Nitric oxide decomposition induced by DC corona discharge

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1. Introduction

Nitric oxide (NO) is a highly reactive polluting gas that is emitted from a variety of sources, including car engines, power plants, iron and steel plants, etc. The reduction of these emissions using non-thermal plasma technologies is the object of a continuous research [1], due to the large impact that air pollution has on human health. In this work, decomposition of NO by means of DC corona discharge is investigated, as well as the formation of other species by the electrical discharge.

2. Experimental

The corona discharge reactor consists of a tungsten wire (∅ 0.1 mm) situated along the axis of symmetry of a 5 cm long stainless steel cylinder (∅ 17 mm) [2]. The reactor is initially filled with a mixture of high purity oxygen (5%) and nitrogen (95%). Then, 200µl of nitric oxide is injected into the chamber immediately before the application of the high voltage. The effect of the corona discharge on the decomposition of NO is determined by means of UV absorption spectrophotometry. The UV beam of the spectrophotometer traverses the discharge reactor parallel to the corona wire. Therefore, measurements of light absorption by the gas mixture are directly carried out inside the discharge reactor. The evolution of other species, like ozone (O_3), nitrous oxide (N_2O) and nitrogen dioxide (NO_2), have been as well quantified using the same technique.

3. Results

Corona discharge generates a variety of radicals that accelerate the decomposition of nitric oxide. This effect can be appreciated in Fig. 1, where the temporal evolutions of NO, with HV on (5kV) and off, are compared. Ozone density is also shown in this figure. This species only appears after the total extinction of NO. This fact would suggest that ozone molecules generated by the electrical discharge participate actively in the decomposition of NO, possibly through the reaction

$$NO + O_3 \rightarrow NO_2 + O_2.$$

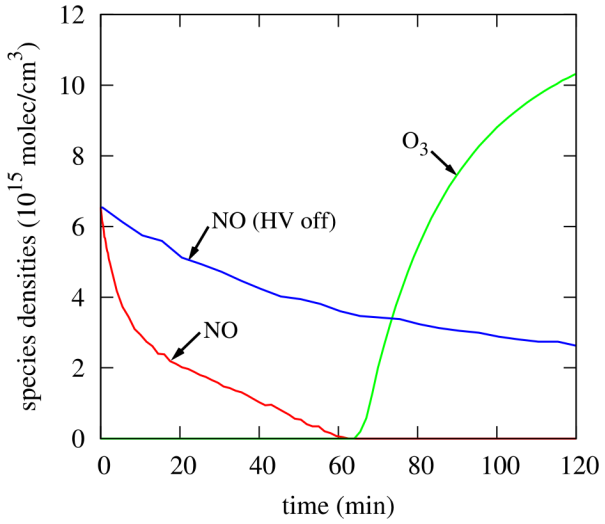
However, oxygen atoms generated by electron impact also contribute to the oxidation of NO molecules through

$$NO + O + M \rightarrow NO_2 + M,$$

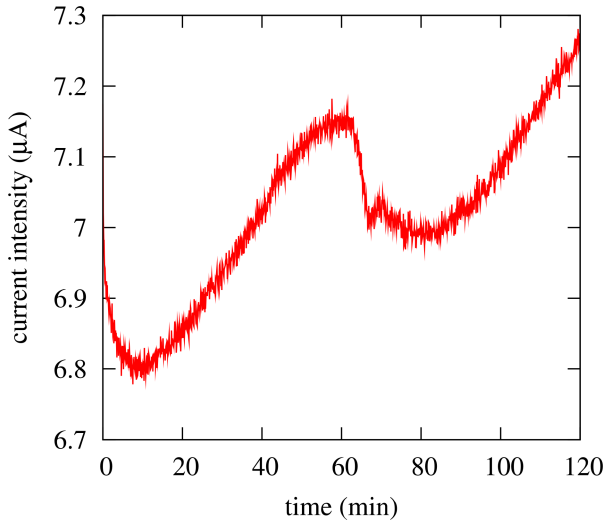
(M: third body collision partner) and the depletion of O atoms may inhibit the fomation of O_3 while NO is present. Therefore, both effects are possibly behind the delayed appearance of O_3, which is accompanied by a sharp decreased in the corona current (Fig. 2). In addition to NO and O_3, the presence of N_2O and NO_2 was also registered. While the density of N_2O increased steadily in time, NO_2 could not be longer detected after the extinction of nitric oxide.

References

[1] H. Kim. *Plasma Process. Polym*. 2004, **1**, 91–110.
[2] F. Pontiga et al.. *Annu. Rep. Conf. on Electrical Insulation and Dielectric Phenomena*, 2007, 671-674.



Temporal evolution of nitric oxide and ozone densities.



Corona current intensity as a funtion of time