15W DIODE-PUMPED TM:YAG DOUBLE-CLAD WAVEGUIDE LASER

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Summary

Laser sources with wavelengths around 2μm are of interest for medical, commercial, and remote sensing applications. Typically, high average powers coupled with good beam quality are also desirable for these applications. Diode-pumped planar waveguides are an attractive solution for efficient and compact lasers, with excellent thermal properties and good prospects for power scaling due to their slab geometry[1]. Here, we present results for a planar direct-bonded double-clad waveguide, with a Tm:YAG core, un-doped YAG inner cladding, and sapphire outer cladding layers. The YAG/sapphire numerical aperture is sufficient to contain the highly divergent radiation of a laser diode, allowing a side-pumped arrangement with two proximity-coupled λ_p=785nm 20W diode bars, as shown in figure 1. Thus we obtain efficient pumping in a very simple and compact configuration. The thin waveguide dimensions lead to a high pumping intensity, as required for efficient operation of quasi-three level laser systems. Pumping from both sides of the waveguide is also useful in producing a relatively uniform gain distribution. Mirrors were directly coated onto the end faces of the waveguide structure, forming a plane-plane resonator with 10% output coupling.

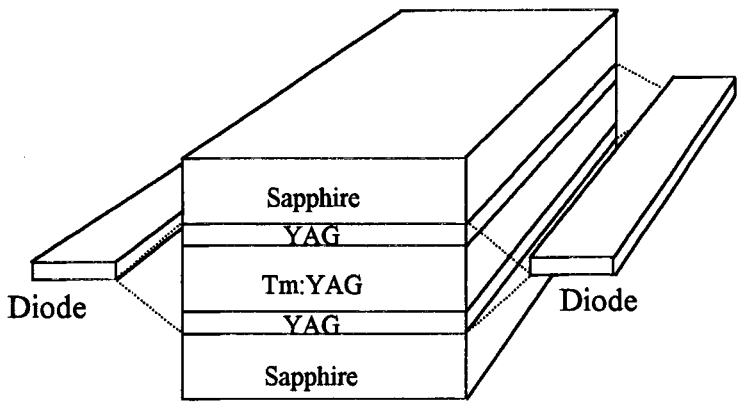

Figure 1 Proximity-coupled, diode-pumped, double-clad Tm:YAG waveguide

In Tm:YAG cross relaxation processes enable the quantum yield to approach 2, i.e. 2 laser photons for one pump photon. Thus slope efficiencies greater than the Stokes efficiency ν_l/ν_p=0.39 are possible. For 44W of pump power we obtained 15W at 2.02μm , corresponding to an optical to optical efficiency of 34% and a slope efficiency of 61% with respect to absorbed power. The beam quality of the waveguide laser was diffraction-limited in the guided axis due to gain selection of the fundamental mode from the multimode double-clad structure[1]. However, the 5mm wide gain region in the unguided plane led to a highly multimode output in this axis. The prospects for further power scaling and improved beam quality will be discussed.

1. D.P. Shepherd, S.J. Hettrick, C. Li, J.I. Mackenzie, R.J. Beach, S.C. Mitchell and H.E. Meissner, "High-power planar dielectric waveguide lasers," in press J. Phys. D : Appl. Phys. 34, (2001).