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POWERFUL SOURCES OF VUV RADIATION BASED ON RUN-AWAY ELECTRON PREIONIZED DIFFUSE DISCHARGE*

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The paper deals with the development of powerful sources of VUV emission on the base of diffuse discharge formed in non-uniform electric field by run-away electrons. The VUV radiation spectra of diffuse discharges in various high-pressure gas mixtures have been studied and the VUV radiation power has been measured, as well. Parameters of diffuse discharges in mixtures of rare gases with F_2 and in pure rare gases, CO, H_2 were investigated.

The discharge gap was consisted of two needles set at a distance of 4 mm or blade electrodes 30 cm length with a gap of 18 mm. To form the diffuse discharge, a GIN-55-01 generator was used, which forms a train of pulses with an amplitude in the incident wave up to 38 kV and a FWHM duration of $\tau_{0.5} \approx 0.7$ ns with a rise time of $\tau_{0.1-0.9} \approx 0.7$ ns or a RADAN-220 formed pulses wit an amplitude up to 250 kV with pulse duration of 2 ns (FWHM) at a matched load. Emission spectra in the range 120–540 nm were recorded with a VM-502 vacuum monochromator (Acton Researcher Corp.), while the radiation power was measured with a vacuum photodiode with copper cathode. The experimental equipment and measurement procedure is described in [1, 2].

It is shown that upon excitation of pure rare gases by a series of successive voltage pulses with a duration of 0.7 ns, arriving at an interval of 30 ns, the intensity of the second continuum radiation decreases to the second and subsequent voltage pulses, and increases in the afterglow. It is confirmed that in a pulsed diffuse discharge, the second continuum of rare gas dimers makes the largest contribution to the radiation energy of the diffuse discharge between two needles.

Sufficient homogeneity of diffuse discharges was found to makes it possible to use it as a source of excitation of lasers based on various gas mixtures at an elevated pressure. This is evidenced by the continuation of the VUV laser pulses during several current oscillations in the gap.

It was found that quite uniform diffuse discharge can be formed between long blade electrodes using a RADAN-220 generator. As a result powerful stimulated emission in the VUV range was obtained on ArF* (193 nm), F^*_2 (157 nm) and H_2 (≈160 nm) molecules. The total duration of the laser pulses at 157 and 193 nm is as long as 30 ns, while that at 160 nm did not exceed 5 ns. The radiation energy on F^*_2 molecules increased linearly with He-F_2 gas mixture pressure. The maximum radiation energy on F^*_2 molecules at He pressure of 8.5 atm is as high as 3 mJ. In this case, a further increase in the generation energy is possible. The electrical efficiency of the F^*_2 laser reached 0.15%, which corresponds to the parameters of F^*_2 lasers obtained upon excitation by a transverse discharge with UV preionization [3].

Stimolated emission was obtained in pure H_2 and He-H_2 mixture at pressures up to several atm. Maximal radiation energy on H_2 molecules was about 0.15mJ, which is second only to the results obtained in [4].

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