Phase I Project Summary – NNX11CH51P

Research Objective

Prior to future manned and/or unmanned lunar exploration activities, it is imperative that high fidelity lunar soil simulants be developed in order to accurately evaluate surface operations and the life span/efficiency of any equipment exposed to the lunar surface. Current regolith simulants lack certain constituents, such as glass and agglutinate particles. These phases, which can account for up to 60% by volume of a mature lunar soil, significantly influence the hardness, flowability, friction, magnetic susceptibility, and electrostatic properties of the lunar regolith. The objective of this research was to explore a viable plasma processing method to enhance the fidelity of NU-LHT-2M Highland simulant.

Research Performed

Using a manufacturing approach based on thermal spray technology, Plasma Processes demonstrated a viable technique to enhance the maturity of NU-LHT-2M Highland simulant. Specifically, a high temperature plasma was employed to process the simulant in a inert/vacuum environment. The rapid melting and solidification of the simulant in an airless atmosphere imitates the melt/solidification process caused by high velocity micrometeoroid impact on the lunar surface.

Research Results

The manufacturing approach employed during this effort yielded glassy spheroids and vesiculated, agglutinate-like phases containing nano-phase iron, which resemble those observed in actual lunar soils. The combination of these phases and the root lunar simulant in correct proportions has significant potential of yielding a high fidelity derivative Highland simulant.

Phase II Justification

The Phase I was a successful initial investigation of enhancing the fidelity of NU-LHT-2M Highland simulant. Follow-on efforts are essential to advance the maturity of the current approach. Specific objectives of a Phase II effort are as follows:

1. Optimize hardware and conditions to increase the overall glass phase content of the plasma processed NU-LHT-2M simulant.
2. Explore approaches to produce higher fidelity agglutinate particles. Some glassy phases generated with established plasma processing parameters are vesicular, irregular-shaped, agglutinate-like particles. However, further development is needed to attach/bond crystalline phases to these glassy agglutinate-like phases, thereby generating phases that closely resemble lunar agglutinates.
3. Establish an optimized, high yield production process. Processing must be optimized to ensure repeatability. Additionally, production yields must be sufficient in order to minimize unit costs and generate required quantities within a reasonable time.

Apply plasma processing approach to alternative Highland simulants, if available.