Photon impact on condensed acetone: Astrochemical Implications

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Introduction

Acetone is an important precursor of more complex organic molecules, which can lead to prebiotic species. Acetone was the first 10 atom molecule observed in the interstellar medium found in the direction of Sgr B2 molecular cloud[1]. This kind of astronomical environments is highly subjected to ionizing agents, like UV and X-ray photons, charged particles such as protons, alpha particles and electrons, leading to ionization, dissociation and desorption processes.

The proposed mechanism for the formation of interstellar acetone involves grain mantle chemistry where gas phase CO molecules condense on the surface of interstellar grains[2]. The interaction of stellar radiation and charged particles with the icy surfaces of interestellar grains produces neutral or ionic fragments such as HCO, CH_3O, CH_3OH_2, H_2CO and H, C and O free atoms. At surface temperatures around 50 K these radicals can readily diffuse to react with surface CO molecules leading to acetone and other complex organic molecules that can desorb to the gas phase[3].

To understand the chemical evolution and to quantify the role of acetone and more complex organic molecules in the gas phase and in the icy mantles of interstellar grains, it is necessary to establish the main formation routes, which require the study of the ionization, dissociation and desorption processes of these molecules caused by the interaction with ionizing agents.

Results and Discussion

We have employed soft X-ray photons at the oxygen and carbon 1s-edge to simulate the effects of stellar radiation field on astrophysical ices. The experiments were carried out at the Brazilian Synchrotron Light Source (LNLS), using the Spherical Grating Monochromator (SGM) beam line. The ions produced from 10K acetone ices were mass/charge analyzed by time-of-flight mass spectrometry (TOF-MS) and the main desorbed fragments were CO^+, HCO^+, O^+ and $CO2^+$.

The photostability of the acetone ices were tested by exposing the ices to different soft x-ray doses (5-50 min). The *in situ* analysis was performed by Near-edge X-Ray Absorption Fine Structure (NEXAFS). The photodissociation cross-section and half-live were determined and interpreted in terms of astrophysical implications.

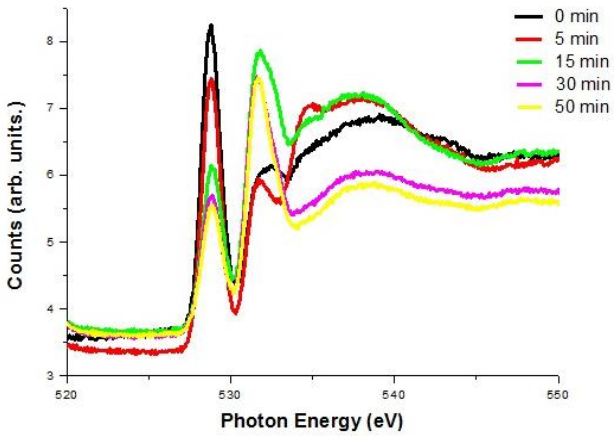

Figure 1. Photostability of acetone ice due to soft X-ray exposure as a function of time.

Conclusions

Several ionic fragments have been identified and their desorption rate per impact were determined. Photodissociation cross sections and half-lives were determined and extrapolated to astrophysical environments. These data can be helpful to establish more accurate astrochemical models.

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