

Evaluating degradation of organic matter in Murchison meteorite captured by aerogel after hypervelocity experiments

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The low-density silica aerogel (0.01 g/cm³) [1] is used as a dust capture medium in the Tanpopo mission [2]. One of the purposes of the mission is capturing cosmic dust in the ISS orbit. This aerogel is expected to reduce degradation of materials by hypervelocity impacts. In order to evaluate potential degradation of the cosmic dust, we conducted capture experiments using a two-stage light-gas gun and Murchison powders as cosmic dust analogs. 30-100 μm powders were fired at 4.4 km/s and 5.9 km/s. The extracted grains were embedded in sulfur and ultramicrotomed. C-, N- and O-XANES analyses were performed for two grains from each shot. The STXM images and elemental maps for C, N and O showed no clear evidences for surface degradation, nor differences between surface and interior of the sections of the Murchison grains after the shots, although there were some heterogeneity of the elemental distributions and textures. The sizes of the analyzed thin sections that roughly represent the recovered grain sizes were in the range of 10-25 μm for 4.4 km/s shot, while 10-40 μm for 5.9 km/s. The C-XANES spectra of the Murchison after the 4.4 km/s shot have organic features, e.g., aromatic/alkene C=C, ketone C=O, aliphatic C-C, and carboxyl O-C=O, but in the case of the 5.9 km/s shot, most of these features disappeared. The results indicate that the grains fired at 4.4 km/s seem generally intact, but the grains fired at 5.9 km/s show drastic changes in organic structure. Although further discussion is required on the size effects, the threshold impact velocity for organic survivability might be between 4.4 and 5.9 km/s. At least, organic matter in cosmic dust with entry velocity of ~4.4 km/s or less can survive from the impact to the 0.01 g/cm³ aerogel.

[1] Tabata et al. (2015) *OLEB*, 45, 225-229. [2] Yamagishi et al. (2009) *Trans. JSASS Space Tech. Japan*, 7, Tk_49-Tk_55.