IAF MICROGRAVITY SCIENCES AND PROCESSES SYMPOSIUM (A2)
Fluid and Materials Sciences (2)

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SYNTHESIS OF CATALYST NANOMATERIALS FOR PHOTOELECTROCHEMICAL WATER-SPLITTING IN MICROGRAVITY

Abstract

An uttermost priority of human space exploration is the sustainable fabrication and recycling of materials, mitigating the consequences of an impossible resupply of resources from Earth. Moreover, the long-term missions to Moon and Mars will require the use of in-situ resource utilization (ISRU) technologies to synthesise materials in harsh environments and reduced gravitation. This opens a path for research on the fabrication and synthesis of materials that have potential for developing energy conversion technology in these environments. Photoelectrochemical (PEC) energy conversion, in fact, is currently investigated for space applications, due to its potential in converting water and carbon dioxide into oxygen, hydrogen, and useful carbon compounds. Further, the monolithic design of PEC devices, which include integrated semiconductor-electrocatalyst systems, offers significant advantages for long-term space missions, such as a compact and lightweight payload. Finally, PEC devices benefit from the presence of catalysts (metals or metal oxides depending on the process) on their surfaces, to favor charge separation and mobility across the semiconductor-electrolyte interface. Since microgravity is known to affect the synthesis of nanomaterials by inducing increased crystallinity and increased porosity, which are attractive qualities in a catalyst material, the present study investigates the effect of microgravity on the synthesis of metal and metal oxide nanocatalysts via photoelectrodeposition, and on their performance in photoelectrochemical water splitting. The starting metals are chosen with regards to their availability in extraterrestrial environments for future ISRU (e.g. Ruthenium), and the processes are tested against their terrestrial counterparts in the Drop Tower of ZARM, at the University of Bremen, Germany.