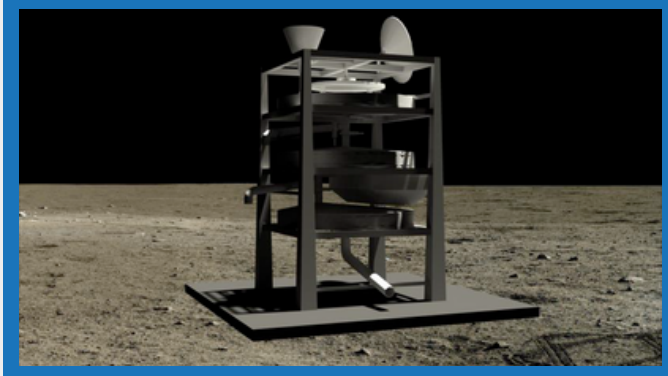
2023 BIG IDEA CHALLENGE FINALISTS

COLORADO SCHOOL OF MINES

"LUNAR ALLOY METAL PRODUCTION PLANT" LAMPP

Faculty advisors: Dr. Christopher Dreyer, Dr. George Sowers
Team video: https://www.youtube.com/watch?v=hBdOzuSIX8k

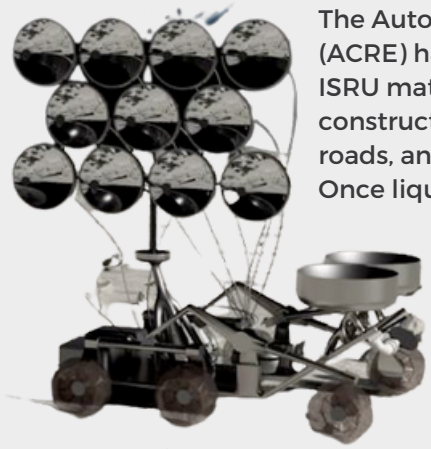


The Lunar Alloy Metal Production Plant or LAMPP is a self-contained, scalable, deployable metal production system designed for use in the lunar environment. LAMPP is based off the nascent technology of Molten Regolith Electrolysis which has been proposed as a possible way to extract metals on the lunar surface. The LAMPP system allows for a controlled MRE reaction, with oxygen as a byproduct, and the ability to extract pure metals or create metal alloys for further use.

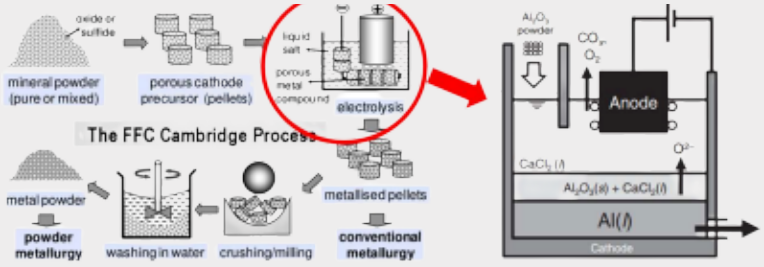
NORTHWESTERN UNIVERSITY

"ACRE: AUTONOMOUS CASTING ROVER"

Faculty advisor: Dr. Ian McCue
Team Video: https://youtu.be/khwXW69RZIg



The Autonomous Casting RovEr (ACRE) harnesses sunlight to melt ISRU materials for the construction of landing pads, roads, and other rigid structures. Once liquified, molten material is poured into cavities and patterns on the exposed lunar surface that are formed by the rover's plow as it drives. The crucible is then refilled and the process repeats with complete autonomy, taking advantage of the near-constant sunlight at elevated regions of the lunar south pole for continual production.



MISSOURI UNIVERSITY OF SCIENCE & TECHNOLOGY

"LUNAR IN-SITU ALUMINUM PRODUCTION THROUGH MOLTEN SALT ELECTROLYSIS" (LISAP-MSE)

Faculty advisors: Dr. Daoru Han, Dr. Jeffrey Smith, Dr. Fateme Rezaei, Dr. David Bayless, Dr. William Schonberg, Dr. Daniel Stutts
Team Video: https://youtu.be/2sTxaKRNSQE

The goal of Artemis is to establish a sustained presence on the Moon. To aid in this mission, we propose utilizing anorthite, an aluminum rich and abundant lunar mineral, via the proposed concept of Lunar In-Situ Aluminum Production through Molten Salt Electrolysis (LISAP-MSE). The proposed LISAP-MSE project, if successful, will demonstrate the use of the Fray-Farthing-Chen (FFC) Cambridge process to reduce aluminum oxide into aluminum metal and oxygen gas via molten salt electrolysis.

MASSACHUSETTS INSTITUTE OF TECHNOLOGY

"ARTEMIS STEELWORKS: ADVANCING REACTOR TECHNOLOGIES FOR ELECTROLYTIC MANUFACTURING OF IN-SITU STEEL"

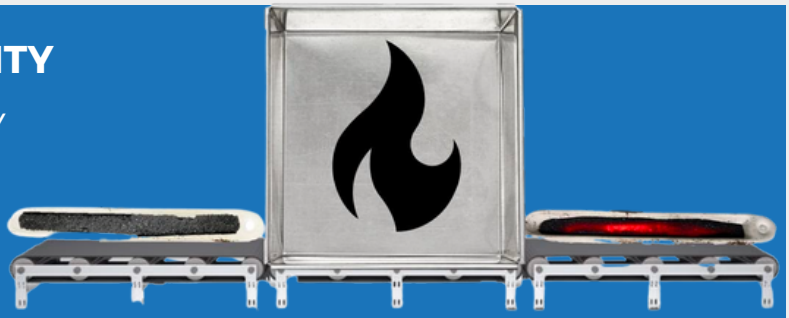
Faculty advisors: Dr. Jeffrey Hoffman, Dr. Antoine Allanore, Dr. Martin Culpepper, Dr. Olivier De Weck, George Lordos
Team Video: https://youtu.be/wOU8oUOQowA

The ARTEMIS Steelworks (Advancing Reactor Technologies for Electrolytic Manufacturing of In-situ Steel) team at MIT will demonstrate production of electrolysis. We'll build and qualify two reactors, test steel properties and simulate a pressure vessel model in the lunar environment. Innovations include a sonicator to dislodge O2 bubbles from anodes, thermal gradient control to extend system life, and in-situ alloying for direct steel production.

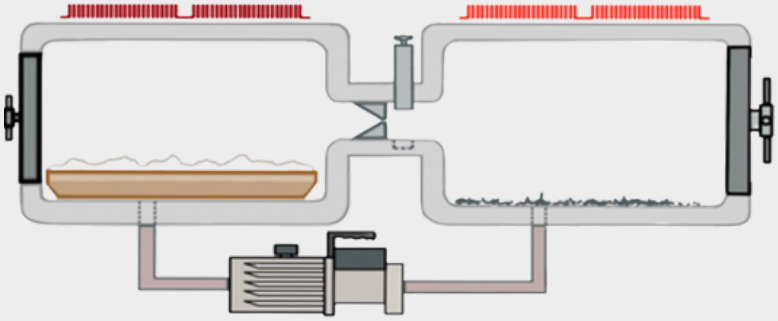
THE PENNSYLVANIA STATE UNIVERSITY

"DEVELOPMENT OF THE SMELTING WITH MICROWAVE ENERGY FOR LUNAR TECHNOLOGIES (SMELT) SYSTEM FOR IN-SITU RESOURCE PROCESSING"

Faculty advisors: Dr. Sven Bilén, Dr. Aleksandra Radlińska
Team Video: https://youtu.be/aNXUg-mv7Tk



The SSPL proposes SMELT: Smelting with Microwave Energy for Lunar Technologies. SMELT is a lunar smelting application that utilizes microwave sources and concentrates them onto a prepared metal dust to provide enough thermal energy to reach a critical melting point. A material conveyance system will move the metal mass through the SMELT system and output a molten substance which can be used for molding.



UNIVERSITY OF UTAH

"PRODUCTION OF STEEL FROM LUNAR REGOLITH THROUGH CARBONYL IRON REFINING (CIR)"

Faculty advisors: Dr. Hong Y. Sohn, Dr. Michael F. Simpson, Dr. Michael L. Free
Team Video: https://www.youtube.com/watch?v=BX4GHkZNz00

Carbonyl Iron Refining (CIR) is a promising avenue to extract iron from reduced lunar regolith and refine it into a high purity powder product. The process is two-stage. First, iron oxide in lunar regolith is reduced. Second, the disparate iron particles are refined via the formation and subsequent decomposition of Fe(CO)5(g). Stand out characteristics of the concept are its native synergy with oxygen production and additive manufacturing, as well as its regenerative attributes.

UNIVERSITY OF NORTH TEXAS

"SOLID-STATE INTEGRATED MANUFACTURING PROCESS FOR LUNAR ENVIRONMENT" (SIMPLE)

Faculty advisors: Dr. Rajiv S. Mishra, Dr. Hector Siller, Dr. Ravi Sankar Haridas
Team Video: https://www.youtube.com/watch?v=uaAAr_HZRRg

Need for infrastructure development on Moon as a part of the Artemis mission demands simple manufacturing methods for extrusions, pipes, metal cables, wires, and metal matrix composites (MMCs) using in-situ lunar resources. We propose a SIMPLE (Solid-state Integrated Manufacturing process for Lunar Environment) concept of an energy efficient integrated manufacturing process for pipes, extrusions, cables, wires and MMCs with an additional additive manufacturing (AM) capability.