CMM - Fibre Optical Sensors

Presider: R. Ulrich, *Technical University, Hamburg-Harburg, GERMANY*

14:00 CMM1 (Invited)

Long Fibre Grating Characterisation using Low Coherence Reflectometry

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Optical fibre dispersion compensation,[1] and distributed fibre sensors,[2] make use of long fibre gratings. Their reflectivity and time delay are usually characterised as a function of wavelength using an expensive tunable laser.[3],[4] We have recently achieved similar results with a new low-cost low-coherence reflectometry technique, which is related to earlier techniques for optical fibre characterisation.[5]

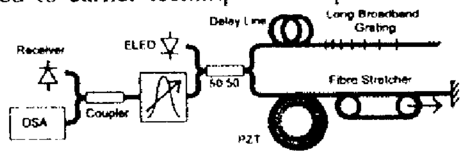

Fig.1 Schematic Diagram of the characterisation system

A fibre Michelson interferometer contained a 5cm long broadband grating (reflectivity 40%, chirped from 1528 to 1532nm) in one arm and a mirror in the other. The interferometer was illuminated by an ELED (peak wavelength 1515nm, bandwidth 110nm, power density 30nW/nm) and balanced using a fibre stretcher.(Fig.1)

Light from the interferometer reached the receiver via a wavelength-tunable filter, consisting of a circulator and a strained reference grating (reflectivity 90%, bandwidth 0.18nm, unstrained wavelength 1529.05nm). Its wavelength could be measured with an optical spectrum analyser (OSA) or calculated from the applied strain. A piezoelectric transducer (PZT) modulated the reference path length to observe interference fringes at the output of the transimpedance receiver.

The fringes were maximised when the wavelength of the long grating matched that of the tunable filter at the chosen time delay. The time delay was calculated from the extension applied to the reference arm, while the reflectivity of the long grating was obtained from the amplitude of the fringes. A time delay accuracy of 1.7ps was measured for the system by tuning the time delay at a constant wavelength and measuring the range of delays that produced good fringe contrast. The wavelength resolution of 0.18nm was determined by the reference grating.

By using the reference grating to form a band-pass filter located before the receiver, rather than a reflective filter in the reference arm, light from the broadband grating outside the wavelength range of interest was discarded. This reduced the DC offset of the fringes, improving the signal to noise ratio when the receiver operated close to its shot-noise limit.

The long grating was characterised by setting the time delay and tuning the filter for maximum fringe contrast. The results of the new system compare well with those from a tunable laser system (Fig.2), confirming the performance of the new technique.

The new system is a cost-effective all-fibre system, not requiring expensive measurement equipment. As this technique can select short sections of the long grating, it will, for the first time, allow the characterisation of a grating with an arbitrary wavelength distribution, for example from an arbitrarily strained long grating in a structural monitoring system. Signal processing may be used to improve the wavelength or time delay accuracy.

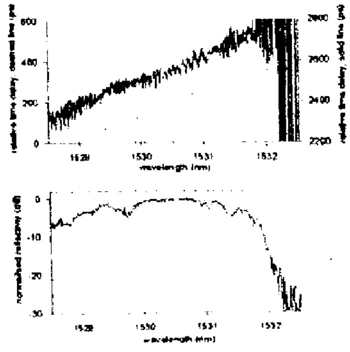
Fig.2 Performance of the new system (dashed line) and a tunable laser system (solid line), arbitrary time delay offset

1. F.Oulette, *Opt Lett*, 12, 847, (1987)
2. S.H.Huang, M.M.Ohn, M.Leblanc, R.Lee, R.M.Measures, SPIE, 2294, 81, (1994)
3. S.Barcelos, M.N.Zervas, R.I.Laming, D.N.Payne, *IEE Colloquium Fibre Gratings and Their Applications*, 96 (1995)
4. S.H.Huang, M.M.Ohn, R.M.Measures", SPIE 2444, 158, (1995)
5. J.Stone, L.G.Cohen, *Elect Lett*, 18, 716, (1982)