

Production of Construction Materials on the Moon by Sintering and Combustion Synthesis

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Sintering has been proposed in the past as a simple and efficient way to produce construction materials from the lunar regolith. The range of properties and usefulness of construction materials may be expanded significantly by using a technique known as combustion synthesis. In combustion synthesis, a powdered mixture of reactants that react exothermally is molded to form the desired object shape. When ignited, the mixture "burns" and, if controlled properly, the reaction can go to completion, producing high temperature reaction products. Essentially all of the energy required is provided by the reaction, so that ovens are not necessary. For example, a mixture of CaO and TiO₂, both common oxides in lunar materials, can be reacted to form CaTiO₃ (perovskite), a refractory material of potential utility. In order to provide reactants for combustion synthesis, natural lunar minerals would have to be chemically separated. Some of this could be done by recovery of byproducts from other operations. For example, TiO₂ is a product of the extraction of oxygen from ilmenite by hydrogen reduction. Anorthite might be separated into its constituent oxides to provide starting materials for combustion synthesis. Although energy would be required for the chemical separation, some of the energy is recovered through the exothermal reactions that occur during combustion synthesis. For many reactants, as for sintering, combustion synthesis can be carried out in vacuum. We propose a series of experiments with natural lunar soil (simulants) and lunar oxides ranging from sintering (external heat applied) to combustion synthesis (internally heated) to establish the properties of the materials that can be produced. It is also necessary to establish the conditions under which useful construction elements, such as bricks, beams and plates, may be produced.