High-Power Diode-Bar-Pumped Nd:YLF Laser at 1.053μm

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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 1.064μm [1] and 1.047μm [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 1.053μm 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 1.053μm 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 ~80) for orthogonal planes. Each pump beam was then collimated and focused to a $1/e^2$ beam radius of ~300μm 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 ~28.4W incident on the Nd:YLF rods the laser produced an output power of 10.7W at 1.053μm in a TEM_{00} beam with M^2 values ≤ 1.1 in orthogonal planes. Although having a significantly lower

W. A. Clarkson, C. Bollig, P. J. Hardman and D. C. Hanna, "High-Power Diode-Bar-Pumped Nd:YLF Laser at 1.053μm."

emission cross-section than the 1.047μm transition, laser oscillation occurred preferentially on the 1.053μm 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 1.053μm transition. A detailed characterisation of the lasers performance will be presented.

References

[1] W. L. Nighan, D. Dudley and M. S. Keirstead, in Conference on Lasers and Electro-Optics, 1995 Technical Digest Series, Vol. 15 (Optical Society of America, Washington, D.C., 1995), p.17.

[2] J. Harrison, P. F. Moulton and G. A. Scott, in Conference on Lasers and Electro-Optics, 1995 Technical Digest Series, Vol. 15 (Optical Society of America, Washington, D.C., 1995), postdeadline paper CPD20.

[3] W. A. Clarkson, A. B. Neilson and 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.

W. A. Clarkson, C. Bollig, P. J. Hardman and D. C. Hanna, "High-Power Diode-Bar-Pumped Nd:YLF Laser at 1.053μm."

Figure Captions

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

Fig. 2 Diode-bar focusing scheme.

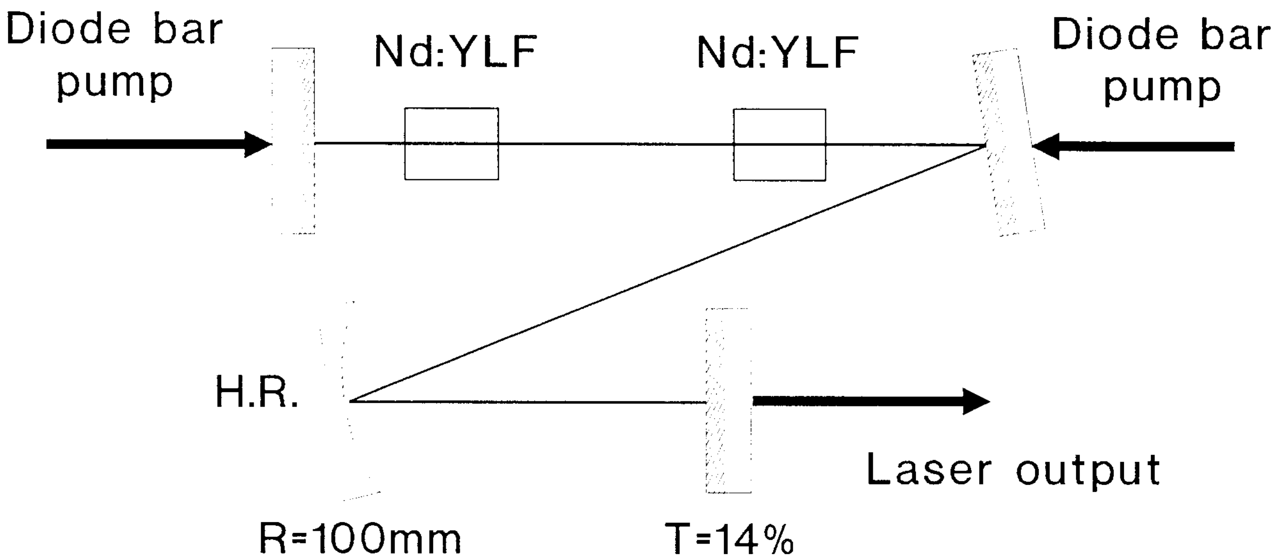
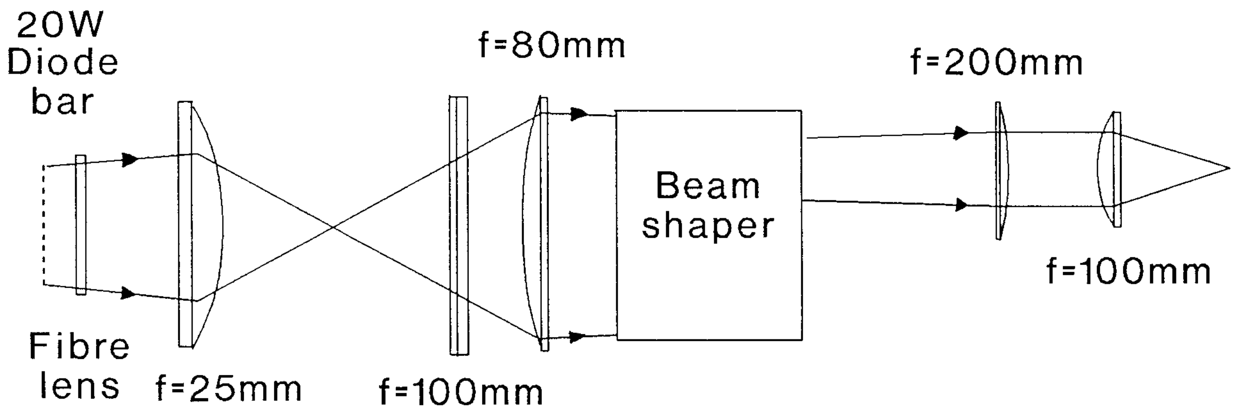

Diode bar pump
Nd:YLF
Nd:YLF
Diode bar pump
H.R.
Laser output
R=100mm
T=14%

Fig 2


20W
Diode
bar
f=80mm
f=200mm
Beam
shaper
f=100mm
Fibre
lens
f=25mm
f=100mm