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Time Delay Characterization of a Tunable Chirped Fibre Grating for Dispersion Compensation

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The development of chirped fibre grating filters for dispersion compensation in long fibre telecommunications links requires full and accurate amplitude and time delay characterisation of these devices. We have recently demonstrated a wavelength scanning interferometric technique with sub-picosecond time-delay and 3pm wavelength resolutions to provide such measurements [1]. The system is based on an all-fibre Michelson interferometer. The reference arm of the interferometer is phase-modulated to generate an electric signal at the photodetector which carries the optical phase and amplitude information of the reflective fibre device under test, which is included in the signal arm. The amplitude response of the interferometer is directly proportional to the field reflection coefficient whilst the time delay is given by the derivative of the relative phase with respect to wavelength. A high wavelength resolution tunable laser source (HP8168A/C) is used in conjunction with a fully automated set-up to provide sub-picosecond resolution.

Our set-up has been routinely used to characterize and assist the development of chirped fibre gratings at the ORC/Southampton. We have tested a 4 cm long holographic fibre grating with different temperature gradients applied to it in order to induce variable chirp. At room temperature, its 3dB bandwidth and peak reflectivity were 0.09 nm and 31%, respectively. The temperature gradient was achieved by placing the grating in a 45mm long V-groove made on an aluminium slab, and heating its left and right sides with two separate peltier elements. By applying a temperature gradient of 50°C/45mm to the grating, its spectrum broadens, its peak reflectivity reduces and a positive time delay slope of +1200 ps/nm is induced. Reversing the temperature gradient to -25°C/45mm (fig 1), the chirp is reversed and the delay slope changes sign. Spectral broadening and decrease in the peak reflectivity are also observed and the measured dispersion in this case is -1100 ps/nm. The ripples in the delay slope edges are in good agreement with theoretical predictions [2]. Several different temperature gradients were characterized and the results will be discussed in the presentation.

Our measurements have shown that by applying variable temperature gradients to a **4 cm** grating, dispersion up to ±2050 ps/nm (3-dB bandwidth = 0.08nm) is induced, which is capable of compensating the dispersion of over **120 km** of standard telecom fibre. Although this grating can be chirped further, we have noticed that this causes ripples in the time delay slope which degrade its dispersion compensation capability. Our results are very repeatable and have proved to be in very good agreement with other time delay measuring techniques [1], as well as with theory [2] and recent system measurements [3].

[1] S Barcelos, M N Zervas, R I Laming et al; "High Accuracy Dispersion Measurements of Chirped Fibre Gratings", submitted to Electronics Letters.

[2] M N Zervas, D Taverner, S Barcelos and R I Laming; "Study of Linearly-Chirped Fibre Gratings"; National Quantum Electronics Conference, QE-12, Southampton, UK, 4-8 September1995, submitted.

[3] R I Laming, N Robinson, P L Scrivener, S Barcelos, M N Zervas; "A dispersion tunable grating in a 10Gbit/s 100-220km step index fibre link", European Conference on Optical Communications, ECOC'95, Brussels, Belgium, September 95, submitted.

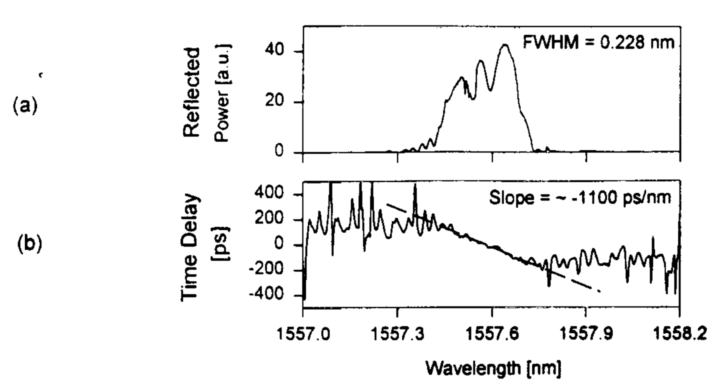

Figure 1: Reflected power (a) and time delay response (b) for grating with a temperature gradient of -25°C/45mm applied to it.