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NEAR OPTIMUM OPERATION OF A DIODE-LASER PUMPED FIBRE LASER.

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Abstract

We describe near optimum operation of a diode laser pumped single-mode fibre laser characterised by a maximum output power of 5.5mW at 1088nm, a laser tuning range of 92nm and a Q-switched peak power of over 13W.

Introduction

The development of low-loss rare-earth doped fibres has led to the construction of a number of single-mode fibre lasers [1-6]. These new lasers have many advantages; they are not only compatible with standard single-mode fibres and potentially very inexpensive, but their solid-state nature also renders them extremely reliable. In addition, due to the small volume of the active core, low threshold and efficient operation has been achieved [3]. Room temperature operation of a 3-level glass laser [4] and laser action of transitions never previously achieved in glass [5] have been reported. The broad nature of the transition in glass also allows an extensive tuning range to be obtained [6].

For many operational requirements such as fibre sensors and optical time-domain reflectometry, diode laser pumping of a fibre laser is highly desirable. Previously [1,3], we reported the operation of a neodymium-doped fibre laser operating at 1088nm and pumped by a GaAlAs laser. The present work is aimed at the development of an efficient, optimised version capable of high output power and wide tunability.

Experiment

Efficient CW operation of the fibre laser was achieved by directly butting each end of a section of doped fibre to dielectric-coated mirrors, thus minimising the cavity losses [1]. Pump light from a Sharp LT015 diode laser operating at 825nm was launched longitudinally through the input mirror using special diode laser objective lenses. In this manner, a laser launch efficiency for this pump source of 41% was

achieved. The increased pump power gave a larger round-trip laser gain and allowed the use of an output mirror with a transmission of 25% at the lasing wavelength. The CW lasing characteristic is shown in Fig.1. The laser threshold was 4.7mW absorbed, maximum output power was 5.5mW and and the overall slope efficiency was 46%, indicating that these devices are very efficient sources. The spectral width was several nanometres FWHM, depending on pump power, and the output was centred at 1088nm.

Inclusion of a wavelength-selective feedback element in the cavity allows the broad fluorescence linewidth to be exploited, giving tunable operation. This was achieved by removing the output coupler and collimating the light onto a diffraction grating. An intracavity pellicle was used to couple out the laser emmision. Rotating the grating gave a tuning range of 92nm, from 1062nm to 1154nm, with a maximum power of 0.25mW at 1088nm (Fig.2).

The experimental arrangement shown in Fig.3 was used to Q-switch the fibre laser. An acousto-optic modulator (AOM) was inserted into the cavity in such a way that the cavity high-Q state was achieved by switching on the AOM and feeding back the first order diffracted beam using a high reflectivity mirror. In this way it is possible to provide a high blocking action and hold off laser oscillation despite the high gain present. Moreover, since the AOM was not 100% efficient in the "on" state, a significant amount of light remained in zero-order and provided the laser output.

A typical Q-switched pulse is shown in Fig.4. The peak power was 13.3W and the FWHM was 120ns with a repetition rate of 400Hz. Figure 4 shows approximately 100 consecutive Q-switched pulses superimposed, thus demonstrating the excellent pulse-to pulse stability of this system. Further optimisation should be possible and a Q-switched peak power in excess of 100W can be expected.

By replacing the high reflectivity output mirror with a diffraction grating, simultaneous tunable and Q-switched operation can be achieved. This is in contrast ot other solid-state Q-switched lasers and represents one of the advantages of these devices as fibre sensor and backscatter sources.

Conclusion

By careful optimisation of the laser parameters, we have increased the output power and tuning range available from a diode-laser pumped neodymium-doped fibre laser over that previously reported. CW and Q-switched powers of 5.5mW and 13.3W respectively with an extensive tuning range of 92nm around 1088nm have been demonstrated.

References

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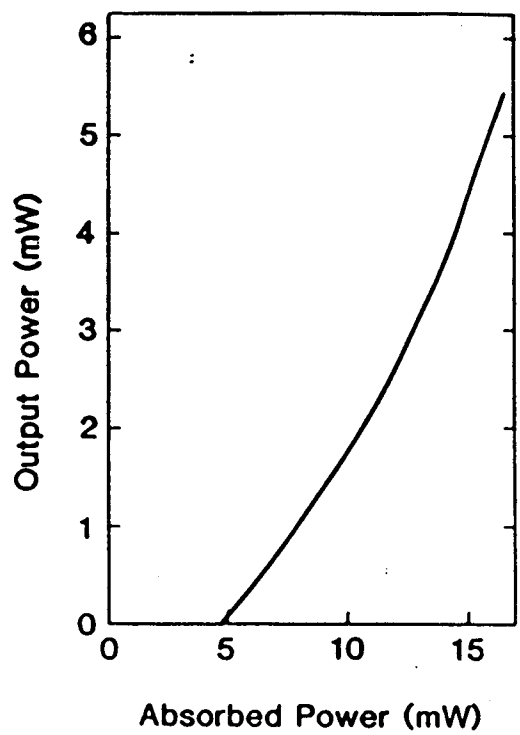

Fig.1. CW lasing characteristic.

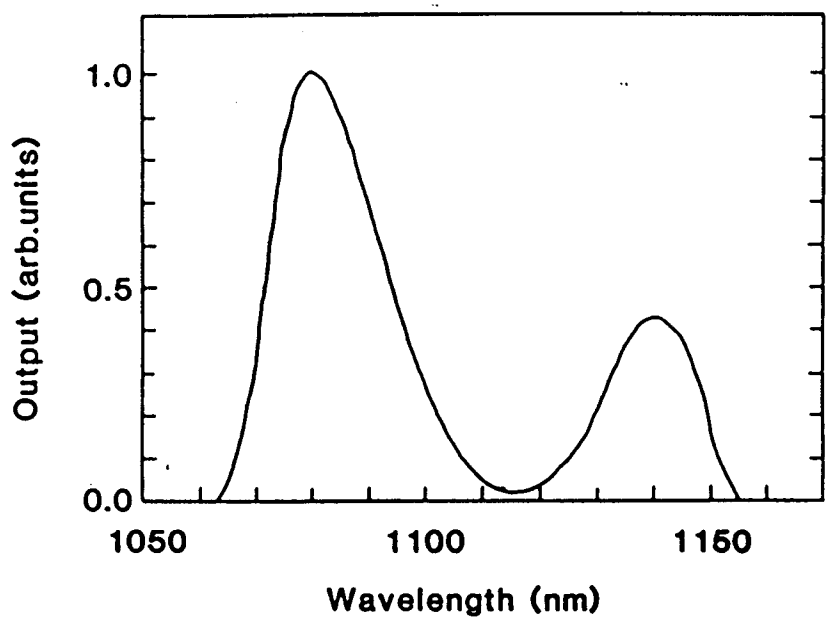

Fig.2. Fibre laser tuning range.

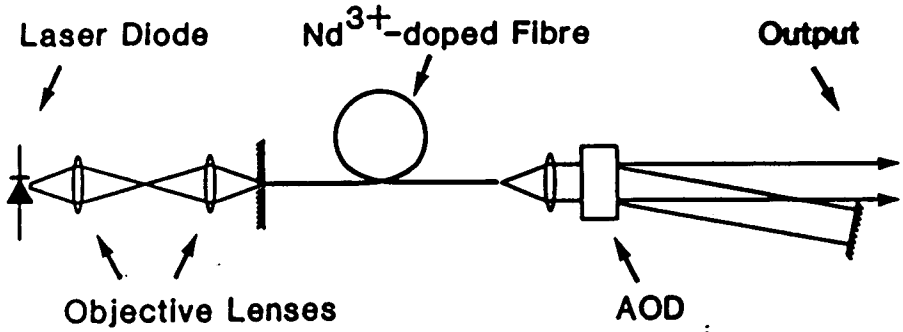

Fig.3. Experimental arrangement for Q-switching fibre laser.

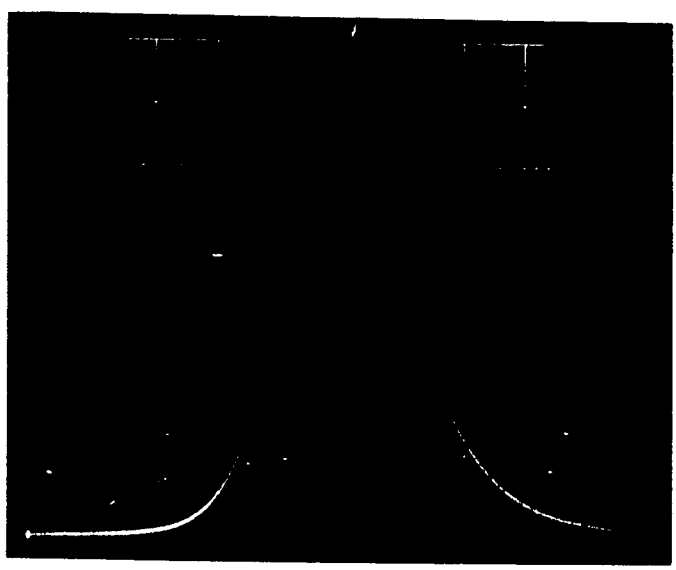

Fig.4.
Typical Q-switched pulse.
FWHM 120ns
13.3W peak power.