Efficient Discharge Lasers Pumped by Generators with Inductive Energy Storage

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Results of investigation of different gas lasers pumped by the inductive energy storage (IES) generator obtained during the last two years are reported. It was shown that the generator allows to form long-lived stable discharge in the laser mixtures. As a result, pulse duration, output energy and efficiency of the lasers under study were improved.

The development of efficient discharge lasers on mixtures or rare gases with halogens is associated with solution of the following two problems. First one consists in formation and sustaining of an uniform volume discharge in a halogen containing gas mixtures. Second one is improvement of the efficiency of energy transfer from a pumping generator to this volume of discharge plasma. As usual, comprehensive double discharge pumping circuits and x-ray preionization are used [1]. In this circuit a high-voltage generator with low stored energy ignites volume discharge while a low-voltage storage deposits main part of pumping energy in the impedance matched mode. This pumping technique allowed to extend pulse duration of excimer lasers [2, 3]. Simple alternative way of development of double-pulse circuits was suggested in [4] using a generator with an inductive energy storage for the pre-pulse generation.

The present paper reports development of efficient UV-preionized long-pulse gas lasers pumped by inductive generators. The laser active volume was varied from 300 cm^3 to 6 l. The inductive generator includes primary capacitor C_0=40-550 nF and provides pumping pulse duration 150-500 ns and is very simple in operation. Therewith only 10-20% of energy stored in C_0 was spent for the pre-pulse formation. The inductive storage formed across the laser gap d=4-10 cm a high-voltage pulses with an amplitude up to 100 kV and rise-time as short as 20–30 ns. Besides, the inductive generator provides very fast increase of discharge current. These factors significantly improve discharge stability in mixtures of rare gases and halogens and allow to reach long-pulse operation of different gas lasers.

Ultimate efficiency of discharge laser on HF(HD) molecules was attained in the SF_6-H_2(D_2) mixtures.

Long-pulse efficient XeCl lasers were developed using pre-pulse from the inductive storage. Maximal output of the XeCl laser was 1,5 J in the pulse of 450 ns in duration and electric efficiency of 1,6%. Maximal laser efficiency of 4% was obtained with pumping pulse duration of 200 ns.

Output energy of 0,5 J and intrinsic efficiency of about 3% were obtained on XeF molecules. Total laser pulse duration at 353 nm can reach 200 ns.

Laser pulses at 248 nm with duration of about 100 ns were easily obtained using the inductive generator. Therewith KrF laser output was as high as 0,65 J while the laser efficiency reached 3,5%. Discharge and laser parameters in the Ne-Kr-HCl mixtures were studied, as well.

Maximal at the present date output energy at 337 nm (over 100 mJ) and pulsed power (6 MW) was obtained in the SF_6-N_2 mixture. Therewith the pulse duration of nitrogen laser was as long as ~100 ns in mixtures of N_2 with NF_3.

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