26PB13 AN EFFICIENT LD PUMPED ND:YAG LASER SYSTEM

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Many applications of laser-diode (LD) pumped solid-state lasers, such as laser radar, material processing and inertial confinement fusion reactor driver, require scaling of LD pumped lasers to higher average and peak power. In this paper, we describe an efficient LD pumped 1.064μm Nd:YAG laser MOPA (Master Oscillator Power Amplifier) system with an output power of 50MW(1ns) at 50Hz and an optical-optical conversion efficiency in excess of 10%.

The laser system configuration is shown in Fig.1. In the LD pumped AO mode-locked and Q-switched oscillator, the pulse width of the mode-locked pulse with 0.5nJ output energy per pulse was elongated to 910ps by means of an intracavity etalon. The induced thermal lensing effect in the Nd:YAG rod due to longitudinal pumping was compensated using astigmatically compensated cavity. Good stabilities of the output energy (±3%) and peak power (±5%) were obtained[1].

The output of the master oscillator is amplified by a LD-array pumped regenerative amplifier, similar to the arrangement used by Dimmick[2]. Two Nd:YAG rods, 15mm long and 3.5mm in diameter were proximately pumped by two quasi-CW (200μs) 300W laser diode arrays at a 50Hz repetition rate. The amplifier provided a gain of 71dB, producing 6.0mJ pulses at a repetition rate of 50Hz. Energy extraction efficiency as high as 48% was obtained at a pulse width of 910ps[3], as shown in Fig.2. The experimental data were well fitted by the Lowdermilk and Murray theory[4] taking into account no gain recovery and a single pass cavity transmission of 92%.

The output beam from the regenerative amplifier was amplified in the double pass main amplifier. As shown in Fig.3, four Nd:YAG disks (8mm x 10mm x 14mm) were each pumped from both sides by two quasi-CW (200μs) 300W LD arrays (in total eight LD arrays). The disks were surface-cooled by He gas. A focused intensity of 3kW/cm^2 with the LD array (emitting area of 10mm x 1.2mm with five arrays) was obtained by using a set of collimating and focusing lenses. The output of the main amplifier was 48mJ, well fitted by the Frantz-Nodvik equation[5]. An optical-optical conversion efficiency of 14.9% in the disk amplifier and a net amplifier energy extraction efficiency of 60% at 50Hz were obtained as shown in Fig.4.

In conclusion, we have constructed a LD pumped 1.064μm Nd:YAG laser MOPA system having an overall optical-optical conversion efficiency of 11.0% and a pulse energy of 48mJ (about 1ns) at 50Hz.

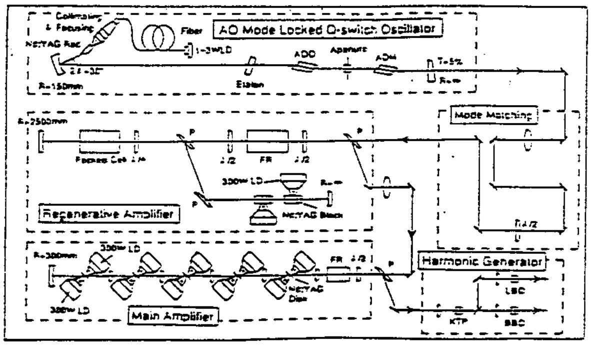

Fig.1 Schematic of a LD pumped Nd:YAG laser MOPA system.

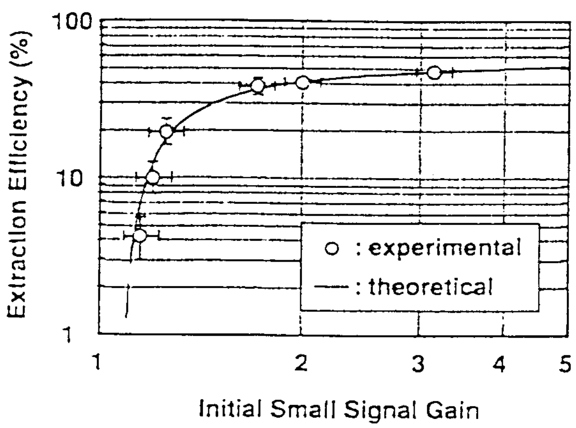

Fig.2 Energy extraction efficiency as a function of the initial small-signal gain of the regenerative amplifier.

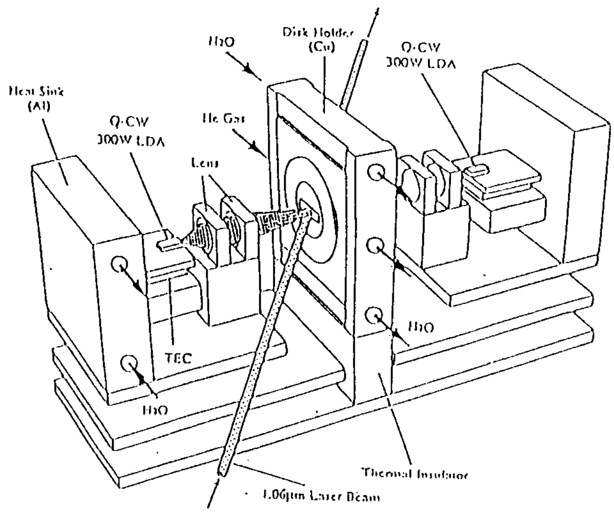

Fig.3 Schematic of a LD pumped disk amplifier.

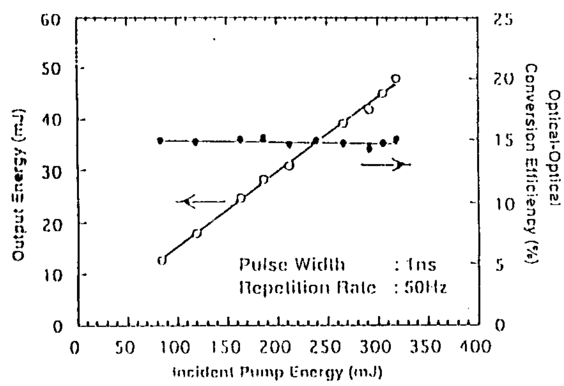

Fig.4 Output energy and optical-optical conversion efficiency as a function of the incident pump LD energy.

References

1)M.Ohmi et al.: Jpn.J.Appl.Phys., in press (1994).

2)T.E.Dimmick : Opt.Lett.15, 177 (1990).

3)K.Naito et al.: Appl.Phys.Lett.64, 1186 (1994).

4)W.H.Lowdermilk and J.E.Murray : J.Appl.Phys.51, 2436 (1980).

5)L.M.Frantz et al.: J.Appl.Phys.34, 2346 (1963).