STABLE AND LONG-LIVED HIGH-FREQUENCY ELECTRODELESS MERCURY-ISOTOPE LAMPS

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It is shown that a gas absorber placed in the discharge volume of a mercury high-frequency electrodeless lamp (HEL) allows one to increase significantly its operational stability and service life as well as to decrease essentially the consumption of expensive mercury isotopes. A setup for measuring the HEL radiation intensity in the 253.7-nm *line is described. The measurements of the HEL relative intensity as a function of the period of its continuous operation are discussed.*

High-frequency electrodeless lamps (HELs) filled with the mercury isotope are used in different branches of science and technology, for example, in spectroscopy (Ref. 1), nuclear magnetometry (Ref. 2), photochemistry (Ref. 3), and so on.

With the beginning of the series production of atomic adsorbtional mercury gas analyzers of types RGA–10, RGA–11, and others (Ref. 4), the need for HELs filled with enriched mercury has increased. The technology that allowed one to produce the necessary number of lamps with identical parameters and much higher stability and longer lifetime with minimum consumption of the isotope (Ref. 5) has been developed.

Bright hydrogen and oxygen lines are observed in the mercury HEL emission spectra in addition to spectral lines of mercury and a rare gas. The presence of hydrogen in the lamps is presumably connected with the oil vapor decomposition in a discharge, because in the mass-spectrum of residual gases recorded after degasing, hydrocarbon impurities with the chemical formula C_nH_m were found (Ref. 6). It is also known that during HEL operation oxygen is liberated from the quartz glass. The intensity of its spectral lines fast increases with the increase of the temperature of a HEL quartz bulb. Oxygen is combined with mercury in the lamp, and the mercury radiation intensity decreases.

The relative radiation intensity of resonance line at 253.7 nm was measured by us as a function of the lamp operation time.

Block diagram of experimental setup is shown in Fig. 1.

The high-frequency electrodeless mercury lamp *1* had a spherical bulb made of quartz glass with a diameter of ~10 mm and a capillary tube 15–20 mm long and 3 mm in diameter. The lamp was placed into the inductor *2*, in which HF-oscillations with a frequency of 50 MHz were excited with the use of the generator *3*. The lamp capillary tube was placed in a special pocket of the Peltier refrigerator *4*, whose temperature was measured and stabilized with the help of the electronic *5*. The radiation from the capillary tube of HEL passed through a hole in the refrigerator and entered the monochromator *6*. Through the output slit of the monochromator the radiation of the resonance lamp line at 253.7 nm was detected by the photodetector *7*, whose output electric signal was recorded by the system *8*. The temporal dependence of the relative intensity of the 253.7-nm line is shown in Fig. 2.

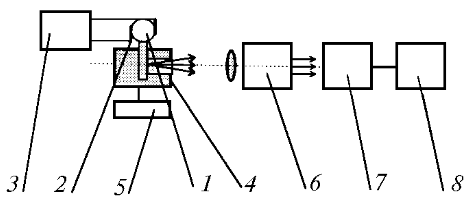

FIG. 1. Block diagram of the experimental setup.

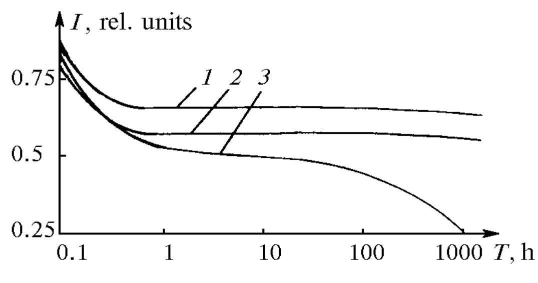

FIG. 2. Dependence between the HEL relative intensity at 253.7 nm *and the time of continuous operation of the lamp.*

Curve *1* illustrates the dependence between the relative radiation intensity and the operation time of the lamp filled with mercury enriched with the Hg–202 isotope to a concentration of 98.4% and Ar at a pressure

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of 2 mm Hg. Curve *2* is for the lamp containing the isotope Hg–202 with the same concentration and Ar at a pressure of 0.5 mm Hg. Curve *3* is for the lamp fabricated together with the lamp *1* (absolutely identical filling), but without gas absorber.

An analysis of the curves shows that in the stationary regime, i.e., 10–15 min after triggering, the intensity of lamps *1* and *2*, after their operation for ~1500 h, decreased by the amount that did not exceed 5%. This allows us to estimate reliably that after operation for 10000 h the intensity of lamps with gas absorber will not decrease by more than 50%. The intensity of the lamp *3* decreases much faster. In addition, after operation for several tens of hours, the rate of decrease of the radiation intensity of the lamp *3* monotonically increased, and extrapolation of this curve shows that the operation time of the lamp without gas absorber will not exceed 1000–1200 h.

Thus, the presence of the gas absorber in HEL increases significantly, several times, the service life of the lamps and improves their operation stability.

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