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IN-SITU RESOURCE UTILIZATION OF LUNAR REGOLITH TO PRODUCE SILICON FOR USE IN PHOTOVOLTAIC MATERIALS TO SUPPORT A LONG-TERM HUMAN PRESENCE ON THE MOON.

Abstract

After a hiatus of forty years, human exploration of the moon and a permanent human presence on the lunar surface is on the space exploration agenda of some countries. The ultimate success of a permanent lunar base will depend on the use of available resources, hence, the in-situ utilization of resources is a critical enabling technology for manned space exploration. Long-term sustainable habitation and industrialisation of the moon will require the ability to produce raw materials, other than just oxygen, from lunar regolith.

During the Apollo and Luna era a great deal was learnt about the mineralogy and chemistry of lunar materials. In addition to abundant oxygen these materials also contain considerable silicon, iron, calcium, aluminum, magnesium, and titanium. Thus far, lunar resource utilization has focused principally on the extraction of oxygen from the lunar regolith, however these proposed processes coproduce materials such as silicon and aluminium, which are specifically needed for the fabrication of silicon solar cells. In-situ production of photovoltaics has innumerable benefits, not only for a lunar base but also for the manufacture of solar arrays for other space applications. The work by Dr. Landis in 1995 has proposed a processing sequence for the reduction of raw lunar regolith to produce refined feedstock materials for making structural elements, electrical conductors, solar arrays as well as oxygen. Other valuable co-products include the raw materials needed to produce habitation modules, fuel tanks, and components for spacecrafts.

This work aims to focus on computational modelling of the process outlined by Dr. Landis. The modelling will be done using the chemical plant optimisation software, ASPEN PLUS, to ascertain whether the proposed materials processing plant is feasible as well as the purity of the silicon produced by the process. Further experimental work will be conducted on the last part of the process which is the plasma chamber used to produce the photovoltaic grade silicon from silicontetraflouride. The experiments will utilize lunar regolith simulant and a plasma chamber to test if the operating conditions predicted by the model yield the desired purity of the silicon. This will be used to further validate the model. The model and experiments are still to be conducted and the results will be obtained at a later stage.