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MASS SPECTROMETRY, VISIBLE EMISSION AND FTIR ABSORPTION SPECTROSCOPY APPLIED TO THE STUDY OF GLOW DISCHARGES OF NITROGEN OXIDES.

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The complex variety of physico-chemical phenomena taking place in low pressure non thermal equilibrium plasmas as those generated in hollow cathode discharges is nowadays concentrating an increasing interest at different laboratories all over the world, due to the usefulness of these kind of states for different purposes, such as pollutants removing, reactor walls processing for nuclear fusion experiments or those related to the microelectronic processing industry. The present work concerns the study of the physico-chemical processes taking place in different nitrogen oxides (NO, N_2O, NO_2) continuous and modulated hollow cathode discharges, generated in a cylindrical hollow cathode reactor, specifically designed to be coupled to the different diagnosis devices. Different and complementary techniques have provided useful information about the species appearing during the discharge ignition. These techniques have allowed us to measure the appearance of the main stable products, N_2 and O_2 and the extinction of the nitrogen oxide used in the discharge as well as the appearance of the minor products and the intermediate atomic species. Particular attention has been given to the time resolved mode in which mass spectrometry provides essential information about the temporary evolution of stable molecules outside the plasma region of the reactor and visible emission spectroscopy allows to study the evolution of the unstable atomic species (N, O) and stable N_2 molecule inside the plasma region. FTIR absorption spectroscopy has been useful to detect and quantify the minor stable products (nitrogen oxides) appearing in the discharges. The experimental data have been compared to a quite simple kinetic model which takes into account the most important physico-chemical processes, such as electronic impact dissociation, homogeneous reactions, quenching of excited species, heterogeneous reactions at the surface of the cathode wall and diffusion processes between different regions of the reactor, taking place in the discharge. The comparison of time resolved experimental data and the model results allows us to estimate rate reactions for the electronic impact dissociation processes, whose values are generally unknown. This model can be applied to the three different nitrogen oxides used to generate the glow discharge, showing quite a good agreement between theoretical and experimental results, both for continuous and modulated discharges in a wide range of flux, electronic density (discharge current) and total pressure conditions of the plasma.