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Fibre Bragg Gratings for Dispersion-Free Add/Drop Filtering

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Summary:

The ever increasing demand for bandwidth, led to the introduction of wavelength division multiplexing (WDM) as one technique to increase capacity in the optical fibre networks. Initially 100GHz was set as the standard channel separation by the ITU, but this spacing is due to capacity constraints, already being reduced to 50GHz to accommodate extra data-traffic. Even 25GHz channel separations are currently being discussed and may very well become the trend of the future on the moderate bit-rate of 10Gbit/s, as an alternative to faster bit-rates whilst faster electronics is maturing. This trend therefore calls for filters that can perform filtering duties, that on top of a solid functionality, also act as passive ultra-selective filters that can maintain channel integrity at any cost.

The technology of Fibre Bragg gratings has come a long way since the initial demonstrations in 1978 by Hill et al. at the *CRC* in Canada. Bragg gratings and in particular apodised Bragg gratings has previously been shown to exhibit near ideal characteristics for compact and high filling factor values on grid spacings as small as 25GHz [1]. However, it has also been discussed how these filters, despite their near ideal spectral performance, suffer from non-linear phase attributes in the stop-band, that could limit their use in high bit-rate systems (10Gbit/s and above) [2]. Linear-phase filters therefore have been proposed as a solution to this problem, but some previous demonstrations have suffered from low rejection values [2].

In this talk we show linear-phase (dispersion-less) Bragg grating square-filters for 25GHz and 50GHz channel separations that exhibit grid filling-factor values of 75% and constant reflectivities in excess of 99.9% (>30dB transmission loss) over the full drop window. The linear phase and square spectral performance of the gratings are obtained by imposing a slowly varying envelope function (superstructure) (Fig.1) on the rapidly varying refractive index modulation forming the Bragg grating. This envelope function is generated using apodisation and is imposed during writing using a grating manufacturing technique where full control of all vital grating parameters is available. A recently developed inverse scattering algorithm is used for the design of the envelope function [3]. The manufactured

filters are tested at 10Gbit/s NRZ and show that $<10^{-11}$ bit-error-rate (BER) is obtained for constant received power throughout the useful band (Fig.2). Additionally, we will discuss the importance of these filters for dispersion-free filtering at high bit-rates, by comparing their performance with "traditionally" apodised Bragg grating filters. It will be demonstrated how this new family of gratings out-performs the standard apodised Bragg gratings for their linear-phase characteristics and that they allow for tuning and drift of the transmitter over the full bandwidth of the grating without being affected by dispersion at any point in the stopband.

References:

[1] STRASSER, T.A. et al., 'UV-induced fiber grating OADM devices for efficient bandwidth utilization', In proceedings to *OFC'96*, paper PD8, 1996.

[2] IBSEN, M. et al., 'Optimised square passband fibre Bragg grating filter with in-band flat group delay response', *IEE Electron. Lett.*, **34**, (8), pp. 800-802, 1998.

[3] FECED, R. et al., 'An efficient inverse scattering algorithm for the design of non-uniform fiber Bragg gratings', *IEEE Journal of Quantum Electron.*, **35**, (8), pp. 1105-1111, 1999.

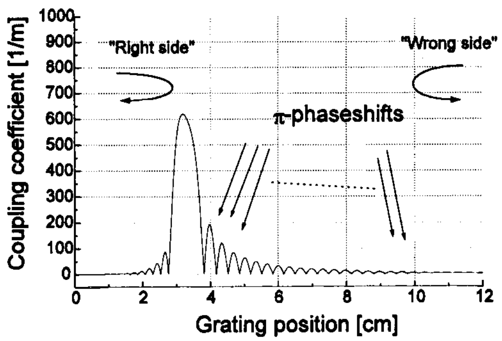

Fig.1 *Refractive index profile of 99.9% reflectivity 50GHz linear-phase filter with directional input.*

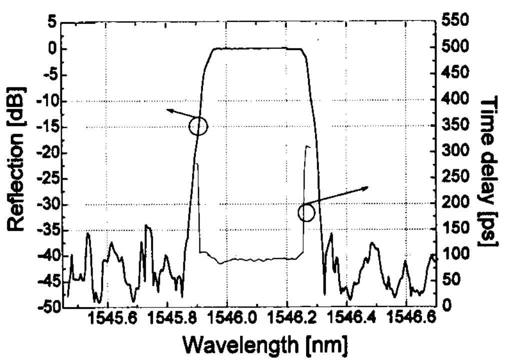

Fig.2a *Measured reflection and time-delay spectra of the 50GHz linear-phase Bragg grating from the "right side".*

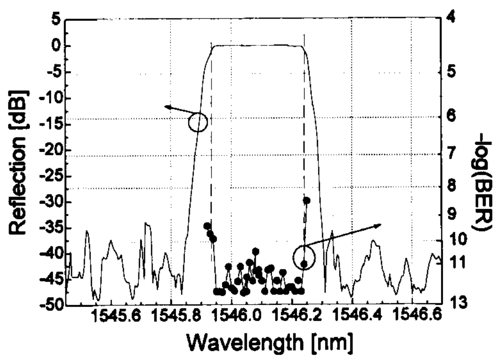

Fig.2b *Measured reflection and BER performance of the 50GHz linear-phase Bragg grating from the "right side".*