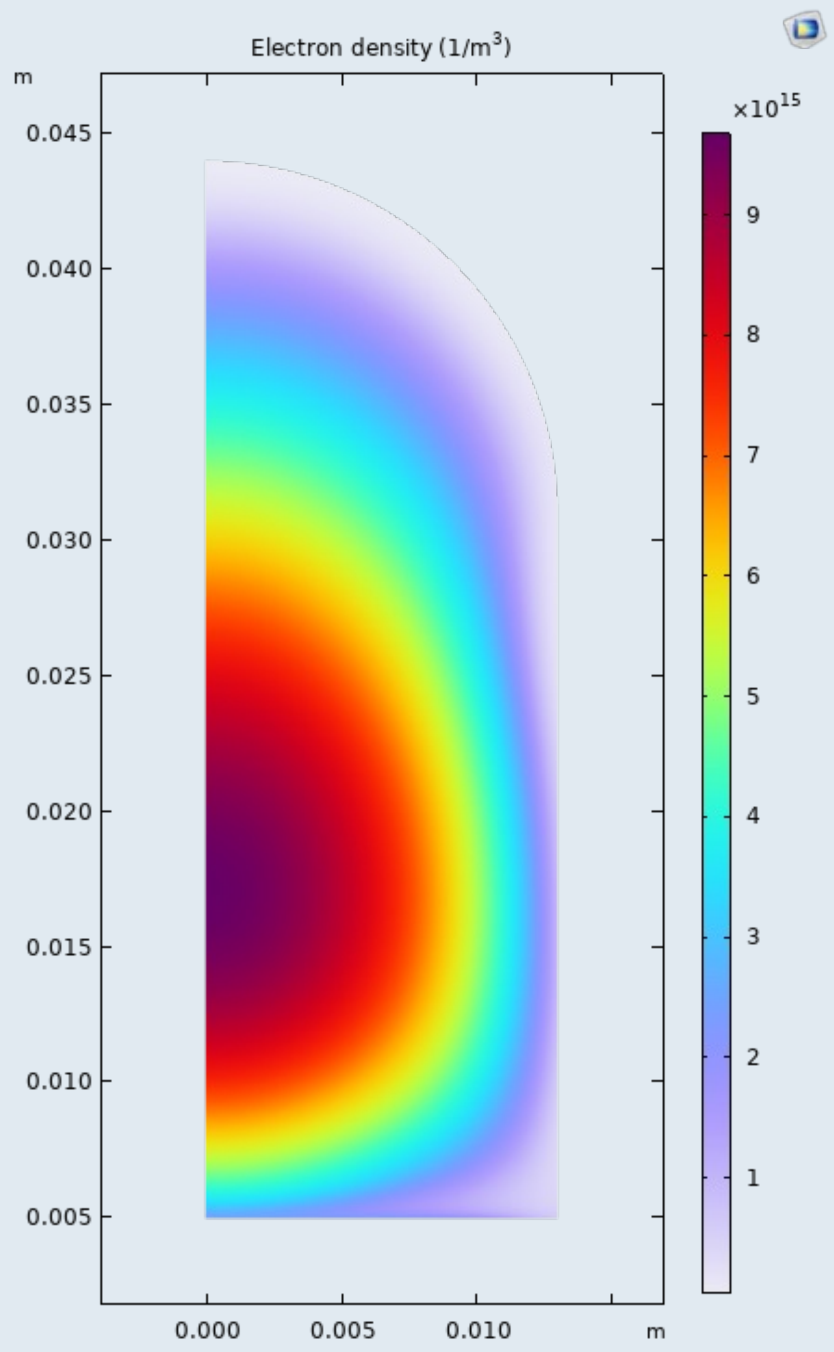

Low-Pressure RF Discharge in Hydrogen for Atom Production

The model accounts for both capacitive and inductive coupling. The dissociation/recombination kinetics is studied as a function of pressure.

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Abstract

Low-pressure discharges in Hydrogen are used as high-intensity sources of atoms for fundamental and material processing applications.

In this study, we investigate a small volume, low pressure RF discharge.

A quartz vessel is filled with Hydrogen at pressure in the range [5:30] Pa. The RF signal at 160 MHz is provided by a external flat spiral.

A axisymmetric fluid model is proposed that accounts for capacitive and inductive coupling.

In addition, the dissociation/recombination kinetics is solved that accounts for the neutral chemistry at the walls.

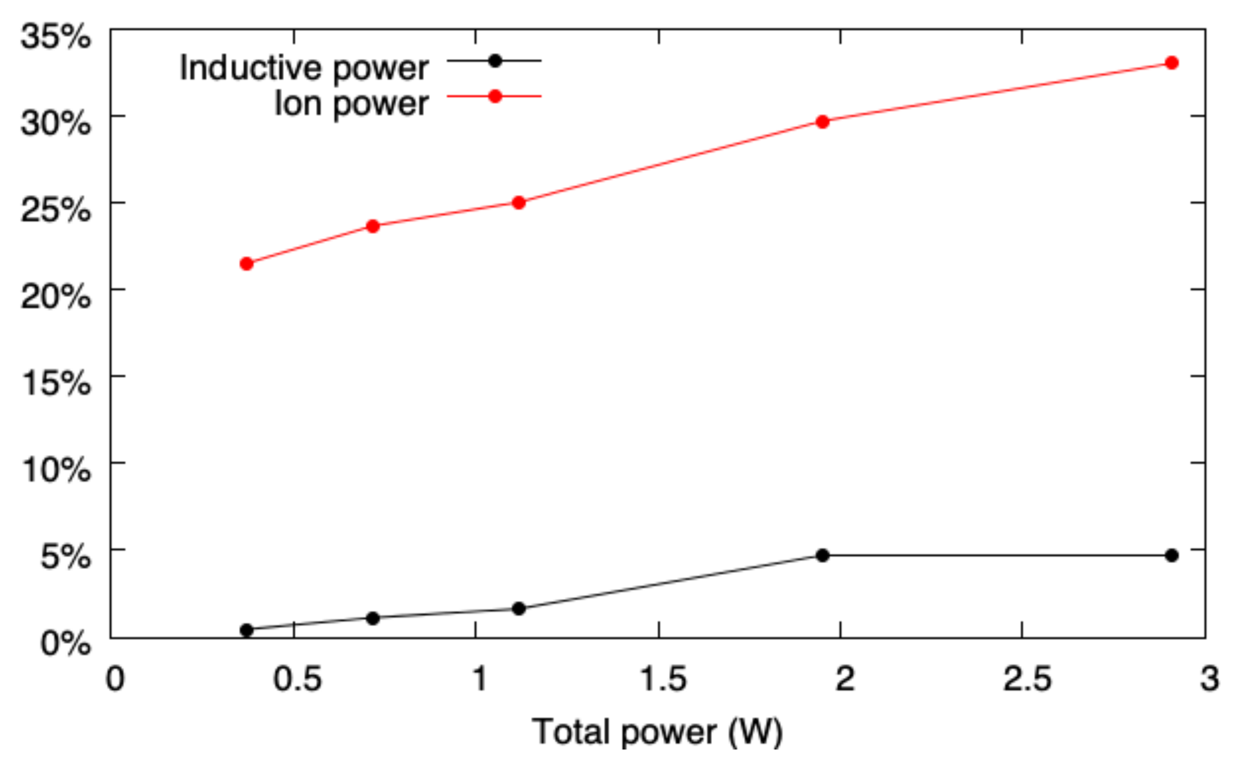

FIGURE 1. Fraction of inductive and ion power as a function of total absorbed power. Pressure is 10 Pa.

Methodology

The **Plasma** physics is used to model the capacitive coupling of the RF source to the plasma.

The inductive coupling is modelled with the **Magnetic Fields** physics that computes the magnetic field produced by the current flowing in the coil. This is then coupled to the plasma via the Multiphysics couplings **Plasma Conductivity** and **Electron Heat Source**.

The source terms for the dissociation/recombination kinetics are averaged over the RF period with auxiliary **Domain** and **Boundary ODEs**. These are then used in a **Heavy Species Transport** model to find the dissociation degree.

Results

Results are validated against PIC simulations [1]: plasma density, electron temperature, capacitive and inductive power absorption are compared for different working pressures.

COMSOL results reproduce accurately the PIC results at pressures of 20 Pa or larger, but the differences increase at lower pressures when non-equilibrium effects arise in the sheaths and collisionless heating becomes important.

Results show that the dissociation degree is strongly dependent on the atom recombination probability at the glass walls.

Large uncertainties affect the modeling of the glass aging.

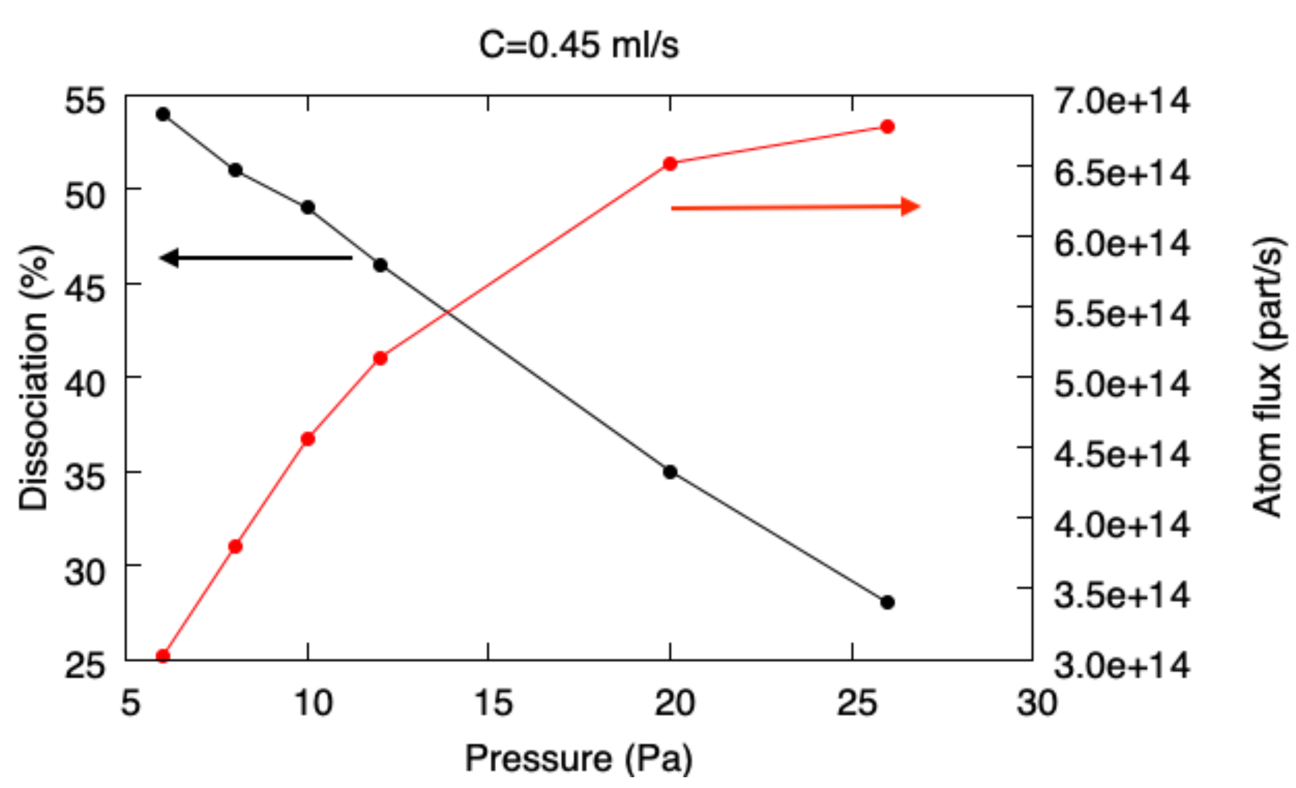

FIGURE 2. Dissociation degree and atom flux as a function of pressure. RF voltage is 220 V (peak value).

REFERENCES

[1] K. Matyash, R. Schneider, F. Taccogna, A. Hatayama, S. Longo, M. Capitelli, D. Tskhakaya, F.X. Bronold, Particle in cell simulation of low temperature laboratory plasmas, Contributions to Plasma Physics **47**(8-9), 595-634 (2007).

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