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On the Rotational Distribution of N_2 in the Ar—N_2-Discharge The O—O-Band of the Second Positive System

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Abstract

The rotational distribution of the O—O-band of the second positive system of N_2 was determined by the Ornstein method in the glow discharge of an argon-nitrogen mixture at medium pressure. Evidently, for the rotational R- and P-lines some straight lines can be fitted for rotational quantum numbers between 2 and 60 according to usual representation. The slopes of the curves indicate that the Boltzmann distribution does not exist for all the levels. For each of these straight lines can be declared a value of rotational temperature. The dependence of the several rotational temperatures on the discharge current is essential lower than the corresponding dependence of the gas temperature, which is calculated by means of the energy balance. The influence of the energy transfer from metastable argon atoms to ground-state nitrogen molecules on the rotational distribution seems to be insignificant. Comparisons with rotational distributions in pure nitrogen plasmas point at the influence of interactions between nitrogen species.

1. Introduction

Usually, in non-isothermal plasmas the gas temperature is determined from the rotational structure of molecular spectra [1]. In the last years some authors doubt that it is permitted to make statements about the translational temperature of heavy particles by the Ornstein method, because they found in non-isothermal plasmas differences between translational and rotational temperatures by reason of simultaneous temperature measurements by means of various methods. In the same way as for the system argon-nitrogen deviations are observed both between the rotational and the gas temperature [2—4] and from a general Boltzmann distribution [5—10]. For these phenomena the selective energy transfer from metastable argon atoms to ground-state nitrogen molecules was mostly held responsible.

The method of determination of gas temperature on the rotational structure is based on the assumption that the excitation of the upper electronic levels occurs by direct electron collisions with ground-state molecules, at which the population of rotational levels of the ground-state molecules is resulted from collisions with the neutral particles. In this paper the population of rotational levels is investigated in the positive column of an argon-nitrogen discharge at low currents. In distinction to the investigations of the most other authors a nitrogen portion of more than 10% was chosen. An essential difference between gas temperature and electron temperature at small concentrations of electron was aspired.