Acid Leaching and Electro-Deoxidation of Lunar Regolith Simulants to Produce Aluminum Metal. J. N. Ortega[1], J. Smith[1], F. Rezaei[1], D. Bayless[1], W. Schonberg[1], D. Stutts[1], and D. Han[1], [1]Missouri University of Science and Technology, 1870 Miner Circle, Rolla, MO 65409. (Contact: handao@mst.edu)

Introduction: The LISAP-MSE project. funded through NASA BIG Idea Challenge 2023, investigates a process developed to produce aluminum metal on the lunar surface via molten salt electrolysis. This process is outined in the flowchart as seen in Figure 1 below.

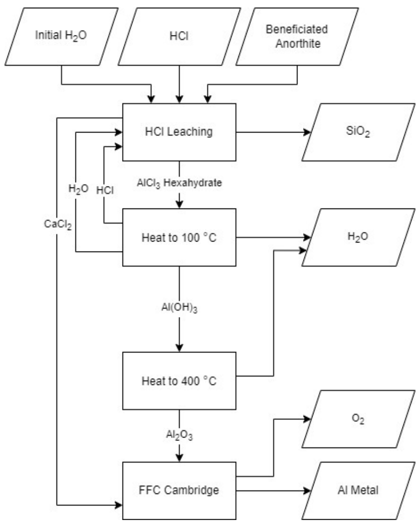

Figure 1: LISAP-MSE Flowchart

Methodology: The LISAP-MSE project, will demonstrate the use of electro-deoxidation to reduce aluminum oxide (i.e., alumina) into aluminum and oxygen gas via electrolysis in a molten salt bath for the production of aluminum on the Moon. This process will be similar to that shown in Figure 2 below.

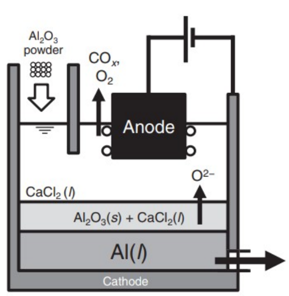

Figure 2: Aluminum Oxide Electrolysis [1]

It will be shown that with a steady supply of hydrogen chloride, this in-situ resource utilization (ISRU) method can supply almost all of the necessary materials consumed in electro-deoxidation to produce aluminum metal, oxygen, water, and silica from anorthite.

Results: Leaching of the anorthite using hydrochloric acid and then two thermal decomposition steps were completed. Once the thermal decomposition steps were completed, XRD confirmed that approximately 37% of the crystalline solids present in the final product was with nearly all of the remaining material being calcium aluminates.

Next, the alumina was electrolyzed. Upon completion, a 6 milimeter diameter, metallic, spheroid was discovered in the testing apparatus (Fig. 3), it was removed and analyzed using SEM-EDS. Shown in Table 1 is the table of scan results at numerous spectrum sites taken on the materials surface.

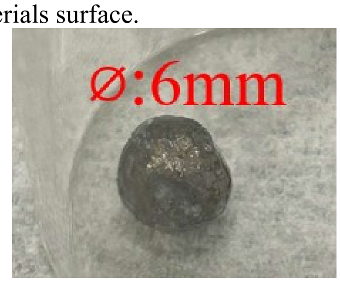

Figure 3: Metallic Spheroid Produced in Electro-Deoxidation

Table 1: SEM-EDS Spectra

Normalized mass concentration [%]

Spectrum	Carbon	Oxygen	Magnesium	Aluminium	Silicon	Calcium	Zirconium	Platinum
Spectrum 1	5.7	0.8		93.4		0.1		
Spectrum 2	4.7	0.9	0.5	92.1		0.4		1.5
Spectrum 3	5.1	0.8		93.2		0.9		
Spectrum 4	5.8	0.3	0.4	93.2		0.2		
Spectrum 5		0.5	0.5	89.4	0.4	9.3		
Spectrum 6	10.4	0.7	0.1	88.8		0.0		
Spectrum 7	99.6	0.4						
Spectrum 8	99.2			0.8				
Spectrum 9	87.7	1.3		10.9				
Spectrum 10	8.3	9.5	0.1	78.2	0.4	3.6		
Spectrum 11	10.0	7.0	0.3	82.7				
Spectrum 12	8.2	3.9	0.1	87.8				
Spectrum 13		5.0	0.1	85.0		2.3	7.6	
Mean	**31.4**	**2.6**	**0.3**	**74.6**	**0.4**	**2.1**	**7.6**	**1.5**
Sigma	**41.4**	**3.1**	**0.2**	**32.5**	**0.0**	**3.2**	**0.0**	**0.0**
SigmaMean	**11.5**	**0.8**	**0.0**	**9.0**	**0.0**	**0.9**	**0.0**	**0.0**

In this table, it can be seen that aluminum is present with very little oxygen. It can be concluded that aluminum metal was produced in this process.

References: [1] Kadowaki H. et al. (2018) *Journal of The Electrochemical Society,* 165.