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ELECTRON RECOMBINATION IN THE NOBLE GASES.

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Electron recombination in gases(especially noble ones) has been urately researched in a many experiments[1], [2]. In these experints plasma was created with pulsed h.f.discharge in gases filled in crowave cavity. The rate of plasma decay wasmeasured in afterglow y microwave method originally developed by Biondi and Brown[3], [4]. wever plasma ionization degree and electron temperature small differences in all works.

This paper deals with the investigation of recombination of plasma produced by high energy electron beam as well as by high voltage discharge. Gas pressure was varied from 5 up to 150 mm Hg. Pulsed electron accelerator ELIT-1[5], worked out in our Institute was utilased as electron source. The electron beam parameters were: E =500 keV, I =10 A, τ =2.10^{-6}sec. The electron beam was traversed through 50-micron titanium foil to the microwave cavity, filled with a noble gas, and after that the electron beam was controlled by collector. Open cilindrical E_{010} cavity with Q-value of 1500 was used. The cavity was pumped preliminary to 10^{-5} mm Hg, and than was filled with a pure gas. Electron concentration decay in afterglow was measured by a resonant frequency shift[6]. Electron recombination study of plasma produced by high voltage discharge was carried out with just the same microwave apparatus and gas sistem. Plasma was created in quartz tube which was located inside the cavity. The discharge parameters were: U =20 kV, I = 30 A, τ =10^{-7} sec.

It is impossible to determine the type of recombination which is predominated from electron decay rate measurements. It is assumed that dissociative recombination in slightly ionization gases is predominated:

$$XY^{+} \;+\; e \;\longrightarrow\; XY^{*} \;\longrightarrow\; X^{*} \;+\; Y^{*} \;[2].$$

In present experiments decay of plasma with different initial conditions was studied. Gas was highly ionizated, and electrons were very hot, when plasma was produced by high voltage discharge($p<40$ mm Hg). For $p>40$ mm Hg an ionisation degree and electron temperature were smaller. When fast electrons were passing through the gas the ionization degree was small. Secondary electrons were cooled quickly and their temperature was close to "room" temperature just after end of current pulse. He, Ne, Ar, Xe recombination coefficient α ($p<60$ mm Hg) for both cases are shown in Fig.1. In Table I the measured recombination coefficients are compared with published data(p =25 mm Hg).

As shown from Fig.1 and Table I value of α for Xe is independed on initial conditions, but for other gases value of α for electron-beam-created plasma is larger, than for discharge case, and α dependence on atomic number is considerably changed. Recombination coefficients for discharge case and for electron beam case($5<p<150$ mm Hg) are represented in Fig.2 and Fig.3, respectively. As it is shown in these Figures for both cases the difference of α is smaller for higher pressures. Fig.4 shows electron concentrations for different gases at p =25 mm Hg as a function of time(electron beam case). These oscillograms represent microwave power damping in wavequide, through which the filled quartz tube was traversed[6]. From Fig.4 one can see that recombination rate in He is higher in comparison with other gases ... on lower oscillograms appeared because of incomplete concordance of microwave system).

It is known that large recombination rate is conditioned by dissociative recombination of molecular ions with excited atoms. Reaction rate of molecular ions formation is 10.8.$10^{-32}$$cm^6$/sec for He, and 5.8.$10^{-32}$$cm^6$/sec for Ne. Molecular ions binding energies are 2.16 eV for He_2^+, 1.0 eV for Ne_2^+, 0.05 eV for Ar_2^+; Xe_2^+ binding energy is still lower. The rate of this reaction increases, when gas temperature decreases, therefore increase of gas pressure must lead to the incresing of summary recombination rate. The recombination rate for electron beam case is higher than that one for discharge case, because of average electron energy at first case is lower. Since dissociative energy of Xe_2^+ is $\sim 10^{-2}$ eV Xe_2^+ recombination rate is just the same for both cases. He_2^+ dissociation energy and the reaction rate are higher, than other gases, and its recombination rate is large.

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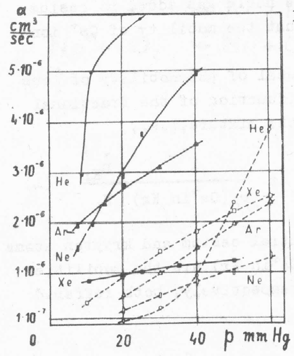

Fig.1. Recombination coefficient : fulled curves -electron beam cases; dotted curves -high voltage discharge cases.

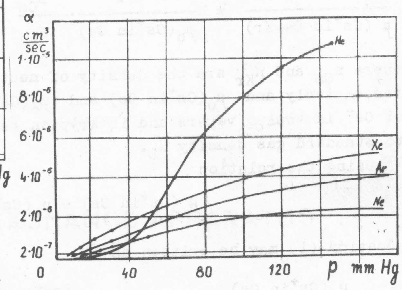

Fig.2. Recombination coefficient as a function of pressure in high voltage discharge cases.

TABLE I. Recombination coefficient α sm^3/sec.		He	Ne	Ar	Xe
PUBLISHED RESULTS		1.7.10^{-8}/3/	3.4.10^{-7}/4/	8.8.10^{-7}/4/	
		4.0.10^{-9}/1/	2.3.10^{-7}/1/	6.7.10^{-7}/1/	1.4.10^{-6}/1/
PRESENT RESULTS	disharge	1.10^{-7}	4.10^{-7}	8.10^{-7}	1.2.10^{-6}
	electron beam	6.5.10^{-6}	4.10^{-6}	3.10^{-6}	1.10^{-6}

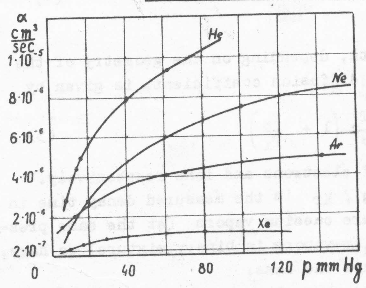

Fig.3. Recombination coefficient as a function of pressure in electron beam cases.

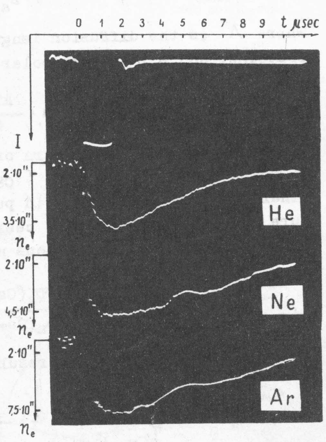

Fig.4. Electron concentration in gases for p = 25 mm Hg(highest oscillogram is represented electron current) - electron beam case.

R E F E R E N C E S .

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