Lunar Construction Material Production Using Regolith Simulant in a Geothermite Reaction. E. J. Faierson[1] and K. V. Logan[1], [1]National Institute of Aerospace – Virginia Tech, 100 Exploration Way, Hampton, VA, 23666 USA, Corresponding author E-mail: faierson@vt.edu

Establishing a permanent human presence on the Moon will necessitate the use of in-situ resources to both reduce launch costs and conserve space within the launch vehicle. Experiments have shown that a chemical reaction can be initiated by applying heat to a mixture of lunar regolith simulant and aluminum powder. The reaction between regolith simulant and aluminum powder exhibited characteristics of a thermite-type reaction and is shown in Figure 1. Thermite-type reactions between minerals and a reducing agent are referred to as geothermite reactions by the authors.

Figure 1. Propagation of a geothermite reaction through a cylinder sample

The product of the geothermite reaction examined in this study was a ceramic-composite material with a near-net shape. Experiments have primarily been conducted in a standard Earth atmosphere; some experiments have been conducted in a vacuum (~0.6 Torr) environment.

X-Ray Diffraction (XRD) analyses indicated that silicon, grossite ($CaAl_4O_7$), corundum (Al_2O_3), and spinel ($MgAl_2O_4$) were common chemical species present within the reaction product, both in standard and vacuum environments.

Scanning Electron Microscopy (SEM) analyses have indicated growth of nano-scale whiskers in the standard atmosphere reaction products as shown in Figure 2. Energy Dispersive Spectroscopy (EDS) indicated that the nano-scale whiskers were primarily composed of aluminum nitrides, indicating interaction with atmospheric gases.

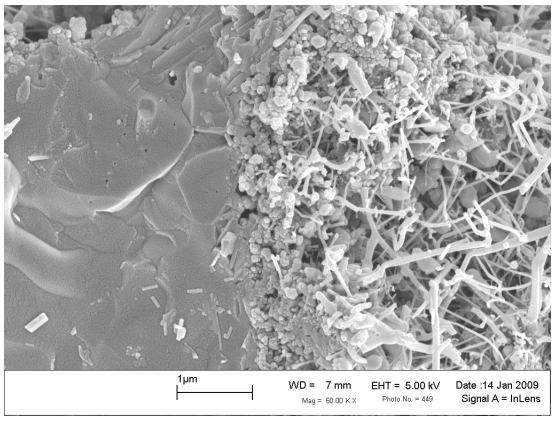

Figure 2. Growth of aluminum nitride nanowhiskers on the surface of a particle

Mechanical testing has indicated that reactant proportions and simulant particle size can affect the compressive strength of the reaction product formed in a standard atmosphere. Mean compressive strengths up to 18 ± 3.7 MPa were measured. Whiskers of aluminum nitride likely increased the strength of the reaction products.

The product of the geothermite reaction has potential for use in landing pads, blast berms, roadways, radiation shielding, and micro-meteoroid shielding on the lunar surface. Using the reaction product in some of the above applications could also mitigate lunar dust issues.

Future work will involve further experiments in vacuum and utilization of a solar furnace to initiate the geothermite reaction. Use of a solar furnace would be an efficient way to implement the geothermite reaction on the Moon due to availability of sunlight.