Letters to Editor

ELECTRON TEMPERATURE AND DENSITY IN THE DISCHARGE OF RARE-GAS-BROMINE MIXTURES

ТЕМПЕРАТУРА И ПЛОТНОСТЬ ЭЛЕКТРОНОВ В РАЗРЯДЕ, ПРОИСХОДЯЩЕМ В СМЕСЯХ ПЛЕМЕННОГО ГАЗА И БРОМА

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This paper deals with the experimental determination of the electron temperature and density in positive columns of He, Ne and Kr, and their mixtures with bromine. The discharge tube was 20 mm in diameter and 50 cm in length. The partial pressure of He, Ne and Kr was 1334 Pa, and 4002 Pa, and 1334 Pa, respectively. The partial pressure of bromine in the mixture varied with temperature changes

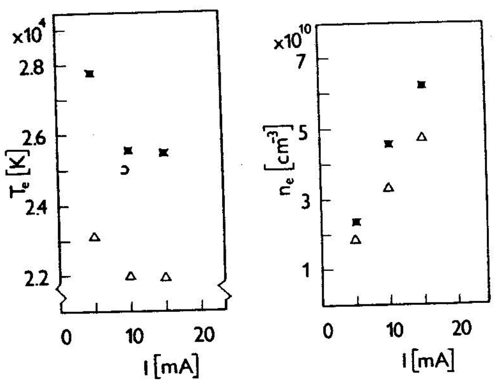

Fig. 1. Electron temperature (T_e) and electron density (n_e) as a function of current stength; ● denotes measurement performed in He discharge: $p_{He} = 1334$ Pa, x, Δ denote measurements performed in He—Br_2 discharges: $p_{He} = 1334$ Pa, $p_{Br_2} \simeq 0$ Pa; $p_{He} = 1334$ Pa, $p_{Br_2} = 4$ Pa, respectively.

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of the cooled end of the tube. At a temperature of −183 °C the partial pressure of bromine was nearly 0 Pa but at −77 °C, it was 4 Pa. The tube had Ir—Pt electrodes.

The plasma parameters were determined by means of the double-probe method. A cylindrical double-probe of 0.25 mm diameter and 5 mm length was used. The electron temperature was calculated from the probe current-voltage characteristics [1]. The electron densities were calculated following the

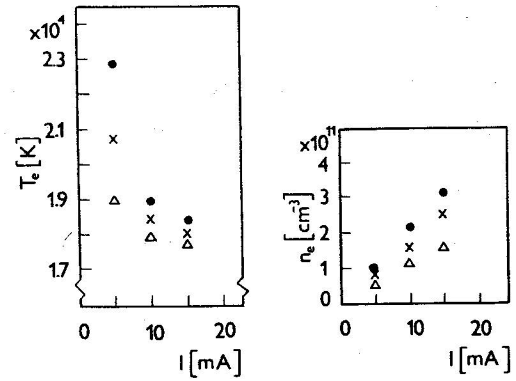

Fig. 2. Electron temperature (T_e) and electron density (n_e) as functions of current strength; ● denotes measurement performed in Ne discharge: $p_{Ne}=4002$ Pa, x, Δ denote measurements performed in Ne—Br_2 discharges: $p_{Ne}=4002$ Pa, $p_{Br_2}\simeq 0$ Pa; $p_{Ne}=4002$ Pa, $p_{Br_2}=4$ Pa, respectively.

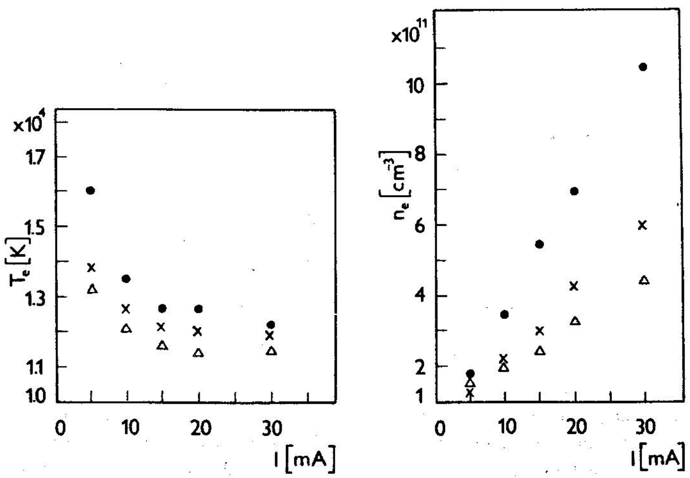

Fig. 3. Electron temperature (T_e) and electron density (n_e) as functions of current strength; ● denotes measurement performed in Kr discharge: $p_{Kr}=1334$ Pa, x, Δ denote measurements in Kr—Br_2 discharges: $p_{Kr}=1334$ Pa, $p_{Br_2}\simeq 0$ Pa; $p_{Kr}=1334$ Pa, $p_{Br_2}=4$ Pa, respectively.

method of medium pressures [2]. The ionization cross section of He, Ne and Kr was chosen to be 2.6; 3.0; 4.6×10^{-15} cm², respectively [3]. Since the temperature of negative ions T_- in the mixture was $T_-\simeq T_p \ll T_e$, (where T_p is the temperature of positive ions), the electron densities were calculated at same way as for electron-positive gases [4]. Figures 1, 2 and 3 show the electron temperatures and electron densities as functions of current in pure rare gases and their mixtures with bromine. The electron temperature decreases with the increasing current strength whereas the electron density increases approximately linearly with the increasing discharge current. As the electron temperature decreases with the increasing bromine pressure, the rate of ionization of rare-gas atoms becomes smaller. Therefore the electron density decreases.

In pure helium and its mixture with the trace amounts of bromine ($p_{Br_2}\simeq 0$ Pa) at the constant discharge current, the temperatures and the densities of electrons remain unchanged. With the presence of the smallest traces of bromine in Ne and Kr mixtures both the temperatures and the densities of electrons decrease. This could be explained by the influence of the second-order collisions between the rare-gas metastable (Ne and Kr) atoms and bromine. This process, for example, was studied in Ne—Br_2 [5] and in Kr—Br_2 [6] mixtures.

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