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Capacitively coupled rf plasmas in N\textsubscript{2}-H\textsubscript{2} mixtures

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This paper studies the modifications induced in low-pressure radio-frequency (rf) capacitively coupled nitrogen plasmas, by the addition of a few amount of hydrogen (up to 5\%). The work is of interest for material processing, such as the nitriding or the etching of low-k substrates, as well as in planetary studies, namely when N\textsubscript{2}-CH\textsubscript{4} plasmas are adopted.

The plasmas are studied using both experiments and simulations. The experimental setup is a parallel-plate reactor (driven at 13.56 MHz frequency), surrounded by a cylindrical metallic grid to confine the discharge [1]. Electrical diagnostics allow measuring: (i) the electron density, by using a resonant cavity method; (ii) the effective rf power coupled to the plasma, by using the subtractive method [2]. Optical emission spectroscopy diagnostics are used to study the evolution, with the working conditions, of: (i) the First Negative System with the N\textsubscript{2}\textsuperscript{+} band; (ii) the atomic hydrogen H\textsubscript{\beta} line at 486.1 nm; (iii) the atomic argon line at 811.5 nm (Ar is used here as an actinometer). Simulations use a hybrid code that couples a 2D (r, z) time-dependent fluid-type module, describing the transport of the charged particles, to a very complete 0D kinetic module, for the nitrogen-hydrogen mixture. Results reveal that the electron density increases with the amount of injected H\textsubscript{2}, at constant coupled power.

References

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