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CW ARGON LASER WITH 0.5 kW OUTPUT POWER

G. N. Alferov, V. I. Donin, and B. Ya. Yurshin
Institute of Semiconductor Physics, Siberian Division, USSR Academy of Sciences
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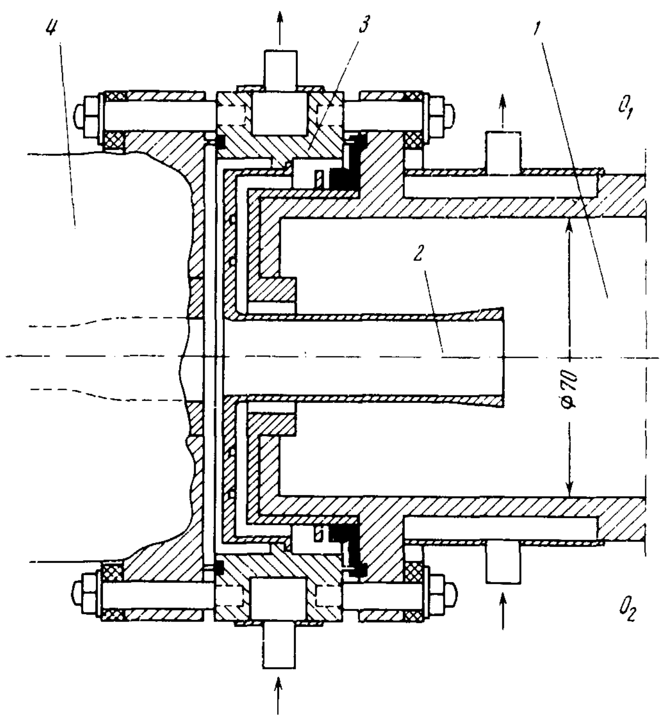
1. We report here the realization of continuous visible coherent emission of 500 W power from a laser using Ar-II ions. This is an unprecedented output power for the short-wave part of the electromagnetic spectrum. In addition to the large output power, the laser described below exceeds all the existing high-power ionic gas lasers in output power per unit discharge length, in efficiency, and in operating time. This combination of unique characteristics of the Ar-II laser was made possible by solving a number of fundamental problems of obtaining powerful stationary discharges at reduced pressure and investigating the saturation of the power of ionic lasers as a function of the pumping current.

2. Inverted population of the 4p - 4s electronic transitions of singly-ionized argon was produced in a plasma of a high-power dc discharge. The laser was constructed in the form of two large-current discharge tubes with a common cathode between them. The tubes were made up of individual aluminum sections, each coated with an Al_2O_3 film to increase the endurance to ion bombardment in the discharge and to improve the heat dissipation [1, 2, 5]. The active part of the discharge, with 1.6 cm diameter in each tube, was 1.5 m long, the individual sections were 2.5 cm long, and heat-resistant rubber was used as the vacuum sealing material. The argon was continuously fed into the cathode region and pumped out slowly at the anode ends. The construction of the dismountable cold cathode is shown in the figure. The operating principle is based on retaining the cathode spots of the arc inside the cathode cavity by means of a self-heating refractory bushing [1, 3]. The use of this principle has made it possible to construct a cathode capable of delivering a stationary current of approximately 1 koloampere in a low-pressure discharge and keep the evaporation from the cathode from affecting the plasma in the active part of the discharge. To reduce the cathode voltage drop and increase the stability of the cathode, metallic bismuth was added to the working cavity. The optical resonator was 4 m long and made up of two internal multilayer mirrors produced by cathode sputtering. The transmission of one mirror was 8%, that of the other 2%, and the curvature radius of both mirrors was R ∿ 10 m.



Arc cathode (the construction is symmetric about the O_1O_1 axis): 1 – working cavity of copper, 2 – heating bushing of molybdenum, 3 – bushing holder, 4 – discharge tube. The teflon vacuum seal is shown black; the arrows show the direction of the cooling water.

3. The laser generation was produced under conditions of saturated discharge

current [1, 4, 5]. With the argon pressure in the cold part of the system approximately 0.4 mm Hg, the discharge current in each tube was 390 A. The output power was 500 W at an efficiency relative to the discharge (including the voltage drop at the electrodes) exceeding 0.2%. The generation power was measured by a calorimetric method with accuracy ±10%. In addition to the stronger generation lines with λ = 5145 Å and λ = 4880 Å, the emission spectrum contained also lines of wavelength 5017, 4965, 4765, and 4579 Å.

4. With repeated switching, the laser operated a total of 140 hours before the cathode failed. The working lifetime can undoubtedly be increased by improving the cathode. Although the field power in the resonator was high (5 kW), no output-power decrease due to any changes in the resonator mirrors was observed. This is a particularly important fact, and clearly illustrates the advantages of the principles employed here to obtain high-power discharges for gas lasers, since usually the damage suffered by the discharge tubes and by the electrodes in high-power ionic lasers is quite appreciable, soils the optical-resonator elements, and prevents normal operation of the resonator. According to published data [6], the actual service life of the most powerful argon lasers with 100 W output power amounts therefore to several minutes, an obstacle to the scientific and practical utilization of high-power argon lasers.

We note in conclusion that in addition to good output characteristics and relatively long service life, the laser described here is comparatively easy to construct and can be used for a variety of scientific and practical applications in which high-intensity stationary light fluxes are needed.

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LIGHT SCATTERING IN A KH_2PO_4 CRYSTAL UNDERGOING A HIGH-TEMPERATURE PHASE TRANSITION

O. A. Shustin, T. S. Velichkina, L. F. Mikheeva, and I. A. Yakovlev
Moscow State University
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We investigated light scattering in a KH_2PO_4 crystal undergoing a phase transition at ±175°C. We show that the total intensity of the scattered light decreases near the transition point. An investigation of the fine structure of the scattered-light line has made it possible to determine the temperature dependence of the hypersonic-wave velocity.

A phase transition at a temperature near 175°C was observed in KH_2PO_4 crystals [1], as revealed by the strong temperature dependence of the dielectric constants of the crystal. Blinc and co-workers [2] have investigated this phase transition by proton magnetic resonance, by x-ray scattering, by cold-neutron scattering, and by determining the infrared absorption spectra. The temperature dependence of the dielectric constants of the crystal and of the infrared reflection spectra near the phase-transition point was investigated in [3]. It was established that below the phase-transition point the H_2PO_4 groups rotate about one axis, and this calls for overcoming the potential barrier of two hydrogen bonds. Above the transition temperature, hindered rotation of the H_2PO_4 groups about all three axes sets in, and this involves overcoming hindrances exerted by all four bonds. The change of the crystal enthalpy, $\int_{171}^{200} \Delta C_p \Delta T = 1.1$ kcal/mole, indicates that a first-order phase transition takes place in the crystal.

We have investigated the high-temperature transition of the KH_2PO_4 crystal by the light-