CuBr laser with a transistor switch

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Two modifications of the CuBr laser, i.e., a modification with the typical pump unit employing a thyratron as a switch and that employing specially developed pump unit with a high-voltage transistor switch are comparatively studied. It is shown that the specially developed pump unit of the CuBr laser has advantages over the thyratron one in both technical and operating parameters.

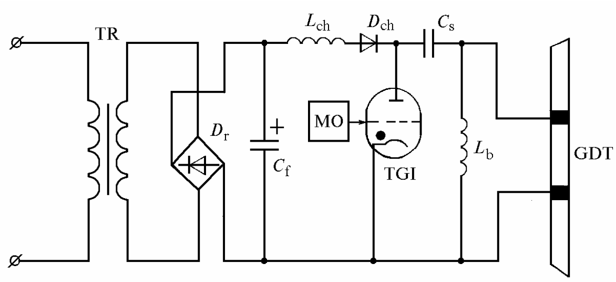
The state-of-the-art of the development of CuBr lasers indicates that soon they will be quite competitive with copper-vapor lasers in many practical applications. In main technical parameters the CuBr laser compares well with the Cu laser and even outperforms it in such parameters as efficiency, pulse repetition frequency, time of the laser warm-up to the lasing mode.[1,2]

One of the problems arising in the manufacturing commercial metal-vapor lasers, in particular the CuBr laser, is the development of reliable, long-lived, and compact pump sources.

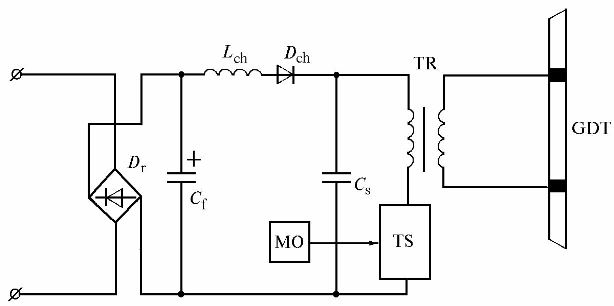
Gas-discharge thyratron switches widely used now for pumping metal-vapor lasers have some basic disadvantages: first of all, short lifetime no longer than several hundred hours and unstable switch time, that hampers strict synchronization of laser systems (in particular, systems of the generator–amplifier type).

It is well known that the optimal (and maximum) pump pulse repetition frequencies in the CuBr lasers are higher than those in the pure Cu lasers; they are tens (hundreds) kHz (Ref. 3). The commutation characteristics of thyratrons at such high frequencies are significantly worse than at a low frequency. Modulator tubes, tasitrons, and transistors possess better commutation characteristics as compared with the thyratrons at high frequencies. The pump circuits with modulator tubes are rather bulky, and Russian TGU1–5/12 tasitrons require water cooling, what creates additional problems.

In this paper we present the results of tentative comparative study of two modifications of the CuBr laser: the modification with a typical pumping unit, in which a TGI1–500/16 thyratron serves as a switch, and that specially developed at the Institute of Optical Monitoring SB RAS with a high-voltage transistor switch. Figure 1 shows the functional pumping circuitry.



a



b

Fig. 1. The pump circuits with thyratron switch (*a*) and with a transistor switch (*b*): transformer TR, rectifier D_r, filtering capacitor C_f, by-pass inductance L_b, charging inductance L_{ch} (choke), charging diode D_{ch}, energy storage capacitor C_s, thyratron TGI, master oscillator MO, gas-discharge tube GDT, and a transistor switch TS.

The CuBr gas-discharge tube with the discharge channel of 15 mm in diameter and 300-mm long active zone served as an active element. The tube was filled with neon as a buffer gas at the pressure of 30 mm Hg. The comparative studies were conducted at the pump (and output) power less than the optimal values, at which the lifetime of sealed-off GDTs achieves 1000 h. The results of comparative tests are given in Table 1.

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Table 1. Test results

Scheme	Output power, W	Working frequency, kHz	Consumed power, W	Supply voltage, V	Documented switch lifetime, h	Size, mm	Mass, kg
a	0.5	15	840	220±5	500	850 × 440 × 220	46
b	0.5	35	660	220±10	10000	830 × 290 × 110	27

The pump pulse duration in the circuit employing a thyratron is typically 100 ns (at half maximum), and for the transistor switch it is 40 ns. Correspondingly, the optimal value of the pump pulse repetition frequency is higher (the working frequency of 35 kHz is not a limit for the transistor switch). It is seen from the table that the developed pump unit with the transistor switch has significant advantages over the traditional one in some parameters. Note also that this unit employs only home made parts, and each element operates in the certified mode. There are strong grounds to believe that the developed unit will be reliable in use and not expensive in production.

References

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