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# Laboratory Simulation of Space Weathering to Connect a Missing Link between Asteroids and Meteorites

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Visible-to-NIR reflectance spectra of S-type asteroids are different from those of ordinary chondrites (Chapman, 1996). There are also spectral difference between lunar rocks and soils of similar composition. These spectral mismatches are explained by so-called "space weathering". Space weathering would cause overall depletion, reddening of spectra, and weakening of absorption bands. Itokawa – Hayabusa's target is also an S-type asteroid with relatively moderate space weathering. To explain space weathering, [1] proposed nanophase metallic iron particles in soil coatings from the deposition of ferrous silicate vapor produced by high-velocity dust impacts or sputtering by solar wind. Nanophase iron particles were confirmed in the rim of lunar soils [2]. Recent ground-based and spacecraft observations confirm the strong link between S-type asteroids and ordinary chondrites [3]. And NEAR spacecraft confirmed S-type asteroid Eros has elemental composition categorized within ordinary chondrite groups.

We succeeded in reproducing the optical property change expected as space weathering, using nano-second pulse laser irradiation simulating high-velocity dust impacts [4]. And using TEM, we confirmed the formation of nanophase iron particles within vapordeposited rim of laser-irradiated olivine grains [5].

In order to have more direct spectral comparison, we irradiate pellet samples (8mm to 12mm in diameter) of meteorite powder with grain radius smaller than 125 micron under vacuum. We irradiate Moorabie (L3), Allegan (H5), NWA055 (L4), and Allende (CV3). Significant reflectance decreases were observed when ordinary chondrites were irradiated by pulse laser. Repetitive irradiation would have saturated the spectral change. Significant spectral decreases were observed even when irradiation time was once at NWA055 or even when the irradiation pulse laser energy was lower (10mJ) at Allegan. Reddening was obtained upon the alteration of Moorabie and Allegan. In the case of NWA055, not only the visible reflectance but also infrared reflectance was decreased largely, and resulting reddening is weaker. In all three ordinary chondrite samples, the spectral decreases were more significant compared with pure olivine or pyroxene. It is partly because the initial reflectances of those ordinary chondrites at 1067nm (laser wavelength) are darker and about 50% of olivine. Contained iron in ordinary chondrite would have also contributed the space weathering. The pulse laser irradiation on carbonaceous meteorite Allende also changed the reflectance spectrum.

## References

[1] Hapke et al. (1975).
[2] Keller and McKay, 1993.
[3] Binzel et al., 1996; Chapman, 1996.
[4] Yamada et al., 1999 – *Earth Planets Space* **51**, 1255-1265.
[5] Sasaki et al., 2001 – *Nature* **410**, 555-557; 2002 - *Adv. Space Res.*, **29**, 783-788.