

120-W Q-switched cladding-pumped Yb-doped fibre laser

Yoonchan Jeong, J. K. Sahu, M. Laroche, W. A. Clarkson, K. Furusawa, D. J. Richardson, and J. Nilsson

Optoelectronics Research Centre, University of Southampton, SO17 1BJ, UK

Tel: +44 23 8059 3139, Fax: +44 23 8059 3142, Email: yoj@orc.soton.ac.uk

The output powers of fibre lasers at 1 μm continue to grow and such lasers are now beginning to compete with conventional solid state lasers (for example, Nd:YAG lasers) in many important application areas, e.g., material processing, medicine, range finding, etc. Fibre lasers benefit from a geometry that allows easy thermal management and an easy selection of a high quality output beam. So far a pulse energy of 7.7 mJ and 10 W average output power has been reported from a large core Yb-doped Q-switched fibre laser [1]. In fact, the maximum extractable energy is limited by the build-up of amplified spontaneous emission or spurious lasing between pulses [2], and thus, large-mode area (LMA) fibres are preferred. Besides the pulse energy, factors to be considered are the average power and the beam quality, which are especially important for applications operating at very high average power levels such as materials processing. In this paper, we investigate Q-switching of LMA cladding-pumped Yb-doped fibre laser in terms of its high-power operation. We designed and fabricated an LMA fibre with a 30 μm diameter, 0.07 NA, core, and a 350 μm D-shaped inner cladding with 0.49 NA. The continuous wave slope efficiency was $\sim 84\%$ with respect to the absorbed pump power at 975 nm. The experimental setup for the Q-switched fibre laser is shown in Fig. 1. A diode-laser stack at 975 nm was used as the pump source. The first-order diffracted beam from the acousto-optic modulator was fed back by a dichroic mirror that had a high reflectivity at $\sim 1 \mu\text{m}$, the diffraction efficiency of which was $\sim 70\%$. The fibre length was ~ 9 m. The Q-switched pulse energy and the average power are shown in Fig. 2. A maximum pump power of 250 W was launched into the fibre. We evaluated the maximum pulse energy to 8.4 mJ at $\sim 1.06 \mu\text{m}$, for a repetition rate of 0.5 kHz, though with a large uncertainty because of the high level of amplified spontaneous emission present between pulses. The maximum average power at the repetition rate of 200 kHz was 120 W with 0.6 mJ pulses. The pulse width was ~ 460 nsec at a low repetition rate. These values are the highest that have ever been reported for a Q-switched fibre laser, to the best of our knowledge.

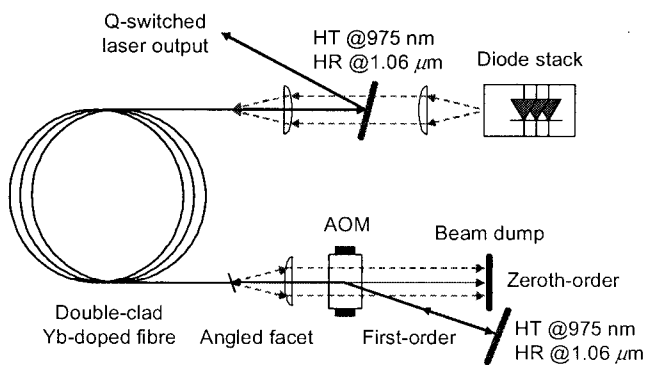


Fig. 1. Experimental setup.

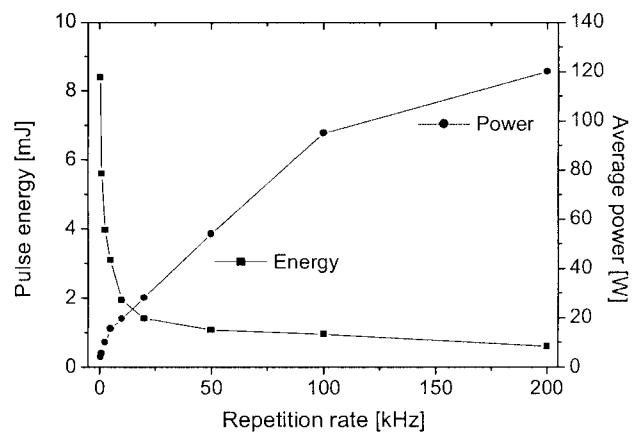


Fig. 2. Pulse energy and average power.

References

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