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LBO intracavity frequency doubled, Cr:YAG passively Q-switched Nd:YAG green laser

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Abstract

A LD-pumped, LBO intracavity frequency doubled and Cr:YAG passively Q-switched Nd:YAG green laser was reported in this letter. With 600 mW incident pump laser, Q-switched green laser with average power of 27 mW, pulse width of 15.2 ns, repetition rate of 16.4 kHz and peak power of 108.1 W was obtained. © 2002 Published by Elsevier Science Ltd.

Keywords: LD-pumped; Passive Q-switch; Green laser

1. Introduction

In recent years, considerable attention has been paid to Cr:YAG passively Q-switched lasers [1]. Cr:YAG, which has the advantages of large absorption cross section, high doped-ion concentration, good thermal conductivity, high damage threshold, stable physical and chemical properties, is considered to be an ideal saturable absorber as passive Q-switch for Nd-doped lasers.

LD-pumped, Cr:YAG passively Q-switched infrared lasers have been successfully demonstrated for Nd:YAG, Nd:YVO_4 and Nd:YLF [2–4]. But few reports on intracavity frequency doubling of a LD-pumped, Cr:YAG passively Q-switched green laser as far as we know [5,6]. In this paper, by using a cw laser diode as pump source, Cr:YAG as passive Q-switch, and LBO as intracavity frequency doubler, passively Q-switched Nd:YAG green laser was obtained.

2. Experimental setup

Fig. 1 shows the experimental setup of a Q-switched green laser. Using a cw laser diode to pump Nd:YAG crystal in the resonator, cw laser emission at 1064 nm could be obtained easily. After that, a piece of LBO was placed in the cavity for cw laser at 532 nm generation. Finally, a piece of Cr:YAG crystal was inserted between the Nd:YAG and LBO, then Q-switched green pulse would be achieved at last.

Because in many practical applications, "gray tracks" often appear in KTP during high power, high repetition rate and long-term operation [7], so I-typed critical phase-matching LBO was used for frequency doubling instead of KTP.

LD is a continuous GaAlAs quantum-well laser diode with maximum power of 1 W, emission cross section of $100 \times 1\ \mu m^2$ and divergent angle of $7.8 \times 28.6\ deg^2$. By TEC, LDs emitting wavelength is tuned to Nd:YAG's absorption peak to make Nd:YAG fully utilize the pump light.

The left facet of Nd:YAG (3.0 mm thick, 1 at% doped) is coated with 808 nm AR (anti-reflection) and 1064 nm HR (high-reflection) as a reflective mirror of the resonator, and right facet with 1064 nm AR. Both sides of Cr:YAG ($7 \times 7 \times 1.4\ mm^3$, $T_0 = 87\%$ for small signal) are coated with 1064 nm AR. Both sides of frequency doubling crystal of LBO ($2 \times 2 \times 10\ mm^3$, I-typed critical phase matching) coated with 1064/532 nm AR. The left concave side of M ($\rho = 50$ mm) coated with 1064 nm HR and 532 nm AR, and right-plane side with 532 nm AR. In order to obtain narrow pulse width, all the components should be placed closely to reduce the resonator's length. Here, the resonator's length is about 16 mm.

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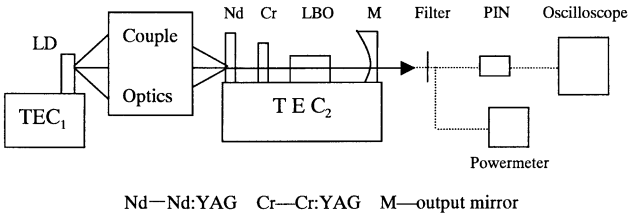

Fig. 1. Setup of passively Q-switched 532 nm laser.

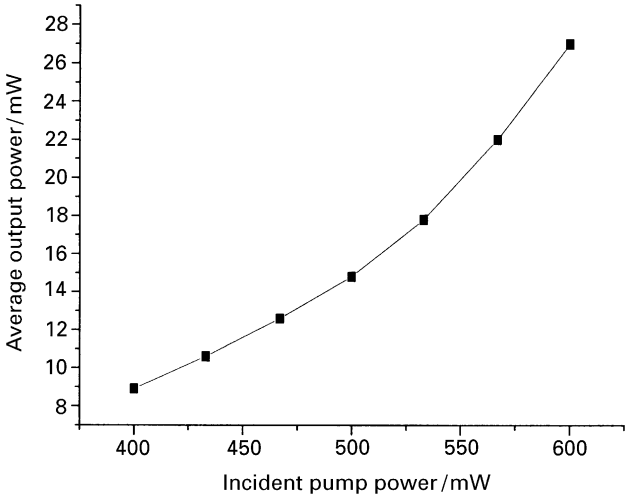

Fig. 2. Average power of Q-switched 532 nm laser vs. incident pump power.

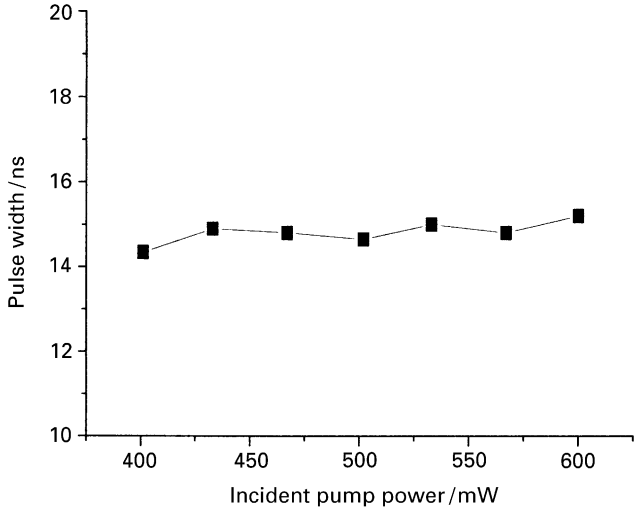

Fig. 3. Pulse width of Q-switched 532 nm laser vs. incident pump power.

3. Results

A powermeter (LabMaster Ultima, model P540), a PIN (model GT-106) and a digital storage oscilloscope (LeCroy, model 9361C, 300 MHz bandwidth) are used to measure the average power, peak power, pulse width and period of Q-switched green laser. Before measuring the parameters

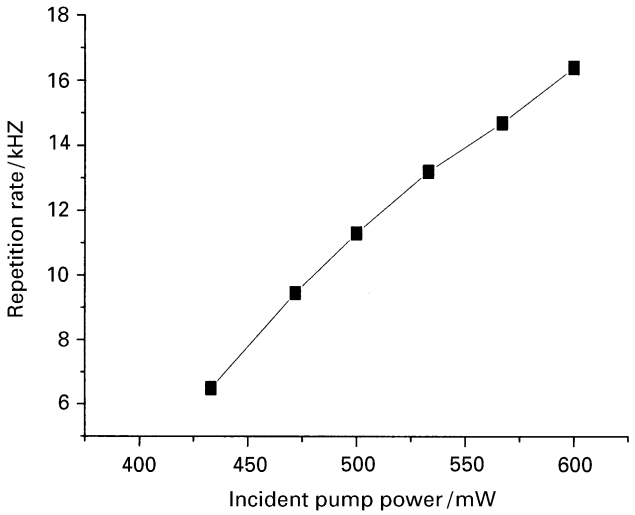

Fig. 4. Repetition rate of Q-switched 532 nm laser vs. incident pump power.

of 532 nm pulse, 808 and 1064 nm are filtered out by a filter.

Measurements show that the threshold of Q-switched green laser is about 290 mW. When the incident pump laser is 600 mW, the Q-switched green laser with average power of 27 mW, pulse width of 15.2 ns, repetition rate of 16.4 kHz and peak power of 108.1 W is obtained, optical to optical conversion efficiency up to 4.5%. Figs. 2–4 show the average power, pulse width and repetition rate as a function of incident pump power, respectively. All the data in Figs. 2–4 are the average values for 10 times measurement with error less than 3% rms.

Figs. 2 and 4 show that the average power and repetition rate greatly increase with pump power increasing. Fig. 3 shows the pulse width is nearly constant within the error bars but there is also a trend of slightly increasing.

4. Conclusions

By using a cw laser diode as pump source, Cr:YAG as passive Q-switch, LBO as intracavity frequency doubler, we have realized passive Q-switched operation of a Nd:YAG green laser. The all-solid-state Q-switched green laser has compact structure and is suitable for long-term operation.

Acknowledgements

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