Detection of $N_2(A)$ metastable molecules in the N_2 RF afterglow

André Ricard[1*] , Namjun Kang[2], Minwook Lee[2] and Soo-ghee Oh[2]

[1]*LAPLACE, 118 route de Narbonne, F-31062, Toulouse, France*
[2]*Division of Energy Systems research, Ajou University, Suwon 443-749, Korea*
[(*)]ricard@laplace.univ-tlse.fr

Emissions of NO bands have been recorded by emission spectrometry in N2 RF flowing afterglows. From the NO band intensities , it is obtained the density of N2(A) metastable molecules in the afterglows. The N2(A) metastable molecules in the late afterglow disappeared as for the N-atoms at the NO titration point.

RF capacitive flowing discharge and post-discharge is experimentally studied in N_2 gas by using optical emission spectroscopy at a pressure p= 8 Torr, a flow rate Q_{N2} =1 slm and a transmitted RF power W_T=100 W. In these conditions the flowing discharge is distinguished by early and late afterglows as reproduced in Fig.1.

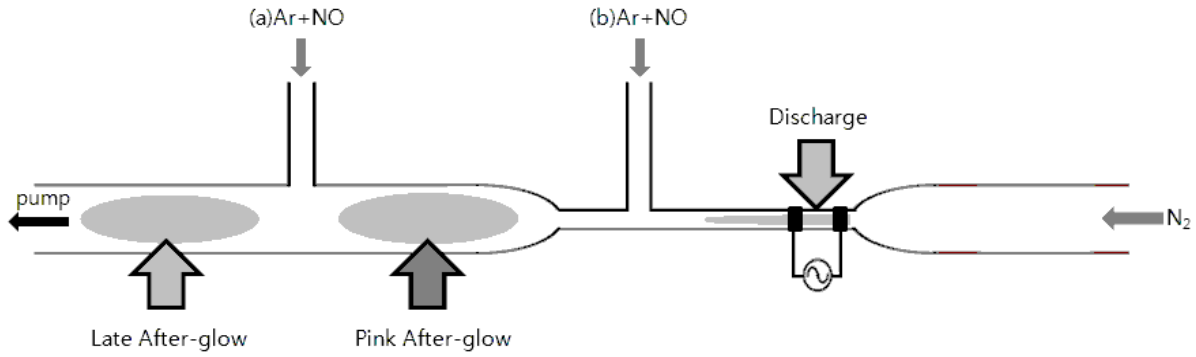

Fig. 1. Flowing afterglows in a downstream quartz tube of dia.21 mm after a capacitive RF discharge in an upstream tube of dia.6 mm and 30 cm length. An Ar-1.5% NO gas mixture can be injected after the early afterglow (a) or after the discharge end (b).

The kinetic modelling in N_2 afterglows as O_2 is introduced into the RF discharge and post-discharge is reported in a companion paper [1]. It is presently reported the variations of NO_β and NOγ band emissions as NO is introduced from an Ar-1.5%NO gas mixture before the early (b) and late (a) afterglows.

The Ar-1.5% NO gas mixture is usually introduced in the N_2 afterglow for N-atom density measurements. The NO titration consists to observe the change of colour in the late afterglow from the violet, due to NO_β emission at low NO flow rate, to the green due to NO_2^* emission at high NO flow rate [2].

In addition to NO_β emission , it is presently observed NO_γ emission as reported in Fig.2 with the intensities of the NOγ(0-3) , 259 nm and the NOβ(0-4), 262 nm bands versus the Ar-1.5% NO introduced before the late afterglow (a) .

The NO_β and NOγ bands are produced by the following reactions [3] :

$$- N+O+N_2 \rightarrow NO(B) + N_2 \qquad (a)$$
$$NO(B) \rightarrow NO(X) + NO_\beta$$

$$- N_2(A) + NO_{ext} \rightarrow N_2(X) + NO(A) \qquad (b)$$
$$NO(A) \rightarrow NO(X) + NO\gamma$$

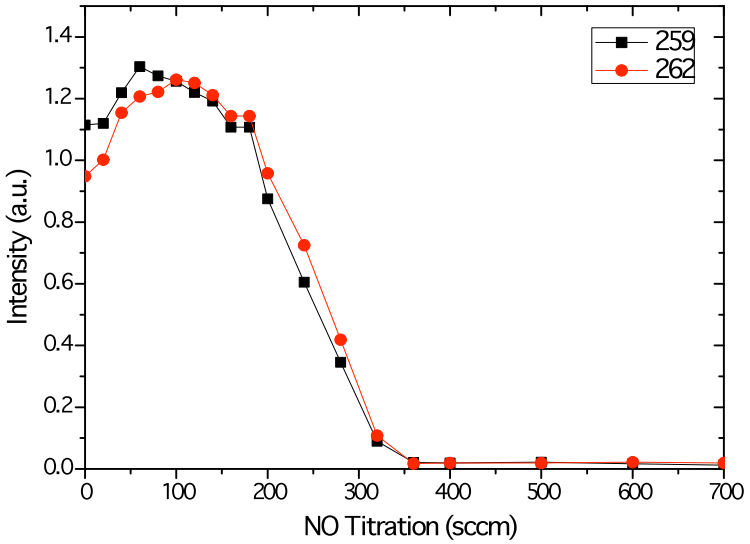

Fig.2 Intensities of NOβ (262 nm) (circles) and NOγ (259 nm)(squares) versus the Ar-1.5% NO flow rate introduced in the late afterglow after the pink (a) . N_2 gas with a purity of 99% at 1 slm , 8 Torr , 100 W.

The disappearance of NO_β emission corresponds to the classical titration point to determine the N-atom density [2]. In conditions of Fig.2 (Q_{N2}=1 slm , p=8 Torr , W_T=100 W) with an extinction point at $Q_{Ar\text{-}1.5\%NO}$ =350 sccm , it is determined a N-atom density of 1.3 10^{15} cm^{-3}.

In Fig.2 ,the NOγ intensity follows the NO_β intensity. It is concluded that the $N_2(A)$ metastable molecules in the late afterglow disappeared as for the N-atoms at the titration point.

Others results will be presented, first by replacing the N_2 gas of low purity (99%) by a pure one (99.999%) and by comparing the NO_β and NOγ intensities as the Ar-1.5%NO gas mixture is introduced in positions (a) and (b) of Fig.1.

By a kinetics analysis , it will be evaluated the density of $N_2(A)$ in the afterglows.

References

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