TEMPORAL SHAPES OF PULSES GENERATED BY NV-CENTERS DIAMOND LASER

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Diamond has a number of properties that make it a promising material for the manufacturing of active elements of solid-state lasers, namely high thermal conductivity, low coefficient of thermal expansion and high hardness. Despite the fact that attempts to obtain lasing in diamond crystals have been made since 1970s, until recently only lasing on H3 color centers was obtained, and only in two works [1, 2], the results of which are still failed to repeat.

Progress was made in 2021, when laser generation was obtained at the NV^- color center [3]. The topic was developed, in particular, in [4], where a lasing pulse energy of 48 μJ was achieved.

An important part of research into new types of lasers is the study of the temporal shapes of radiation pulses in various modes. Until now, no detailed studies of this issue have been carried out in relation to lasers on NV-centers in diamond.

In this work, we studied the temporal shapes of laser pulses obtained by pumping a diamond crystal containing NV-centers with pulsed laser radiation at a wavelength of 532 nm. It is believed that the laser at NV-centers operates according to a four-level scheme, with the lower laser level having a very short lifetime. In our experiments, the duration of the pump pulse was about 20 ns at half maximum. In this case, the generation pulse began at the leading edge of the pump pulse. Its form was a sequence of short spikes with a duration of less than 3.5 ns at half maximum. From impulse to impulse, the structure changed in a chaotic manner. The envelope had a duration at half maximum of about 7-8 ns.

The decline in the lasing pulse began approximately after reaching the maximum pump pulse. If the ideas about the structure of the working levels of the NV-center are correct, then this fact indicates an increase in absorption at the laser wavelength in the crystal as it absorbs the pump pulse. It was shown in [4] that the laser pulse energy at NV-centers in diamond increases significantly when it is irradiated with laser radiation at a wavelength of 405 nm. Perhaps this phenomenon is somehow related to what is described above. The hypothesis is that there can be two types of absorption in a crystal, caused by different mechanisms: one “fast” with a characteristic time of the order of a few ns, the second “slow” with a characteristic time of tens of seconds.

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