Ultra compact eye-safe laser for rangefinding

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***Abstract*—We demonstrate an eye-safe diode pumped ultra compact Yb:Er:glass laser with 3 mJ pulse energy in free running mode with repetition rate 1 Hz. We investigate phototropic gates for Yb:Er:glass lasers. The developing laser operates in a wide temperature range.**

Keywords—eye-safe laser; rangefinding; passive Q-switches; Yb:Er:glass; glass-ceramics; compact laser.

I. INTRODUCTION

Yb:Er:glass lasers are most commonly used for laser rangefinders with a low pulse repetition rate (less than 10 Hz) [1]. The trend to making ranging systems portable requires size and power consumption minimization of the developed lasers[2]. We introduce an eye-safe ultra compact Yb:Er:glass laser with diode end pumping. We use a 12 W semiconductor laser diode with maximum of emission spectrum at 940 nm. We carried out a research on characteristics of various phototropic gates for Yb:Er:glass lasers.

II. EXPEREMENTAL SETUP AND RESULTS

Fig. 1 depicts an optical layout of the developed laser.

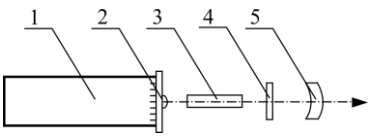

Fig. 1. 1 – pump diode; 2 – cylindrical lenses; 3 – active rod with end mirror; 4 – passive gate; 5 – output coupler.

The emitted radiation is collected to a rod face via two cylindrical lenses arranged perpendicularly to each other. 7.5 W reach the end of the active rod. The active element is a Yb:Er:glass with concentration of Yb and Er 2.5 x 10^{21} per cm^3 and 2.7 x 10^{19} per cm^3 respectively. The cylindrical active rod with 1 mm diameter and 5 mm length. Waveguide beam propagation in the active medium is employed. The input face on active rod has HR 1540 nm and AR 940 nm coatings, the output face has HR 940 nm and AR 1540 nm. A small gain coefficient in the active element determines high requirements for its quality and characteristics. We investigated 4 passive gate types for Yb:Er:glass lasers to choose the most suitable for the developing laser.

The free running mode energy of the developed laser is 3 mJ at 7.5 W pumping. Pulse repetition rate is 1 Hz. Optical efficiency of the laser in free running mode amounted 5%. The laser head volume is 5 cube centimeter. Developed laser operates in a wide temperature range.

We investigate 4 types of passive gates that can be used as Q-switches: Co^{2+}:$MgAl_2O_4$ glass-ceramics, Co^{2+}:$MgAl_2O_4$ crystalline spinel [3], new LGS glass-ceramics and GSAG:V crystal. The Q-switch transmittance dependence on incident beam power density was derived in order to determine the contrast and residual transmittance. Derived dependences are shown in Fig. 2.

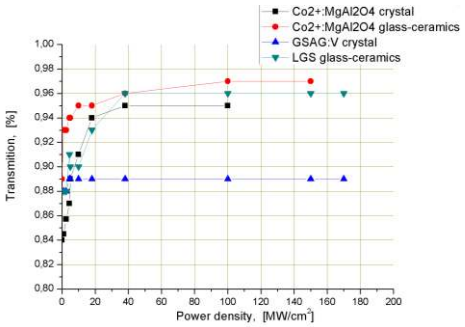

Fig. 2. Passive Q-switches transmittance dependences on incident beam power density.

GSAG:V crystal is not an appropriate Q-switch for 1.54 um laser. Hence Co^{2+}:$MgAl_2O_4$ glass-ceramics Q-switch showed the best performance for 1.54 um and will be used in the ultra compact Yb:Er:glass laser.

III. SUMMARY

The eye-safe ultra compact Yb:Er:glass laser with semiconductor diode end pumping was developed. A research of various passive Q-switches for Yb:Er:glass lasers was carried out. Pump energy increase will be realized by implementing a laser diode with the same geometry but a higher power (up to 16 W). Using a more powerful diodes will allow us to achieve 1.2 mJ pulse energy in Q-switched operating mode. This laser opens new horizons for compact portable range finding system.

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