Attenuation rate of stress wave in sintered and non-sintered glass beads targets

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Abstract

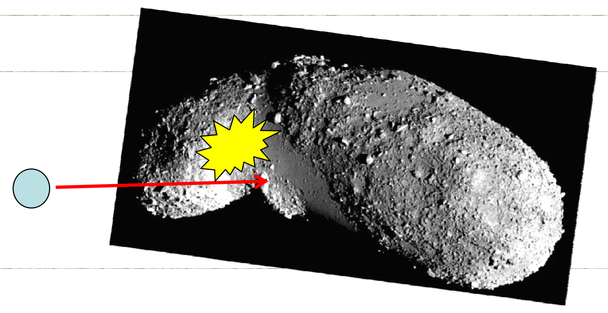
Porous structure is common in asteroids and satellites of the outer planets.
To study the relationship between the structure of small bodies and their thermal and collisional evolution, we performed experimental series about the attenuation rate of stress wave in porous small bodies quantitatively.
We found in the results of our experiments using sintered glass beads and rubble-pile glass beads powder that the antipodal ejecta velocities have similer dependencies on the distance from the impact point and the power law index of the attenuation rate was -2.

1 : Background

Porous structures are believed to be common in small bodies.
ex. asteroids, Kuiper-belt objects.

Laboratory impact experiments into porous objects have a significance for studying origins and collisional evolution.

This study investigate the relationship between attenuation rate and internal structure of small bodies quantitatively



Initial peak pressure

↓↓ (attenuation)

Antipodal pressure

- **Destruction strength of Porous bodies**
- **Possibility of ejection of regolith particles and boulders from the surface**

2 : Target and experimental procedures

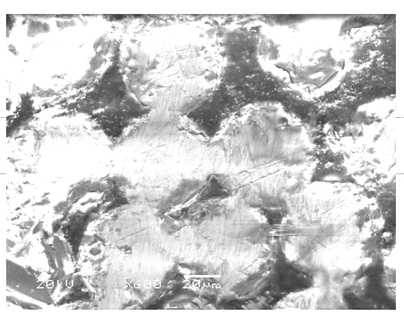
We conducted five types of experiments for glass bead targets using light-gas gun and two-stage light-gas gun.

Samples are soda lime glass beads of 50 micron diameter, nominal density is 2.5 g/cm3 and melting point is 734 ℃. compressive strength of each particle is about 850 MPa.

The following table shows the experimental conditions.

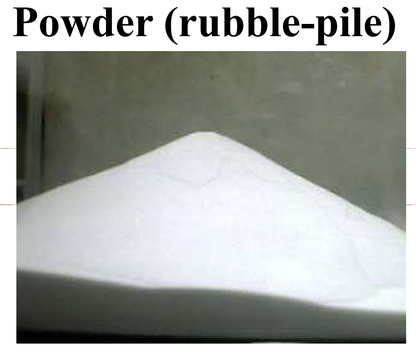
	Target shape (Consisting grain size)	porosity	Compressive strength (MPa)	Impact velocity (m/s)
Ex. I	Sintered disk（50μm）	39 %	2	Low(190～262)
Ex. II	Sintered disk（50μm）	39 %	2	High(1700～2080)
Ex. III	Sintered disk（50μm）	32 %	40	High(1900～3390)
Ex. IV	50, 500μm	41%	**	Low(257～282)
	Powder 5μm	60%		
	hollow beads	91%		
Ex. V	Powder	41 %	**	High(2380～3800)

Sintered



SEM images ×600

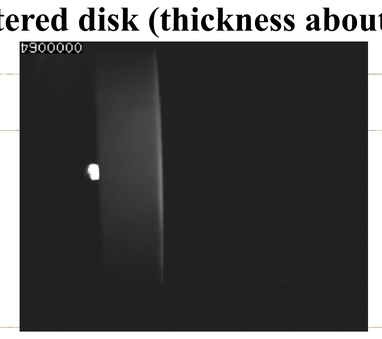
Powder (rubble-pile)



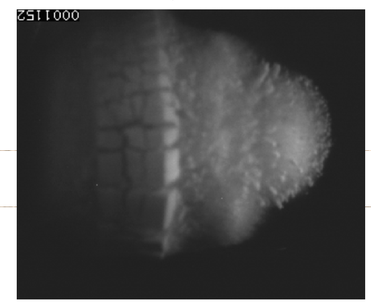
3 : Results

Antipodal ejection velocities were measured by high-speed video images and are normalized with the projectile velocities.

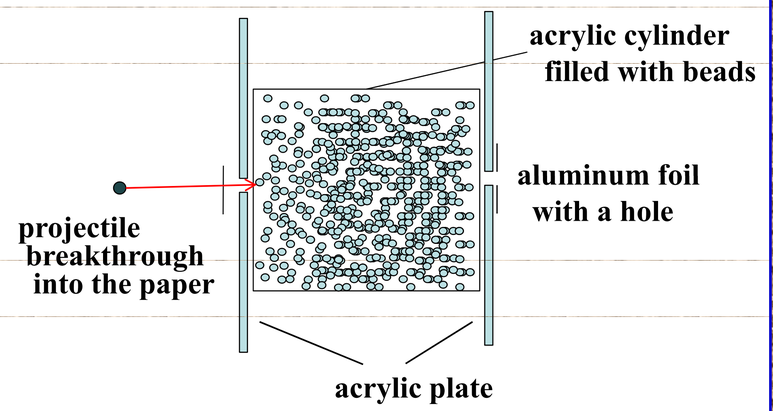
sintered disk (thickness about 26mm)



high-speed video images **1.09ms**

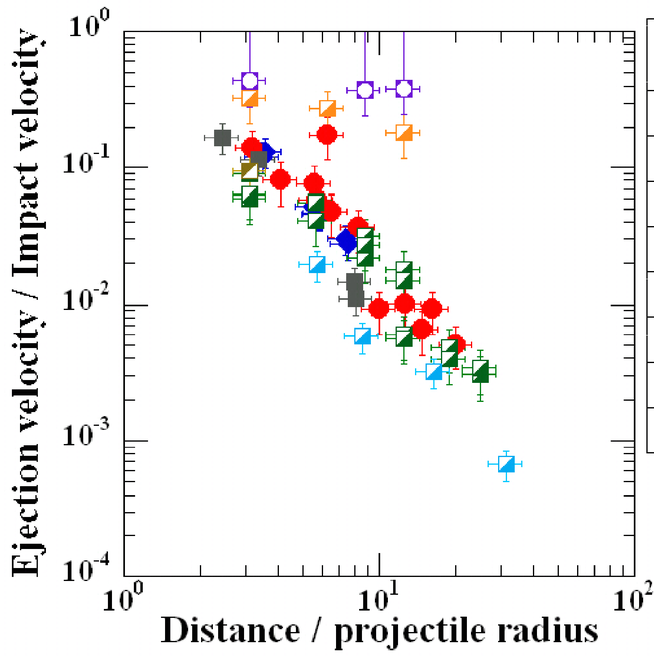


configuration of powder targets



Antipodal ejecta jet out from the hole of aluminum foil.

★Glass beads were stable due to frictional force.



	Target porosity	Impact velocity	condition	Grain size (micron)
◆	39%	High	Sintered	50
●	39%	Low	Sintered	50
■	32%	High	Sintered	50
◪	41%	Low	Powder	50
◪	41%	Low	Powder	500
◪	60%	Low	Powder	5
○	91%	Low	Powder	5-50 (hollow)
◪	41%	High	Powder	50

Slope ～ -2

No difference between sintered and powder targets

The reason why the result of the higher porosity targets are plotted above the others is myabe that what we measured was not the antipodal ejection velocity due to the stress wave but just projectile velocity.

4 : Summary and Next

- **The attenuation rates of ejection velocity were found to be similar and about 2, despite of different impact velocity and different target condition.**
- **Next step is to investigate the attenuation rate of stress wave of more porous targets, quantitatively.**