Sulfur-Powered Space Weathering

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Space weathering should control the change of brightness and color of the surface regolith of airless silicate bodies: optical darkening, reddening and weakening of absorption bands. Formation of nanophase iron particles through solar wind implantation or micrometeorite bombardments is the cause of the optical property changes of the space weathering. A small S-type asteroid Itokawa, which was observed by HAYABUSA spacecraft has weakly weathered LL5/6 spectrum, which was confirmed by detailed analyses of returned samples. The returned samples contain not only nanophase iron but also nanophase FeS (and MgS) particles play some role in space weathering.

In the present study, we conducted laboratory simulation experiments using nano-second pulse laser irradiation simulating high-speed micrometeorite impacts, and found that additional FeS (45-75 μm, 10wt%) as well as additional Fe should promote optical change compatible with space weathering, especially darkening of infrared spectra of olivine. We observed laser-irradiated sample by TEM. The amorphous layer about 200 nm thickness is formed around an olivine particle. Abundant nano particles are observed both at the bottom and the surface of the amorphous layer. On the basis of lattice parameters, we confirmed nano Fe particles but we did not find nano FeS particles. There is possibility that additional FeS promoted production of nanophase iron particles, which would have enhanced the space weathering effect. We also tried preliminary experiments with addition of pure sulfur particles (45-75 μm, 10wt%) instead of FeS particles. We observed small change of reflectance after pulse laser irradiation which is less significant compared with the case of additional FeS. We have started very preliminary experiments using FeS_2, which may enhance the spectral darkening and reddening as FeS.

Keywords: space weathering, regolith maturity, micrometeorites, sulfur, iron sulfide, spectral darkening

