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KEY TECHNOLOGIES FOR SPACE EXPLORATION DEVELOPED AT TU DRESDEN

Abstract

Facing the ever-growing commercialisation of space, particularly within low earth orbit, the academic space sector has reached a pivotal point that will define its role in the upcoming decades. At the same time, space exploration has reached its biggest momentum since the Apollo era. In the Global Exploration Roadmap, the leading space fairing nations defined the way ahead: via cis-lunar space and the moon to Mars. However, 50 years after the Apollo missions, many challenges still remain unsolved, especially for manned missions. This is were academic institutions like universities could play again key role, as they did when paving the way for the democratisation of low earth orbit. The Chair of Space Systems at the Institute of Aerospace Engineering at TU Dresden conducts comprehensive research, ranging from breakthrough space propulsion over miniaturised systems for satellites to scientific payloads and physicochemical processes – intensively lab tested and flown in space. In particular, our research for space exploration is focused on novel propulsion systems (e.g. miniaturised ion thrusters and altitude-adaptive nozzles for landers), energy systems (e.g. miniaturised fusion reactors and flexible foil based thermoelectrics) and electrochemical processes (carbon dioxide electrolysis, miniaturised and fast-response gas sensors for extreme applications, in-situ resource utilisation for oxygen and fuel production). This extensive expertise is useful in various areas of space exploration. As an example, extensive research has been carried out to demonstrate the splitting of carbon dioxide into oxygen and carbon monoxide and vice-versa, by utilising high-temperature fuel cells. This opens up the potential of coupling processes to produce propellants from in-situ resources or an extension with other processes (e.g. bioregenerative life support). Moreover, very small sensors have been developed for in situ measurements of a wide range of gases, partial pressures and flow rates. They enable in-situ measurements in physicochemical processes and environmental control systems (air renewal / control, fuel cells, control of medical / biological processes, human respiratory investigations, etc.) in extreme environments (high vacuum, high temperatures, pure hydrogen or pure oxygen conditions). This conference paper aims to provide a comprehensive overview of these developments in order to initiate a critical discussion on their application for space exploration, exchange ideas and foster collaborations to accelerate innovations.