

Fig. 2: Polarization Extinction Ratio for TE and TM Pass filters

Fig.1 (a) correspond to TE-pass polarizer with optimized grating parameters L = 15.4 mm, Λ = 187.5 μm, and h = 112 nm and shows a wide wavelength rejection band centered around 1.6 μm wavelength for TM polarization. The TE polarization has a transmission of more than 80%. In Fig. 1 (b) we can see TM-pass polarization filter, which correspond to grating parameters L = 15.4 mm, Λ = 191.5 μm, and h = 112 nm. We have also calculated the polarization extinction ratio of the designed filters at different wavelengths and the results are shown in Fig. 2. We can see that for TE-pass polarization filter we have PER in excess of 20 dB over a wavelength range 1.585-1.675 μm. For TM-pass polarization filter the PER is in excess of 20 dB in the wavelength range 1.65 – 1.75 μm. Such polarization filters should be useful in WDM systems.

Conclusion

We have designed polarization filters in planar optical waveguides using LPWG. The grating parameters have been optimized to design TE-pass and TM-pass filters. The designed filters show PER in excess of 20 dB over a wavelength band as large as 100 nm.

References

1. V. Rastogi and K. S. Chiang, "Long period grating in planar optical waveguide", *Appl. Opt.* **14**, pp. 6351-6355 (2002).
2. Q Liu, K. S. Chiang and V. Rastogi, "Analysis of corrugated long period grating in slab waveguide and their polarization dependence", *J. Lightwave Technol.* **21**, pp. 3399-3405 (2003).
3. K. S. Chiang, C. K. Chow, Q. Liu, H. P. Chan, and K. P. Lor, "Band- rejection filter with widely tunable centre wavelength and contrast using metal long–period grating on polymer waveguide", *IEEE Photon. Technol. Lett*. **18**, pp. 1109-1111 (2006).
4. Y. M. Chu, K. S. Chiang, and Q. Liu, "Widely tunable optical band pass filter by use of polymer long-period waveguide gratings", *Appl. Opt*. **45**, pp. 2755-2760 (2006).