CHANNEL CONTROL AND DISPERSION COMPENSATION USING ACTIVE ARRAYED WAVEGUIDE GRATING (AWG)

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ABSTRACT

The role of active Arrayed-Waveguide Grating (AWG) in future dynamic Wavelength Division Multiplexing (WDM) networking and routing was investigated. Simulations were done using the Beam Propagation Method (BPM). The results of this study indicate that active AWG can be used in multiple channel control with SNR up to 19 dB and dynamic dispersion compensation of up to 160 ps/nm.

1. INTRODUCTION

Arrayed-Waveguide Grating (AWG) is emerging as a powerful tool in Wavelength Division Multiplexing (WDM) networks for passive multiplexing and fixed wavelength routing [1,2,3]. Previous work [4,5,6] demonstrated how active AWG provides some important aspects for dynamic WDM networking by means of holographic techniques based on the simulated annealing algorithm. Multiple channel control and dispersion compensation are attractive features of active AWG discussed here. The Beam Propagation Method (BPM) was used in the simulations.

2. HOLOGRAPHIC AWG

AWG can be considered as a planar 4f lens relay system, where the two Free Propagating Regions (FPRs) on either side of the arrayed-waveguide section can be modelled as lenses. This allows holographic techniques, based on Fourier Transform (FT) theory, to be used as an effective tool to tailor the spectral response of AWGs, and achieve multi-channel control, power equalisation, and add/drop filtering [5]. Using holographic techniques the optical path length or phase of the arrayed-waveguides is varied in order to get the desired spectral response. Simulated annealing was used to calculate the holograms, which were superimposed on the arrayed-waveguide section.

2.1 SIMULATION RESULTS

The ability to route the wavelength channel of interest to the desired AWG output port is of great importance. In normal AWG, one wavelength channel appears at each output port. By using an optimised phase hologram, it is possible to choose that wavelength. Linear phase can do the job as well, however, phase holograms have the ability to control the signal passband width or power, and multiple wavelength routing can be achieved, where more than one channel can appear at the same port. The simulation result obtained for triple channel routing using BPM is shown in Fig. 1, where channels 5,6, and 7 were routed to port 8 with SNR of about 10 dB.

Fig 1. Simulation of triple channel phase hologram

3. DYNAMIC DISPERSION COMPENSATION

Dispersion compensation techniques are a critical element in designing high-capacity lightwave communication systems. Here we consider the approach of using AWG with parabolic phase profile applied on the arrayed waveguides section. The parabolic phase profile has the potential to control the dispersion of an AWG, which can be varied by adjusting the amount of parabolic phase shift induced [6].

3.1 SIMULATION RESULTS

Several active AWGs were modelled. The variation of dispersion with design parameters such as the number of Arrayed waveguides, M, the Gaussian parameter, α, to vary the power profile across the waveguides, and the Chirp parameter, F (which controls the strength of the parabolic phase profile) was tested. The results show that the dispersion increases with M since the overall 'length' of the
AWG, given approximately by $M/A_l$, is increasing. If the device length is increasing, then there is a greater time delay through the device between fastest and slowest pulses along the shortest and longest waveguides respectively. Hence, it is more dispersive. Fig. 2 shows the dispersion characteristics for parabolic AWG with $F = 17.6$.

![Dispersion characteristics](image)

Fig.2 The Dispersion characteristics, $F = 17.6$.

Fig. 3 shows a three-dimensional mesh plot of the variation of dispersion as it varies with chirp parameter $F$, and normalized Gaussian apodization parameter $\alpha$. From the plot, it is clear that dispersion is maximized for a uniform power distribution ($\alpha = 0$) along the arrayed waveguides, and it is reduced by increasing $\alpha$. Also the dispersion increases with $F$ until a maximum is reached before declining again.

![Mesh plot of variation of Dispersion](image)

Fig.3 The Mesh plot of variation of Dispersion, with chirp parameter $F$, and normalized Gaussian apodization parameter $\alpha$.

4. CONCLUSION

Active AWGs have a variety of applications in future WDM networks. This work has shown how a holographic filter can be used for channel routing. The simulated annealing algorithm was used to design the phase holograms. The Beam propagation method was used in these simulations. The results show that the signals have routed to the desired ports, with inter-channel crosstalk suppressed by around 19 dB for the single channel case. The holographic designs were robust to fabrication phase errors. Dispersion compensation up to 160 ps/nm was achieved using Parabolic AWG. Higher dispersion compensation rates can be achieved by tailoring some design parameters of the AWG.

5. REFERENCES