High-Power Diode-Bar-Pumped Nd:YLF Laser at 1.053\(\mu\)m

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Scaling diode-pumped solid-state lasers to multiwatt average power levels is an area which has attracted growing interest over recent years, stimulated by the wide commercial availability and relatively low cost of high-power cw diode-bar pump sources. Recent developments in this area have included: efficient, TEM\(_{00}\), end-pumped Nd:YVO\(_4\) and side-pumped Nd:YLF lasers at 1.064\(\mu\)m [1] and 1.047\(\mu\)m [2] respectively with cw powers in excess of 13W. So far, the scaling of diode-pumped solid-state lasers to >10W average power, whilst retaining high overall efficiency has generally been restricted to only the highest gain Nd transitions. Extension of efficient high average power operation to include other useful, but lower gain, transitions such as the 1.053\(\mu\)m transition in Nd:YLF, has been hindered by the inconvenient shape of the diode bar’s output beam. The diode bar, with its highly elongated emitting region produces an output having \(M^2\) beam quality factors \(-1\) in
the plane perpendicular to the array, but $>1000$ in the plane of the array. It is therefore difficult to focus to the small beam sizes required, particularly for low gain transitions in efficient end-pumped configurations.

Here, we describe a simple Nd:YLF laser which yields a high cw output power at 1.053$\mu$m by end-pumping with two 20W cw diode bars, each equipped with a two-mirror beam-shaper [3]. The laser design, shown in Fig.1, utilises a simple folded resonator design containing two 10mm long Nd:YLF rods mounted in water-cooled heat-sinks. Each of the Nd:YLF rods was end-pumped by a 20W diode bar using identical focusing arrangements, shown in Fig. 2. In each case the bar’s output was first collimated in the plane perpendicular to the array by a fibre lens, and then imaged into a two-mirror beam-shaper by a combination of two spherical lenses and a cylindrical lens. The beam shaper was configured to chop up the incident beam into its 24 constituent emitter images and then stack them vertically below each other, thereby roughly equalising the $M^2$ values (to $\sim80$) for orthogonal planes. Each pump beam was then collimated and focused to a $1/e^2$ beam radius of $\sim300\mu$m in the Nd:YLF rod. In order to reduce the risk of the laser rod fracturing the pump wavelength was detuned slightly from the absorption peak to distribute the absorbed power over the entire length of the Nd:YLF. At the maximum combined pump power of $\sim28.4$W incident on the Nd:YLF rods the laser produced an output power of 10.7W at 1.053$\mu$m in a TEM$_{00}$ beam with $M^2$ values $\leq1.1$ in orthogonal planes. Although having a significantly lower
emission cross-section than the 1.047 \mu m transition, laser oscillation occurred preferentially on the 1.053 \mu m line without any polarisation selection. This is believed to be due to a more favourable laser mode spot size due to the smaller thermal lensing for the polarisation corresponding to the 1.053 \mu m transition. A detailed characterisation of the lasers performance will be presented.

References


W. A. Clarkson, C. Bollig, P. J. Hardman and D. C. Hanna, "High-Power Diode-Bar-Pumped Nd:YLF Laser at 1.053\,\mu\text{m}.

Figure Captions

Fig. 1  Diode-bar-pumped Nd:YLF laser.

Fig. 2  Diode-bar focusing scheme.