**CAPTURE OF HYPERVELOCITY DUSTS BY HIGHLY POROUS SMALL BODIES.** T. Okamoto[1], A. M. Nakamura[1], S. Hasegawa[2], K. Kurosawa[2], K. Ikezaki[3], and A. Tsuchiyama[3], [1]Department of Planetary Science, Kobe University,1-1 Rokkodai, Nada-ku, Kobe, Japan (tokamoto@stu.kobe-u.ac.jp), [2]Institute of Space and Astronautical Science, JAXA, [3]Department of Earth and Space Science, Osaka University.

**Introduction:** Dusts in debris disks collide with primitive small bodies and are captured. Such dusts are not necessarily similar to the dust component of the target bodies, but possibly be of different origin transported from the regions of different heliocentric distances. The collision of dusts modifies the surface structure and composition of the target bodies.

The purpose of this study is to examine the physical processes that occur when hypervelocity dusts penetrate into highly porous small bodies, that is the penetration depth and the degree of fragmentation of the dust particles and the morphology and the size of the cavity. Dust penetration processes into silica aerogel have been intensively studied for the calibration of the Stardust tracks [1][2][3], however, it is not clear how far those understandings for dust penetration into aerogel can be extrapolated to dust penetration into porous small bodies in planetary systems. In order to get better understanding of the physical processes of dust penetration into porous small bodies, we conducted impact experiments of porous sintered glass targets with different porosities and impact velocities.

**Experiments:** Hollow glass microspheres of 55 μm in diameter and glass microspheres of 5 μm in diameter were sintered in a cylindrical mold 60 mm in inner-diameter and 150 mm in height. The bulk porosities of the targets were 87 and 94 % for the hollow microspheres and 80 % for the 5 μm glass particles, respectively. The typical target length was about 130 mm.

Impact experiments were performed using a two-stage light-gas gun at ISAS, JAXA. The projectiles were Ti and Al spheres of 1 and 3.2 mm in diameter accelerated using sabot [4]. The impact velocity was ranged from 1.7 to 7.2 km/s. We observed the deceleration process of the projectiles using a flash X-ray imaging system and a high-speed framing camera. The cavity morphology of the targets and the size change of the projectiles were observed using X-ray CT system at Osaka University.

**Results and Discussions:** The 1 mm projectiles were captured by the targets, while the 3.2 mm projectiles disrupted the targets.

*Deceleration of the projectiles.* The penetration of the projectile and the growth of the cavity in the target were imaged from two different directions with some time interval by flash X-ray as shown in Fig. 1. The penetration depths of the projectile at the X-ray exposures were analyzed by the following drag equation:

$$m_p \frac{dv}{dt} = -\frac{1}{2} C_d \rho_t S v^2 \quad (1)$$

where $m_p$, $v$, $C_d$, $\rho_t$, $S$ are projectile mass, projectile velocity, drag coefficient, target bulk density, and the cross sectional area of the projectile, respectively. Here we fixed the projectile mass and cross section to those of the initial intact sphere. However, in general, they change with the penetration depth. The values of drag coefficient thus determined for different shots of Ti 3.2 mm projectiles are shown in Fig. 2. The drag coefficient increases monotonically with the initial dynamic pressure, which corresponds to the increase of the ratio of the cross sectional area to the mass of the projectile due to mass loss and the shape-change of the projectiles.

*Cavity and the residual projectile.* The morphology of the cavity shape is similar to what was observed for the dust penetration into aerogel. The cavity was carrot-shape when the projectile was intact, while it was bulbous when the projectile was fragmented. Typical examples are shown in Fig. 3. Part of the penetration track was filled with the crashed target material.

The volume of the cavity increases with the projectile kinetic energy. Such behavior was observed for dust penetration into foamed polymers [5]. Fig. 4 shows the results of the mass of the cavity material. The mass of the cavity is proportional to the projectile kinetic energy when the residual projectile is still large and at the head of a well-developed track.

**Summary:** We conducted hypervelocity dust penetration experiments using highly porous brittle targets in order to understand the physical processes of dust capture by porous small bodies. We found that the projectile deceleration, the cavity morphology and the volume can be understood in the context of the previous understanding of the dust capture by porous materials such as aerogel and foamed polymers.

**References:** [1] Brownlee, D. et al. (2006) *Science, 314*, 1711-1716. [2] Hörz, F. et al. (2006) *Science, 314*, 1716-1719. [3] Niimi, R. et al. (2011) *Icarus, 211*, 986–992. [4] Kawai, N. et al. (2010) *Rev. Sci. Instruments*, *81*, 115105. [5] Kadono, T. (1999) *Planet. Space Sci. 47*, 305-318.

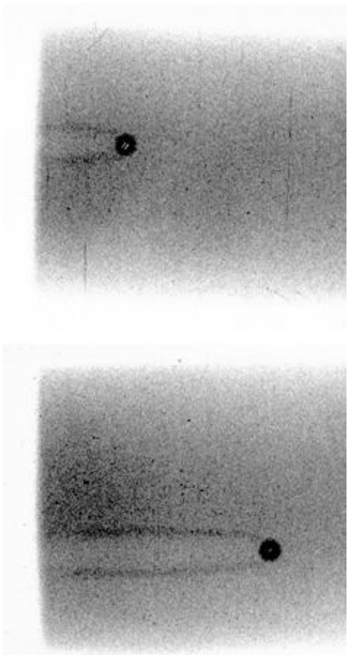

Fig.1. Flash X-ray images of a shot of Ti 3.2 mm projectile into an 87% porosity target. Projectile was impacted from the left with velocity of 1.8 km/s. The elapsed times are 11.0 (top) and 30.9 (bottom) µs, respectively.

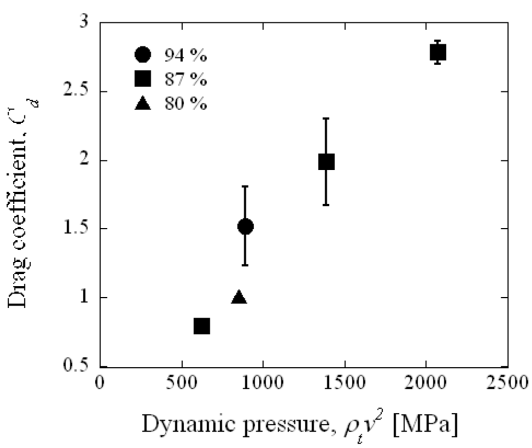


Fig.2. Drag coefficient determined according to Eq. 1 for shots with Ti 3.2 mm projectiles and the targets with different porosity versus the initial dynamic pressure.

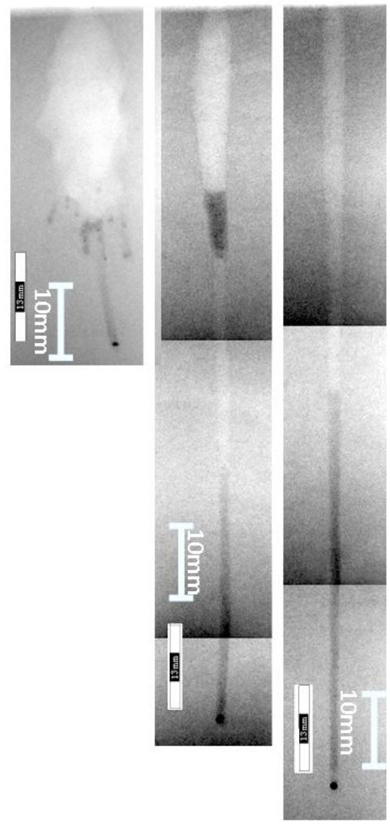


Fig.3. X-ray CT images of the 94 % porosity targets. Projectiles were 1 mm Ti spheres and the impact velocities were 6.7 (left), 4.0 (middle), and 2.6 (right) km/s.

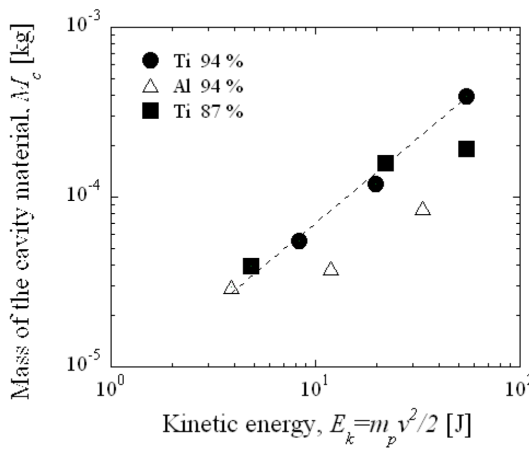


Fig.4. Mass of the material in the cavity versus projectile kinetic energy for 1 mm projectiles. The dashed line is a fit to the experimental data ( $E_k / M_c$ =1.4 × $10^5$ [J/kg]).