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Unique properties of lunar impact glass: Nanophase metallic Fe synthesis

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ABSTRACT

Lunar regolith contains important materials that can be used for in-situ resource utilization (ISRU) on the Moon, thereby providing for substantial economic savings for development of a manned base. However, virtually all activities on the Moon will be affected by the deleterious effects of the adhering, abrasive, and pervasive nature of lunar dust (<20 μm portion of regolith, which constitutes ~20 wt% of the soil). In addition, the major impact-produced glass in the lunar soil, especially agglutinitic glass (60–80 vol% of the dust), contains unique nanometer-sized metallic Fe (np-Fe^0), which may pose severe pulmonary problems for humans.

The presence of the np-Fe^0 imparts considerable magnetic susceptibility to the fine portion of the lunar soil, and dust mitigation techniques can be designed using these magnetic properties. The limited availability of Apollo lunar soils for ISRU research has made it necessary to produce materials that simulate this unique np-Fe^0 property, for testing different dust mitigation methods using electromagnetic fields, and for toxicity studies of human respiratory and pulmonary systems, and for microwave treatment of lunar soil to produce paved roads, etc. A method for synthesizing np-Fe^0 in an amorphous silica matrix is presented here. This type of specific simulant can be used as an additive to other existing lunar soil simulants.

Keywords: Nanophase Fe, metallic Fe, lunar dust, ferromagnet, microwave coupling, magnetization