Laser Properties of In-band Pumped Er$^{3+}$:YVO$_4$ and Er$^{3+}$:KY(WO$_4$)$_2$ Crystals

K.N. Gorbachenya, V.E. Kisel, A.S. Yasukevich, N.V. Kuleshov
Center for Optical Materials and Technologies
Belarusian National Technical University
Minsk, Belarus
gorby@bntu.by

A.A. Pavlyuk
A.V. Nikolaev Institute of Inorganic Chemistry
Siberian Branch of Russian Academy of Sciences
Novosibirsk, Russia

V.N. Matrosov
SOLIX Ltd.
Minsk, Belarus

Abstract—Efficient continuous-wave laser operation of in-band pumped Er$^{3+}$:YVO$_4$ and Er$^{3+}$:KY(WO$_4$)$_2$ crystals was demonstrated. Maximum slope efficiency of 61 % and output power of 50 mW at 1603 nm was obtained for Er$^{3+}$:YVO$_4$ crystal, for Er$^{3+}$:KY(WO$_4$)$_2$ crystal maximum slope efficiency of 27 % with output power of 35 mW at 1609 nm was realized.

Keywords—erbium laser; in-band pumping; vanadates; double tungstates

I. INTRODUCTION

Applications of erbium lasers emitting in the eye-safe spectral range around 1.6 µm include laser range finding, ophthalmology, fiber-optic communication systems, and optical location. In-band pumping in the spectral range 1.5-1.6 µm ($^4I_{13/2}$-$^4I_{15/2}$ transition) of Er$^{3+}$ reduces the quantum defect and thermal load of the crystal and enables to increase strongly laser efficiency and output power in comparison with pumping of Er-doped or Er,Yb-codoped crystals near 1 µm [1]. Here we present continuous-wave room-temperature laser operation of in-band pumped Er:YVO$_4$ and Er:KY(WO$_4$)$_2$ (KYW) crystals.

II. IN-BAND PUMPED Er:YVO$_4$ LASER

The laser experiments were performed in a three-mirrors cavity. A plane–plane Np-cut Er(2at.%):KYW crystal with a length of 14.5 mm was used as an active medium. The facets of the crystal were antireflection-coated for both pump and laser wavelengths. The crystal was mounted on the copper heatsink without any additional cooling. A diode-pumped Er, Yb:GdAl$_3$(BO$_3$)$_4$ laser with output power up to 650 mW at 1531 nm was used as a pump source. The combination of two lenses was used to focus the pump beam in the gain medium into a spot of 70 µm diameter. The pump beam polarization corresponded to the N$_m$ optical axis of the crystal.

Figure 2 shows input–output characteristics of in-band pumped Er:KYW laser. The maximum slope efficiency of 27% with output power up to 35 mW at 1609 nm with polarization E//N$_m$ was obtained for an output coupler transmittance of 2.2%.

Fig. 1. Input-output characteristics of in-band pumped Er:YVO$_4$ laser

Fig. 2. Input-output characteristics of in-band pumped Er:KYW laser

III. IN-BAND PUMPED Er:KYW LASER

The laser experiments were performed in a three-mirrors cavity. A plane–plane Np-cut Er(2at.%):KYW crystal with a length of 14.5 mm was used as an active medium. The facets of the crystal were antireflection-coated for both pump and laser wavelengths. The crystal was mounted on the copper heatsink without any additional cooling. A diode-pumped Er, Yb:GdAl$_3$(BO$_3$)$_4$ laser with output power up to 650 mW at 1531 nm was used as a pump source. The combination of two lenses was used to focus the pump beam in the gain medium into a spot of 70 µm diameter. The pump beam polarization corresponded to the N$_m$ optical axis of the crystal.

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IV. CONCLUSIONS

Efficient continuous-wave laser operation of in-band pumped Er:YVO$_4$ and, for the first time to our knowledge, Er:KYW crystals was demonstrated.

REFERENCES