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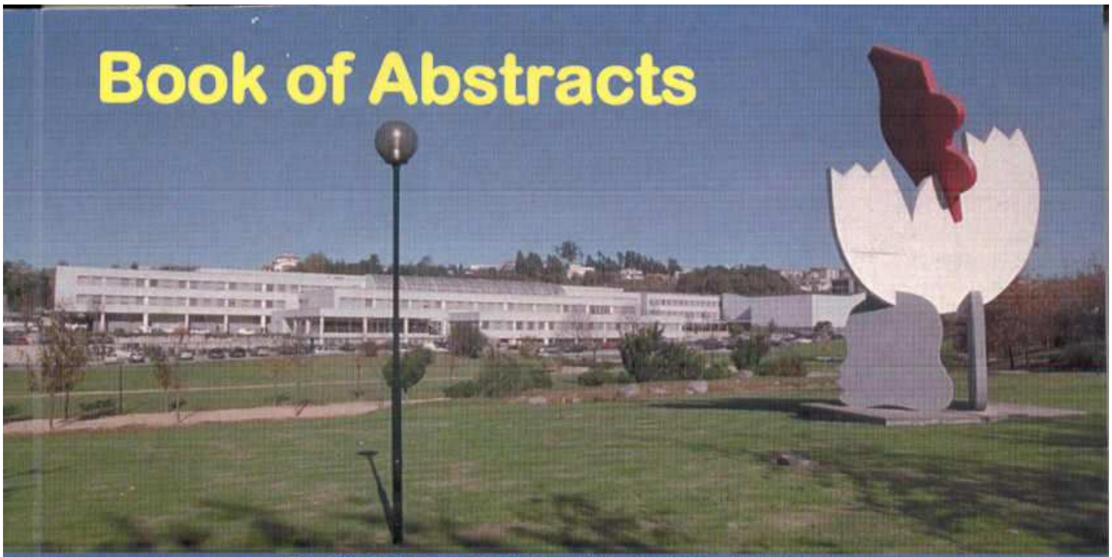

Escola de Engenharia da Universidade do Minho

VI International Materials Symposium

MATERIAIS 2011

XV Meeting of SPM – Sociedade Portuguesa de Materiais

18-20 Abril 2011

Guimarães, Portugal

MODELING OF CAPACITIVELY COUPLED RADIO-FREQUENCY DISCHARGES IN N_2-H_2 MIXTURES

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Capacitively coupled radio-frequency (ccrf) discharges in N_2-H_2 mixtures are becoming increasingly popular. Discharges operated in mixtures of hydrogen and nitrogen are nowadays used as a source of active species for various kinds of applications from etching of low-k materials to modifications of polymer surfaces for biomedical applications. Moreover, these discharges are also being used for studies of planetary atmospheres.

This work presents the modelling of 13.56 MHz ccrf discharges in N_2 -H_2 mixtures, produced within a cylindrical parallel-plate reactor (with 69 mm radius and 33 mm inter-electrode distance), similar to a GEC reference cell surrounded by a lateral grounded grid, for pressures from 0.2 to 1.5 mbar and RF coupled powers up to 30 W. Simulations use a 2D (r, z) time-dependent fluid-type code to describe the transport of electrons and positive ions in the reactor under study, coupled to a very complete 0D kinetic code for the nitrogen-hydrogen mixture. The fluid code solves the charged particle continuity and momentum transfer equations, the electron mean energy transport equations, and Poisson's equation for the rf electric potential. The kinetic code solves the electron Boltzmann equation and the rate balance equations of vibrational excited states and electronic excited states of the N_2 and H_2 molecules, yielding a set of electron transport parameters and rate coefficients for the processes involved in the charged particle production and destruction. The latter include (i) electron-impact ionisation from ground-state; (ii) electron-impact ionisation and associative ionisation involving excited states; (iii) ion conversion; and (iv) electron recombination with ions. The electron parameters are used within the fluid code, allowing for a self-consistent solution to the charged particle transport model by adopting the local mean energy approximation.

Model results are systematically compared to measurements of the self-bias potential, the effective rf power (accounting for circuit losses), the average electron density (obtained by resonant-cavity measurements), and the intensities of radiative transitions with the nitrogen SPS and with atomic lines emitted by argon traces (obtained by Optical Emission Spectroscopy diagnostics).

Keywords: Modelling; Nitrogen; Hydrogen; RF discharges; Plasma.