Electron Energy Distribution Function (0 – 40 eV Range) in Helium in a Longitudinal Hollow-Cathode DischargeUsed for Lasers

Jerzy Mizeraczyk
Institute of Fluid-Flow Machines, Polish Academy of Sciences, Gdańsk (Poland)

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This paper presents results of measurements of the electron energy distribution function (EEDF) in the range 0 – 40 eV, and the electron density and the space potential for the helium plasma of a longitudinal discharge in a hollow cathode as used for He-inert gas and He-metal vapour lasers. The results show that the EEDF and also the mean electron energy, the electron density and the plasma potential differ from those typical of the transverse hollow-cathode discharge.

Introduction

There exist two kinds of glow discharges in a hollow cathode, depending on the position of the anode: the transverse (THCD) and the longitudinal hollow-cathode discharge (LHCD). In the THCD the movement of the electric charge carriers, electrons and ions, is perpendicular to the axis of the hollow cathode (Figure 1). In the LHCD the electrons move along the axis of cathode. It has been found, but not understood, that the efficiency of simultaneous lasing on three basic spectral lines: blue, green and red, in He-Cd mixtures is greater in the LHCD than in the THCD [2]. In the present work the electron energy distribution function (EEDF), the mean energy and concentration of the electrons, and the plasma potential in the LHCD in helium under conditions close to the working conditions of He-inert gas or He-metal vapour lasers are measured. The plasma parameters in the THCD at conventional and high operating voltages were determined earlier ([3], [4]) and shall be compared with the results of the present work.

Using a Langmuir electric probe, the EEDF in a hollow cathode was measured for electron energies up to 40 eV.

Experimental Details

The experimental arrangement was the same as described in [3] and [4]. A discharge tube with a hollow cathode typical for He-inert gas or He-metal vapour lasers was used (Figure 2). The cathode was a stainless-steel cylinder of 49.3 mm length and 5 mm inner diameter. The length of the anode was 10 mm. A cylindrical tungsten probe, 0.5 mm long and 0.05 mm in diameter, was located in the middle of the cathode axis.

The helium pressure was varied from about 2 mbar to 30 mbar. The discharge current was varied from 20 mA to 200 mA except for cases when the probe current was too large, causing probe sputtering, or too small compared to the sensitivity of the measuring set-up.

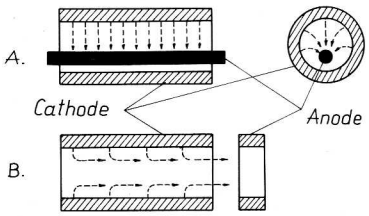

Fig. 1. Schematic diagram of typical hollow cathodes for transverse (A) and longitudinal (B) discharge.

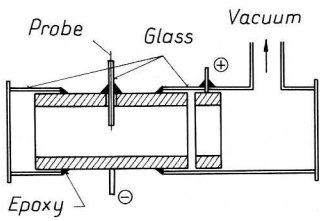

Fig. 2. Longitudinal hollow cathode with measuring probe.

Reprint request to Dr. J. Mizeraczyk, Institute of Fluid-Flow Machines, Pol. Acad. Sci., 80952 Gdańsk, Fiszera 14, Poland.

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