SIMULATION OF SPONTANEOUS RADIATION BY THE TRANSMITTING CHANNEL WITH A CO\textsubscript{2}-LASER

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Based on the methods of kinetic theory of gas lasers, a theoretical model is developed to describe the processes of spontaneous radiation for various working conditions of the transmitting channel using a CO\textsubscript{2}-laser. The model has been developed as applied to investigation of spontaneous radiation of lines P(12), P(14), P(16), and P(20), whose radiation characterizes the performance of optoelectronic devices.

Wide application of laser devices using carbon dioxide in their active element creates a pressing need to investigate the conditions of generation of off-band and spurious radiation. Studies of these types of radiation are aimed at determining their demasking properties and characteristics useful in creating various reconnaissance equipment or allowing for reticence of operation of laser devices by lowering the intensity of the demasking features. The other goal of the investigation is to reduce the off-band and spurious radiation, which may represent undeliberate interference in various reception channels, affecting the electromagnetic compatibility. The spontaneous radiation of the transmitting channels of CO\textsubscript{2}-lasers can also be categorized as off-band and spurious.

The purpose of this paper is to outline the general principles of generation of spontaneous radiation and to assess its characteristics.

Figure 1 shows the pattern of lower oscillation levels of the molecules of CO\textsubscript{2} and N\textsubscript{2} in their principal electron state. Generation of the principal radiation occurs between levels 00\textsubscript{01} and 10\textsubscript{00} (\(\lambda = 10.6 \text{ \textmu m}\)). We can also obtain the principal generation between levels 00\textsubscript{01} and 02\textsubscript{00} (\(\lambda = 9.6 \text{ \textmu m}\)). Occupation of the upper laser level 00\textsubscript{01} in CO\textsubscript{2} occurs through the molecule N\textsubscript{2} owing to discharge. The energy of excited molecules N\textsubscript{2} is transferred to molecules CO\textsubscript{2} at the level of non-symmetric valent oscillation (00\textsubscript{01}), which also has a long lifetime.

At low pressures the width of the line of laser transition depends on Doppler broadening and averages between 50 and 60 MHz. This corresponds to gas temperature within 400–450 K. The broadening caused by collisions at variation of pressure by 1 torr, depending on the gas mixture percentage, is from 4.5 to 6 MHz/torr. The line is considered uniformly broadened only at pressures beyond 25–60 torr. At pressures not exceeding several torr, inherent in longitudinal-pumped CO\textsubscript{2}-lasers, the radiation line remains so narrow that the laser automatically operates in a single longitudinal mode.

The rotational structure of the oscillatory levels considerably expands the range of possible generation frequencies in the oscillatory inversion conditions. In one and the same oscillatory band we can observe P- and R-branches of generation. The respective lines of generation will be denoted \(P(J)\) and \(R(J)\), where \(J\) is the ordinal number of the rotary sublevel at the lower laser level. In the P-branch the transitions occur from the state with a lower \(J\) to the state with a higher \(J\), which, as a rule, is less populated. Because of this, the gain at transitions in the P-branch somewhat exceeds the gain in the R-branch. The rate of establishment of equilibrium in the system of rotary sublevels is high enough (10\textsuperscript{7} s\textsuperscript{-1}/torr\textsuperscript{-1}). Hence, if in the steady-state mode of operation the generation starts at some rotary line, adequately meeting the self-oscillation conditions, it will continue at the frequency of this line, and its power will be determined by pumping into all rotary sublevels of the
REFERENCES


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