Introduction: Biological and organic terrestrial contamination of Martian atmosphere and/or terrestrial space through manned mission and backward biological contamination of earth through returning crew/spacecraft from Martian or any other planet is an issue of serious concern.[1,2] We are proposing an atmospheric pressure plasma based sterilization process to address both forward and backward biological contamination issues associated with both manned as well as unmanned missions.

Applicability of low–temperature or cold plasmas (30-50°C) created in a vacuum (67 Pa), as an effective sterilization source has been demonstrated.[3,4] Current theories regarding the physical basis of cold plasma sterilization are based on the effects of reactive oxygen species.[5] This includes singlet oxygen, atomic oxygen, superoxide and ozone which are produced when molecular oxygen (O₂) if present in the plasma discharge. Cold atmospheric pressure plasma discharge can be created using a very simple electrode configuration and are environmental friendly with no requirement for vacuum pumps. Reducing energy requirements and simple equipment are keys to deploying this technology for space missions and in this regard, atmospheric pressure operation, as opposed to vacuum, of low temperature plasmas may be ideal for the surface decontamination requirements for NASA Planetary Protection.

Herein, we propose a novel atmospheric pressure plasma jet that can function as a sterilization shower, and is adaptable for any conceivable geometry or configuration. The project is aimed at sterilizing the outer section of the astronaut’s space suit (with astronaut), in the airlock section of the crew vehicle, while the astronaut enters it from other planetary environment and also before leaving from the crew vehicle to other planetary atmospheres.

The specific aim of this proposal is to characterize the molecular effects of cold atmospheric pressure plasma exposure in order to understand the requirements needed to sterilize robust microorganisms.

Figure 1. (Top) Schematic of atmospheric pressure plasma shower chamber (Bottom) photograph of atmospheric pressure plasma focused on a finger, demonstrating the low temperature nature of the plasma

To study the effectiveness of the proposed work, a comparison will be made to that of dry heat microbial reduction. An atmospheric pressure plasma system is under construction and several designs of electrode configuration (flat and large area, circular, different sized nozzle) will be built to construct a plasma shower. As shown in Figure 1, the plasma jet consists of individual tubes of diameter ~ 1 cm. A number of these can be assembled to create a showerhead.
References: