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Experimental study about attenuation rate of stress wave in porous small body

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Porous structure is common in the asteroids and satellites of the outer planets. In order to study the relationship between the structure of small bodies and their thermal and collisional evolution, we performed impact experimental series by using porous sintered glass bead targets. The results of the experiments will be used as a reference for future numerical simulations of collisional process of porous bodies.

In order to produce porous targets, we sintered soda lime glass beads of 50 micron diameter and 2.5g /cm3 nominal density. We performed three series of impact experiments for them. First collisional experiments were carried out in air using a light-gas gun at Kobe University. We used targets of roughly the same porosity but different strength (Setoh et al. 2007). The targets had the tea-cup shaped with diameters of 40 and 30 mm and height of 40 mm. The projectiles were polycarbonate cylinders of 10 mm in diameter and 15 mm in length. The impact velocity was varied from 10 to 100 m/s. Second collisional experiments were carried out in air using another light-gas gun at Kobe University. Targets had roughly the same porosity with the targets of the first experiments but the shape of targets and projectiles were different. The targets were about 65 g in mass and had the cylindrical shape. The projectiles were glass spheres with diameter 3.2 mm. The impact velocity was varied from 190 to 260 m/s.

The third experiments were carried out using a two-stage light gas gun at ISAS. We used sphere targets of lower porosity. The targets were about 168g in mass. The projectiles were nylon sphere with diameter 7.0 mm. The impact velocity was varied from 2120 to 3280 m/s.

A comparison between the results of these experimental series and a previous one (Love et al.1993) suggested that high velocity impacts need higher specific energy than low velocity impacts for catastrophic disruption when the targets have same compressive strength.

Next, we performed other impact experimental series for measuring attenuation rate of stress wave in sintered glass bead targets. Glass beads in a mold of diameter 100 mm and height over 30 mm were heated. After cooling down the targets, we cut the targets into discs of three different thicknesses.

The first impact experiments (experiment I) were carried out in air using a light-gas gun at Kobe University. The projectiles were glass spheres of 3.2 mm in diameter. The impact velocity was about 260 m/s. We measured the antipodal velocity of the targets after impact using high-speed camera images taken at 2,000 - 5,000 fps.

The second impact experiments (experiment II) were carried out in vacuum using a two-stage light-gas gun at ISAS. The projectiles were nylon sphere of 7 mm in diameter. The impact velocity was from 1.7 km/s to 2.1 km/s. All the shots were recorded by a high-speed video camera.

When the relation between the thickness of the target normalized by the projectile diameter and the antipodal fragment velocities normalized by the impact velocities was examined, the power-law index was about -2.0 both of low and high velocity impacts. This value of attenuation rate suggested that the result of our collisional experimental series followed PI scaling significantly (Setoh et al. Japan Geoscience Union Meeting 2007).

To study about attenuation rate of stress wave in the porous bodies more quantitatively, the denser target which have higher compressive strength than that of our previous study were produced. We will also report the result of new experiments to a pile of glass beads particles and discuss on the effect of the internal structure of the porous body upon the attenuation rate.