Submitted to CLEO/Europe 2000
Nice
10-15 Sept
1964

High-power room-temperature intracavity-pumped Ho:YAG laser

R. A. Hayward, W. A. Clarkson and D. C. Hanna

Optoelectronics Research Centre
University of Southampton
Southampton, SO17 1BJ
United Kingdom

Tel: +44 23 8059 3776,
Fax: +44 23 8059 3142,
E-mail: wac@orc.soton.ac.uk

Abstract
A Ho:YAG laser is intracavity-pumped in a diode-bar-end-pumped Tm:YAG laser yielding 7.2W of output at 2.097μm for 53.4W of incident diode pump power. The slope efficiency with respect to incident diode power was 17.5%.

High-power room-temperature intracavity-pumped Ho:YAG laser

R. A. Hayward, W. A. Clarkson and D. C. Hanna
Optoelectronics Research Centre
University of Southampton
Southampton, SO17 1BJ
United Kingdom
Tel: +44 23 8059 3776, Fax: +44 23 8059 3142, E-mail: wac@orc.soton.ac.uk

Power-scaling of two-micron solid-state lasers to meet the demands of applications such as LIDAR and mid-infrared generation via nonlinear frequency conversion is an area which has attracted growing interest over recent years. In this paper we describe a simple strategy for achieving high power operation of a Ho:YAG laser. Singly-doped Ho:YAG is an attractive laser material for operation in the two-micron wavelength regime, with lower upconversion losses, and hence a longer effective energy storage time (~8ms) than for Tm-sensitised Ho:YAG. Furthermore, it has an operating wavelength (~2.1μm) which is attractive for LIDAR applications due to its relatively high atmospheric transmission. Unfortunately, Ho:YAG has no absorption band in the 780nm-980nm spectral region and hence cannot be pumped directly with commercially available high-power GaAlAs and InGaAs diode lasers. One solution to this problem is to pump the Ho:YAG laser, in-band, with a diode-pumped Tm laser. Recent work by Budni et al [1] has demonstrated high-power operation of Ho:YAG by direct pumping with diode-pumped Tm:YLF and Tm:YALO lasers. Here we describe an alternative approach for power-scaling of Ho:YAG via intracavity, in-band, pumping in a Tm:YAG laser.

A preliminary requirement for high power operation of Ho:YAG via intracavity pumping is a high-power Tm:YAG laser. The relatively small emission cross-section and quasi-three-level nature of Tm:YAG are demanding on the diode pump laser which must be focussed to a relatively small beam size to achieve the required pump intensity. Also, the resonator design must cope with the strong, highly aberrated thermal lensing which results due to the high thermal loading density. In our experiments a simple folded resonator design (shown in Fig.1) was used, with the mirror curvatures and arm lengths selected to give a relatively small laser mode radius of ~200μm which was roughly independent of thermal lensing. The Tm:YAG rod was pumped through both end faces by the re-shaped outputs [2] from two 785nm diode-bars focussed to a beam radius of ~400μm. In the absence of the Ho:YAG rod and with a 6% transmitting output coupler, we obtained 17.5W of output at 2.013μm from the Tm:YAG laser for 53.4W of incident pump power at a rod heat-sink temperature of 17°C. With the Ho:YAG rod present in the same cavity and the Tm:YAG output coupler replaced by one with high reflectivity at 2.013μm and 6% transmission at 2.1μm, we obtained 7.2W from the intracavity-pumped Ho:YAG laser at 2.097μm. With further optimisation of the cavity design and pump in-coupling optics we believe that a significant increase in power should be achievable.

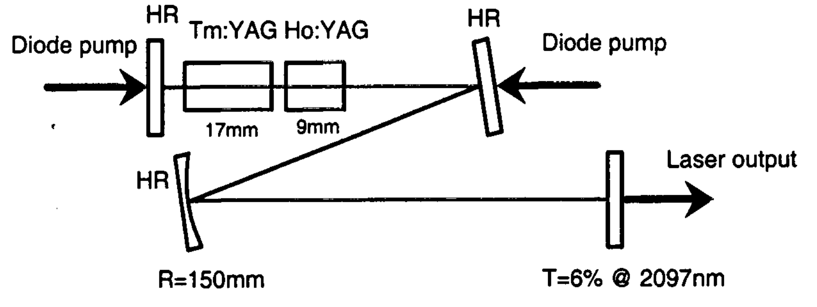

Fig.1 Intracavity-pumped Ho:YAG laser

References

[1] P.A. Budni, L.A. Pomeranz, M.L. Lemons, P.G. Schunemann, T.M. Pollak, J.R. Mosto and E.P. Chicklis, Conference on Advanced Solid-State Lasers, OSA TOPS Vol 26, (1999), pp 454-457.

[2] W.A. Clarkson and D.C. Hanna, Opt. Lett., (21), 375 (1996).