A High-Gain Thulium-doped Fluorozirconate Fibre Amplifier Operating In The 0.8μm Region

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Summary

To date, most research on rare earth doped optical fibre amplifiers has been directed towards developing high gain amplifiers in the second and third telecommunications windows at 1.3μm and 1.55μm respectively. In this paper we describe a Tm^{3+}-doped fluorozirconate fibre amplifier pumped at 785nm and giving 20dB gain at 806nm in the first telecommunications window.

The Tm^{3+} ion in fluorozirconate (ZBLANP) glass has a strong absorption band centred at 790nm corresponding to the $^3H_6$-$^3F_4$ transition of figure 1. Approximately 88% of ions excited to the $^3F_4$ level relax radiatively back to the ground state. The peak of this emission is at $\approx$805nm. By contrast, in Tm^{3+}-doped silica fibres, essentially all ions excited to the $^3F_4$ level decay non-radiatively via multiphonon emission to the $^3H_4$ level as a result of the higher phonon energies in this host, which means that a high gain 0.8μm amplifier based on a Tm^{3+}-doped silica fibre is not achievable.

A 6m length of 500ppmw Tm^{3+}-doped ZBLANP fibre of core diameter 10μm was used for the demonstration of the high gain 0.8μm amplifier. The pump source was a Ti:sapphire laser providing 600mW at 785nm. The signal was provided by a second tunable Ti:sapphire laser, the output power of which was attenuated to $\approx$10μW to allow the measurement of small signal gain. Pump and signal beams were combined using a polarization rotator and polarizing beam splitter and launched co-propagating into the fibre. The ratio of the transmission of the signal when the pump beam was blocked and unblocked was measured, and the host absorption (determined by a cut-back) subtracted from this value to give the small-signal gain. Amplification was observed between 800nm and 830nm (figure 2), with a gain of $\approx$23dB at 806nm for 400mW launched power.

Modelling of the expected performance of this amplifier has been undertaken and is in good agreement with the experimental results obtained. This model also predicts that in an optimized fibre, for 100mW launched power (a power available with high brightness single stripe AlGaAs laser diodes) an amplifier of 23dB gain at 805nm with a 3dB bandwidth of 10nm appears to be feasible. Experiments aimed at the realisation of this predicted performance will be reported. An amplifier with these predicted performance characteristics may find applications in local area networks operating near 0.8μm, since transmitters and receivers in this wavelength region are significantly less expensive than those at 1.3μm or 1.5μm.

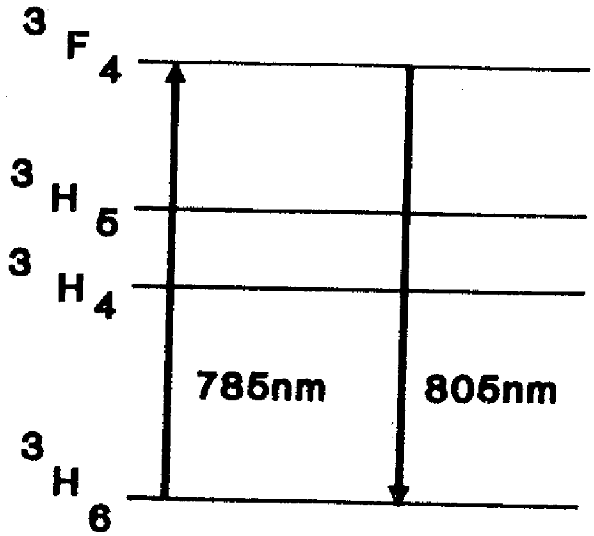

Figure 1:Partial energy level diagram for Tm^{3+}:ZBLANP glass

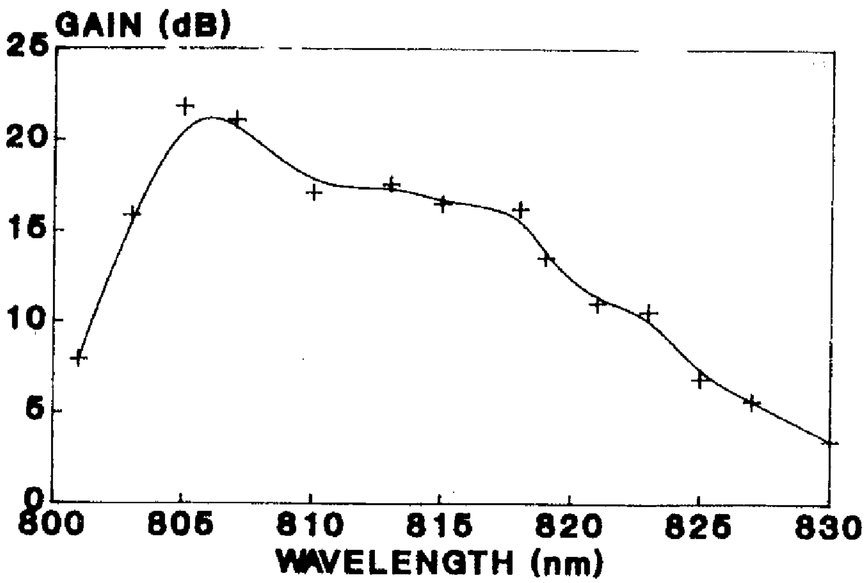

Figure 2: Gain spectrum for Tm^{3+}:ZBLANP fibre amplifier