High-power diode-pumped Tm:YLF slab laser

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Recently, there has been an increased interest in high-power and high-energy 2-µm lasers, due to a number of potential medical, military and scientific applications. Our aim is to develop a high-power Tm:YLF slab laser which can be utilized to pump a Ho slab laser. A 68 W Tm:YLF slab laser was recently presented in [1] pumped from one end by a single 6-bar stack delivering ~300 W of pump power. In this work, we present a Tm:YLF slab laser pumped by two diode-bar stacks from both ends, leading to a maximum output power of 192.5 W.

In the experiments, we used an 11-mm-wide (c-axis), 1.5-mm-thick (a-axis), 19-mm-long (a-axis) 2.5 at. % doped Tm:YLF slab crystal. The slab was sandwiched between two water-cooled copper heat sinks using 0.2-mm-thick indium foil. The water temperature was initially kept at 10 °C. The slab crystal is diode end-pumped by two laser diode stacks (nLIGHT, NL-VSA-05-300-792-F900D). Fig. 1 shows the details of the experimental setup. Two cylindical lenses were used for each stack to produce a line focus inside the slab of ~900 µm in height and ~10 mm in width. The Tm laser was enclosed in a sealed box flushed with dry air. The folded resonator consists of a flat mirror (M1) with high reflectivity (R>99.8%) in the wavelength range 1.9-2.1 µm and high transmission (T > 95%) at the pump wavelength, one flat 45° dichroic mirror (M2) with high reflectivity (R > 99.9%) at the s-polarized component in the wavelength range 1.9-1.95 µm and high transmission at the pump wavelength (T > 98%) and a concave output coupler with 300 mm radius of curvature (M3). 90% of the polarized pump radiation is absorbed at the laser diodes' operating wavelength of 792.5 nm. The physical resonator length was approximately 160 mm.

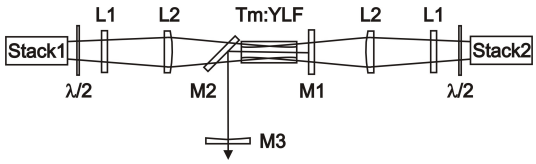

Fig. 1 Experimental setup of the Tm:YLF slab laser: M1 – M3, mirrors; L1 – L2, cylindrical lenses; λ/2, half wave plate @ 792 nm.

The output power as a function of the pump diode power incident on the slab crystal is shown in Fig. 2 (a). A maximum laser power of 192.5 W was obtained with an R = 90% output coupler at a combined pump power level of 550 W. This corresponds to a slope efficiency of 37.6% and an optical-to-optical efficiency of 35%. The measured peak emission wavelength was 1908 nm. The laser beam was σ-polarized (polarization parallel to the a-axis of the YLF crystal). The dependence of the output power of the Tm:YLF laser on the temperature of the crystal-holder at incident pump power levels of 82 W, 450 W and 550 W has been measured and is shown in Fig. 2 (b).

It is planned to use this laser as a pump source for a Ho:YLF slab laser.

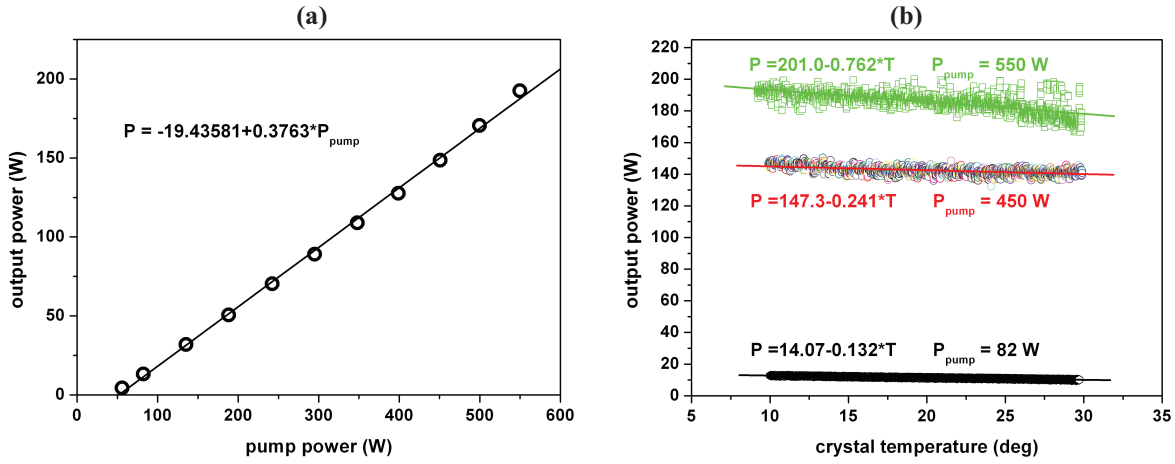

Fig. 2 Output power of the Tm:YLF slab laser (a) as a function of the diode power incident on the slab crystal and (b) as a function of temperature of the crystal-holder at different pump power levels (82 W, 450 W and 550 W).

Reference

[1] S. So, J. I. Mackenzie, D. P. Shepherd, W. A. Clarkson, J. G. Betterton and E. K. Gorton, "A power-scaling strategy for longitudinally diode-pumped Tm:YLF lasers," Appl. Phys. B **84**, 389 (2006).

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