Cryogenic laser generator based on an analogue of Shpolsky matrix WITH PUMPING BY RADIATION OF LOW-TEMPERATURE LASER PLASMA

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In the presented article it is considering the possibilities and prospective of laser generation in organic substances cooled up to the cryogenic temperatures and pumped by low temperature plasma radiation. The obtained results show the possibility of creating highly effective active laser media on the basis of cooled carbon-containing matrices. The active laser media is an analogue of the Shpolsky matrix. In the literature, the Shpolsky effect implies the occurrence of quasilinear electron-vibrational spectra of complex organic compounds dissolved by special way in a specially selected solvents, cooled down to low temperatures [1]. The application of this technique was described in [2], including the use of narrow inhomogeneously broadened lines in Shpolsky matrices, to improve the method of selective laser excitation of luminescence spectra, as well the method of burning stable spectral dips and spectroscopy of single molecules, which makes it possible to eliminate the averaging over the investigated sample volume. The above methods have proved to be effective tools for studying solid media with different degrees of disorder in the structure.The authors in the work [3] suggested the possibility of creating active laser media based on analogues of the Shpolsky matrix, and conducted a series of experiments to test this hypothesis. For these purposes, an experimental setup has been created that makes it possible to study the luminescence of matrices cooled to cryogenic temperatures. The basis for the experiments were earlier studies of the nonlinear optical properties of nanostructured matrices based on artificial opal SiO2 filled with various organic liquid substances (acetone, ethanol) which were frozen to the temperature of liquid nitrogen.The special experimental setup was assembled to study the parameters of promising active laser media based on Shpolsky matrices. Light from pulsed YAG: Nd3 + laser with a frequency doubler 2 (radiation wavelength 1064, 532 nm, 15 mJ/pulse, 15 ns duration, repetition frequency 50 Hz) was used as the pump source in the setup.Note that due to the strong scattering of the active medium, the pumping problem of the proposed laser requires a non-standard optical pumping system. On the one hand, due to scattering and, as a consequence, a small gain, it is necessary to increase the size of the medium, and on the other hand, it is difficult to pump an extended active medium due to the same scattering. To overcome this contradiction, it is proposed to modify the Krechmann scheme for pumping lasers. The proposed active medium based on analogs of the Shpolsky matrix has a significant difference from conventional laser media, namely, significant scattering at the laser transition due to the fundamental inhomogeneity of such media. The solution of the kinetic equations system will allow modeling the processes in the active medium of such laser. According to the results of the preliminary studies, it seems to us promising to create high-performance active laser media based on analogs of Shpolsky matrices. At the same time, it is necessary to take into account modern approaches to the creation of cryogenic disk solid-state lasers, ways to solve problems arising during their design and implementation, as well as advances in the study of the luminescence of organic substances at room and cryogenic temperatures.

References

1. Shpolsky E.V., Ilina A.A., Klimova L.A. // DAN SSSR.1952.87,No.6.P.935.
2. Naumov A.V.// Sov. Phys. Usp. 2013. 56, No. 6. P.605.
3. Voropinov A.V.,Tsipenyuk D.Yu.//(2018)Lasers in science, engineering, medicine. Collection of scientific papers. M.2018.29, p.93.