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# Raman spectrometry as a valuable technique for characterizing Europa's surface

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## Abstract

Raman spectrometry is a spectroscopic technique that relies on the inelastic scattering of a monochromatic light used as excitation. It provides useful information about the vibrational, rotational and other low-frequency modes of the systems under study. This information from these modes turns out to be specific for the chemical bonds in the system, providing a particular fingerprint by which the compounds in the system can be unambiguously identified.

Within this context, Raman spectroscopy has been shown to be a very sensitive method to investigate mineral chemical composition. It is a powerful technique to identify minerals on the planetary surface and is advantageous to majority of other analytic techniques.

Using Raman spectroscopy analysis, we are able to detect trace chemical groups on the surface and inside mineral crystals, or study depth profiles of the crust samples to understand the environmental protection and stress effect.

Another interesting advantage of this technique is that it can be used with solid, liquid or gaseous samples, as well as no sample preparation is needed. The molecular identification from samples without extraction or introducing solvent or other chemical species helps us understand the geochemical and environment settings. Combined morphological feature with chemical stability and relative abundance help us understand how extreme geochemical environments affect constituent elements.

Besides the unambiguous identification of species (organic molecules are in the range of 500-2000 $cm^{-1}$), Raman spectrometry is able to identify the phase of the elements, accomplish temperature measurements and identify the crystallographic orientation of the samples. It provides high spatial resolution that resolves morphology controversies as well as allows us to get not only the nature but also the spatial distribution of the constituent. On the other hand, it is also possible to analyze the evolution in time of the samples given the possibility of getting quick acquisitions.

On the basis of what has been mentioned so far, Raman spectrometry shows to be one of the most useful tools as contact instrument for exploring and characterizing planetary surfaces, such as Europa's surface. These aspects, exploration and characterization of the surface, are critical if one of the main goals of the possible mission to Europa still is to characterize this moon as a planetary object and its potential habitability from the astrobiological point of view. Analyzing the surface environment is the only way to get a high-science return on that field. In that sense, Raman spectra will be an important contribution to the measurements of the key habitability parameters, such as temperature, pH, electrical conductivity, radiation conditions and redox couples, among others.

These spectra may also be useful in stating what organic molecules are present and directly related to plausible past and/or forms of life. This point is based on the capability of the Raman spectroscopy to discriminate and characterize the possible inclusions of CHONPS elemental compounds in those ices.

It is also worth to mention that the aggressive environment on the surface of that moon also impose big constraints on the technology to be deployed: the opto-electro-mechanical design of the spectrometer will require to be as simple as possible in order to comply with those constraints.