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Surface-enhanced Raman spectroscopy (SERS) for identifying traces of adenine in different mineral and rock samples

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Abstract

The aim of this study is to analyze the potentials of SERS as a technique for in-situ identification of life traces in Mars surface explorations using the Raman instrument (RLS), payload of the ESA Mars mission Exomars. This preliminary study focused on detection of adenine on a variety of rocks soils samples using macro-SERS detection.

1. Introduction

The Raman instrument (RLS), payload of the ESA Mars mission Exomars, will analyze the mineralogy of surface and subsurface materials. In this current implementation the instrument could detect organic traces indicative of the presence of life but due to low concentration, other techniques could be used to complement it. Surface-enhanced Raman spectroscopy (SERS) has been shown [1, 2] to provide this capability.

SERS is based on the enhancement of the Raman scattering intensity by molecules that have been adsorbed onto specifically prepared metal colloids. SERS is both surfaces selective and highly sensitive whereas Raman spectroscopy is neither.

This work consists in a preliminary study of the potential of SERS as a life detection method in planetary surface exploration. The focus of this study is the detection of low concentrations of adenine on a variety of rock and soils surfaces.

2. Experimental conditions

Test samples were prepared using powder materials (calcite, basalt and clay) and rock surfaces (olivine sample and carbonate sample) on which a drop of adenine solution at concentrations of 10^{-3} and 10^{-5} mol/l was deposited and allowed to dry. Silver colloid was prepared following the Lee and Meisel method [3] and a drop was placed on top of each surface sample and dried before analysis. Samples were then analyzed using a BWTEK i-Raman BWS415-532 with a laser diode of 532 nm, 40mW, spectral resolution of 5 cm^{-1} and a Raman head probe BWTEK BAC100; 8.1 mm focal distance; 105 µm laser spot.

3. Results

Raman spectra were collected on every sample with adenine before and after the silver colloid addition. The presence of adenine is observable by the 735 cm^{-1} peak. This peak corresponds to the breathing mode of the entire molecule. Before colloid addition, adenine is never detected (spectra no shown).

In Figure 1 the SERS spectra collected from powder samples with adenine after the colloid addition are shown. Adenine peak is detected in all of them.

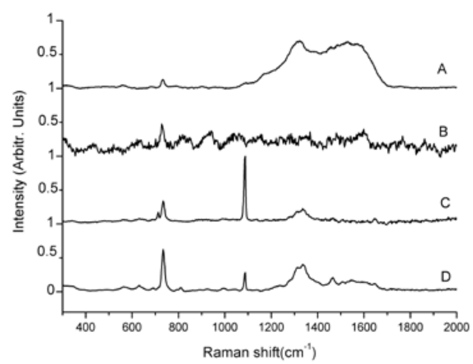

Figure 1: SERS spectra of powder samples with adenine after colloid addition. A) basalt with adenine 10^{-5} mol/l , B) clay with adenine 10^{-3} mol/l, C) calcite with adenine 10^{-5} mol/l, D) calcite with adenine 10^{-3} mol/l.

In figure 2, experiments carried out on rock samples are shown. Adenine peak is detected again in each sample.

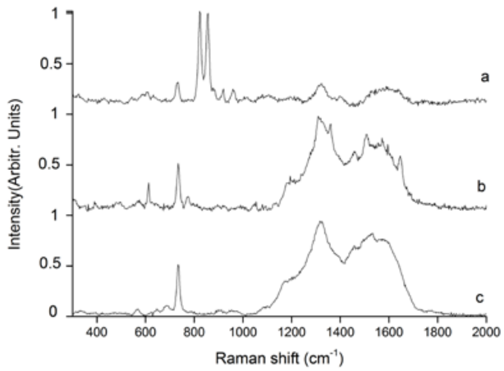

Figure 2: SERS spectra of rock samples with adenine after colloid addition. a) olivine rock with adenine 10^{-5} mol/l. b) carbonate rock with adenine 10^{-5} mol/l, c) carbonate rock with adenine 10^{-3} mol/l.

4. Conclusions

The potential of SERS for detecting traces of adenine in powder materials or rock surfaces has been shown. This is the first step to study the capability of SERS as a tool for detecting traces of life in planetary explorations. The next step will be to continue this study using the Exomars Simulator developed by this laboratory to emulate the conditions in the Mars mission Exomars and to study the possible implementation of the SERS technique in the instrument.

References

[1] Caporali, S., Moggi-Cecchi, V., Muniz-Miranda, M., Pagliai, M., Pratesi, G., Schettino, V.: SERS investigation of posible extraterrestial life traces: Experimental adsorption of adeninde on Martian meteorite. Meteoritics and planetary Sciences 1-8, 2012.

[2] El Amri, C., Baron, M, Maurel, M.: Adenine and RNA in mineral samples. Surface-enhanced Raman spectroscopy (SERS) for picomole detections. Spectrochimica Acta Part A, 59, pp. 2645-2654, 2003.

[3] Lee, P. C., Meisel, D.: Adsorption and surface-enhanced Raman of dyes on silver and gold sols. Journal of Physical Chemistry, 86, pp. 3391-3395, 1982.