XUV Photochemistry in doped ice films on astrophysically relevant substrates

T. Suhasaria, B. Siemer, N. Heming, H. Zacharias
Physikalisches Institut, Westfälische Wilhelms Universität, 48149 Münster, Germany

Introduction

Photo chemically triggered reactions on dust grains are considered to be a major source of molecule formation in interstellar clouds. These grains typically consist of graphitic and silicate particles and are possibly embedded in icy mantles [1] doped with several molecules such as carbon monoxide (CO), carbon dioxide (CO_2), methanol (CH_3OH) and different compounds of PAHs (polycyclic aromatic hydrocarbons). Radiative interactions may occur in region of new born stars at low temperatures and low density.
The processes can be shown in the figure. Experiments have been done with UV radiation and investigation of reactions with XUV-radiation from FLASH in Hamburg are aimed at. The results of the experiments will provide a more detailed insight into the initial stages of molecule formation and the potential for the development of biologically relevant molecules.

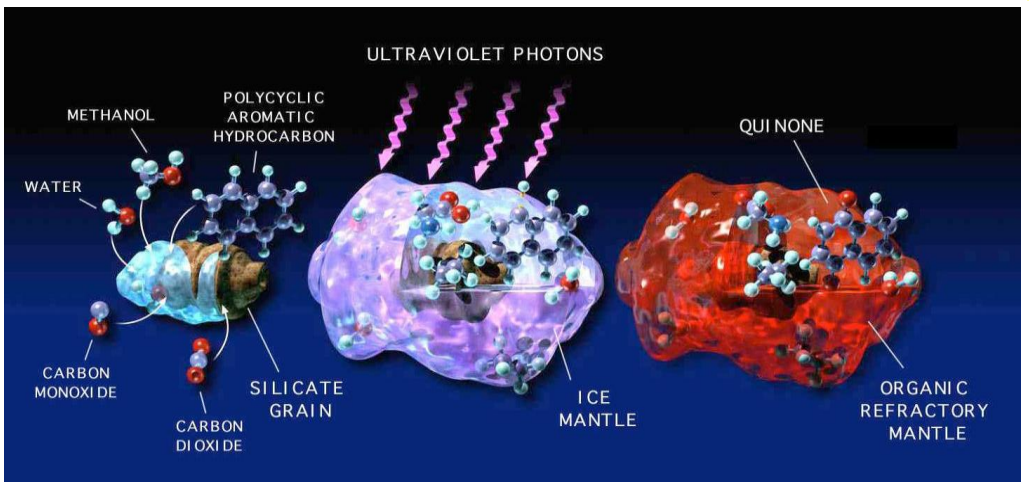


Figure 1. UV irradiation of ices involving both simple and more complex molecules [2].

Summary of works done in our group

Our group have already studied the light-induced desorption of atomic hydrogen from HOPG and also observed photochemical reactions in ice surfaces of D_2O on HOPG due to XUV radiation at FLASH in Hamburg [3].
In our laboratory we use temperature programmed desorption (TPD) to investigate the binding energies of relevant molecules for different coverages on model substrates such as HOPG (highly ordered pyrolytic graphite) or Olivine ($(Mg, Fe)_2 SiO_4$) as an analogue for interstellar dust particle cores. The samples are placed on a helium cryostat to provide low temperatures down to 5 Kelvin [4].

First Experiments

I have started working on Thermodesorption experiments. These experiments characterize the prepared surfaces by giving an insight into the binding energies of the different adsorbates and possible thermal reactions. Kinetic modelling of reactions occuring in the adsorbates can also be adjudged.
The set up of the instrument is as follows:

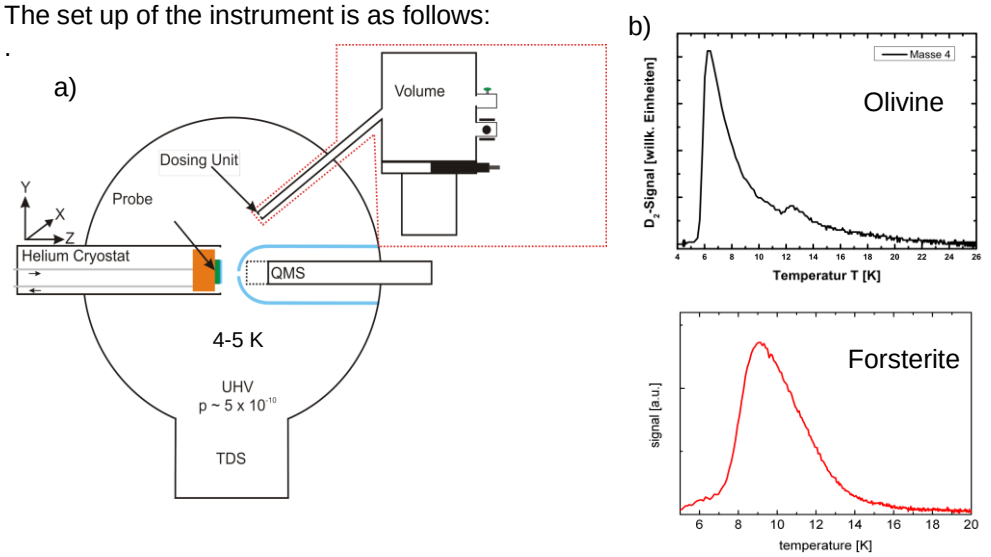


Figure 3(a). Layout of the TDS instrument showing different components. (b). TDS spectra of D2 cover olivine & Forsterite respectively.

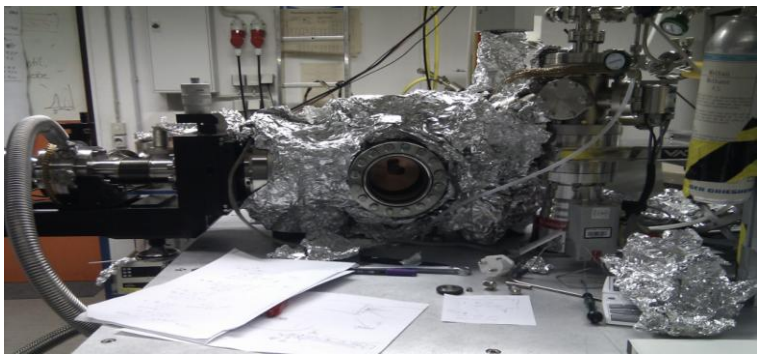


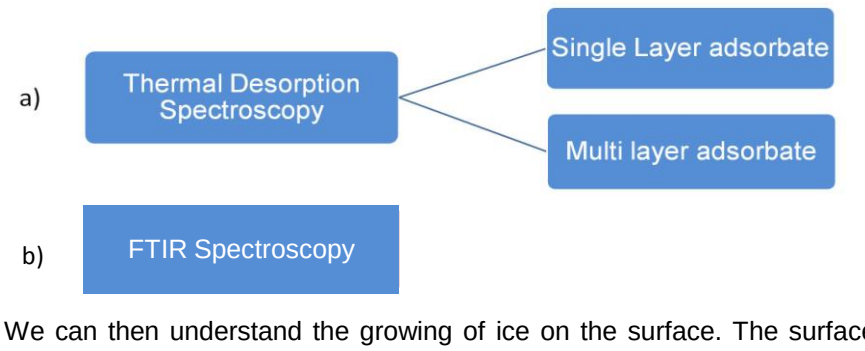
Figure 2. Set up of Thermal Desorption Spectroscopy

Future Experiments

The future experiments that will be carried out can be classified in three categories:

1. Characterization of the prepared surface.
2. Doping of the ice over the surface.
3. Interaction of the prepared with sources of light.

❖ As regard to the characterization of surfaces the techniques used will be:



We can then understand the growing of ice on the surface. The surfaces used will be **Olivines** ($(Mg,Fe)_2 SiO_4$), **Forsterite** (Mg_2SiO_4), Graphite and/ or Graphene. We choose these surfaces to simulate the carbonaceous and siliceous grain particles in the interstellar medium.

❖As regard to the doping of the surfaces we use dopants like CO, CO_2,NH_3 and small PAHs like Coronene and Hexapericoronene.

❖For the interaction of the prepared surfaces the sources of light used will be XUV and Femtosecond Laser.

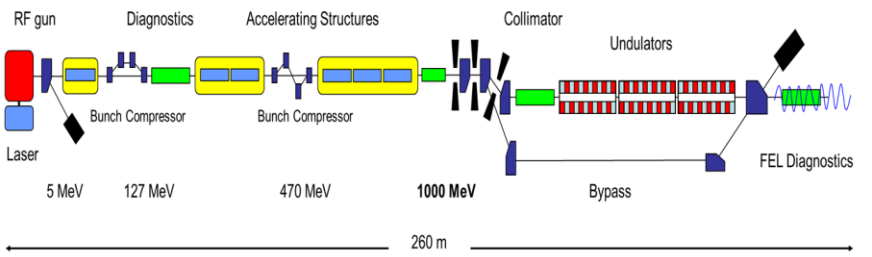


Figure 4. Layout of the FLASH Machine producing XUV radiation in Hamburg

References

(1) D.A. Williams, E. Herbst, Surf. Sci. **2002**, 500, 823.

(2) M.P. Bernstein et al. Sci. Am. **1999**, 26.

(3) B.Siemer et al. **2010**, 22, 084013

(4)N. Heming, Diploma Thesis (**2011**)

Acknowledgements

The entire project is funded by **LASSIE**(**L**aboratory **A**strochemical **S**urface **S**cience **i**n **E**urope) **FP7** (Seventh **F**ramework **P**rogramme) **ITN** (**I**nitial **T**rainning **N**etwork).
Additional funding is provided by **BMBF** via FSP 301 “FLASH”