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# Physical Process on Penetration of High Velocity Dusts Captured by Very Porous Small Bodies

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Through the evolution of the Solar System, dusts collided with each other to become primitive bodies. Such dusts are the original components, i.e. building blocks, of the bodies. Small porous bodies can also contain exotic components because they might have captured dusts which were once located in regions of different heliocentric distances and were eventually transported to the bodies. Large flux of the exotic dusts can modify the structure and composition of the surface.

The purpose of this study is to examine the physical processes, such as the penetration depth, the degree of dust fragmentation, the morphology of the track, when high velocity dusts penetrate into very porous small bodies. Dust penetration processes into silica aerogel has been intensively studied for the calibration of the Stardust tracks (Horz et al.2006 etc). 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.

We prepared three different targets, fluffy 94, fluffy 87 and fluffy 80. Hollow glass microspheres, which are composed of soda lime borosilicate glass were sintered in a cylindrical mold at different condition to have bulk porosities of 87 and 94 %. Low alkali glass particles were also sintered to have 80% bulk porosity. 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, Al and Stainless spheres of 1 and 3.2 mm in diameter, and basalt cylinder of 3.2 mm in diameter and 2.0 mm in height. 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 track morphology of the targets and the degree of the projectile fragmentation were observed using ELE-SCAN (an instrument for X-ray tomography) at Osaka University and got transmission images.

The 1 mm projectiles were captured by the targets, while the 3.2 mm projectiles disrupted the targets. Images by flash X-ray with time interval show the growth of the track and disruption of the projectile in the targets. The deceleration of the projectile was analyzed using the fluid drag equation in which the drag is proportional to the projectile velocity, drag coefficient, target bulk density, the cross sectional area of the projectile and square of velocity. We fixed the projectile mass and cross section to those of the initial value. However, in general, they change during penetration. We obtained the result of the drag coefficient which increased monotonically with the initial dynamic pressure. This agrees with 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.

The track was long and thin, called as carrot-shape, when the projectile was intact, while it was short and thick, called as bulb-shape, when the projectile was fragmented. This is similar to the track of aerogel formed by dust penetration.

The volume of the track increases with the projectile kinetic energy. Such behavior was observed for dust penetration into foamed polymers (Kadono 1999). The mass of the track is proportional to the projectile kinetic energy when the terminal projectile is still large.

In this presentation, we discuss a model of penetration depth. Niimi et al. 2011 presented a model for penetration depth of a carrot-shape aerogel track. This model assumes hat drag is proportional to the square of velocity when projectile has high velocity, while it is proportional to the strength of the target when it is low velocity. We modify this model to fit the result of our experiments.

Keywords: Porosity, Small bodies, Flash X-ray, Deceleration