Humankind’s ambitions of exploring our solar system and parts beyond depend heavily on our ability to collect resources from local environments at our destinations rather than bringing materials on the journey. This is a concept known as in-situ resource utilization (ISRU) and it is one that has been understood by every explorer and settler in the history of humankind. Regolith on the moon and Mars has been shown to be a particularly useful resource and has the ability to provide humans with resources including water, oxygen, construction material, fabric, radiation shielding, metals, and may more. This dissertation focuses on construction materials derived from standard regolith simulant JSCâ€“1A, including bricks, composites, metals and modified powder materials. Sintering processes with JSCâ€“1A were studied to determine optimal heating profiles and resulting compressive strengths. It was determined that the temperature profiles have an optimal effect on smaller particle sizes due to the larger surface area to volume ratio of small particles and sintering being a surface event. Compressive strengths of sintered regolith samples were found to be as high as 38,000 psi, which offers large utility for martian or lunar colonies.

This study also investigates a method for extracting metals from regolith known as molten regolith electrolysis. The alloy of the two major metallic components of regolith, iron and silicon, has been investigated as a structural metal for colonies and a potential feedstock for novel metallic 3D printers. Parallel to these efforts, a new additive manufacturing technique designed to print metal parts in low and zero gravity environments is developed. The mechanical properties from metal parts from this technique are examined and it is determined how the printing process determines a microstructure within the steel that impacts the utility of the technology.

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The public is welcome to attend.