Influence of crystal orientation on Ho:YAP microchip laser generation

Jan Šulc[a], Michal Jelínek[a], Michal Němec[a], Helena Jelínková[a]
Karel Nejezchleb[b], Štěpán Uxa[b]

[a]Czech Technical University in Prague, Faculty of Nuclear Sciences and Physical Engineering
Břehová 7, 115 19 Prague 1, Czech Republic
[b]Crytur, Ltd. Turnov, Na Lukách 2283, 511 01 Turnov, Czech Republic

ABSTRACT

250-word abstract for technical review

The goal of this work was an investigation of Ho:YAP ($Ho:YAlO_3$) crystal as an active medium of resonantly longitudinally pumped multi-watt microchip laser operating at 2.1 μm spectral region. Three Ho:YAP crystals,"a"-cut, "b"-cut, and "c"-cut Pbnm, with the same dimensions (7 mm long, 3 mm in diameter) and Ho-doping concentration (1.06 at.% Ho/Y) were compared. Resonator mirrors were deposited directly on the crystals faces. The output coupler transmission for desired laser emission wavelength range 2.1 μm was 11 % and $T = 3$ % @ 1.94 μm. The pumping mirror was highly reflecting at 2.1 μm and $T = 89$ % @ 1.94 μm. Samples were fixed in air-cooled Cu-heatsink and longitudinally pumped by a CW Tm-fibre laser with the maximum output power amplitude of 12 W @ 1939.2 nm behind a focusing lens ($f = 200$ mm). The laser output power, emission wavelength, and output beam profile were measured in respect to incident pumping power. All three lasers had similar input-output power characteristics with the laser threshold close to 1.5 W and slope efficiencies reaching quantum limit in respect to the incident pumping power. The best result (slope efficiency 79 %, laser threshold 1.54 W, max output power 8.2 W in an almost diffraction-limited, linearly polarized beam) was reached for microchip laser using "b"-cut Ho:YAP crystal. Laser emission wavelength was 2119 nm for "a"-cut and "b"-cut Ho:YAP and 2132 nm for "c"-cut Ho:YAP-based microchip laser. The designed lasers can serve as compact wavelength converters for laser radiation and could be used to expand capabilities of current Tm-fibre lasers used in medicine and industry preserving the overall system efficiency.

100-word summary for the program

Three Ho:YAP crystals ("a"-cut, "b"-cut, and "c"-cut Pbnm; 7 mm long, 3 mm in diameter, 1.06 at.% Ho/Y) were tested as an active medium of multi-watt microchip laser operating at 2.1 μm spectral region. Resonator mirrors were deposited directly on the crystals faces (output coupler transmission 11 % @ 2.1 μm). Samples were longitudinally pumped by a CW Tm-fibre laser (12 W @ 1939.2 nm). All three lasers had similar input-output power characteristics. The best result (slope efficiency 79 %, laser threshold 1.54 W, max output power 8.2 W in an almost diffraction-limited, linearly polarized beam) was reached for microchip laser using "b"-cut Ho:YAP crystal. Laser emission wavelength was 2119 nm for "a"-cut and "b"-cut Ho:YAP and 2132 nm for "c"-cut Ho:YAP-based microchip laser.

Keywords: Microchip laser, solid-state laser, Ho:YAP

Further author information: (Send correspondence to J.Š.)
J.Š.: E-mail: jan.sulc@fjfi.cvut.cz, Tel.: +420 224 358 672, Fax: +420 222 512 735
M.J.: E-mail: michal.jelinek@fjfi.cvut.cz, Tel.: +420 224 358 538, Fax: +420 222 512 735
M.N.: E-mail: michal.nemec@fjfi.cvut.cz, Tel.: +420 224 358 672, Fax: +420 222 512 735
H.J.: E-mail: helena.jelinkova@fjfi.cvut.cz, Tel.: +420 224 358 538, Fax: +420 222 512 735
K.N.: E-mail: karel.nejezchleb@crytur.cz, Tel.: +420 481 319 511, Fax: +420 481 322 323
J.P.: E-mail: stepan.uxa@crytur.cz, Tel.: +420 481 319 511, Fax: +420 481 322 323