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# IN-SITU REGOLITH BASED NANOTHERMITE HEATING FOR LUNAR ROVERS AND EQUIPMENT DURING THE LUNAR NIGHT

**Abstract**

The emergence of the commercialized space industry and increased frequency of lunar missions is enabling novel design considerations for lunar rover and equipment power design. New methods for heating rovers during the lunar nights will become important as technology advances. We are proposing an in-situ nanothermite heating system and will support this work with experimental data to compare to current heating methods.

One problem that consistently and significantly limited lunar missions is the need to survive the lunar night. With extremely low temperatures, thermal engineering is a critical factor in determining equipment lifespan. This problem also applies to missions in permanently shadowed regions of the moon. There are several existing methods of heating lunar rovers such as Radioactive Thermal Generators, Radioactive Heater Units, batteries, and LH2/LOX fuel cells. However, these methods all have their disadvantages. Governmental material control limits commercial companies from accessing radioactive materials. Weight, size, and complexity are limitations to battery and fuel cell methods.

Recent advances in the development of nanothermite fuels has demonstrated that metal fuels can be used as an energy source for lunar missions. We have experimentally shown that metal fuel can be combusted with lunar simulant to produce a self-sustaining exothermic reaction. We have found that magnesium metal fuel and mare regolith oxidizer can produce between 550 J/g and 680 J/g depending on equivalence ratio, with a theoretical limit of 1270 J/g. We will also investigate other metals, alloys and highland simulant as possible fuels and oxidizer, respectively. While possessing comparable or less energy per gram than typical methods, in-situ resource utilization can leverage costs of this system as the specific energy of the fuel is increased due to the readily available regolith.

The present contribution reports on the feasibility and viability of a metal fuel and regolith based nanothermite heating system for rovers during the lunar night. The work will integrate experimental

results on the combustion of metal fuels and lunar simulants with proposed methods and optimizations of utilizing the in-situ resources as a heat source. This evaluation will compare the proposed method of in-situ nanothermite heating to current methods. The presented framework for a new energy system can be further explored to improve future equipment and future in-situ resource utilization, which is critical for sustainability and residency on the moon. In the future magnesium fuel could be processed from regolith or structural mission components, further increasing the system sustainability.