Fabrication of Construction Materials from Lunar and Martian Regolith Using Thermite Reactions with Magnesium. S. Cordova, A. Delgado, and E. Shafirovich, Department of Mechanical Engineering, The University of Texas at El Paso, 500 W. University Ave., El Paso, TX 79968.

Introduction: Use of lunar and Martian regolith for *in situ* production of construction materials would decrease the amount of materials transported from Earth in exploration missions. One promising approach involves mixing regolith with energetic additives that can react either between each other or with the regolith, leading to the formation of sufficiently strong materials. Several research teams studied use of aluminum (Al) as such an additive [1-4]. Combustion with Al, however, requires significant preheating of the mixture [1], adding ilmenite as the oxidizer for Al [2, 3], or adding polytetrafluoroethylene as an activating agent [4].

The present paper summarizes the results obtained with another additive – magnesium (Mg). The studies on combustion of lunar and Martian regolith simulants with Mg were conducted in 2010-2015 at the University of Texas at El Paso and the results were published in journal articles [5-9].

Thermodynamic calculations: Thermodynamic calculations have shown that mixtures of lunar and Martian regolith simulants (JSC-1A, JSC-Mars-1A, and Mojave Mars) with Mg exhibit higher adiabatic flame temperatures than their mixtures with Al (at the same metal concentration).

Combustion experiments: Combustion experiments in normal and reduced gravity have shown that mixtures of all three simulants with Mg ignite with no need for preheating or adding reactants, leading to a steady (Figs. 1-3) or spinning propagation of the combustion wave over the pellet at relatively low concentrations of Mg. Further, use of SHS compaction (quasi-isostatic pressing immediately after combustion) for JSC-1A/Mg mixtures has enabled fabrication of products that are stronger than common bricks.

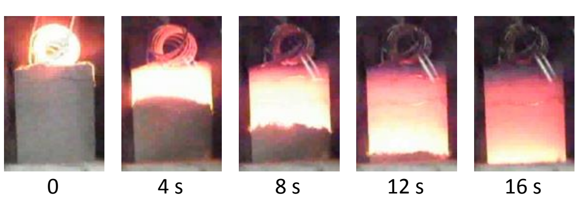

Fig. 1. Combustion propagation over a compacted mixture of JSC-1A regolith simulant with magnesium (13 wt% Mg) [7].

Fig. 2. Combustion propagation over a compacted mixture of JSC-Mars-1A regolith simulant with magnesium (20 wt% Mg) [9].

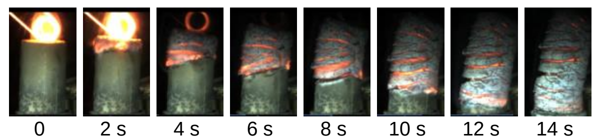

Fig. 3. Combustion propagation over a compacted mixture of Mojave Mars regolith simulant with magnesium (20 wt% Mg) [9].

Thermoanalytical studies: Studies of the reaction mechanisms were conducted using differential scanning calorimetry. It has been shown that iron oxide plays a dominant role in the combustion of JSC-Mars-1A simulant with magnesium. For Mojave Mars material and JSC-1A lunar regolith simulant, which include more silica and less iron oxide, silica exhibits a significant effect on the combustion, promoting reactions at lower temperatures.

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