COMBUSTION-BASED METHODS FOR CONSTRUCTION ON THE MOON. E. Shafirovich, Department of Mechanical Engineering, The University of Texas at El Paso, 500 W. University Ave., El Paso, TX 79968, USA, eshafirovich2@utep.edu.

It is widely agreed that lunar regolith will be used as a construction material on the Moon. However, consolidation of regolith by conventional methods, such as microwave heating [1, 2], requires a significant energy input. An alternative approach for consolidating regolith involves mixing it with energetic additives that can react either between each other or with the regolith, leading to the formation of ceramic materials. The use of chemical energy stored in reactants dramatically decreases the required external energy input and only a small amount of energetic materials is required. Also, energetic metals, such as aluminum and magnesium, could be recovered from regolith [3-5] or by recycling foil, propellant tanks, and other parts.

Studies on combustion of lunar and Martian regolith simulants with magnesium were conducted at the University of Texas at El Paso (UTEP) [6-10]. This research included thermodynamic calculations, combustion experiments in an argon environment at normal and reduced gravity, and thermoanalytical studies of the reaction mechanisms. The results indicate that magnesium is an effective additive that enables a self-sustained combustion of regolith-based mixtures (Fig. 1) through thermit reactions with regolith constituents such as silica and iron oxide.

Fig. 1. Combustion propagation over compacted mixture of JSC-1A lunar regolith simulant with magnesium; pellet diameter: 25 mm [8].

Combustion approaches could also be used for joining regolith items fabricated in situ by other methods. Researchers at NASA Kennedy Space Center have developed sintering techniques for converting regolith into ceramic tiles that are sufficiently strong, survive rocket plumes, and can be assembled into a launch/landing pad [11-13]. It is unclear, however, how to reliably join the tiles in such a pad with relatively small amounts of energy and materials.

Experimental and modeling studies have been conducted at UTEP to investigate the use of self-propagating intermetallic reactions for joining the regolith tiles [14]. A mixture of aluminum and nickel was placed into a gap between two tiles and ignited with a CO₂ laser in an argon environment at 10 mbar pressure, leading to a self-sustained propagation of exothermic aluminum-nickel reaction. Figure 2 shows two tiles joined together as a result of this process. The obtained experimental data on the combustion characteristics are in agreement with modeling predictions. Both experimental and modeling results indicate that the quenching distance in the investigated system is small, which implies that a small amount of the reactive mixture would be required for joining regolith tiles on the Moon.

Fig. 2. Two ceramic tiles made of JSC-1A lunar regolith simulant and joined using aluminum–nickel combustion.

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