Metastable Molecules in O_2 Plasmas probed by High-Resolution Fourier Transform Absorption Spectroscopy

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DC glow discharges in pure oxygen were studied by high resolution (~10^6) VUV absorption spectroscopy using synchrotron radiation and a Fourier Transform Spectrometer. O_2(X), O_2 (a), O_2 (b) and ground state O atoms were observed, allowing their absolute densities to be determined as a function of gas pressure and discharge current.

1. Introduction

Electrical discharges in oxygen-containing gases are found widely in nature and are used for many industrial processes including etching, polymer stripping and surface cleaning as well as for sterilization and other biomedical applications. Metastable molecules (a $^1\Delta_g$ and b $^1\Sigma_g$) and atomic oxygen produced in such plasmas play a vital role in the plasma characteristics. Since they destroy O^- negative ions by associative detachment reactions, they have a strong effect on the plasma conductivity and reactivity. They are principally lost by reactions at the chamber walls, but the surface reaction coefficients are poorly known, limiting the predictive power of models.

Vacuum ultraviolet absorption spectroscopy is a promising technique for detecting these transient species. However, their VUV spectrum has not been measured since Ogawa et al. [2,3] in the 1970's. We have used the excellent spectral resolution (~10^6) and accuracy of the DESIRS VUV Fourier-Transform (FTS) branch at synchrotron Soleil [1] to revisit these measurements. Combining with spectral simulations we can identify the best transitions for future time resolved kinetic measurements on the monochromatic branch of the DESIRS beamline.

2. Experimental Setup

The DC discharge was excited in a 40cm long, 1.2 cm id Pyrex tube with water cooling and stainless steel electrodes and MgF_2 windows to transmit the VUV beam. The transmitted light in the region 120-170 nm is analysed with the FTS [1].

3. Results

Fig 1 compares our results with the spectra of Ogawa et al. O_2 X, a and b bands are observed, with high resolution, allowing the rotational temperature to be determined. The O_2 X and a state densities were determined using the data of Ogawa.

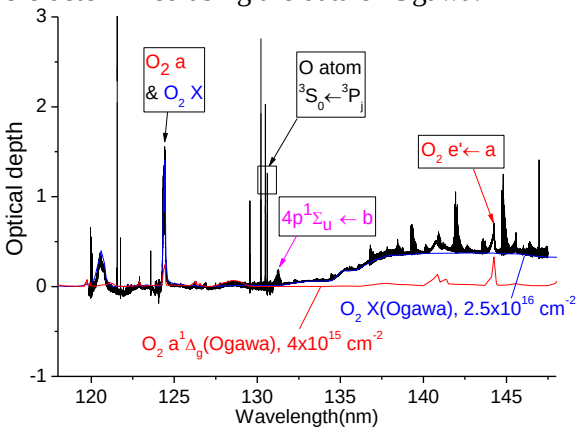

Fig.1. Absorption spectrum of 50 mA discharge, 10mBar He + 0.05mBar O_2

4. Conclusions and perspectives

New high resolution VUV absorption spectra for a $^1\Delta_g$ and b $^1\Sigma_g$ molecules and atomic oxygen are reported. In the future we will perform kinetic measurements using modulated current.

5. Acknowledgments

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6. References

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