SIMULTANEOUS LASING AT THREE WAVELENGTHS WITH λ = 510.6, 578.2, AND 780.8 nm IN A Cu-VAPOR LASER

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Simultaneous laser oscillations on the atomic (λ = 510.6, 578.2 nm) and ion (λ = 780.8 nm) transitions of copper was obtained for the first time using a pulsed gas discharge in a mixture of CuBr *vapor and* He.

The laser transition between Cu^+ levels, in particular on the strongest $6s^3D_3 - 5p^3F_4^0$ transition with λ = 780.8 nm has been obtained under different excitation conditions. For instance, a cw lasing was observed in a hollow-cathode discharge (see Ref. 1) including copper halogen containing mixtures (see Ref. 2) and in a transverse HF discharge (see Ref. 3) whereas pulsed lasing was obtained from a segmented arc discharge (see Ref. 4) as well as from a hollow-cathode discharge (see Ref. 5).

In this paper, a possibility of obtaining pulsed laser oscillation from Cu^+ ion under conventional excitation conditions for CuBr laser (λ = 510.6, 578.2 nm) is considered. The design of a gas discharge cell and power supply were similar to those described elsewhere,[6] the storing and peaking capacitors being 1/9 and 0.23 nF, respectively. Repetitively pulsed excitation was provided in the frequency range from 5 to 30 kHz.

Laser output spectra were monitored using an MDR–23, monochromator, FEU–62 photomultiplier and a stroboscopic S7–17 oscilloscope. The current waveform was fixed using a Rogovskii coil. Quartz laser cell with the inner diameter of 60 mm and active zone length of 1000 mm was employed. CuBr vapor were injected into the discharge zone from heated branches, independently of the excitation conditions.

Laser cavity was composed of two flat mirrors, one of which was coated with Al and the other one with a dielectric reflecting layer about 90% reflectivity in the vicinity of 78 nm wavelength. He and Ne were used as buffer gases.

Variation of the excitation conditions in CuBr–He mixture resulted in appearance of a laser line in red region of spectrum in addition to the atomic lines at λ = 510.6 and 578.2 nm. Spectrum monitoring using a monochromator showed that this is a Cu^+ ion line at λ = 780.8 nm.

In Fig. 1, discharge current and lasing waveforms are presented. It is evident that laser pulse at λ = 510.6 nm lasts within the discharge current rise time whereas laser oscillation at λ = 780.8 nm remains 50 ns after the termination of the discharge current pulse. In these experiments, the rectifier voltage was 6.8 kV, pulse current reached 1 kA, pulse repetition rate was 10 kHz and helium buffer gas pressure was p_{He} = 15 Torr.

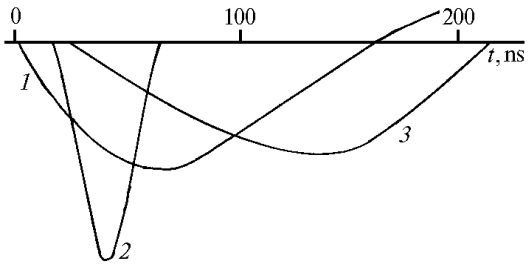

FIG. 1. Waveforms of the discharge current (1) and lasing pulses at λ = 510.6 nm *(2) and* λ = 780.8 nm *(3).*

Under the above mentioned excitation conditions the range of pulse repetition rate for observation of lasing at λ = 780.8 nm was determined to be 8–12 kHz. It is known (see Ref. 1) that lasing at λ = 780.8 nm is related to He in the laser gas mixture.

To confirm the origin of the laser line observed as related to $6s^3D_3 - 5p^3F_4^0$ transition and the mechanism of the upper laser level population helium, buffer gas was replaced by neon at the same pressure 15 Torr. This resulted in an increase of the output power at λ = 510.6 and 578.2 and in the disappearance of the laser line at λ = 780.8 nm. Thus, important role of helium in the mechanism of creating the population inversion was confirmed.

The search for UV ion laser lines related to the population of upper laser levels via the charge exchange from neon to copper has not been done since the output windows of the laser cell were opaque in the UV-region. No output power measurement including ion line at λ = 780.8 nm has been carried out.

Thus, the results obtained allow us to hope to obtain simultaneous laser oscillation on large number of transitions in the UV, visible and IR regions of spectrum in a copper vapor laser under excitation conditions conventional for the self-terminating lasers.

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