PET Degradation in the Martian Environment: Implications for the detectability of Organics on the surface of Mars.

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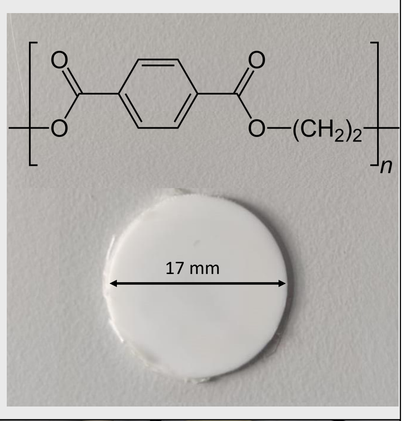
Introduction

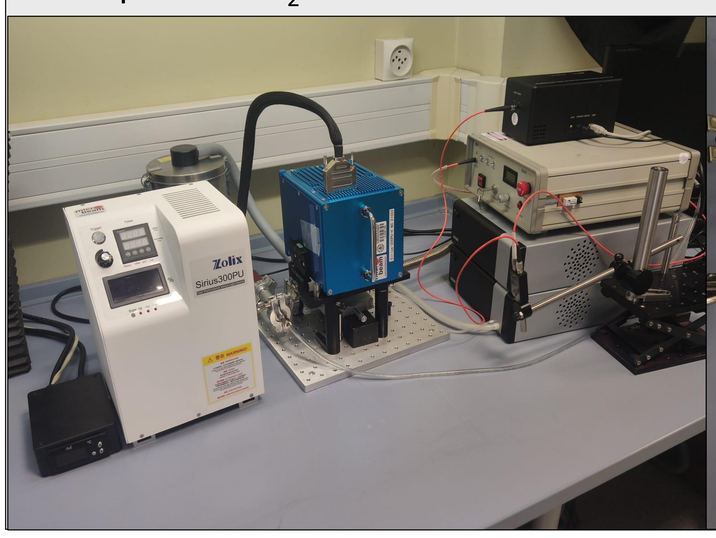
Understanding the evolution of organic molecules is crucial in the field of space missions like Mars 2020. The atmospheric and climatic conditions of Mars present challenges for the preservation of these organic molecules. Due to the absence of an ozone layer in its atmosphere, the amount of UV radiation reaching Mars is higher than that on Earth's surface, thereby altering their characteristics and composition.

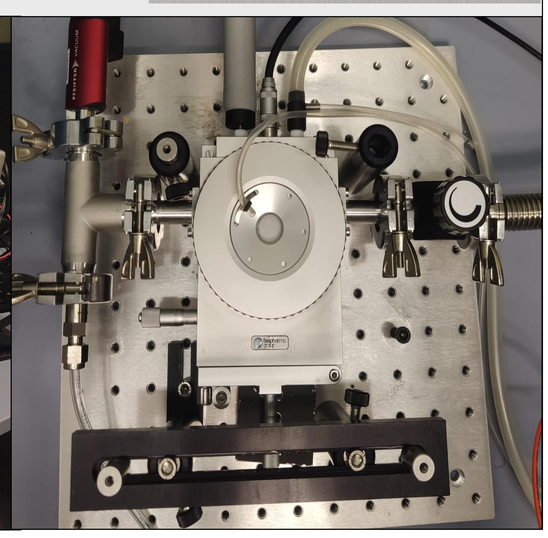
By studying the degradation of PET caused by UV radiation, valuable information about the stability of organic matter in the Martian environment can be obtained. This study focuses on characterizing the degradation mechanisms that occur in a PET sample due to UV radiation, influenced by ambient temperature.

Materials and Methods

The material is a polymer PET Ertalyte, similar to the one used on the NASA Mars2020 SuperCam instrument Calibration Targe. The set up parameters have been designed and characterized. PET samples are irradiated with different doses at a temperature of 0 ºC and -50 ºC in an inert atmosphere of N_2.







Experiments conducted in this study

The main objective is to evaluate the influence of ambient temperature on the UV degradation process of PET. For this purpose:

1. The experimental device has been designed, assembled and characterised.
2. The thermal influence on the Raman spectral measurements has been verified.
3. The variability of the Raman spectra in the UV degradation of PET influenced by the ambient temperature has been studied.

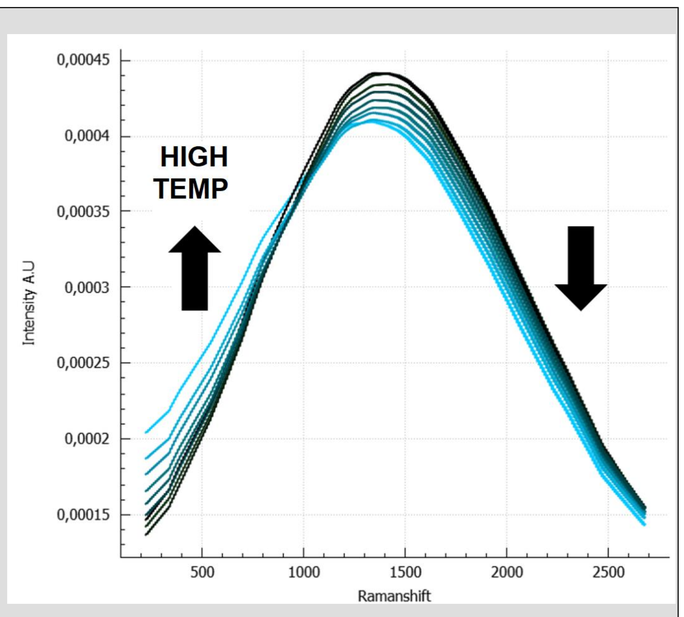
Conclusions

- A laboratory system has been configured, allowing for control of the ambient temperature, atmosphere, UV and a Raman spectrometer setup for acquiring spectra under the sample's ambient conditions.
- Increasing the ambient temperature of the sample induces changes in the intensity of the luminescence background.
- The results obtained have shown that the degradation rate caused by UV radiation increases as the temperature rises. This finding demonstrates how seasonal temperature changes on Mars can affect the rate of PET degradation.

Results

Exploring the Effect of Temperature on PET Spectral Measurements:

Increasing temperature in steps of 10˚C reveals the emergence of maximum signals at higher temperatures in low spectral regions, while maximum background values shift to lower temperatures in high spectral regions.

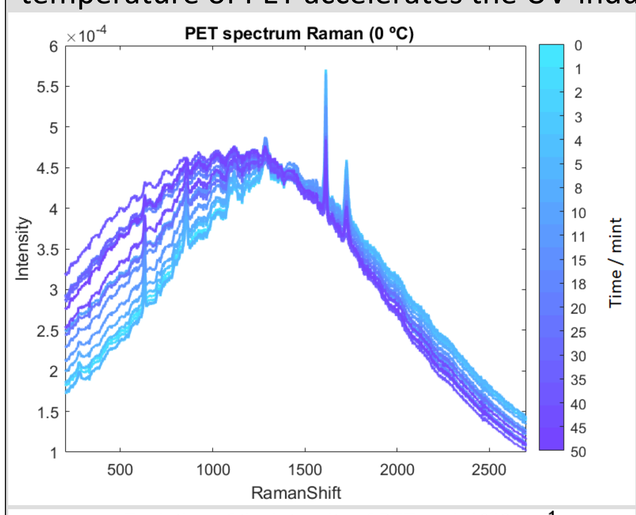


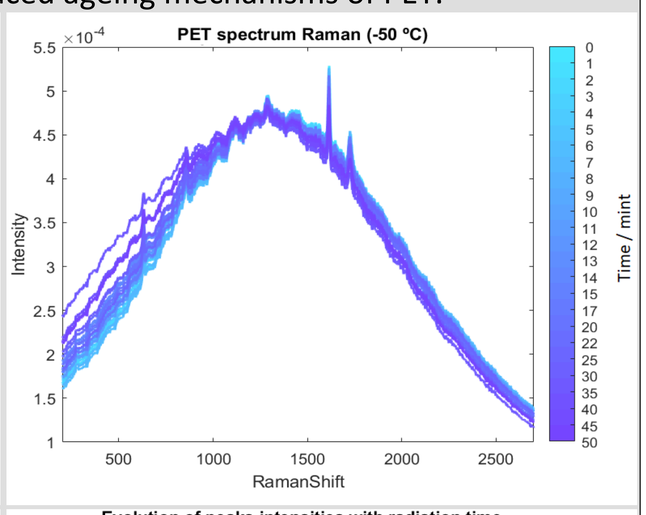
Verification of photodegradation:

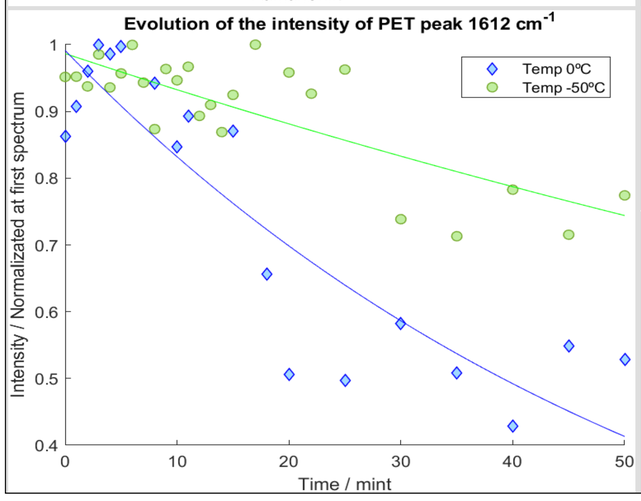
In the verification of photodegradation, it was shown that the observed spectral changes are attributed to UV radiation. By using UV-blocking glass slides, it was confirmed that the variations are not due to IR-induced heating but solely caused by the presence of UV radiation. However, a high level of heating caused by IR can increase the degradation speed by UV.

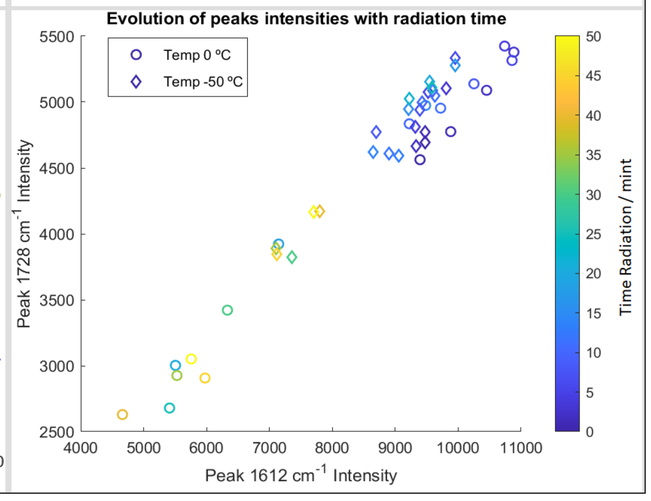
Evolution of the luminescence profile of UV-induced degradation in PET :

The variations in the luminescence profile are more marked as the ambient temperature of the sample is higher. At higher temperatures, the peak intensity decreases more rapidly, indicating a lower signal due to degradation. Furthermore, the ratios between the two strongest peaks follow a linear trend, indicating that they vary in the same proportion. It is noteworthy that the peak intensities at higher temperatures reach lower levels. It is demonstrated how increasing the ambient temperature of PET accelerates the UV-induced ageing mechanisms of PET.









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