American Geophysical Union, 2015 National Meeting

Advances in Raman spectroscopy for *in situ* identification of minerals and organics on diverse planetary surfaces: from Mars to Titan

J. Blacksberg, E. Alerstam, Y. Maruyama, C. Cochrane, Jet Propulsion Laboratory, California Institute of Technology
G.R. Rossman, California Institute of Technology, Division of Geological and Planetary Sciences

We present recent developments in time-resolved Raman spectroscopy for *in situ* planetary surface exploration, aimed at identification of both minerals and organics. Raman is a non-destructive surface technique that requires no sample preparation. Raman spectra are highly material specific and can be used for identification of a wide range of unknown samples. In combination with micro-scale imaging and point mapping, Raman spectroscopy can be used to directly interrogate rocks and regolith materials, while placing compositional analyses within a microtextural context, essential for understanding surface evolutionary pathways. Due to these unique capabilities, Raman spectroscopy is of great interest for the exploration of all rocky and icy bodies, for example Mars, Venus, the Moon, Mars' moons, asteroids, comets, Europa, and Titan.

In this work, we focus on overcoming one of the most difficult challenges faced in Raman spectroscopy: interference from background fluorescence of the very minerals and organics that we wish to characterize. To tackle this problem we use time-resolved Raman spectroscopy, which separates the Raman from background processes in the time domain. This same technique also enables operation in daylight without the need for light shielding. Two key components are essential for the success of this technique: a fast solid-state detector and a short-pulse laser. Our detector is a custom developed Single Photon Avalanche Diode (SPAD) array, capable of sub-ns time-gating. Our pulsed lasers are solid-state miniature pulsed microchip lasers. We discuss optimization of laser and detector parameters for our application. We then present Raman spectra of particularly challenging planetary analog samples to demonstrate the unique capabilities of this time-resolved Raman instrument, for example, Mars-analog clays and Titan-analog organics.

The research described here was carried out at the Jet Propulsion Laboratory, California Institute of Technology, under a contract with the National Aeronautics and Space Administration (NASA).