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SYMPOSIUM ON VISIONS AND STRATEGIES FOR THE FAR FUTURE (D4)
Novel Concepts and Technologies (1)

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ATMOSPHERIC PRESSURE PLASMAS – A NEW CLASS OF TOOLS FOR SUPPORTING FUTURE EXPLORATION MISSIONS

Abstract

Non-equilibrium atmospheric pressure plasmas have become a focus of interest in a wide array of research and industrial applications in the recent years. These discharges are relatively cold (300 K - 350 K), small (cm), work at atmospheric pressure and are rather simple to operate in comparison to other plasmas. The chemistry of these discharges is complex and produces a wide array of reactive species, ranging from ozone, OH, NOx to H2O2. Next to that, charged species and (V)UV-radiation are also main components of plasmas.

This interesting chemistry led to a broad range of industrial applications from waste water treatment, detergents, oxidants for catalytic processes to interesting biological applications. Recently, the bactericidal effects of atmospheric pressure plasmas have gained increasing attention for possible applications including dermatology, desinfection of heat sensitive medical devices, dentistry or stimulated blood coagulation.

Two examples are presented highlighting promising applications in development that could support future space exploration missions.

A cold atmospheric pressure radiofrequency plasma jet has recently been used to investigate inactivation of Pseudomonas auruginosas, a gram-negative bacterium found often in burn wounds. It has been indicated that the reactive species created in the jet induce changes in the liquid chemistry, increasing concentrations of molecules such as HNO2, ONOO- and H2O2 which are known from literature to have growth inhibitory effects. This could be essential both for human health care during long term missions, where resources are scarce, as well as for research itself (planetary protection, sterilisation of tools and large areas, etc.).

The other example is an atmospheric pressure glow discharge, aiming to produce H2O2 from pure water in the gas phase. It has many applications because of its oxidative properties and has also been used as propellant for chemical propulsion engines. Being able to produce propellants in-situ or precursors for more complex oxidative chemical processes in a reliable and simple way in remote locations could allow for complex future mission scenarios.

Applications based on a good understanding of the chemistry in these plasmas would allow future missions to efficiently use in-situ resources with relatively low power and mass requirement. While the economic viability by which these systems are generally measured is rather low, the advantages of these systems are clear. Their low mass, compact size, low power consumption and high reliability could make them key enabling technologies for space exploration.