



Time Resolved Raman and Fluorescence Spectrometer for Planetary Mineralogy

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Raman spectroscopy is a prime candidate for the next generation of planetary instruments, as it addresses the primary goal of mineralogical analysis which is structure and composition. It does not require sample preparation and provides unique mineral fingerprints, even for mixed phase samples. However, large fluorescence return from many mineral samples under visible light excitation can seriously compromise the quality of the spectra or even render Raman spectra unattainable. Fluorescence interference is likely to be a problem on Mars and is evident in Raman spectra of Martian Meteorites[1]. Our approach uses time resolution for elimination of fluorescence from Raman spectra, allowing for traditional visible laser excitation (532 nm). Since Raman occurs instantaneously with the laser pulse and fluorescence lifetimes vary from nsec to msec depending on the mineral, it is possible to separate them out in time. Complementary information can also be obtained simultaneously using the time resolved fluorescence data.

The Simultaneous Spectral Temporal Adaptive Raman Spectrometer (SSTARS) is a planetary instrument under development at the Jet Propulsion Laboratory, capable of time-resolved in situ Raman and fluorescence spectroscopy. A streak camera and pulsed miniature microchip laser provide psec scale time resolution. Our ability to observe the complete time evolution of Raman and fluorescence in minerals provides a foundation for design of pulsed Raman and fluorescence spectrometers in diverse planetary environments.

We will discuss the SSTARS instrument design and performance capability. We will also present time-resolved pulsed Raman spectra collected from a relevant set of minerals selected using available data on Mars mineralogy[2]. Of particular interest are minerals resulting from aqueous alteration on Mars. For comparison, we will present Raman spectra obtained using a commercial continuous wave (CW) green (514 nm) Raman system. In many cases using a CW laser the strong mineral fluorescence saturates the detector and Raman spectra are unattainable. This problem is overcome by using time resolved Raman where fluorescence is eliminated.

[1]Frosch et al., Anal. Chem. 2007, 79, 1101-1108

[2]Bell, J.,ed, The Martian Surface: Composition, Mineralogy, and physical Properties, Cambridge University Press, 2008