

RADIATION KINETICS OF THE “HOT” MOLECULES $N_2(C^3\Pi_U)_{v=0}$ IN THE BARRIER DISCHARGE IN HUMID ARGON AT ATMOSPHERIC PRESSURE

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Abstract. The technique of cross-correlation spectroscopy was used to investigate radiation kinetics of the barrier discharge (BD) in humid argon at atmospheric pressure. Emission spectrum was found to consist of the peaks of argon, the bands of $OH(A^2\Sigma^+)$ radical, and the bands of molecular nitrogen (2^{nd} positive system), although the concentration of N_2 admixture in argon was about 10 ppm, only. The most intensive lines corresponding to the species listed above were chosen as their spectral indicators. Spatio-temporal distributions of radiation intensity for thus selected wavelengths within the microdischarge channels were determined with the resolution of 0.1 mm over spatial coordinates and of 1.6 ns over time. The detailed kinetic analysis of experimental data led us to the assumption that the metastable excited states of argon Ar^* play a dominant role in the experimentally observed radiation kinetics as well as in the electrical breakdown mechanism. To confirm this working hypothesis, we carried out a series of additional measurements focusing on the evolution of rotational band of the 0-0 transition of the 2^{nd} positive system of nitrogen. The main idea of such test is based on the special properties of the reaction $N_2(X) + Ar^* \rightarrow N_2(C) + Ar$, in which the “hot” molecules of $N_2(C)$ (i.e. the molecules with an abnormal distribution over rotational levels) are formed. The results of our measurements demonstrated a noticeable broadening of the rotational band at $\lambda < 337.1$ nm during the period of 100-200 ns after the first breakdown event corresponding to the sharp peaks of Ar^{**} emission at $\lambda = 751$ nm and $\lambda = 764$ nm. This phenomenon is explained by a gradual change in the mechanism of $N_2(C)$ excitation: from the excitation by direct electron impact during the first phase of the microdischarge development, to the excitation via metastable excited states of argon (Ar^*) during the second phase of the process being considered.

1. INTRODUCTION

Barrier discharges (BDs) in humid argon can be regarded not only as prospective plasma chemical generators of the OH-radicals [1], but also as useful UV-radiation sources [2]. An improvement of their efficiency is hardly possible without deep understanding of the discharge mechanism and dominant chemical pathways leading to the reaction products of interest. To achieve this, a complete plasma diagnostics (including electrical measurements, spatially resolved kinetic spectroscopy, and chemical analysis of the stable reaction products) of the BD in humid argon has to be carried out. In the previous publications [3-5], some preliminary diagnostic results concerning the system being considered were reported. In particular, it was assumed that experimentally observed radiation kinetics in a BD in humid argon can be explained at least qualitatively, taking into account formation of the metastable argon atoms in the microdischarge channel, and the consequent elementary processes with their participation. The objective of this research was to test this hypothesis, i.e. to clarify the role of the excited metastable states of argon in the mechanism of the microdischarge development. The technique of the spatially resolved cross-correlation spectroscopy (CCS) was used as a basic tool to investigate radiation kinetics within the microdischarge channel.

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