Abstract

In 2018 ESA and NASA plan to send the ExoMars rover to the Martian surface. This rover is planned to have a suite of analytical equipment that includes a Raman spectrometer. In this context, an evaluation of Raman spectroscopy as an analytical tool for interplanetary studies is investigated. The preparation techniques for appropriate inorganic and organic mixtures are interrogated. Methods are investigated to optimize the homogeneity of over 50 samples involving mineral phases; calcite, gypsum and goethite and selected organic biomolecular systems; anthracene, naphthalene and beta-carotene. From mixtures produced of these organic and inorganic materials differences between homogeneity of the samples is observed. Different mixing techniques are investigated to reduce this, however all the samples display variation on a micron scale. To resolve this issue a grid system of 9 points is implemented on solid samples and solutions are used to produce standards. The standards are devised using a range of instrument validation parameters for comparison between commercially available spectrometers and the prototype instrument. From these standards a prototype instrument is optimized for data acquisition and an evaluation procedure for instrument performance is established. The prototype Raman spectrometer is evaluated to match the specifications of the spectrometer on board ExoMars rover. A range of astrobiological relevant samples are interrogated; geological samples, biomarkers, cellular systems and bio-geological inclusions. From these samples detection of organics is observed to be only possible, with Raman spectroscopy where organics are localised in high concentrations, upon grinding and mixing geological inclusions Raman spectroscopy is unable to detect the organic components.

Key words; Raman Spectroscopy, Astrobiology, Space Exploration, Biomaterials, Geomaterials and Instrumentation