A Microwave-Pumped Planar CO_2-Laser

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The radiation parameters of a diffusion-cooled compact planar CO_2-laser pumped by microwave discharge at a frequency of 2.45 GHz are studied. An average output power of 25 W and an efficiency of ~13% are obtained. A peak output power of 580 W is achieved for 20-us pulses emitted at a pulse repetition rate of 400 Hz. The dependence of parameters of the CO_2-laser on the input pulse power in the range 0.8-8 kW, the composition and pressure of the working mixture and the pump pulse duration and repetition rate are studied experimentally.

In recent years, interest in the application of microwave discharge for pumping CO_2-lasers has grown considerably [1-5] mainly due to the availability of magnetrons operating at a frequency of 2.45 GHz (which are widely used in microwave ovens). An average output laser power of over 100 W achieved upon repetitively pulsed lasing [1] suggests that such systems are promising for the development of a new generation of compact, sealed, cheap and simple CO_2-lasers that do not require a cumbersome system of working gas circulation. Therefore, the study of diffusion-cooled, microwave-discharge-pumped, planar CO_2-lasers is undoubtedly of current interest.

We used a 2M-130 magnetron from a microwave oven with a pulse power up to 8 kW and average power up to 1.8 kW. A rectangular waveguide of size 90×45×500 mm forms volume microwave resonator closed on one side and adjusted by short-circuiting plunger. The magnetron is matched with the resonator on the microwave power input side with the help of an impedance transformer based on hybrid tee with two similar movable plungers. Microwave power is extracted from the volume resonator through an extended slit in the narrow wall of the waveguide (analogue of the slot antenna) and is supplied to laser head.

The laser head cross section is a gas-discharge structure formed by two profiled aluminium plates and pressing quartz plate whose lateral side faces the microwave resonator slit. Discharge channel of size 2×25×250 mm is formed by the gap between polished aluminium and quartz plates. In such a structure, the electric field in the discharge region is perpendicular to the surface of the dielectric plate. Because the microwave power enters the discharge region from one side only, the discharge current is closed on the other side through an aluminium plate. Therefore, the microwave discharge is not concentrated only in the vicinity of the dielectric plate surface, but is distributed uniformly over the entire thickness of the discharge region. The active medium has a volume of 12.5 cm^3, and hence the average input power density amounts to 160 W cm^{-3}.

The radiation parameters of a diffusion-cooled compact planar CO_2-laser pumped by microwave discharge are studied. All the experiments were performed without circulation of the working gas mixture. An average output laser power of 25 W and an efficiency of ~13% are obtained. A peak output power of 580 W is achieved for 20-us pulses emitted at a pulse repetition rate of 0.4-7 kHz. The dependence of parameters of the CO_2-laser on the input pulse power in the range 0.8-8 kW, the composition and pressure of the working mixture and the pump pulse duration and repetition rate are studied experimentally. The experimentally achieved specific energy output from a unit area of the active medium was about 0.4 W cm^{-2}. Optimal relations between these parameters are determined for the given design of the laser. The design of the CO_2-laser can provide kilowatt peak powers.

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