GAS DISCHARGE RM ION LASERS OPERATING AT HIGH PULSE REPETITION FREQUENCY*

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Pulsed gas discharge lasers on resonance-metastable (RM) transitions still remains in-demand devices due to their unique parameters, which include high gain coefficient, narrow line-width, large radiation pulse power, etc. [1]. Specific areas of their application include active optical systems, dermatology, micromachining and etc. In general lasers on RM atom transitions are more efficient and powerful than on the ion ones. However, this situation can be different in case of high pulse repetition frequency (PRF), because maximum of the average output power P_{av} for atom RM transitions is reached at lower values of PRF. For example, recently [2], for Ba^+ laser growth of P_{av} up to 60 kHz was demonstrated, meanwhile for the copper vapor laser maximum of the average output power lies in the range of ~ 10 - 30 kHz [1]. High PRF is important in active optical systems, because it determine temporal resolution. So, it is valuable to study other ion RM lasers operating at high PRF (100 kHz and more), as they may be more suitable for this distinct application. Also, a lot of ion RM transitions in UV spectrum range exists, which increases potential interest in the investigation of these lasers. Excitation of RM lasers at high PRF is complicated due to high prepulse electron concentration, which requires rapid voltage growth between the GDT electrodes in order to achieve preferable electron temperature for laser levels excitation. One of the possible solution is to use appropriate nanosecond switching devices, such as described in [3].

Two different active medium were investigated. In the first, lasing occurred on 4p $^2P^o_{3/2}$ - 3d $^2D_{5/2}$ (λ = 854.2 nm) and 4p $^2P^o_{1/2}$ - 3d $^2D_{3/2}$ (λ = 866.2 nm) RM-transitions in Ca^+. Second studied laser operated on $5d^{10}6p$ $^2P_{3/2}$ - $5d^96s^2$ $^2D_{5/2}$ RM-transition in mercury ion (λ = 398.4 nm). In case of Ca^+ laser gas discharge tube (GDT) was manufactured from BeO ceramics with inner diameter of 1.5 mm and length of 55 cm. The operating temperature of the active medium was maintained by an external heater. The studies were carried out using helium, neon or a mixture of helium and hydrogen as a buffer gas in the active medium of the laser. The lasers operated in the burst mode to perform the measurements while independently controlling the pumping power and the temperature of the GDT wall. Maximum measured average output power in the steady-state mode at PRF 100 kHz reached more than 5 W (Fig. 1), which is almost an order of magnitude higher than obtained in other studies [1].

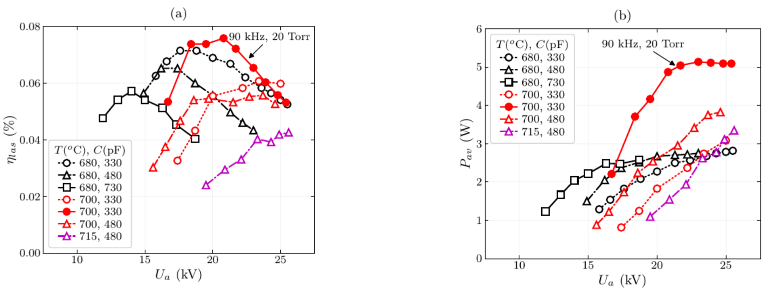

Fig.1. Dependences of the laser efficiency η (a) and average output power P_{av} (b) on the voltage amplitude U_a at the operating capacitance for different values of the operating capacitance C and GDT wall temperature T. Helium buffer gas pressure p equals 10 Torr and PRF f = 50 kHz, except for the curve with maximum values.

To investigate output parameters of UV Hg^+ laser two externally heated GDT with various inner diameters (5 and 12.5 mm) were constructed. Excitation circuit was modified in order to increase operating PRF up to 200 kHz. As the result lasing with radiation pulses duration of ~ 20 ns were obtained in burst operation mode.

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