MEASUREMENTS OF THE ABSOLUTE DENSITY OF GROUND STATE RO-VIBRATIONALLY EXCITED D_2 MOLECULES IN AN ECR-DRIVEN PLASMA BY MEANS OF SYNCHROTRON RADIATION

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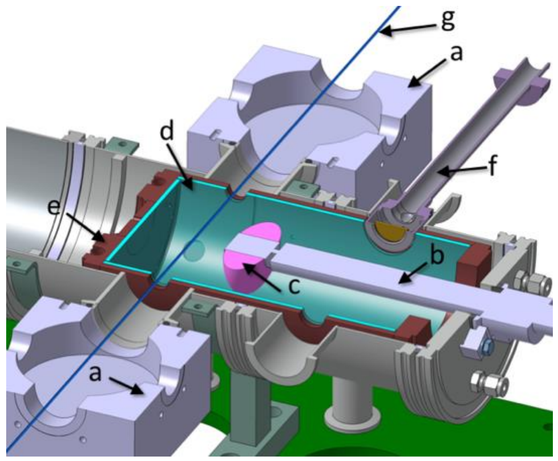
Introduction

The present work is devoted to the direct probing of highly ro-vibrationally excited molecules of the D_2 ground state. A D_2 plasma is studied in the ECR-driven source SCHEME II+ which is coupled to the VUV Fourier Transform Spectrometer at the DESIRS beamline of the SOLEIL synchrotron (Saint-Aubin, France). Absorption spectra are recorded in different operational conditions, i.e. for pressures ranging from 1 – 36 mTorr, under constant microwave power (150 W). Both bare Quartz and fresh in-situ magnetron sputtered thin films of tantalum (Ta) and tungsten (W) upon the Quartz surface are investigated.

Experimental Setup



Schematic representation of the SCHEME II+ setup: (a) Differential pumping unit; (b) plasma source; (c) ECR coupling zone; (d) Quartz surface; (e) Copper temperature regulated part; (f) magnetron sputtering cathode (Angstrom Sciences™); (g) Synchrotron Radiation beam

Concept

Volume production → Dissociative Attachment: $D_2\left(X^1\Sigma_g^+; v"\right) + e\ (< 1\ eV) \rightarrow D + D^-$

Electron excitation and radiative decay (EV)

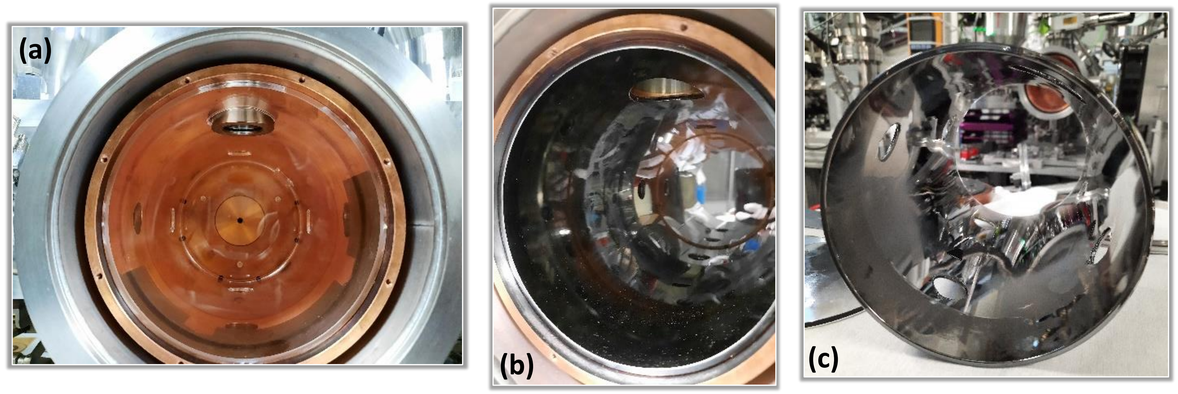
$D_2\left(X^1\Sigma_g^+;\ v_i\right) + e \rightarrow D_2(B^1\Sigma_u^+, C^1\Pi_u) + e$

$\rightarrow D_2\left(X^1\Sigma_g^+;\ v_f\right) + e + hv, \qquad v_f > v_i$

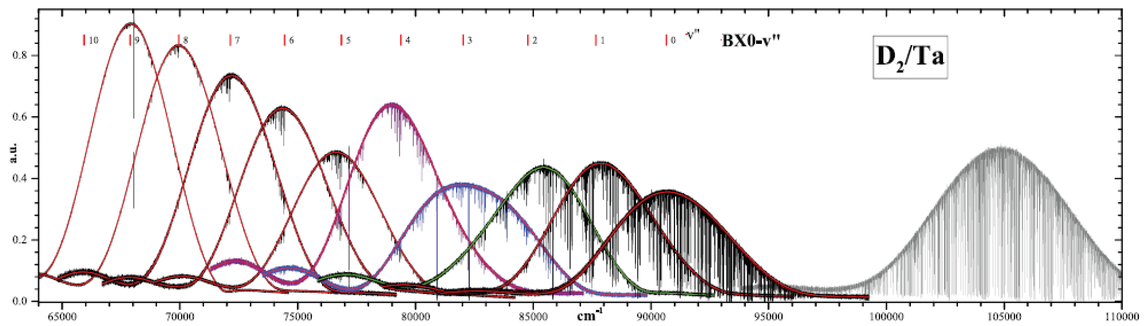
Recombinative Desorption

$\boldsymbol{D + D_{surface} \rightarrow D_2\left(X^1\Sigma_g^+; v"\right)}$

It is therefore interesting to study the effect of various plasma-facing materials on the production of highly ro-vibrationally excited molecules. Here, in situ magnetron sputtered thin films of Ta and W are investigated in addition to a bare Quartz surface.



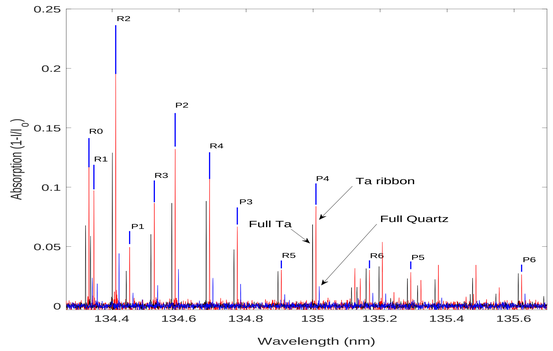
Photograph of: (a) the interior of SCHEME II+ with the magnetron cathode in position for the sputtering procedure; (b) the source interior after 70 min of Ta deposition; (c) the quartz cylinder outside the source on which the result of a 90 min Ta deposition can be seen.



Representative example of a raw spectrum recorded by the VUV-FTS for ten undulator settings in the 64000-96000 cm^{-1} energy range from BX09 (on the left) to BX00 and an additional range 100000-111000 cm^{-1} for the D Lyman series (on the far right)[1].

Preliminary Results

- Previously, it has been demonstrated that with the use of bulk material the yield of ro-vibrationally excited molecules is enhanced. This is justified by the higher intensity of the recorded absorption spectra in the corresponding conditions as seen in the figure below.
- Partial Ta coverage of the quartz surface appears to be more efficient.



Absorption spectra of the BX0-6 band for three different plasma-facing conditions (Full bare Quartz, Full Ta, and Ta ribbon accounting for 20% coverage)

- On the contrary, the use of in situ magnetron sputtered material does not lead to similar observations, i.e. preliminary processed spectra show that there is little to no variation in comparison with the reference bare Quartz surface. This matter is currently under scrutiny.

References

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