CIF 22-5: Making Rocket Fuel from Moon Rocks: Silicon-Liquid Oxygen (SiLOX) as a Hybrid Propellant

Project PI: Kenneth Engeling (kenneth.engeling@nasa.gov)

Team Members: Ryan Gott (ryan.p.gott@nasa.gov), Shayla Peak (swilhelm2020@my.fit.edu), Joel Olson (joel.a.olson@nasa.gov), Tracy Gibson (tracy.l.gibson@nasa.gov), Nilab Azim (nilab.azim@nasa.gov), Griffin Lunn (griffin.m.lunn@nasa.gov), Lucy Somervill (lucysomervill@vt.edu), and Rehan Rashid (NASA OSTEM Intern)

Activity Type: New Start

Primary STMD Taxonomy: TX01.1.5 Hybrids

Start TRL: 1 **End TRL:** 3

Executive Summary: The research team at KSC explored the controlled passivation and burning of Lunar soil constituents in an oxygen combustion vessel for use as an in-space resource. Technologies such as carbothermal reduction (CaRD) and molten regolith electrolysis (MRE) are being developed to remove the oxygen for use and leave constituents in an enriched state. This leaves behind reduced compounds that can react with oxygen for heat generation. The team at KSC looked to explore the feasibility of controlling such reactions in a pure oxygen environment for potential technology integrations.

Our proof-of-concept demonstrations have given promise to many potential applications for the controlled burning or combustion of nano- and porous silicon for silicon based, Lunar economy applications. The team at KSC was able to control the burn rate and total energy released effectively via pre-treatment of the nano-silicon in a muffle furnace at varying temperatures at one-hour durations. We created a new capability at KSC with the supporting safety documentation and procedural writeup. Our work highlights the need for greater investigation to understand the regenerative properties of the proposed porous silicon discs, and its viability of a thermal and electrical energy source. This work has demonstrated the proof-of-concept that elemental silicon is able to be combusted with gaseous and liquid oxygen in a controlled manner. This report provides such evidence as well as theoretical calculations and assumptions made for technologies that would be useful in Lunar surface operations with in-situ resources. The concepts are based on the assumption that oxygen extraction technologies from Lunar regolith processing will result in enriched silicon that may be adapted for the presented use cases. Additionally, the energy storage concept is able to be adapted for terrestrial use and integrated into already existing infrastructure.