Diode-Pumped Intracavity OPO $KTP/YAG : Nd^{3+}$ Laser for $Cr^{2+} : ZnSe$ Pumping

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To date, one of the urgent tasks of laser physics is the development of new effective coherent sources for the mid-IR range, in particular in the area of 2.5 μm [1]. Attention to such systems is due to the fact that in this part of the spectrum, there are the main absorption lines of water and hydrocarbons, as well as other organic and inorganic compounds important for the tasks of biology and medicine. Divalent Cr^{2+} ions in ZnSe crystal have wide luminescence and absorption bands and allow obtaining tunable generation in the spectral region of 1.4-2.1 μm. The absorption band broadens from 1.4 to 2.1 μm. There is no compact, efficient, well-developed and reliable nanosecond laser source for this spectral region.

In this report, we proposed to use a side-pumped diode-pumped Nd^{3+}:YAG laser with an intracavity optical parametric oscillator (OPO) in a KTP crystal with degenerate collinear phase matching configuration as an excitation source for Cr^{2+}:ZnSe laser. In the experiment, we used an OPO based on a 6×6×15 mm^3 KTP crystal which was installed in a copper block with a Peltier temperature controller. Spherical mirror with a radius of curvature of 1 m, HR at wavelengths of 1064 nm and 1.9-2.4 μm and a flat output coupler with $R_{1064} = 0.99$ and $R_{2128} = 0.70$ composed the fundamental laser cavity. The Q-switched regime was arranged by an acousto-optical modulator. The intracavity glass plate at the Brewster angle polarized the pump radiation. Additional intracavity flat mirror with high transmission at 1064 nm and HR at 1.9-2.4 μm was used to arrange a compact cavity for the OPO laser. The configuration of the coupled cavity was optimized by software to ensure high stability and obtain a minimum cross-section of the pump beam in the KTP crystal.

The oscillation in mid-IR with a maximal output power of 0.63 W was obtained under electrical pump power of 255 W and a pulse repetition rate of 500 Hz. Precise rotation of the KTP crystal provided the oscillation at a single wavelength of 2128 nm, while dual-wavelength oscillation in the 2000-2140 nm region was observed in the case of rotation of the crystal. The energy of the output pulses was measured to be 1.26 mJ. It is necessary to note that the output radiation was composed of two collinear beams (signal and idle) with rectangular polarizations. The electrical-optical efficiency of a two-micron laser reached 0.3 per cent, and the slope efficiency was 2.5 per cent which was much higher than that of flash lamp pumped lasers.

The generation of Cr^{2+}:ZnSe laser on a crystal at a wavelength of 2494 nm was obtained. Thanks to the smooth adjustment of the laser wavelength, it was possible to achieve optimal absorption of pumping by divalent chromium ions. The average power of Cr^{2+}:ZnSe laser at a pulse repetition rate of 500 Hz reached 28 mW at 280 mW pumping and a wavelength of 2 μm. Maximum efficiency of Cr^{2+}:ZnSe laser reached 10 per cent. The duration of generation pulses decreased from 90 ns (1064 nm) to 12 ns (2 microns) and 9 ns (2494 nm).

References

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