23rd IAA SYMPOSIUM ON BUILDING BLOCKS FOR FUTURE SPACE EXPLORATION AND DEVELOPMENT (D3)
Interactive Presentations - 23rd IAA SYMPOSIUM ON BUILDING BLOCKS FOR FUTURE SPACE EXPLORATION AND DEVELOPMENT (IP)

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BIOMOON: A SUSTAINABLE LUNAR BASE

Abstract

The BioMoon base represents a groundbreaking approach to establishing a self-sustaining human presence on the Moon. Central to this initiative is the use of in-situ resource utilization (ISRU) to harness and transform lunar resources into essential life-support and construction materials, drastically reducing dependency on Earth-based resupply missions. One of BioMoon's key advancements is electrochemical regolith extraction, which isolates oxygen and metal oxides from lunar soil. This process supports life-support systems by producing breathable oxygen and provides raw materials for constructing habitats, storage units, and tools. Additionally, high-pressure sintering techniques transform processed regolith into durable, radiation-resistant building components that shield inhabitants from cosmic radiation and micrometeorite impacts.

BioMoon incorporates a tardigrade-inspired bio recycling system that processes organic waste into nutrient-rich biofertilizers. Leveraging microorganisms modeled after tardigrades, this system ensures the resiliency of food production in extreme environments. Hydroponic farming facilities integrate this biofertilizer to grow crops in closed-loop ecosystems, providing a sustainable food source for lunar inhabitants. The base harnesses lunar ice deposits to produce water, oxygen, and hydrogen through advanced electrolysis and filtration systems. This water supports both human consumption and crop irrigation, while hydrogen serves as fuel for energy systems and transportation.

BioMoon's infrastructure is deployed and maintained by advanced autonomous rovers, which use AI-driven mapping and excavation tools to optimize resource extraction and assembly. These rovers also integrate modular construction systems, enabling the expansion of the base as needed. Aligned with the United Nations' Sustainable Development Goals (SDG 9: Industry, Innovation, and Infrastructure), BioMoon sets a new benchmark for environmentally responsible lunar operations. By blending advanced ISRU technologies with autonomous systems and sustainable ecosystems, BioMoon paves the way for humanity's enduring presence on the Moon.

Studies confirm the necessity and feasibility of the BioMoon base's innovations. For instance, the work by Hoffman et al. (2000) on lunar resource utilization indicates that processing regolith for oxygen and construction materials is not only possible but essential for long-term lunar habitation. Moreover, research by Gleason et al. (2012) on hydroponic farming in closed environments shows that such systems

can efficiently support food production in extraterrestrial habitats. Additionally, studies on autonomous robotic systems by NASA's Jet Propulsion Laboratory (2018) highlight the capability of AI-driven systems in optimizing construction and resource extraction on the Moon, ensuring the scalability and sustainability of the BioMoon base.