47th STUDENT CONFERENCE (E2)
Student Team Competition (3-GTS.4)

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IN SITU MARTIAN ADDITIVE MANUFACTURING

Abstract

A significant barrier to the sustained human exploration of Mars is the supply of high quality components and structural materials. A Hohmann transfer to Mars takes 8 - 9 months and costs approximately $105k per pound of supplies landed on the surface. Additive manufacturing using locally sourced materials may provide an economically feasible solution to establishing long term human habitation on Mars. However, in situ additive manufacturing comes with many challenges including balancing material properties with process efficiency and understanding the variable Martian environment.

This study, conducted by a student team at the University of Michigan and sponsored by the Northrop Grumman Corporation, aims to additively manufacture a test specimen using only materials extracted from Martian regolith simulant. The investigated extraction procedure involves a series of acid and base dissolution and precipitation steps to isolate alumina, silica, and iron oxide from the regolith. Sulfuric acid and sodium hydroxide reagents used for these reactions are targeted for high recovery to maximize material recycling. The extracted alumina is then analyzed using X-Ray fluorescence and processed to refine its morphology. This research focuses upon using Direct Write additive manufacturing to print a part using alumina, an abundant component of Martian regolith and well-established ceramic in additive manufacturing. Printed parts will be tested to help understand potential applications for this technology in establishing a Martian colony.

Preliminary extractions have shown potential, as base and acid dissolutions have extracted alumina with 40% purity prior to additional processing, with around 8-10% chemical recoverability thus far. Current research in the chemical processing is optimizing for extracted alumina purity to improve material performance for printed parts. We are also investigating crystallization/evaporation techniques to improve acid/base recoverability. Martian environmental conditions, such as lower gravity and different atmospheric composition, are also being investigated to determine their effects on the additive manufacturing process. Future work will investigate how this process can be scaled and automated to manufacture parts for use in sustaining human habitation on Mars and other extraterrestrial bodies.