H^- and D^- production efficiency in a multi-dipole ECR-plasma source as a function of gas pressure

M. Mitrou[1,2], P. Svarnas[1], S. Béchu[2]

[1]High Voltage Laboratory, Electrical and Computer Engineering Dept., University of Patras, Rion-Patras, GR-26504, Greece

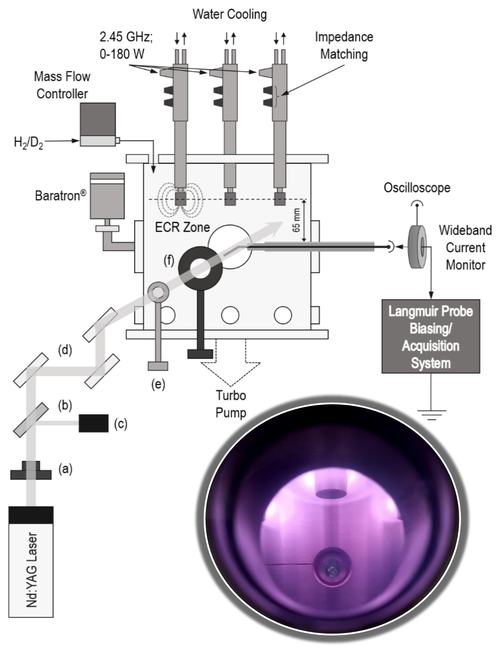
[2]Univ. Grenoble Alpes, CNRS, Grenoble INP, LPSC-IN2P3, 38000 Grenoble, France

E-mails: maria.mitrou@ece.upatras.gr, svarnas@ece.upatras.gr, bechu@lpsc.in2p3.fr

Introduction

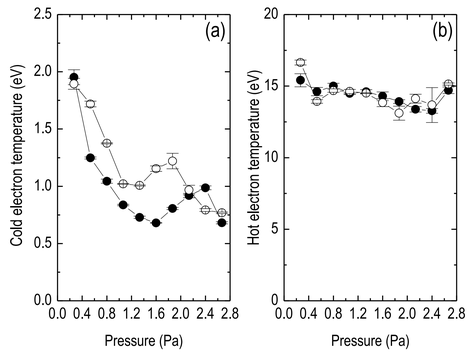
The present work is devoted to the ECR volume source Prometheus I, extending its exploitation to D_2 since previously operation only with H_2 had been thoroughly carried out. Basic plasma properties are accessed via electrostatic probe and laser induced photo-detachment. The experiments are carried out throughout a wide range of working pressure, whereas the microwave power is maintained constant. The results are then compared and evaluated so as to identify similarities and differences between the ECR plasmas of the two isotopes.

Experimental Setup

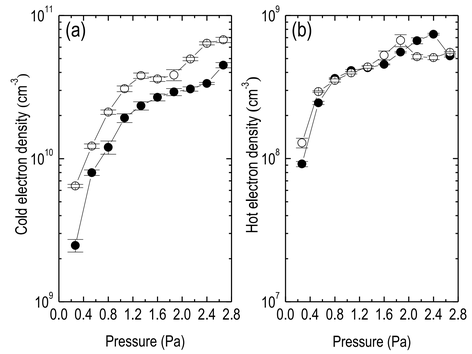


(a) ½ wave-plate on rotation mount; (b) beam splitter; (c) beam dump; (d) mirrors; (e) Ø5 mm diaphragm; (f) pyroelectric laser energy sensor

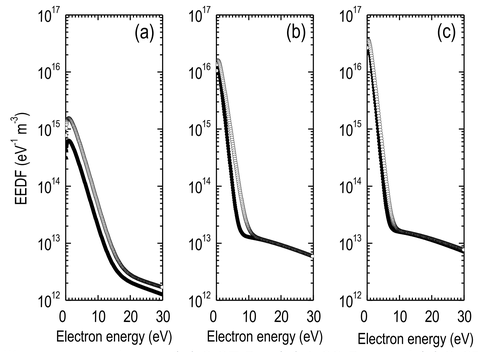
Results



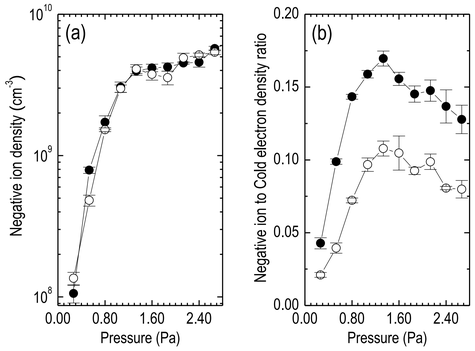
(a) Cold and (b) hot electron temperature vs. the operating gas pressure. ● H_2 ; ○ D_2 ; 0.9 kW



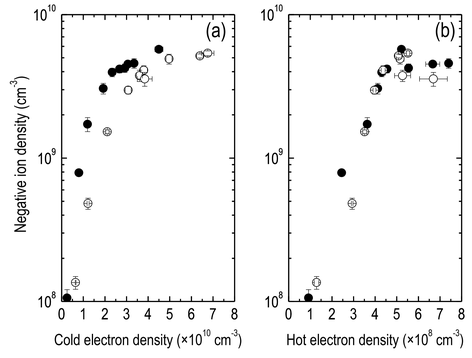
(a) Cold and (b) hot electron density vs. the operating gas pressure. ● H_2 ; ○ D_2 ; 0.9 kW



EEDFs under bi-Maxwellian assumption at (a) 0.27 Pa, (b) 1.33 Pa, and (c) 2.67 Pa. ● H_2 ; ○ D_2 ; 0.9 kW



(a) H^- & D^- ion density and (b) H^- & D^- ion to cold electron density ratio vs. the operating gas pressure. ● H_2 ; ○ D_2; 0.9 kW.



H^- & D^- ion density vs. (a) cold and (b) hot electron density. Data pairs are created with the pressure elimination. ● H_2 ; ○ D_2 ; 0.9 kW.

Conclusions

- The plasma potential, cold electron temperature, and cold electron density tend to be higher in deuterium.
- No pronounced difference in the hot electron density and temperature is found between the two plasmas.
- The two observations on the electrons are jointly mirrored on the EEDF patterns. The diverging features between the H_2 and D_2 EEDFs are more pronounced at the lower pressures.
- A similar H^- and D^- negative ion yield (up to 6×10^{15} m^{-3}; under the present conditions) is achieved.
- For equal plasma densities an isotope effect is exhibited showing higher H^- density over the entire pressure range.
- The n_{H^-} / n_e ratio is constantly higher than the n_{D^-} / n_e one and they both peak around 1.33 Pa.

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