Current status of Life Detection Microscope (LDM) for Mars surface exploration

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Today’s Mars is a cold and dry planet, but ancient Mars would have had a large amount of liquid water on the surface. Several billion years ago, Mars could have been similar to the early Earth from which life arose, and life may have also originated on Mars during this period. Although the Viking mission in 1976, which explored life on Mars, did not find evidence for life [1], many findings associated with the possibility of life have been discovered since the Viking mission: past and present aqueous environments, organic compounds, methane, reduced compounds for microorganism energy sources, and so on [2] [3]. These findings suggest that microorganisms might exist on Mars surface.

For searching extant microorganisms, a microscopic instrument would be a powerful tool, which directly images life forms and identify their shapes, sizes, and other morphological structures, but it has not been used in space missions yet. For *in situ* detection of microbial cells, we have proposed the Life Detection Microscope (LDM) which visualizes organic compounds by staining the samples with fluorescent pigments [4]. The LDM scans a volume of 1 mm^3 and detects organic compounds including cells and other biological materials in high sensitivity ($<10^4$ cells per gram clay). The fluorescent pigments have been selected to identify the fundamental features of cells by differentiating among organic compounds surrounded by membranes or enzyme activity. The LDM is also equipped with a high resolution imaging system (1 μm/pixel) which visualizes detailed life forms as well as regolith and dust particles [5]. Our investigation goals are the followings. 1) Identify cell-like structure in which organic compounds are enveloped by membrane, which may represent Martian life. 2) Search for organic compounds in Mars surface samples. The compounds include cells, other biological materials, and abiotic polycyclic aromatic hydrocarbon (PAH). 3) High-resolution characterization of regolith and dust particles. Here we will report the current status of the development of LDM.

References

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