Surface roughness and cohesion of impact fragments of meteorite targets

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The shape and cohesive force of particles making up small bodies have significant effects on the physical properties of the bodies. The shape of particles affects the angle of internal friction and thus the porosity of the particle layer [1]. The cohesive force of particles would enable the fast rotation of small bodies [2]. Also, the deformation and failure modes of rubble piles depend on the angle of internal friction and the cohesive force [3]. We have measured the shape and cohesive force of meteorite particles ground with a pestle and mortar. We showed that the smaller the circularity C (= $4\pi S/L^2$; S and L are the two-dimensional projected area and perimeter of the particle, respectively) and the larger the arithmetic mean roughness *Ra* (the average of the deviations from the mean surface), the smaller the cohesive force [4]. However, the ground meteorite particles have larger circularities than Itokawa rocks and basalt impact fragments, although they are different in size, and may also have different surface roughness. Therefore, we conducted impact experiments and collected tens of micron-sized particles ejected from meteorite targets to measure the circularity, surface roughness, and cohesion.
We collected the ejecta particles from impacts of a 1/8-inch stainless steel projectile and 1 mm aluminum projectiles to blocks of Allende at a speed of ~0.13 and ~2.9 km/s, respectively. We measured the circularity C and the axial ratio b/a (the ratios of the long-axis a and short-axis b lengths of the ellipsoidal approximation of the two-dimensional projection) of the ejecta using an optical microscope. We measured the roughness *Ra* of the ejecta using a confocal laser microscope.
The axial ratio b/a of the ejecta is 0.69–0.70 on average, similar to that of tens of micron-sized impact fragments of basalts and L5 chondrites (~0.7) [5] and the ground Allende particles (0.72 on average) [4]. The circularity C of the ejecta is 0.66–0.67 on average, similar to that of Itokawa rocks and basalt impact fragments (0.64–0.73 on average) [4], but smaller than that of the ground Allende particles (0.75 on average). Here, we compared the values of the circularity when the number of constituent pixels of each particle was corrected to 3000 pixels because the circularity depends on the number, i.e., image resolution [4]. The roughness *Ra* of the ejecta was ~500 nm, larger than that of the ground Allende particles (~300 nm) [4]. We will also compare the cohesive force of the Allende ejecta and ground particles, measured using a centrifugal method [4,6].

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