Compact Nd:YAP/V:YAG nanosecond pulse generator at 1342 nm

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The aim of this work was to design a compact passively Q-switched diode-pumped laser generating stable nanosecond pulses in the spectral region of 1.34 µm with pulse energy reaching 0.2 mJ. Such a system could serve as a compact laser source of long-range high-resolution LIDAR for autonomous vehicle control. The use of radiation in this spectral region (compared to 1 µm sources) is advantageous because the background radiation intensity is reduced due to its absorption in atmospheric water vapour, and the 1.3 µm radiation is safer for the eye due to its higher absorption in water in comparison to 1.06 µm radiation – see Fig. 1.[1, 2] As a proven compact source of short pulses at a wavelength of 1.3 µm represents a microchip laser based on the Nd:YAG/V:YAG composite.[3] Previously we demonstrated a more flexible laser system based on independent Nd:YAG and V:YAG crystals, operating at wavelength 1318 nm.[4] Currently we present similar system based on the combination Nd:YAP/V:YAG crystals, which offer better wavelength and polarization stability.

The designed laser followed our previous system based on the Nd:YAG/V:YAG combination.[4] In the current version we used the Nd:YAP crystal as a gain medium (16 mm long, 0.5 at.% Nd/Y) and a similar V:YAG saturable absorber ([100]-cut, $T_0 = 85\,\%$ @ 1.3 µm). The mirrors of the laser resonator were directly deposited on the Nd:YAP crystal (pumping mirror highly reflecting at 1.3 µm radiation; highly transparent for 808 nm) and on the V:YAG crystal (output coupler with reflection 85 % at at 1.3 µm). For longitudinal Nd:YAP pumping, a fibre-coupled laser diode (fibre core diameter 400 µm; wavelength 805 nm, $f_{rep} = 10 - 500$ Hz, $\Delta t = 1$ ms, $E_{pmp} = 18$ mJ) was used. Two aspheric lenses were used to focus pumping radiation into the Nd:YAP crystal (pumping beam waist was 280 µm).

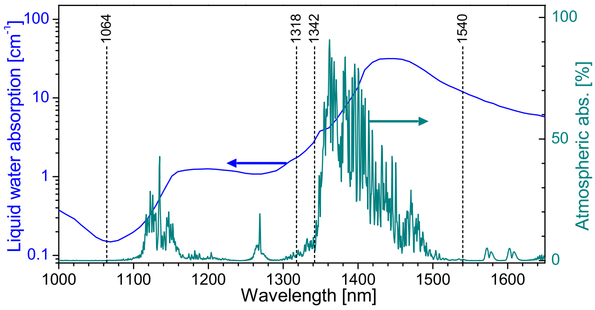

Fig. 1. Liquid water and atmospheric absorption spectra.

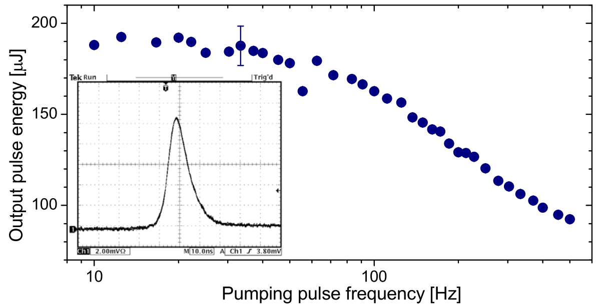

Fig. 2. Pulse energy in dependence on pumping pulse repetition rate (inset – oscillogram example).

The generated pulse energy in dependence on pumping pulse frequency is shown in Fig. 2. The maximum reached pulse energy 192 µJ corresponds to the peak power of 16 kW. In the whole range of tested frequencies, the laser generated stable ∼ 12 ns long pulses (FWHM, Fig. 2 – inset) at wavelength 1342 nm. The output beam with the TEM_{00} cross-section was linearly polarized (degree of polarization > 99 %). The relative fluctuation of pulse duration, pulse energy, and pulse peak power at a fixed pumping repetition rate was lower than 1 %. We can conclude that realized compact laser source of 1.34 µm radiation is a more flexible variant of the microchip laser and due to the stability of the output radiation parameters, it is suitable both for distance measurement and for further nonlinear conversion of the generated radiation, both to visible and far infrared spectra.

References

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