

Physical and Chemical Processes in the Working Mixture of I₂-Laser of the UV-Range with Optical Pumping

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I₂-laser of the UV-range with optical pumping can be used in lidar system for monitoring the atmosphere impurities containing nitrogen or sulfur (SO₂, NO₂, etc.). The spectrum of excitation of luminescence of electronic transitions D' \rightarrow A' of molecular iodine in a gas phase is presented. Effective working mixtures of I₂-laser with optical pumping on a basis of perfluoroalkanes have been found.

Spectral density of radiation of the Sun fails to an ultra-violet part of the spectrum, so creation of a laser with a wavelength in the UV spectrum field, as an element of lidar systems, can be perspective in a raise of a sensitivity and noise immunity of these systems. Absorption bands of some substances, containing nitrogen or sulfur (SO₂, NO₂, etc.), are located in the UV spectrum field. They are small components of atmosphere, and an effective monitoring system of them can be created on the basis of the laser of the UV-range.

A gas laser of the UV-range on electronic transition D' \rightarrow A' (342 nm) with optical pumping (I₂-laser) is based on collisional transfer of electronic energy between terms ³Σ_u⁺(D) and ³Π_{2g}(D') of iodine molecule. In this report the spectrum of excitation of luminescence of electronic transitions D' \rightarrow A' (so D \rightarrow X (326 nm), and D' \rightarrow Δ (510 nm)) of molecular iodine in a gas phase is presented. A facility for measurement of an I₂ luminescence signal consists of two monochromators. The vacuum monochromator was used for monochromatisation of excitation signal of luminescence. A deuteroneon lamp with power 170 Wt was used as a source of irradiation. A separate photomultiplier tube was used for a control and measurement of an excitation signal. A double monochromator was used for recording of spectra of I₂ luminescence. Transmission optical system was calibrated by a hydrogen lamp and secondary etalon of irradiation.

To evaluate an efficiency of optical pumping the dependence of intensity of transmitted light at 190 nm (the maximum of the spectrum of excitation of luminescence) on length of an absorbing layer was been established. A measuring cell provided change of length of the absorbing layer in limits (0.40) mm with precession of length equal to 0.1 mm. Total volume of the cell changes by only 2.5% so a pressure stays practically constant. This dependence was used for treatment experimental results because of "slits" between rotational lines in structure of a I₂ molecule adsorption.

The dependence of intensity of luminescence D' \rightarrow A' on pressure of buffer gas was investigated for 24 substances. The kinetic model is offered, and rate constants for collision processes, which take place in a working mixture of the I₂-laser, are calculated. Power dependence of the rate constants of transfer of electronic excitation I₂ on the reduced mass of colliding molecules was established. For inert gases the exponent is equal 0.5, for the investigated lines of perfftoralkanes it is equal 2. Constants of deactivation of electronic excitation of I₂ molecule correlate with size of potential of ionization of colliding particles.

Effective working mixtures of I₂ - laser with optical pumping on a basis of perfluoroalkanes have been found. It is shown, that if there are, in structure of perfluoroalkyl chains of buffer gases, H, Br, I atoms, CN groups or C=C double connections, they will be quenching upper laser level with gas-kinetic deactivation constants.

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