

Low-pressure nitrogen afterglows with oxygen addition

Vasco Guerra¹, André Ricard² and Soo-ghee Oh³

¹*Instituto de Plasmas e Fusão Nuclear, Instituto Superior Técnico,
Universidade Técnica de Lisboa, 1049-001 Lisboa, Portugal*

²*Université de Toulouse, UPS, INPT, LAPLACE, 118 route de Narbonne, F-31062
Toulouse, France*

³*Division of Energy Systems Research, Ajou University, Suwon 443-749,
Republic of Korea
vguerra@ist.utl.pt*

Nitrogen discharges and their afterglows are interesting for a number of applications, such as surface modification of materials, atmospheric plasma chemistry, pollution abatement, or plasma sterilization. The nitrogen afterglow may be divided into two regions. In the early (pink) afterglow, there is a raise in the concentrations of several species after an initial decay [1] and a strong emission of the first negative system. The kinetics of the $N_2(B)$ in this zone is governed by reactions involving vibrationally excited molecules, $N_2(X,v)$, as well as $N_2(A)$ and $N_2(C)$ molecules and nitrogen atoms. The late (yellow) afterglow is dominated by the 3-body recombination of N atoms, forming predominantly $N_2(B,v=11)$, and the first positive system emission.

Understanding the elementary processes ruling the concentrations of the different active species is a crucial step in order to optimize any specific application. Measurements of nitrogen and oxygen atomic concentrations in the afterglow, of the $N_2(A)$ density in the late afterglow, and of the modification of the emission intensities from the 1^- and $NO\beta$ systems under oxygen addition, have been reported very recently [2,3]. In this work, the model developed in [1] to study the kinetics of the nitrogen afterglow is extended to investigate the influence of small amounts of oxygen added into a nitrogen afterglow and interpret the results in [2,3]. It is shown that a very important effect is the destruction of vibrationally excited molecules by O atoms, in V-T collisions and/or in the NO formation reaction $N_2(X,v\geq 13)+O\rightarrow NO+N$, which subsequently affect the chain of reactions taking place along the pink afterglow.

[1] V. Guerra, P. A. Sá, and J. Loureiro, “Kinetic modeling of low-pressure nitrogen discharges and post-discharges,” *Eur. Phys. J. Appl. Phys.* **28** (2004) 125–152.

[2] N. Kang, M. Lee, A. Ricard, and S. Oh, “Effect of controlled O_2 impurities on N_2 afterglows of RF discharges,” *Curr. Appl. Phys.* **12** (2012) 1448–1453.

[3] A. Ricard, S. Oh and V. Guerra, “Line-ratio determination of atomic oxygen and $N_2(A\ ^3\Sigma_u^+)$ metastable absolute densities in an RF nitrogen late afterglow,” accepted for publication.

Acknowledgment

This work has been supported by the Portuguese Fundação para a Ciência e Tecnologia (FCT) funds to Instituto de Plasmas e Fusão Nuclear – Laboratório Associado.