22nd IAA SYMPOSIUM ON VISIONS AND STRATEGIES FOR THE FUTURE (D4)
Innovative Concepts and Technologies (1)

Author: Mr. Denis Michael Acker
Institute of Space Systems, University of Stuttgart, Germany

Ms. Elizabeth Gutierrez
University of Stuttgart, Germany
Mr. Prishit Modi
University of Stuttgart, Germany
Mr. Olaf Drozdowski
Poland
Mr. Claudiu Mortan
University of Stuttgart, Germany
Mr. Tharshan Maheswaran
Institute of Space Systems, University of Stuttgart, Germany
Mr. Andreas Pahler
University of Stuttgart, Germany

INNOVATING LUNAR LIVING: A PEROVSKITE SOLAR CELL FACTORY FOR THE DIANA LUNAR VILLAGE

Abstract

The establishment of solar cell production facilities on the lunar surface denotes a significant advancement towards fostering self-sustaining lunar infrastructure for enduring exploration missions. This endeavor highlights the crucial role of in-situ resource utilization (ISRU) for self-sufficiency. The study examines the feasibility of a perovskite solar cell factory using up to 90% lunar resources, addressing lunar infrastructure energy needs. The impulse for this factory stems from the need for self-sustainability. Its establishment on the lunar surface is propelled by clear advantages over other solar cell types. Unlike silicon-based cells, which are less mass-efficient due to their thicker films, perovskite cells use Earth-abundant materials like lead, tin and halides, reducing dependency on rare elements like indium and gallium found in CIGS cells. Perovskite cells also show promise in radiation tolerance, due to their lead content and thin-film layers, crucial for lunar conditions. Their thin glass substrates can be sourced through ISRU, enhancing lunar infrastructure sustainability. By harnessing lunar materials for solar cell production, the proposed factory aims to establish a closed-loop system, wherein energy needs are autonomously met, thus reducing dependence on external supply chains. This approach not only ensures the long-term viability of lunar settlements, but also lays a robust foundation for the expansion and evolution of a lunar infrastructure. The research encompasses a comprehensive analysis of energy requirements, materials logistics, and manufacturing processes to inform the design and operation of the proposed factory. Key considerations include the energy needs for factory construction and operation, the requisite materials for solar cell production, the integration of machinery as well as robotic systems for automated manufacturing, and the logistical challenges associated with transporting equipment and resources to the lunar surface. Furthermore, emphasis is placed on the scalability and adaptability of the proposed factory design to accommodate the dynamic needs of lunar infrastructure. An exemplary design is proposed for the DIANA lunar village, estimating energy demands of up to 8 gigawatts (GW), thereby illustrating the practical application of perovskite solar cell production in supporting large-scale lunar

settlements. In conclusion, the establishment of perovskite solar cell production on the lunar surface represents a significant stride towards realizing self-sustaining lunar infrastructure. This paper provides an extensive framework for future research and development endeavors aimed at advancing the sustainability and feasibility of lunar exploration and habitation missions.