Laser-Induced Fluorescence Spectroscopy of Martian mineral analogues

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Identification of methane (Freissinet et al. 2015) and hydrated salts (Ojha et al. 2015) on Mars by NASA have improved our understanding of Martian habitability. A miniaturized fluorescence microscope for detecting extraterrestrial life cell using fluorescence pigments have been under consideration in the Japanese future Mars exploration project (Yamagishi 2011). However, the application of this instrument is limited for the detection of fluorescently-labeled cells and/or organic compounds. This issue would be improved if Laser Induced Fluorescence Spectroscopy (LIFS) is combined with the fluorescence microscope, and planetary geological survey with a high spatial resolution would become possible. This study aims to understand LIFS spectral characteristics of the Martian surface mineral analogues.

We used 14 kinds of minerals. YAG laser was used in the LIFS experiment (wavelength: 355 nm, Laser power: 8 mJ/pulse, pulth width: 5 ns, laser spot size: 8 mm, oscillation frequency: 10Hz). LIFS spectra were measured with a wavelength range of 375-525 nm. Delay time from laser irradiation was 0 ns (gate 150 ns). Streak camera was used for the measurement of fluorescence life time.

Four silicate minerals showed broad spectra with a peak around at 400-550 nm. Five hydrated salts, boric acid, calcium oxide showed a developed peak around 405 nm, which are possibly derived from hydroxyl radicals. Calcium carbonate showed two characteristic peaks at 435 and 458 nm, and sodium tetraborate showed a peak at 435 nm. On the other hand, no fluorescence was detected from iron oxide, that is one of the major components of Martian surface.

The fluorescence lifetimes of the silicates were in decreasing order of talc > kaolinite, zeolite > montmorillonite. The fluorescence lifetime of sodium tetraborate was the shortest, which was distinct from the other minerals. All the hydrated salts had similar fluorescence lifetime.

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