



NASA SBIR 2017 Phase I Solicitation

S4.05 Contamination Control and Planetary Protection

Lead Center: JPL

Technology Area: TA4 Robotics, Telerobotics and Autonomous Systems

A need to develop technologies to implement Contamination Control and Planetary Protection requirements has emerged in recent years with increased interest in investigating bodies with the potential for life detection such as Europa, Enceladus, Mars, etc. and the potential for sample return from such bodies. Planetary Protection is concerned with both forward and backward contamination. Forward contamination is the transfer of viable organisms from Earth to another body. Backward contamination is the transfer of material posing a biological threat back to Earth's biosphere. NASA is seeking innovative technologies or applications of technologies to facilitate meeting portions of forward and backward contamination Planetary Protection requirements as well as analytical technologies that can ensure hardware and instrumentation can meet organic contamination requirements in an effort to preserve sample science integrity.

For contamination control efforts, analytical technologies and techniques for quantifying submicron particle and organic contamination for validating surface cleaning methods are needed. In particular, capabilities for measuring Total Organic Carbon (TOC) at $\ll 40$ ppb or $\ll 20$ ng/cm² on a surface and detection of particles < 0.2 microns in size are being sought. In addition, techniques for detection of one or more of the following molecules and detection level are being needed:

- DNA (1 fmole).
- Dipicolinic acid (1 pg).
- N-acetylglucosamine (1 pg).
- Glycine and alanine (1 pg).
- Palmitic acid (1 pg).
- Squalene (1 pg).
- Pristane (1pg).
- Chlorobenzene (< 1 pg).
- Dichloromethane (< 1 pg).
- Naphthalene (1 pg).

For many missions, Planetary Protection requirements are often implemented in part by processing hardware or potentially entire spacecraft with one or more sterilization processes. These processes are often incompatible with particular materials or components on the spacecraft and extensive effort is made to try to mitigate these issues. Innovative new or improved sterilization/re-sterilization processes are being sought for application to spacecraft hardware to increase effectiveness of reducing bio-load on spacecraft or increase process compatibility with hardware (e.g., toxicity to hardware, temperature, duration, etc.). Accepted processes currently include heat processing, gamma/electron beam irradiation, cold plasma, and vapor hydrogen peroxide. Options to improve materials and parts (e.g., sensors, seals, in particular, batteries, valves, and optical coatings) to be compatible with currently accepted processes, in particular heat tolerance, are needed. NASA is seeking novel technologies for

preventing recontamination of sterilized components or spacecraft as a whole (e.g., biobarriers). In addition, active in-situ recontamination/decontamination approaches (e.g., in-situ heating of sample containers to drive off volatiles prior to sample collection) and in-situ sterilization approaches (e.g., UV or plasma) for surfaces are desired.

Missions planning sample return from bodies such as Mars, Europa, and Enceladus are faced with developing technologies for sample return functions to assure containment of material from these bodies. Thus far, concepts have been developed specifically for Mars sample return but no end-to-end concepts have been developed that do not have technical challenges remaining in one or more areas. Options for sample canisters with seal(s) (e.g., brazing, explosive welding, soft) with sealing performed either on surface or in orbit and capability to verify seal(s), potentially by leak detection are needed. In addition, capability is needed for opening seals while maintaining sample integrity upon Earth return. These technologies need to be compatible with processes the materials may encounter over the lifecycle of the mission (e.g., high temperature heating). Containment assurance also requires technologies to break-the-chain of contact with the sampled body. Any native contamination on the returned sample container and/or Earth return vehicle must be either be fully contained, sterilized, or removed prior to return to Earth, therefore, technologies or concepts to mitigate this contamination are desired. Lightweight shielding technologies are also needed for meteoroid protection for the Earth entry vehicle and sample canister with capability to detect damage or breach to meet a 10^{-6} probability of loss of containment.