High-Power Diode-End-Pumped Tm:YLF Slab Laser Delivering 189 W at 1890 nm

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Abstract: We present a high-power Tm:YLF slab laser double-end-pumped by two 300 W laser diode stacks. The resonator was designed such that the laser emitted at 1890 nm instead of the natural operating wavelength of 1912 nm. At full incident pump power, it delivered up to 189 W of stable output.

1. Introduction

High-power and high-energy 2-µm lasers have received increased interest due to a number of potential military, medical and scientific applications. The objective of this experiment was to develop a high-power Tm:YLF slab laser which could be used to pump a Holmium slab amplifier which is seeded by a pulsed single-frequency Ho:YLF ring laser which has been previously demonstrated [1].

A Tm:YLF slab laser similar to the one presented here was previously reported which delivered 192 W of output at 1912 nm [2]. However, a change in operational wavelength of the Tm:YLF laser was critical for improved absorption of the pump light in the Holmium YLF and LuLF amplifier crystals used in the amplifier pumped by this laser.

We therefore designed the slab laser to operate on the π-polarisation at 1890 nm instead of operating on the σ-polarization at 1912 nm, as previously demonstrated [2]. This was achieved by inserting a Brewster plate in the resonator and implementing a laser cavity that accommodated the stronger negative thermal lens associated with the π-polarisation.

The resonator (Fig. 1) consisted of a 300 mm concave output coupler (R=90 %, M1) and a 200 mm concave high reflector (M2). The 2.5% doped Tm:YLF crystal used measured 11 x 1.5 x 19 mm^3 and was end-pumped by two 300 W diode-laser stacks. To be able to pump the laser crystal from both sides, a 45º folding mirror (M3) was used.

2. Results

The output power as a function of the pump diode power incident on the slab crystal is shown in Fig. 2. A maximum laser power of 189 W was obtained at a total of 561 W of incident pump power. This corresponds to a slope efficiency of 38% and an optical-to-optical efficiency of 33%. The measured peak emission wavelength was 1889 nm. The laser beam was π-polarized (polarization parallel to the a-axis of the YLF crystal). Of the 561 W of pump light incident on the slab crystal, 83 W was transmitted, implying that even better performance can be achieved in a configuration where the pump light is passed through the crystal multiple times.

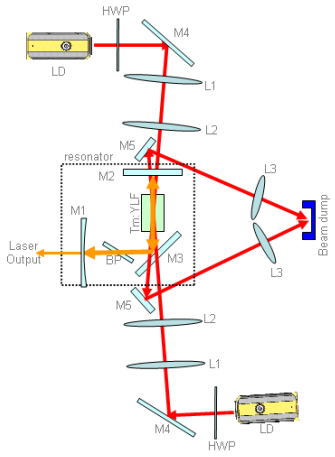

Fig. 1: Schematic diagram of the Tm:YLF laser.

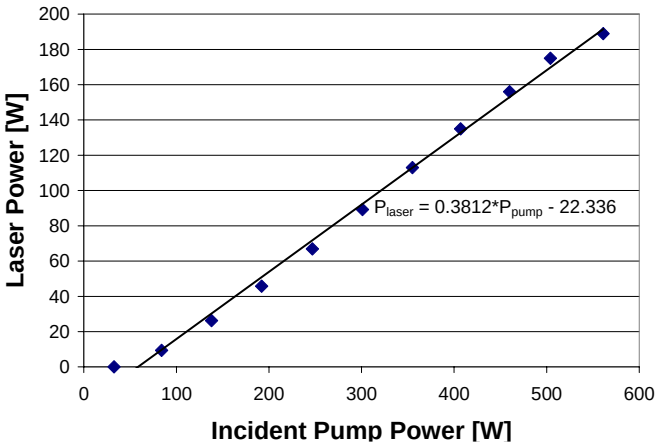

Fig. 2: Tm:YLF laser power output vs. incident power.

3. References

[1] C. Bollig, M.J.D. Esser, C. Jacobs, W. Koen, D. Preussler, K. Nyangaza and M. Schellhorn, "70 mJ Single-Frequency Q-Switched Ho:YLF Ring Laser-Amplifier System Pumped by a Single 82W Tm Fibre Laser," Middle-Infrared Coherent Sources, Trouville, France, 8-12 June, 2009 Mo3 (invited).

[2] S. Ngcobo, C. Bollig, M. J. D. Esser and D. Preussler, "High-average power Tm:YLF slab laser for pumping a Ho:YLF slab amplifier" in *South African Institute of Physics 54th annual conference*, *University of KwaZulu-Natal, KwaZulu-Natal, July 2009*, paper 375, (2009).