Space weathering simulation experiments on the Murchison meteorite with low-energy pulse laser irradiation

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Reflectance spectra of some C-type asteroids could be the result of surface alteration by space weathering [1-2]. As a cause of space weathering, micrometeorite bombardments were simulated by pulse laser irradiation on carbonaceous chondrites [3-6]. In this study, we aim to understand the low-degree space weathering effects on C-type asteroids by pulsed Nd-YAG laser irradiation on Murchison pellet samples with lower energies of 0.7, 1, 2, and 5 mJ than in previous studies.

It was found that as the laser energy increased, the spectral slope in the UV-Vis range decreased (bluing), the overall reflectance decreased (darkening), and the 0.7 and 3 μm absorption bands were suppressed without any significant changes in the band center position or the width. Although these changes were also observed in high-energy laser experiments [6], the magnitudes of changes were low. FE-SEM observation showed that melted/bubbled structures were present on the surface of the particles collected from the 5 mJ irradiated area, which may be products of rapid heating and cooling by laser irradiation. The chemical compositions of melted/bubbled structures were similar to those of FeS-rich particles splashed from 15 mJ irradiated area [6].

The degrees of spectral bluing and band suppression correlate well with laser energies, but that of darkening does not. Darkening progresses up to 5 mJ in laser energy but becomes satulated at higher energies, suggesting that darkening of C-type asteroids caused by micrometeorite bombardments would stop earlier than other spectral changes.

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