Planetary In Situ Capillary Electrophoresis System for End-to-End Analysis on Life Detection Missions

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The search for life on extraterrestrial settings can be approached in different ways; for example, by looking for cellular structures, metabolic activity, or at the molecular level by searching for patterns in the organic molecules present. This last approach is particularly powerful as it allows us to look for life as-we-know-it but also for unknown forms. Analysis of patterns in the distributions of organics (biosignatures) can provide powerful evidence to support the claim that a sample has a biotic component. In order to obtain these biosignatures, it is necessary to perform in situ liquid-based analysis and the analysis should include a separation technique. In this context, microchip electrophoresis (ME) is ideally suited for this task and holds unique promise in the search for life on other worlds. Yet regardless of the analytical technique chosen for organic analysis, the use of a liquid-based extraction method is also essential in order to gain access to trace levels of organics that may be present in the samples. The extraction apparatus should be able to receive any type of sample encountered during a mission, including solids, ices, or mixtures thereof, and deliver a liquid extract to the ME system. Hence, we consider the extraction step to be an intrinsic component of any microchip analyzer for planetary exploration. Here we present the Planetary In Situ Capillary Electrophoresis System (PISCES).[1] This instrument couples an extractor and a microfluidic analyzer in order to provide true “Sample-In-Data-Out” functionality.[2, 3] The system was remotely operated aboard a rover during a simulated Mars mission in the Atacama Desert, Chile.[2] Hence, this is the very first demonstration ever of automated analysis of soil samples using an ME-LIF instrument. The development and validation of this system represents a critical step in the advancement of this technology for future implementation on a spaceflight mission.

References

1. Willis, P.; Creamer, J. S.; Mora, M., Implementation of microchip electrophoresis instrumentation for future spaceflight missions. *Anal. Bioanal. Chem.* **2015,** *407* (23), 6939-6963.
2. Kehl, F.; Kovarik, N.; Creamer, J. S.; Da Costa, E. T.; Willis, P. A., A Subcritical Water Extractor Prototype for Potential Astrobiology Spaceflight Missions. *Earth Space Sci.* **2019,** *6*, 2443– 2460.
3. Mora, M. F.; Kehl, F.; Tavares da Costa, E.; Bramall, N.; Willis, P. A., Fully Automated Microchip Electrophoresis Analyzer for Potential Life Detection Missions. *Anal. Chem.* **2020,** *92* (19), 12959-12966.