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Electron energy distribution function (0–40 eV range) in helium in a high-voltage discharge in a hollow cathode used for lasers

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Abstract. This paper presents results of measurements of the electron energy distribution function (EEDF) in the range 0–40 eV and the electron density for the helium plasma of a high-voltage discharge (HVD) in a hollow cathode as used for He–inert gas and He–metal lasers. The EEDF has been measured employing the method of the second derivative of the electric probe current–voltage characteristic. The results show that the shape of the EEDF for the HVD in the hollow cathode is similar to that for the conventional transverse hollow-cathode discharge (HCD) operating at low voltage. However, the increase of the operating voltage in the hollow cathode results in energetic redistribution of electrons and a selective change of the efficiency of atomic processes. It appears then that the relative number of electrons within the energy interval from several eV to 20 eV is lower in the HVD than in the conventional HCD. This is believed to be the result of the lower efficiency of the excitation of metastable states of helium in the HVD. Above the energy of 35 eV the relative number of electrons in the HVD is higher than that in the conventional HCD. Thus ionisation seems to be one of the most favoured atomic processes in the HVD.

1. Introduction

Recently the hollow-cathode discharge (HCD) has been used to obtain lasing in inert gases and their mixtures with metal vapours (Schuebel 1980, Rozsa 1980, Gerstenberger *et al* 1980). The advantage of using the HCD for the excitation of the lasing gas media is an improvement of the excitation efficiency of highly energetic ion states due to a more suitable electron energy distribution function (EEDF). Besides, the EEDF may be more freely regulated in the HCD than in the positive column used in many common lasers.

Regulation of the EEDF is possible in the so-called high-voltage discharge (HVD) in a hollow cathode developed by Rozsa (1975). It has been observed that insertion of an anode system inside the cathode results in a 3–4 times increase of the operating voltage. This in turn must raise the number of electrons in the 'tail' of the EEDF. As a result, the degree of excitation of high-energy ionic laser states is improved in such discharges (Rozsa *et al* 1977a, b, c, Janossy *et al* 1978, Mizeraczyk *et al* 1981, Iijima 1982a, b, Kawase 1982).

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