Photochemistry on the International Space Station: A study of the effects of the solar electromagnetic radiation on organic refractory samples

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In the outer solar system, spectroscopic evidences show that ices cover the solid objects such as the Trans Neptunian Objects (TNO) and the cold satellites of giant planets. N_2, CH_4, CO, CO_2, C_2H_6, and the often dominant H_2O are some of the icy molecules already identified [1]. These ices are continuously exposed to the ultraviolet and ion irradiation causing the chemical rearrangement of the molecular bonds and the formation of new molecular species. Laboratory experiments show that refractory organic residues are formed after ion irradiation or UV photolysis of simple icy mixtures containing C, N, and O [2]. These residues remaining after all the icy species have sublimed contain the triple CN bonds that are considered relevant to the pre-biotic chemistry [3].

Here we present the contribution of our group to the ESA project called "*Photochemistry on the Space Station*" (PSS). The samples that we produced in our laboratory (LASp – Catania) consist in the refractory materials formed by irradiating with 200 keV He^+ icy mixtures N_2 : CH_4 : CO (1 : 1 : 1) at 16 K. This mixture is representative of the icy molecules present on the surface of TNO [4]. After the irradiation, the refractory residues remain on the sample holder substrates (MgF_2 windows furnished by European Space Agency) up to room temperature. Infrared spectra of these residues confirm that these samples contain different chemical groups, including triple C≡N bonds.

Since August 2014, some of these samples are on board the International Space Station (ISS) in the EXPOSER2-Facility exposed to the solar electromagnetic radiation [5-6]. The aim of this experiment is to study the effects of the solar photons on the organic samples. The end of this experiment is scheduled for the late 2015 when the samples will come back to Earth and analyzed in detail in our laboratory.

In this work, we present also a preliminary analysis of the temporal evolution of the organic residues guarded in our laboratory at room temperature and pressure. For some refractory residues we collected several spectra in a time frame of about 1000 days and we investigated how the intensity of the bands naturally evolve over time. We noticed that the amplitude of the multi-peaked band distinctive of CN double and triple bonds undergoes a slow natural decay over time. This analysis is very important for comparison with the samples exposed to the radiation during the ISS journey to disentangle the effects of the solar radiation from the natural degradation.

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