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Narrow linewidth, High Power Q-switched Erbium doped Fibre Laser

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For distributed temperature sensing based on Brillouin scattering, narrow linewidth pulsed sources are required to spectrally resolve the Rayleigh and Brillouin backscattered radiation. The temperature is determined by the relative intensity of the Rayleigh and Brillouin backscattered light i.e. the Landau-Placzek ratio[1]. Typically the backscattered Brillouin is separated from the Rayleigh by about 10 GHz. A Q-switched fibre laser using a narrowband in-fibre Bragg grating as an output coupler ensures the Q-switched laser operates with a narrow linewidth, whilst the Q-switched operation produces the high power pulses necessary to produce a stong back-scattered Brillouin signal. Figure 1 shows the optical arrangement used for the Q-switched laser.

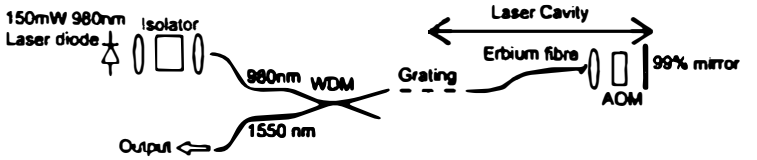

Figure 1 - Schematic of Experimental Arrangement

The laser cavity is formed between the Bragg grating and a high reflectivity (99%) broadband coated mirror. The laser is Q-switched using an acousto-optic deflector operating in a zero order arrangement. A wavelength division multiplexer (WDM) is used to couple the pump radiation into the fibre. The Erbium fibre is pumped with a 150 mW semiconductor laser diode at a wavelength of 980 nm. This pump wavelength, free from excited state absorption[2], is more efficent than pumping in the 810 nm pump band. The Q-switched pulses produced by the laser at a 200 Hz repetition rate have peak powers greater than 75 Watts with pulse widths of 20 ns. The spectral linewidth of the laser was measured with a spectrum analyser, (resolution 12 Ghz). Figure 2 shows the plot of the laser linewidth, which is resolution limited by the instrument giving a linewidth of 12 Ghz. The grating used in this experiment has a reflectivity of >40% and bandwidth of <8 Ghz, at a centre wavelength of 1558.6 nm. From previous experiments the laser linewidth matches the grating bandwidth, therefore we can expect that the linewidth of the laser is less than 8 Ghz. The narrow linewidth and high powers demonstrated make this an ideal source for temperature sensing based on the Landau-Placzek method.

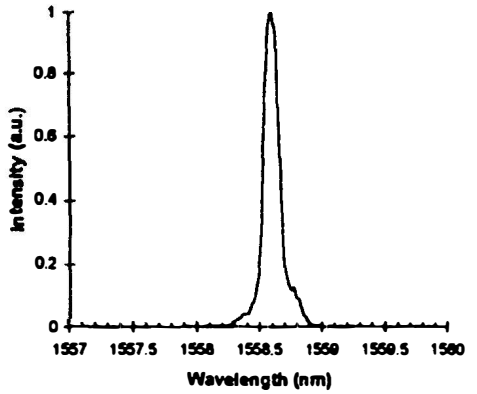

Figure 2 - Spectral output of Q-switched laser

References

[1] P.C.Wait, T.P.Newson, "Landau Placzek ratio applied to distributed fibre sensing", *Optics Communications* 122 pp.141-146 (1996)

[2] R.I.Laming, M.C.Farries, P.R.Morkel, L.Reekie and D.N.Payne, "Efficient Pump wavelengths of Erbium doped optical amplifiers", *Electronics Letters*, 25(1), 1989, pp.12-14