S5-P-034402

INVESTIGATION OF FEATURES OF AN ABNORMAL DISCHARGE, A HOLLOW CATHODE DISCHARGE, AND AN OPEN DISCHARGE FOR EXCITATION OF LASERS ON SELF-LIMITED TRANSITIONS

E.V. BELSKAYA, P.A. BOKHAN, P.P. GUGIN, D.E. ZAKREVSKY, T.A. ZIRENKO

Rzhanov Institute of Semiconductor Physics SB RAS, Novosibirsk, Russia

Different types of discharges are used to create population inversion in gas lasers: an abnormal glow discharge (AD), hollow cathode discharge (HCD), an open discharge (OD). In order to compare and determine the most effective type of discharge for excitation of lasers at self-terminated transitions, the operating ranges, achievable parameters and features of populating the metastable state of the helium atom as a test laser at a self-terminated transition were investigated.

The most efficient way to excite lasers at self-terminated transitions is to pump them with an electron beam due to the large value of the electron excitation cross section of the first resonant level, which is usually the upper laser level. The power of laser radiation is proportional to the pressure of the working gas, respectively, operation at high pressures is preferable.

All discharges are realized in cuvettes of close geometry: the active area is an open cylinder with diameter D=33 mm and length L=60 mm. In AD the electrodes are two steel rings with inner diameter D, with the distance between them equaled to L. In OD the cathode is a cylinder of silicon carbide with diameter D. As an anode in the OD a metal grid with a diameter of 27 mm was installed coaxially with the cathode. The cathode in HCD is a silicon carbide cylinder with diameter D, the anode is metal rings located at a distance of 12 mm on both sides of the cylindrical cathode.

Studies in the pulse mode of the current-voltage dependences at different helium pressures demonstrated the following features:

1) the volumetric, uniform character of the luminescence was observed at a significantly larger pressure range in the OD (up to 50 Tor) compared to the HCD and to the AD (up to 7 Tor).
2) the discharge current did not depend on the helium pressure in a wide pressure range $I \propto U^{\alpha}$ in OD and HCD. The current was determined by both gas pressure and voltage $I \propto U^{\alpha} p^{\beta}$ in AD. The dependence of the current only on the voltage at different pressures suggests that the mechanisms of electron generation differ from those in the anomalous discharge.

The relative magnitude of the metastable state (MS) occupancy of the helium atom as a test medium was investigated by recording the absorption in the discharge cuvettes of sample laser radiation at the self-terminated He transition ($2^1P_1^0 - 2^1S_0$) with λ=2.058 nm. Since the absorption of radiation occurs at the He ($2^1S_0 - 2^1P_1^0$) transition, the absorption coefficient, k, determined from the ratio of intensities of incoming and outgoing radiation: $\frac{I_{out}}{I_0} = e^{kL}$, is proportional to the population difference of the metastable He (2^1S_0) level (MS) and resonant one. It was obtained experimentally that the absorption coefficient and, consequently, the MS population observed in AD is much higher than in other types of discharge. It was obtained that the smallest MC population is observed in OD at the same excitation parameters of the cuvettes.