Collisional disruption of porous weak targets at low impact velocity

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Porous structure is common in asteroids and satellites of outer planets. In order to study the relation between structure of the small bodies and their thermal and collisional evolution, we prepared porous sintered targets, measured the compressive strength, and determined their impact strength.

Previous studies showed, using sintered glass beads (Love et al. 1993), the targets with higher compressive strength have higher impact strength and the targets with higher porosity have higher impact strength. However, in these experiments, the porosity of the targets were changed according to the compressive strength. Therefore, we fixed the porosity while the compressive strength was varied. Our experiments were performed with low impact velocity condition because low impact velocities are common among icy bodies far from the Earth.

We sintered soda lime glass beads of 50 micron diameter and 2.5g cm^{-3} nominal density at various temperatures and durations to produce targets with similar porosity ($\sim$40%) and different compressive strength (0.2$\sim$7.8MPa). We performed impact disruption experiments using a low velocity light-gas gun at Kobe University ($\sim$100m/s). We used cylindrical polycarbonate projectiles, 1.5 cm in height and 1.0 cm in diameter. We determined the specific energy (J/kg of projectile kinetic energy per kilo gram initial target mass) for the condition that the largest fragment mass being the half of the initial target mass is the "threshold" energy for collisional disruption, Q* (Fujiwara et al. 1989, Holsapple et al. 2002), for each target.

The result was that the targets with higher compressive strength (S) have higher Q*, impact strength: $Q^* = 2.6 \pm 0.5 \times S^{0.45}$. However, the absolute values of the impact strength of our targets were several tens times lower than the previous results of the impact disruption with impact velocity of $\sim$6km/s (Love et al. 1993).

In this paper, we will report about the new results of the impact experiments with a few times higher impact velocities than before with small projectiles (3.2 mm diameter – glass sphere) and will discuss on the effect of projectile/target size ratios on the impact strength.