Near and mid-IR tunable lasers have several potential applications in high-resolution spectroscopy, metrology, trace gas analysis, laser remote sensing of the atmosphere and medicine. Transition metal (TM\textsuperscript{2+}) doped A2B6 compounds are of interest as gain media for infrared solid-state lasers \cite{1}. The luminescence band of these materials lies in the spectral region of 2-6 microns and is large enough (~1 μm).

In the course of studies aimed at developing compact mid-IR range lasers, efficient generation had been demonstrated in a variety of A2B6 crystals doped with Cr\textsuperscript{3+} and Fe\textsuperscript{2+} ions. Lasers based on crystals with chromium ions covered the entire spectral region of 1.88–3.61 μm \cite{2–3}, and in lasers based on crystals with iron ions generation was implemented within the wavelength range of 3.49–6.1 μm \cite{4–7}.

In this paper, we report the optical and laser properties of a new Fe\textsuperscript{2+}-laser material, namely, Fe\textsuperscript{2+}:ZnTe. The Fe\textsuperscript{2+}:ZnTe single crystal was grown by one stage seeded physical vapor transport method. The TM\textsuperscript{2+} ions were introduced into the host straightforwardly during the crystal growth.

Laser generation in A2B6 crystals doped with divalent iron ions occurs at the \(^5\text{T}_2 \rightarrow \(^5\text{E}\) transition of the Fe\textsuperscript{2+} ion. In this work, the lifetime of the \(^5\text{T}_2\) state of the Fe\textsuperscript{2+} ion in ZnTe was measured to be 39±5 ns at room temperature and 29±2 μs at liquid nitrogen temperature.

The laser characteristics of Fe\textsuperscript{2+}:ZnTe crystal were studied at room temperature. During laser experiments, uncoated 5.3-mm thick Fe\textsuperscript{2+}:ZnTe crystal was pumped in a 15 cm plano-concave cavity consisting of a spherical high reflector (R = 20 cm) and a flat output coupler with transmittance of 11.5% at a wavelength of 5 μm. The pump source was a pulsed Er:YAG laser operating at a wavelength of 2.94 μm in the passive Q-switching mode with 40-ns temporal width and 30-mJ output energy.

The maximum output energy of the Fe\textsuperscript{2+}:ZnTe laser reached 0.18 mJ at a slope efficiency of 2.4% with respect to absorbed pumping energy. For wavelength tuning experiments a CaF\(_2\) 70.3° prism was inserted in the cavity. The laser radiation spectrum was tuned within the range of 4.35–5.45 μm.

Among the earlier studied A2B6 crystals doped with iron, the Fe\textsuperscript{2+}:ZnSe crystal demonstrated the highest generation efficiency. For this reason, in this work we compared the laser characteristics of Fe\textsuperscript{2+}:ZnTe and Fe\textsuperscript{2+}:ZnSe crystals. For this purpose, one active element was replaced by another. Also, the output coupler was replaced by a mirror with a transmittance of 72% at the generation wavelength of the Fe\textsuperscript{2+}:ZnSe laser (4.4 μm).

In these experiments, the output energy of the Fe\textsuperscript{2+}:ZnSe laser reached 5.8 mJ at absorbed pumping energy of 18 mJ; the slope efficiency of the laser was 39%, which exceeds significantly the values achieved in the Fe\textsuperscript{2+}:ZnTe laser. This difference in the results is, apparently, explained by the much higher level of intrinsic losses in the Fe\textsuperscript{2+}:ZnTe crystal (~31% for the double pass of the cavity) as compared with the Fe\textsuperscript{2+}:ZnSe crystal (~< 3.7%).

\[7\] V. V. Mislavskii, M. P. Frolov, Yu. V. Korostelin, et al., The 14-th International Conference on Laser Optics “LO-2010” (St. Petersburg, Russia, 28 June – 2 July 2010), Technical Program, p. 60, WeR1-p18.