Industrial Scale Manufacturing of Lunar Dust Simulants with Remotely-Coupled Transferred Arc Plasma

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Lunar simulants are a core requirement with applications across many NASA and commercial space exploration programs. A partial list of programs that require simulants include: lunar oxygen extraction, excavation equipment testing and development, surface stabilization, health studies and general hardware testing are all end users of lunar simulants. As realized from the Apollo missions, the moon's surface contains a high percentage of glass (~30%) and agglutinates (30 to 60%).

The lunar regolith is unique by terrestrial standards. Extremely small and jagged particulates comprise the majority of the surface and dust. Many believe the unique material was formed by the constant micrometric impact on the lunar surface. Zybek Advanced Products, Inc. has developed a high-power plasma process that provides a similar thermal energy and temperature gradient of a micrometric impact on the lunar surface. Using an example impact of a 0.01 kg micrometeorite traveling at 100,000 km/hr, the kinetic energy is 385KJ. Assuming 90% thermal equilibrium in 1 second yields an energy rate of 347 KW. ZAP's remotely-coupled transferred arc system provides a similar thermal history for the feed stock material.

In addition to manufacturing lunar simulant glass and agglutinate, ZAP is using the high power remotely-coupled plasmas (up to 900 KW) to produce Anorthosite, Pyroxenes and Olivines from oxide ingredients. The oxides (e.g., SiO2, CaO, Al2O3, etc.) are mixed in the proper ratios, brought to molten temperatures and allowed to cool in a fashion that promotes crystal growth. The crystals are then milled with a pulse mill back to the proper size faction.

This talk will present the plasma-based process used to manufacture multi-ton quantities lunar simulants and dust materials. Data is also presented that compares the manufactured dust simulants to the actual Apollo samples.