LABORATORY SIMULATION OF THE EFFECT OF FES ON SPACE WEATHERING

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Introduction: In the standard model of space weathering, changes of surface optical properties of airless silicate bodies - reddening, darkening, and attenuation of absorption bands - are explained by nanophase metallic iron (nanoFe) particles, which are formed on regolith particles by high velocity dust impacts as well as irradiation of the solar wind ions [1]. Those nanoFe particles were discovered in lunar soils, Kapoeta meteorite, and regolith grains from the surface of S-type asteroid Itokawa. Experimental studies using nano-second pulse laser confirmed that nanoFe should control the spectral darkening and reddening. Observed reddening of S-type asteroid families is correlated with dynamical asteroid ages after family-forming disruption [2]. However, weathering degree should depends on mineral compositions such as olivine/pyroxene ratio [3] and iron abundance.

Itokawa: In ordinary chondrites, iron sulfides is the main sulfur-bearing mineral. TEM observation of dust grains of Itokawa revealed the presence of not only iron, but also nanophase FeS particles, which are embedded within a surface vapor-deposited thin layer (<10 to 15 nm) [4]. One Itokawa's grain is composed mainly of FeS (about 40 micron) with smaller olivine and pyroxene particles [5], and some other Itokawa particles also contain FeS. Simulation using a pulsed laser on the Ehole H5 chondrite produced a vapor-deposited coating, which consists of amorphous Mg-rich silicate glass and abundant nanophase (2-5 nm) FeS particles [6]. On the other hand, the surface sulfur depletion of S-type asteroid Eros was explained by the same mechanism (high velocity dust and solar wind particle impacts) as space weathering [7].

Effect of FeS: To examine the effect of FeS on the surface optical properties of silicate bodies , we conducted pulse laser irradiation experiments on mixture of olivine (and pyroxene) and FeS particles with sizes typically 45-75 micron, under various FeS fraction (0-20 wt %). We find that addition of FeS should promote the change of optical properties in accordance with space weathering, especially darkening. Compared with the cases where iron particles are mixed, darkening of infrared region is characterized. Observations by FESEM and HR microscope, surfaces of olivine particles after laser irradiation are likely coated by vapor-deposited material. TEM observation of FIB section of a coated particle show feature of layered amorphous rim containing nanophase iron particles. The search of nanophase FeS is ongoing.

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