EMISSION SPECTRA OF THE GLOW DISCHARGE IN RARE GAS – CH_3BR AND I_2 THE MIXTURES

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Glow discharge spectra in the rare gas – CH_3Br (I_2) mixtures are presented. An intense emission from KrBr*, XeBr*, XeI*, I_2* and* IBr* *molecules has been obtained experimentally. B–X band of* XeBr* *molecules was found to be the most intense in the UV spectral region. Radiation power of* 3 W *at the efficiency of* 2.5% *has been achieved at* $\lambda \approx 282$ nm.

As known there exists a demand for using relatively narrow-band (in contrast to the mercury lamps being used and emitting several wavelengths) sources of UV radiation in some industrial processes such as photostimulation of different chemical reactions (see Ref. 1), destruction of toxic industrial wastes by UV radiation (see Ref. 2) and so on. In spite of their advantages efficient sources of coherent UV radiation (excimer lasers) are too complicated in design and expensive in operation and, second, provide radiation from a limited list of molecules and, correspondingly, at few wavelengths. At the same time incoherent sources (lamps) are much more simpler in design, allow wider range of excitation regimes, pressures and gas mixture composition as compared to the lasers. Moreover, two recent papers reported high radiation efficiency (up to 20% and more) at $\lambda \approx 308$ nm obtained in a glow discharge that demonstrates the possibility to industrially use such radiation sources. In this connection widening of the class of gas mixtures of rare gases with halogens well operating when pumped with a glow discharge seems to be promising.

The aim of the present paper was to acquire the glow discharge emission spectra in mixtures of rare gases with CH_3Br and I_2.

Experiments were conducted using a quartz tube 600 mm in length and 40 mm inner diameter. The glow discharge emission spectra were recorded with a specialized complex which included an MDR–23 monochromator (inverse linear dispersion 13 Å/mm), a wide-band photomultiplier FEU–100, a DC amplifier U5–11 and an X–Y recorder N–307. Spectral half-width of the complex instrumental function was no more than 0.02 nm. The radiation intensity was measured with a photodiode FEK–22SPU according to the procedure described in detail in Ref. 6. Working mixtures were prepared directly in the tube. A high-voltage transformer operated from the standard ac line (220 V, 50 Hz) was used as a power supply. It provided operating voltage up to 10 kV and up to 300 mA current. Discharge current and voltage across the tube were measured with a milliampermeter and kilovoltmeter, respectively.

In our experiments we studied the gas mixtures Xe(Kr)–CH_3Br, He(Xe, Kr, Ne, Ar)–I_2. Peak radiation power (up to 3 W) was obtained in Xe: CH_3Br + 3:1 gas mixture at the total pressure of 4 Torr. The current and voltage across the tube were 50 mA and 2 kV, respectively. Therewith, the radiation efficiency with respect to the input power was as high as 2.5%. Figure 1 shows emission spectra of the glow discharge positive column obtained under the above conditions. Spectral half-width of the most intense $B–X$ transition of XeBr* molecules ($\lambda \approx 282$ nm) was about 6 nm (that of KrCl* and XeCl* molecules obtained under close pumping conditions was about 4.5 and 8 nm, respectively). Besides, $D–X$ band of XeBr* molecules is present in the spectrum. No emission from the $C–A$ band was observed.

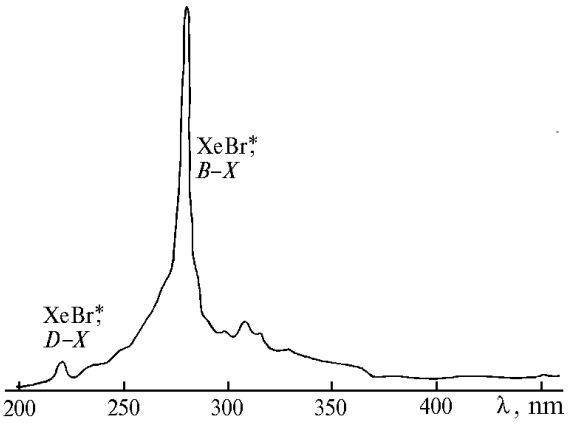

FIG. 1. Emission spectra of Xe:CH_3Br = 3:1 *mixture obtained at the total pressure of* 4 Torr.

The radiation power in Kr:CH_3Br = 3:1 gas mixture at the total pressure of 6 Torr does not exceed 0.85 W, pumping condition being the same. In this case spectral half-width of $B–X$ band of KrBr* ($\lambda \approx 206$ nm) molecules was observed to be no more than 2.5 nm. When the tube operates with Xe – I_2 mixture containing tracks of bromine in addition to

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B–X band of XeI* molecules ($\lambda \approx 253$ nm) *B–X* and *D–X* bands of XeBr* molecules at $\lambda \approx 282$ and 221 nm, bands of I_2* and IBr* molecules at $\lambda \approx 342$ and 386 nm were observed in the glow discharge spectra (see Fig. 2).

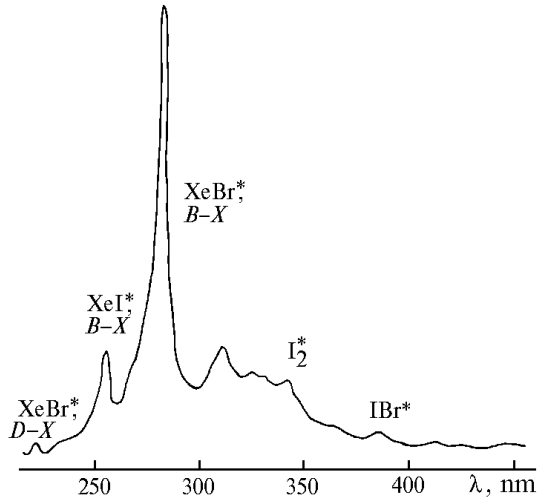

FIG. 2. Emission spectra of $Xe:I_2 = 3:1$ *mixture obtained at the total pressure of* 5 Torr. *The mixture contains uncontrollable traces of bromine.*

Thus when investigating emission spectra of the glow discharge in mixtures of rare gases with CH_3Br and I_2 we have observed emission from the molecules XeBr* at $\lambda \approx 282$ and 221 nm, KrBr* at $\lambda \approx 206$ nm, XeI* at $\lambda \approx 253$ nm, I_2* at $\lambda \approx 343$ nm, and IBr* at $\lambda \approx 386$ nm. Maximum power of UV radiation up to 3 W and efficiency up to 2.5% was demonstrated when using *B–X* band of XeBr* molecules at $\lambda \approx 282$ nm. Absorption of radiation by the tube walls caused by deposition of products of CH_3Br decomposition appears to be one of the possible reasons for low efficiency of the lamp.

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