SINGLE LONGITUDINAL MODE OPERATION OF A FIBRE LASER

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ABSTRACT.
We report the first operation of a monomode fibre laser oscillating on a single longitudinal mode. The laser incorporates an integral fibre grating and the output linewidth is 1.3MHz FWHM.

SUMMARY.
The inclusion of rare-earth dopant ions into monomode fibres has led to the development of a new class of laser devices. Fibre lasers have been operated on a number of transitions and efficient CW action [1] has been achieved. In addition, Q-switched [2] and widely tunable lasers [3] have been constructed. Typically, these lasers have been characterised by a large lasing bandwidth. Fibre gratings have been employed previously to achieve single longitudinal mode operation of diode lasers [4] and have been incorporated into fibre lasers to produce narrow linewidth devices operating at 1.08um and 1.55um [5]. Here we describe the construction and characteristics of a fibre laser containing a fibre grating and operating at 1082nm on a single longitudinal mode.

The experimental configuration is shown in Fig.1. The pump source was a CW Rh6G dye laser operating at 594nm and the pump light was launched through the input mirror with an efficiency of approximately 32%. The input mirror was chosen to have a high transmission at the pump wavelength (T=90%) and a high reflectivity at the lasing wavelength (R=99.8%). The doped fibre was characterised by a dopant concentration of approximately 2000ppm. The fibre grating was fabricated directly in the doped fibre and was overlaid with oil of refractive index 1.452. The peak reflectivity of the grating was greater than 80%, centred at 1082nm, with a bandwidth of 0.8nm. For minimum cavity loss the fibre was cleaved and butted against the input mirror.

Initially the output from the fibre laser was analysed with a scanning Fabry-Perot interferometer. With an absorbed pump power of 40mW and a fibre cavity length of approximately 50cm some 10 longitudinal modes were seen to oscillate. The fibre cavity was gradually cut back to a length of 51mm at which only a single longitudinal mode oscillated. The absorption of the fibre at 594nm (>100dB m-1) was such that most of the pump light was absorbed in this length.

The CW laser characteristic is shown in Fig.2. The threshold for laser action was 6mW launched power and the laser slope efficiency was 2.3%. The output wavelength was measured to be 1082nm, coincident with the peak reflectivity of the grating, as expected. The single longitudinal mode remained stable with

no other modes visible up to the maximum available launched pump power of 40mW.

A delayed self-heterodyne interferometer was used to investigate the spectral character of the fibre laser output. The interferometer had a nominal resolution of 100kHz with a 2km fibre delay line and the RF spectrum analyser had a resolution of 30kHz. The RF output from the interferometer is shown in Fig.3. The output was approximately Lorentzian in profile, indicating that the coherence length of the laser was significantly shorter than the interferometer delay line. In this case the optical linewidth is half the RF linewidth. The RF linewidth was measured to be 2.6MHz FWHM resulting in an optical linewidth of 1.3MHz FWHM (1.0MHzmW).

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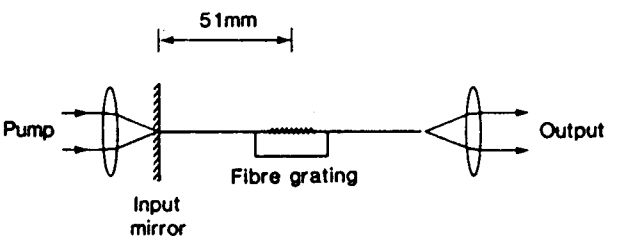

FIG.1 EXPERIMENTAL CONFIGURATION OF SINGLE LONGITUDINAL MODE FIBRE LASER

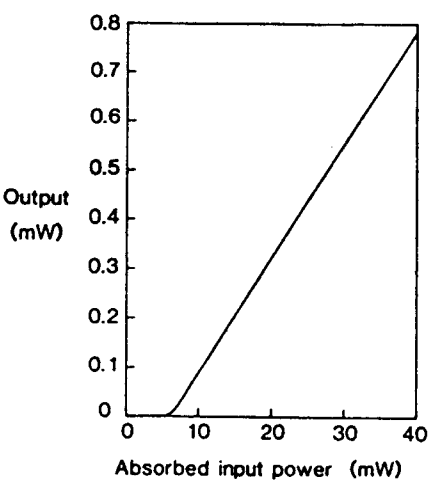

FIG.2 CW LASING CHARACTERISTIC

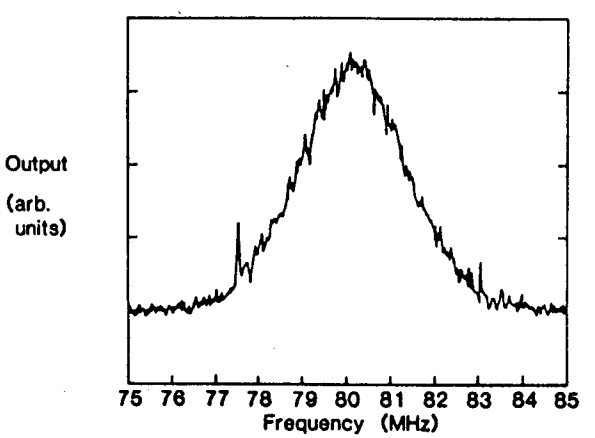

FIG.3 RF OUTPUT FROM SELF HETERODYNE INTERFEROMETER