Kinetic and Potential Sputtering of Lunar Regolith: Contribution of Solar-Wind Heavy Ions

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Sputtering of lunar regolith by protons as well as solar-wind heavy ions is considered. From preliminary measurements of H+, Ar+1, Ar+6 and Ar+9 ion sputtering of JSC-1A AGGL lunar regolith simulant at solar wind velocities, and TRIM simulations of kinetic sputtering yields, the relative contributions of kinetic and potential sputtering contributions are estimated. An 80-fold enhancement of oxygen sputtering by Ar+ over same-velocity H+, and an additional x2 increase for Ar+9 over same-velocity Ar+ was measured. This enhancement persisted to the maximum fluences investigated (~1016/cm2). Modeling studies including the enhanced oxygen ejection by potential sputtering due to the minority heavy ion multicharged ion solar wind component, and the kinetic sputtering contribution of all solar wind constituents, as determined from TRIM sputtering simulations, indicate an overall 35% reduction of near-surface oxygen abundance. XPS analyses of simulant samples exposed to singly and multicharged Ar ions show the characteristic signature of reduced (metallic) Fe, consistent with the preferential ejection of oxygen atoms that can occur in potential sputtering of some metal oxides.

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