Molten Regolith Electrolysis Performed in Vacuum Testing at Kennedy Space Center: Analysis of the Retrieved Core Sample. A.J. Meier[1] , J. Olson[2], D. Essumang[3], E. Bell[4] , J. Toro[5], J.Smith[6], T.Johnson[7], M.M. Tessima[8], R.Ebrahim[9], M.Hinkel[10], A.Ignatiev[11], [1]NASA, Kennedy Space Center, Fl, 32899 (anne.meier@nasa.gov), [2]NASA, Kennedy Space Center, Fl, 32899 (joel.a.olson@nasa.gov), [3]NASA, Kennedy Space Center, Fl, 32899 (deborah.essumang@nasa.gov), [4]NASA, Kennedy Space Center, Fl, 32899 (evan.a.bell@nasa.gov), [5]NASA, Kennedy Space Center, Fl, 32899 (jaime.a.toromedina@nasa.gov), [6]NASA, Kennedy Space Center, Fl, 32899 (jackson.l.smith@nasa.gov), [7]NASA, Kennedy Space Center, Fl, 32899 (thad.w.johnson@nasa.gov), [8]NASA, Kennedy Space Center, Fl, 32899 (misle.m.tessema@nasa.gov), [9]Lunar Resources, Inc., Houston, TX 77058 (rabi@lunarresources.space), [10]Lunar Resources, Inc., Houston, TX 77058 (mark.hinkel@lunarresources.space), [11]Lunar Resources, Inc., Houston, TX 77058 (alex@lunarresources.space).

Introduction: The NASA Space Technology Mission Directorate (STMD) Game Changing Development (GCD) program funded a collaboration with NASA and industry to demonstrate the Molten Regolith Electrolysis (MRE) process in a vacuum environment. MRE has been a long time studied technology for oxygen (O_2) production from regolith on the lunar surface[1] [2]. MRE remains a promising technology for O_2 production for human life support and propellant supply, as well as for construction materials that are retrieved from the molten metal slag. The MRE demonstration occurred in December 2024 at Kennedy Space Center (KSC) with Lunar Resources, Inc. (LUNAR), using ICN-LHT-1G (also known as CSM-LHT-1G) regolith [3]. LUNAR was funded via an SBIR Phase III contract (Contract #80NSSC22C0001). A LUNAR manufactured reactor was tested in the KSC Atmospherically Sealed Simulator for In-situ System Testing (ASSIST) chamber. The O_2 and its gaseous byproducts were analyzed during the regolith electrolysis using the NASA developed Volatile Monitoring and Oxygen Measurement System (VMOMS). VMOMS included a residual gas analyzer, oxygen sensors, and a gas chromatograph. A core sample was retrieved after the molten regolith cooled down post electrolysis. A computed tomography (CT) scan was performed on the retrieved core sample. X-ray photo-electron spectroscopy (XPS), scanning electron microscopy (SEM), energy dispersive spectrometer (EDS), and X-ray fluorescence (XRF) measurements were all collected to provide insights on composition and morphology of the sample. This work describes some of the results of the retrieved core analysis as well as discussions on future work that the KSC MRE team will be performing on a fully integrated MRE system, to further develop the technology.

Figure 1. Core sample removed from reactor after MRE testing complete.

References: [1] Standish (2010) *Design of a Molten Materials Handling Device for Support of Molten Regolith Electrolysis*. Thesis, Ohio State University. [2] S. S. Schreiner, (2015) *Molten Regolith Electrolysis reactor modeling and optimization of in-situ resource utilization systems*. Thesis, Massachusetts Institute of Technology, 2015. [3] A. Slabic et al., (2024) *Lunar Regolith Simulant User's Guide Revision A*.