TEM_{00} mode efficiency enhancement in diode-side-pumped Nd:YLF

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Diode pumped solid state lasers have been increasingly used in high-power laser engineering since the obtained devices are compact, robust and very efficient. In the side pumping configuration, the pump power can be increased once the beam is not focused into the crystal. However, in order to improve the efficiency and the beam quality in this geometry, it is necessary to guarantee a better overlap between pump beam and intracavity beam. In this work, we present a compact Nd:YLF diode-side-pumped slab laser using a resonator design based on total internal reflection inside the gain media, demonstrating that a double pass through the gain media can improve the output beam quality. The Nd:YLF crystal was grown at our in-home crystal growth facility by the Czochralski technique with 0.8mol% concentration of neodymium. Then a crystal slab was cut and polished with dimensions of 14 x 13 x 4 mm^3. This slab was side pumped by a 20W TM polarized diode bar thermally tuned to operate at 792nm. With the purpose of avoiding fracture due to thermal stress, the diode was operated mostly in the qcw regime with a diode pulse width of 2ms and a repetition frequency of 35Hz, resulting in a duty cycle of 7%. In a first experiment, we have demonstrated that a side pumped Nd:YLF laser in a compact cavity, using only two mirrors, with a configuration based in a total internal reflection inside the crystal results in a multimode output power of 6 W for 17.1 W of pump power. In a second experiment, a resonator was mounted with the adding of a third mirror, resulting in a double pass configuration with two bounces at the pumped face. Then, we have demonstrated that the second pass can improve the beam quality to fundamental mode with M^2 of 1.17 x 1.02 in the horizontal and vertical directions, respectively and 4.1W of output power for 17.1 W of pump power.