High power room temperature operation of a Tm:YAG laser longitudinally pumped by a 20W diode bar

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Abstract

We report efficient room temperature operation of a Tm:YAG laser end-pumped by a 20W diode-bar. An output power of 3.5W TEM_{00} has been obtained for 14.5W of incident pump power.

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Summary:
Diode pumped Tm:YAG laser operation in the eyesafe 2μm region is of great interest due to its numerous applications in important areas such as LIDAR and medicine. However, efficient end-pumping of this transition has proved problematic due to its quasi-three-level nature which requires a pump beam of high intensity and rather small diameter. This has been difficult to achieve with high power diode bars on account of the inconvenient shape of their output beam. Generally these lasers have been operated at reduced temperature to alleviate the reabsorption associated with the quasi-three level character.

Here we describe application of the two-mirror beam-shaping technique recently reported[1], to reconfigure the output beam from a high-power diode bar so as to produce nearly equal M^2 values for orthogonal planes and also allow efficient end-pumping of a Tm:YAG laser. The set-up consists of a 20W cw diode bar operating at 782nm with its output re-shaped and focused to a spot diameter of 260 μm by 360 μm with corresponding M^2 values of ~70 and ~110. We used a simple 25mm long linear cavity, with a convex input mirror to compensate the strong thermal lensing in the 8mm long 6% doped Tm:YAG rod. The rod was mounted on a water cooled heat sink, which was maintained at room-temperature (20 °C). Using this unoptimised cavity design with a plane output coupler of 3% transmission, 3.5W of TEM_{00} output (M^2 values of 1.0 and 1.2 in horizontal and vertical planes) at 2013nm was obtained for 14.5W of pump power incident on the laser rod. Cooling the rod mount to 10°C resulted in a slightly higher output power of 3.7W. The rather high threshold of 4.5W was due to the cavity being unstable at low pump powers, for which the thermal lens was not strong enough to counteract the convex input mirror. While a much lower threshold of 1.1W was obtained with a stable cavity, this did not produce good beam quality at high pump powers due to poor mode matching. Nevertheless this low threshold is indicative of high gain capability with this pump so that more complex resonators containing more components, such as single-frequency ring resonators should be readily accommodated. We will report efforts aimed at further extending the performance of this laser using optimised resonator designs.

1. W. A. Clarkson, A. B. Neilson, D. C. Hanna, in *Conference on Lasers and Electro-Optics,* 1994 Technical Digest Series, Vol. 8 (Optical Society of America, Washington, D.C., 1994), p. 360.