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Cratering experiments of porous surface in strength regime using low density impactors

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The Cassini spacecraft has obtained the high resolution images of small impact craters of saturnian satellites. Some of the satellites have low mean density, ~1 g/cm^3, so these are considered to be the ice-rock bodies. For example, Iapetus has a density of ~1.1 g/cm^3 and has been taken images of the surface by Cassini down to the resolution limit of ~10 m/pixel.

The surface of these bodies is considered to have been covered with regolith layer formed by fallen debris of impact ejecta. The layer gained porosity in the reaccumulation process. If the regolith layer contains fine icy debris, it would have strength by sintering. It is likely that temperature increase or compaction due to further impact advances sintering of regolith layer.

In this study, we conducted cratering experiments to investigate the cratering formation process on porous surface in strength regime. In order to prepare targets with different porosity and strength, we sintered 55 micron diameter hollow sphere soda-lime borosilicate glass with varying sintering temperature to attain porosity of 73-94% and strength of 0.6-1.9MPa. Impactors were sintered soda-lime borosilicate glass spheres (~1.3 g/cm^3) and porous alumina spheres (~1.8 g/cm^3) to simulate low density bodies. Impact velocity was 100-300 m/s. We used a small gas gun at Kobe University in this study.

In this study, penetration hole was formed on the target of porosity 94%. Hole depth decreased as target porosity decreased and finally a bowl-shaped crater was formed on the target of porosity 74%. On the other hand, hole diameter was constant and approximately the same with the diameter of the projectile over the parameter range of this experiment.

We will compare the results with previous study and discuss the cratering formation process on porous surface of small bodies.

Keywords: porosity, strength, ice-rock body, satellite, impact experiment