Bragg Grating Design Method for the Implementation of an Optimised Symmetric Add/Drop Multiplexer

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Abstract: An efficient and simple method is proposed for the design of a novel Bragg Grating based Optical Add Drop Multiplexer. Central to this method is the existence of generic engineering curves that relate for any BG of a specific apodization profile, its penetration slope $\alpha=L_p/L_g$ to its reflectivity. The implemented by this method, interferometric device based on a full-cycle waveguide coupler exhibits symmetric and simultaneously optimised add/drop responses, of zero loss.

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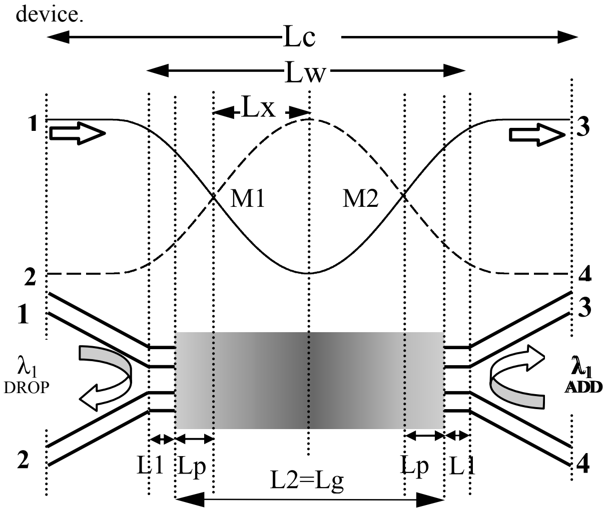
Optical Add/Drop Multiplexers (OADMs) based on Bragg Gratings (BG) are low cost and high performance solutions for use in Dense Wavelength Division Multiplexing (DWDM) Optical Communication Systems. A number of different BG-based four-port OADMs implemented in interferometric configurations [1-2] have been proposed to date. Mainly they are based on half-cycle waveguide couplers (HCC) with a BG written into the uniform coupler waist [2], with the known limitations of the non symmetric add/drop response [3]. The design and implementation of the novel symmetric full cycle based OADM discussed here, overcome the performance limitations of the aforementioned HCC based OADMs.

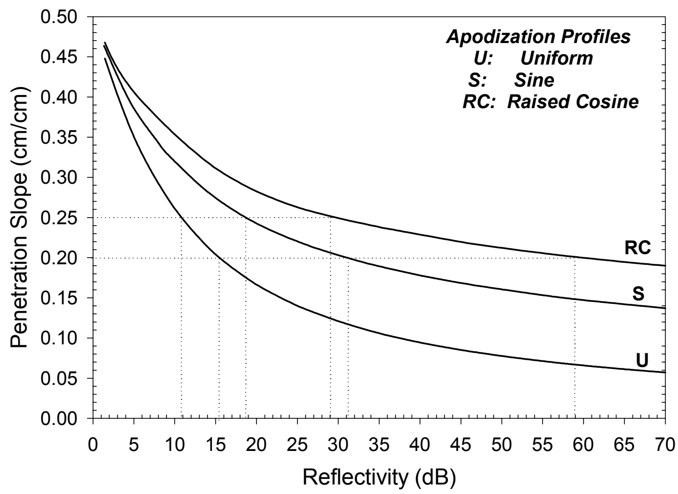
The proposed device is shown schematically in Fig. 1. The length L_c of the coupler is equal to the beat length Z_c between the even and odd supermodes of the coupler which is defined as $Z_c=\lambda/(n_e-n_o)$ where n_e and n_o are the effective refractive indices of the even and odd supermodes respectively, and λ is the operating wavelength. The length L_x corresponds to $\pi/2$ phase difference between the normal modes at the coupler waist, L_p is the penetration depth at the design Bragg wavelength and L_g the BG length. In contrast, the length of a HCC is $L_c=Z_c/2$. The optimised operation of the device requires that the BG should be placed symmetrically in the coupler and should have a suitable length in order to make the penetration points of the light - as coming from the left and right side of the device- coincident with the points M1 and M2 respectively. Figure 1 illustrates the operational principle of the device where a stream of WDM channels enters through Port 1 and the channel at wavelength λ_1 (DROP) is reflected by the BG and dropped optimally at Port 2. Reciprocally, the channel λ_1 (ADD) is inserted through Port 4 and is added optimally through Port 3.The optimum and symmetric inscription of the BG in the uniform coupler's waist assure the fully optimised Add and Drop operations of the OADM device.

Design Procedure: The realization of the proposed device requires the exact matching of the geometrical characteristics of the FC coupler and the employed BG**.** A simple and effective method is proposed for the implementation of the FCC OADM. Central to this procedure is the existence, which is proposed here, of generic engineering curves that relate for any BG of a specific apodization profile, its penetration slope $\alpha=L_p/L_g$ to its reflectivity. Figure 2 presents characteristic curves for three typical cases, a uniform, a sine apodised and a raised cosine apodized grating. The design procedure is based on the exact matching of the geometrical characteristics of the BG to the characteristics of the coupler. Considering a BG inscripted in the uniform coupler's waist, we can write, based on Fig. 1:

$$L_g = 2aL_g + 2L_x \Rightarrow L_g = \frac{2L_x}{(1-2a)} \qquad (1)$$

This equation, together with the engineering curves form the design tools for the implementation of the novel improved device.





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