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TECHNOLOGICAL DEMONSTRATION OF ALUMINA AND SILICA PRODUCTION FROM LUNAR ANORTHITE BY ARTIFICIAL WEATHERING

Abstract

We present progress on a workbench prototype for payload development used decompose lunar anorthite (CaAl2Si2O8) using acid weathering. This project has for goal to extract alumina (Al2O3) and Silica (SiO2) from anorthite. Given that anorthite is abundant in the lunar highlands and practically free of sodium, it is a particularly attractive source of base materials. The intent was to confirm a sustainable means of producing smelter grade alumina for the purpose of in-situ manufacturing as well as silica extraction as part of a near closed-cycle environment. The silica produced is intended for the manufacturing of fused silica glass, thermal insulation fibers, and optical fiber cables. The alumina on the other hand can be used for the production of neutral refractory ceramics which can withstand temperatures of approximately 2000C. Both the silica and alumina can also act as sources of metals (pure Si and Al) through electrochemical reduction which also produces oxygen (O2) as a useful biproduct. Lunar soil samples not being readily available, a sample of Earth-sourced anorthosite was used in its stead for our demonstration. To generate alumina and silica, the anorthosite was treated with hydrochloric acid (HCl) to dissolve the anorthosite. Silica remained as a precipitate, while the calcium and aluminium dissolved into solution. After further treatment, Aluminium Chlorite Hexahydrate (AlCl3·6H2O) precipitated out of solution and upon completion of a double calcination, smelter grade alumina was produced. Worthy of note is that by varying the calcination parameters it is possible to generate chemical grade alumina if such crystal size were to be desired. We concluded that this means of producing alumina and silica offered a viable approach for lunar in-situ resource extraction and utilisation. Further developments will be carried out to transform the workbench demonstrator into a payload format that could be deployed to the Moon.