In-situ Astrobiological Exploration Using an Ultrasonic Sampler and Sensor Platform Based on the USDC

Y. Bar-Cohen, X. Bao, Z. Chang and S. Sherrit
Jet Propulsion Laboratory, Pasadena, CA

ABSTRACT

The search for existing or past life in the Universe is one of the most important objectives of many future NASA missions. To support this objective the development of ultrasonic devices that can serve as a sampler and sensors platform for in-situ astrobiological analysis is currently underway at JPL. These devices are being designed to probe and select sampling sites, collect various forms of samples, and host sensors for measuring chemical/physical properties. The devices are made to drill down to various depths from several centimeters in basalt to several meters in ice. The technology is based on the novel Ultrasonic/Sonic Driller/Corer (USDC), which requires low axial force, thereby overcoming one of the major limitations of planetary sampling in low gravity using conventional drills. The USDC was demonstrated to: 1) drill ice and various rocks including granite, diorite, basalt and limestone, 2) not require bit sharpening, and 3) operate at high and low temperatures. The operation of the device is analytically modeled and investigated for constraints that can affect the use of the USDC as a platform for probing, sampling, sensing, and in-situ analysis. The USDC is being considered for probing sampled materials and the surroundings prior to acquisition in order to optimize the selection of sites with the highest likelihood of containing biological signatures. Methods of acquiring samples in different forms are being studied and the effects of the sampling process are investigated to assure minimum impact on the sample characteristics. Using sensors that are mounted on the bit, including thermocouple and fiberoptics, real time measurements are enabled without concern for cross contamination that may result from sample transfer. These challenges are being investigated both analytically and experimentally and the results will be reported in this paper.