LUNAR ALLOY METAL PRODUCTION PLANT
NASA 2023 BIG IDEA CHALLENGE

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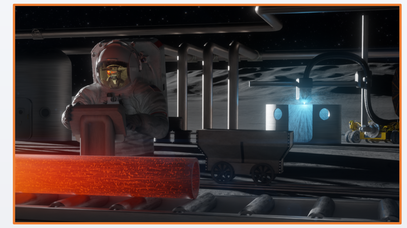
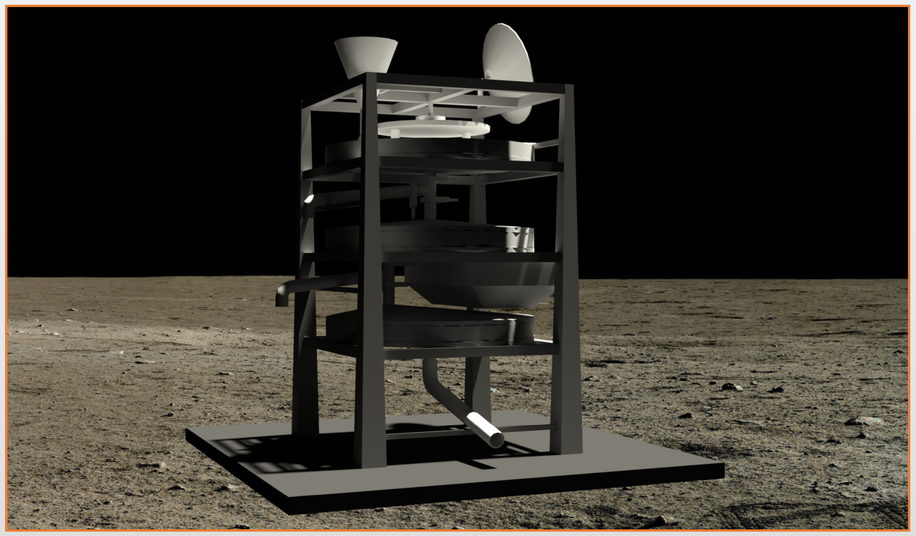


The Colorado School of Mines team was selected as 1 of 7 universities to receive funding for the 2023 NASA BIG Idea Challenge. Our proposed work will advance the state of Molten Regolith Electrolysis (MRE) technology as several critical technologies must still be developed. Specifically, refractory materials to contain molten regolith, which is known to be highly corrosive and challenging to contain and handle, and the development of liquid metal flow technology. Beyond developing this technology on Earth, these supporting technologies must also be optimized for the lunar environment, including the impact of dust, vacuum, and 1/6th gravity on molten flow and containment.

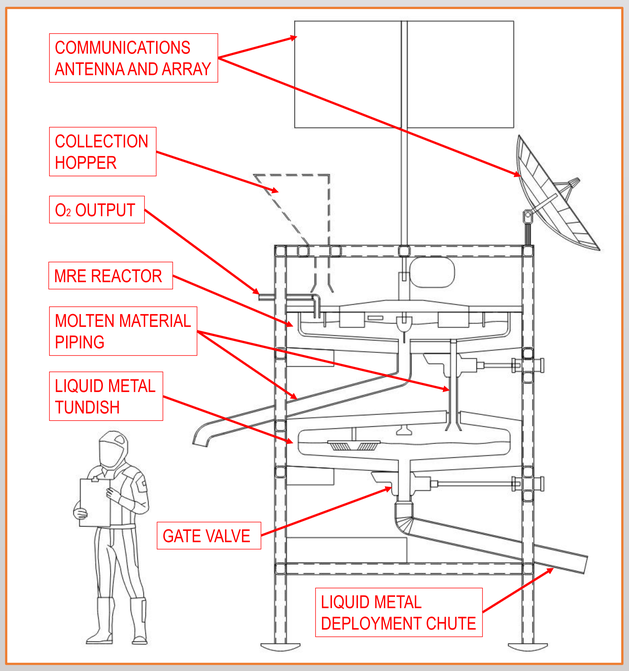


BIG IDEA CHALLENGE CONCEPT

In order to support the human exploration of space, the use of local resources, otherwise known as In-Situ Resource Utilization (ISRU), is needed. The Lunar Alloy Metal Production Plant (LAMPP) is a self-contained, scalable, deployable metal production system designed for use in the lunar environment. LAMPP is based off the nascent technology of MRE, which has been proposed as a possible way to extract metals on the lunar surface. MRE passes an electric current through molten regolith to split oxygen from metal oxides to control production rates of oxygen and high-quality metal.

The LAMPP system has the potential to provide metallurgical-grade alloys that enable the development of sustainable lunar infrastructure. The extraction of metal is critical to the operation of lunar bases that utilize pressure vessels, piping, power cables, and supporting structures. LAMPP can meet these challenges by deriving metals from the lunar regolith.

The ultimate project objective is to be presented at the 2023 BIG Idea forum in November. It is to produce a preliminary system design that will be conducted as a result of the project objectives.



OBJECTIVES

1. Unify what is known about MRE and associated technologies in the form of a review paper. This includes a literature review of known refractory material performance.

2. Test and select refractory materials as containment for molten regolith of highlands and mare compositions considering qualities such as longevity, robustness, and corrosion resistance. This includes dipstick, crucible, and molten flow over plate testing.

3. Understand and build a reference for how metals flow at high temperatures in vacuum and how refractory materials and gravity may be impacted.

Selected References*: [1] ASM Handbook Committee. (2018). ASM International (pp. 1099–1201. [2] Carol, E. (2019) Space Resources Roundtable. [3] Curreri, P. A. et al. (2006). MSFC Independent Research and Development Project No. 5-81. [4] Grossman, K.D. et al. (2021) ASCEND 2021 (p. 4019). [5] Naser, M. Z. (2019). Progress in Materials Science (Vol. 105). [6] Sadoway, D. (2005). Lunar Regolith Simulant Materials Workshop. [7] Schreiner, S et al. (2016). Advances in Space Research, 57(7), 1585–1603. [8] Sibille, L., and Sadoway, D. (2009). Space Propulsion and Energy Sciences International Forum. [9] Sibille, L., and Dominguez, J. A. (2012). Production on the Moon and Mars. [10] Sirk, A. H. et al. (2010). ECS Transactions, 28(6), 367–373. [11] Standish, E. et al. (2010). Graduate Program in the Department of Materials Science and Engineering, The Ohio State University. *Full references are provided in abstract.

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