Detection of nucleotides adsorbed onto clay by UV Resonant Raman spectroscopy: a step towards the search for biosignatures on Mars

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The payload of Mars 2020 space mission includes a deep UV resonance Raman and fluorescence spectrometer SHERLOC dedicated to the detection of luminescence and Raman signal of condensed carbon and aromatic organics that could potentially be biosignatures. Among minerals detected on Mars surface, phyllosilicates exhibit a strong affinity to organic molecules, including nucleotides, which adsorption mechanisms onto clay minerals have been well documented, whilst there is a lack of an overview of Raman studies of organics adsorbed onto phyllosilicates.
Here, we used a deep UV resonant Raman setup to track down the signature of the nucleotide desoxyguanosine- 5'-monophosphate (dGMP) adsorbed onto selected minerals, pyrophyllite, chlorite, nontronite and montmorillonite. Excitation with a 244 nm laser indeed avoids luminescence of natural phyllosilicates and enhances the Raman signal of the organic molecule chosen here as a model biosignature. However, the deep UV energy of the laser focused onto the samples may induce severe photo-damage to the organic compound without adequate precaution. We used the Raman signature of dGMP to characterize deep UV effect after an irradiation of several minutes (8 - 260 mJ) until a stable spectroscopic signal is detected and could show that it is sensitive to minute amount of dGMP and adsorption mechanism.
The effect of widespread oxidants such as perchlorate on the Martian surface is also investigated here because of potential implication in the degradation of nucleotides under UV irradiation. In this study, we also discuss the strategy for the detection and preservation of adsorbed biomolecules onto clay surfaces.

Keywords: Deep UV resonant Raman spectroscopy, nucleotides, biosignature, adsorption

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