RADIAL DISTRIBUTIONS OF THE CHARGED PARTICLES IN A He–Kr HOLLOW CATHODE DISCHARGE

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Radial distributions of He^+, He_2^+ and Kr^+ were measured in a hollow cathode discharge in He and in He–Kr mixtures using a mass spectrometer. The dimensions of the discharge were similar to those used in He–Kr^+ hollow cathode discharge lasers. From the ion densities the electron density was derived. Introducing krypton into the helium discharge results in decreasing both the densities of He^+ and He_2^+ ions. During this process the radial distributions of the He^+, H_2^+ and electron density change from parabolic into saddle-like profiles. The changes of radial profiles of the charged particles in the He–Kr hollow cathode discharge may affect the lasing properties of the mixture.

1. Introduction

The knowledge of space distributions of neutral and ion species in lasing gas mixtures excited by an electric discharge is necessary for understanding the laser properties of the mixtures and the excitation mechanisms leading towards population inversion. Particularly, the problem seems to be of importance for lasing media consisting of mixtures of gases, or mixtures of gases and metal vapours excited by an electric discharge of cylindrical geometry. The axial and radial distributions of the neutral and ion species of the He–metal vapour ion lasers were studied for the case of the excitation in the positive column only. The results helped to obtain uniform distributions of the lasing species along the positive column in the positive column He–Cd^+ laser [1]. They gave also a new viewpoint on the current saturation effect of the positive column He–Cd^+ laser power output [2,3]. To the authors' knowledge the axial and radial distributions of the neutral and ion laser species of the He–metal vapour or the noble gas mixture ion lasers excited in the hollow cathode discharge (HCD) have not been measured yet.

In this work the results of mass spectrometric measurements of the radial distributions of He^+, He_2^+, Kr^+ and electron density in the He–Kr laser mixture excited in the HCD are presented. The He–Kr^+ HCD laser, generating blue and violet lines, is one of the most promising lasers from the HCD laser group [4].

Although the technology of some HCD lasers approach commercialization level, the excitation mechanisms and operating behaviour of these lasers are not fully understood. Our study delivers new data which might be useful for better understanding properties of the He–Kr^+ HCD laser as well as other He–metal vapour ion HCD lasers, including the He–Cd^+ laser. It must be said, however, that further measurements in He–metal discharges are necessary to support the conclusions presented below.

2. Experimental

We only give a short description of the experimental setup used, since it has already been published in detail [5]. A cylindrical hollow cathode (length 30 mm, inside diameter 5 mm) was sampled in two radial positions (central and 1.5 mm off-axis) with respect to a fixed sampling probe (free metal