1.8-W CW Er:YLF diode-pumped laser

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Abstract: We report a diode-pumped CW Er:YLF laser with ~2-W output power. To the best of our knowledge this is the highest reported output power for a CW Er:YLF laser. The device is based on an Er:YLF slab, side-pumped with two diode laser bars. The maximum slope efficiency is 13% and the operating wavelength is 2.81 μm.

OCIS codes: (140.3480) Lasers, diode-pumped; (140.3500) Lasers, erbium; (140.3580) Lasers, solid-state

The main objective of this work is to achieve high CW output in the 3-μm wavelength range from a solid state laser. As it was shown in previously published papers [1-3], Er:YLF is an efficient 3-μm material suitable for laser diode pumping. The highest "true" CW output power of 1.1 W from an Er:YLF laser was reported by Jensen et al. [2] for 15% Er:YLF crystal end-pumped with a fiber-coupled diode laser bar. However, the output of the laser was emitted in both directions because both resonator mirrors had approximately the same transmission of 0.22% at 2.81 μm. Fracture of the Er:YLF pump face prevented the authors from achieving higher average output power.

The brightness limitations of high-power fiber-coupled diode lasers significantly limits the efficiency of end-pumped Er:YLF lasers. Moreover, an end-pumping geometry limits the total pump power that can be delivered to the crystal because of pump face fracture. This significantly complicates power scaling of an end-pumped Er:YLF laser.

In the present work we have developed a CW Er:YLF laser based on an Er:YLF slab side-pumped by two diode laser bars. The side-pumped slab design has the potential to scale to much higher power than end-pumped configurations. 40-W 980-nm diode laser bars are readily available from several different vendors, providing sufficient pump power. A schematic sketch of the laser set-up is shown in Fig. 1.

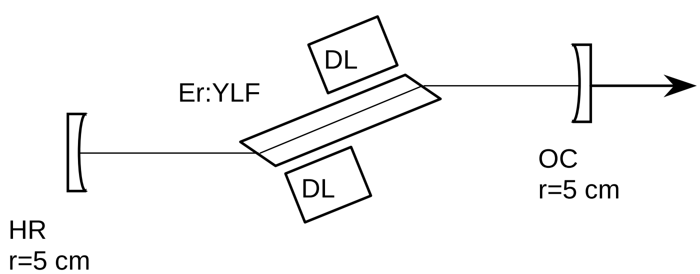

Fig. 1. Schematic layout of side-pumped Er:YLF laser.

As an active medium we used a Brewster-cut, 15% Er:YLF crystal which was side-pumped by two fast-axis-collimated 980-nm diode laser bars. In all our experiments, we used a nearly-confocal resonator based on two concave mirrors with either 10-cm or 5-cm radius of curvature. Typical input/output curves for two different values of output coupling (mirrors with 5-cm radius of curvature) are shown in Fig. 2. Output couplers with transmission ranging from 0.5% to 4% at 2.81 μm were tried. The beam from the Er:YLF laser with concave mirrors having 5-cm radius of curvature was diffraction limited in the vertical plane (normal to the plane of Fig. 1) and 5-10 times diffraction limited in the horizontal plane.

Using a second low-power CW Er:YLF laser as a probe we measured the single pass gain of the system to be on the order of 4-5 %/cm for 20-W pump power per bar.

Efforts are underway to increase the power output by improved mode overlay, optimization of output coupling, and the use of higher pump powers. We also plan to test the scheme with multiple passes of the laser beam through the Er:YLF slab to increase average power and improve beam quality.

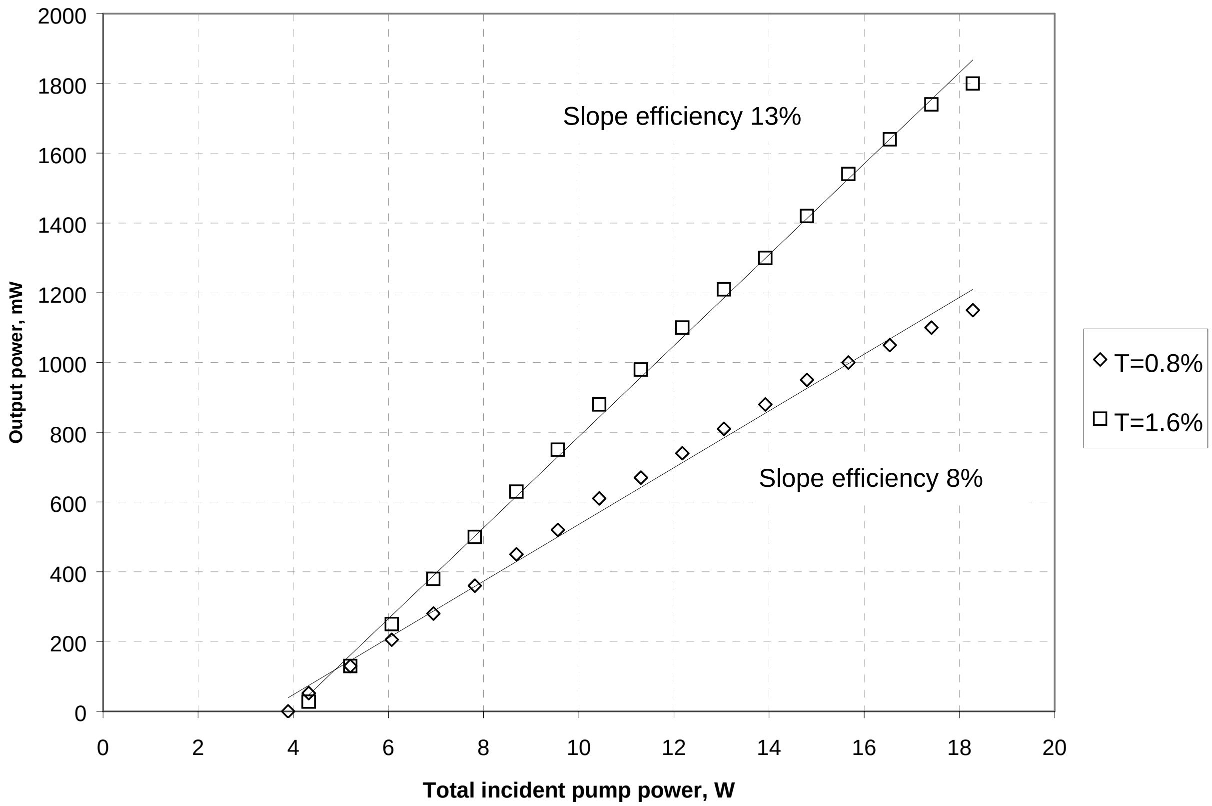

Fig. 2. Input/output dependencies for a side-pumped CW Er:YLF laser operating at 2.81 μm for two different values of output coupling.

References

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