Two-Photon Absorption in $La_{0.05}Gd_{0.95}VO_4$ Crystal at 523 nm Under Irradiation with Picosecond Pulses

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Vanadate crystals are perspective crystals as a host matrix for diode-pump lasers, including those with intra-cavity second harmonic generation (SHG). However, the efficiency of SHG can be reduced by lowering of the transmission of SHG radiation due to the two-photon absorption (TPA) and induced absorption.

Two-photon interband absorption was investigated using the excitation by the SHG radiation of a passively mode-locked flash-lamp-pumped linearly-polarized TEM_{00}-mode $YLiF_4$-crystal laser, which provided trains of picosecond pulses at a wavelength of 523.5 nm with a duration of 25 ps. The total energy of the train of ∼20 pulses was measured to be about 1.5 mJ. The laser radiation was focused by a lens ($f = 250$ mm) into the a-cut $La_{0.05}Gd_{0.95}VO_4$ sample 8-mm long within a spot with diameter of 0.1 mm. The output radiation was collimated and directed to a photodiode. The oscilloscope DPO 4104 registered temporal shapes of the input and output beams by two calibrated photodiodes. The intensity of each picosecond pulse was proportional to its energy. The energy of output pulses from descending part of the train was reduced due to TPA and induced absorption. Using the technique described in [1], the TPA coefficient in $La_{0.05}Gd_{0.95}VO_4$ crystal was measured to be equal to 0.16 cm/GW and slightly depended on the orientation of the sample.

To analyze the temporal behavior of the induced absorption, the collimated beam of a He-Ne laser (632.8 nm) was focused on the excited volume of the sample. The maximal value of the induced absorption that appeared immediately after the end of the pump pulse train depended on the total energy of the pump pulse and could reach 63 per cent. Two temporal stages of the decay of the induced absorption were observed. The first rapid stage has a lifetime of about 70 μs. The slow stage was characterized by a lifetime ranging from 270 to 520 μs and depended on the energy of the incident train. The residual absorption after half a second was less than 1 per cent. The nature of the creation and disappearance of interband optical centers is discussed.

References

[1] D S Chunaev, V I Lukanin, V E Shukshin, P G Zverev, V N Slegel and V D Grigorieva, Laser Phys. Lett. **17**, 015801 (2020)