Rock Sampling from Surface of Small Bodies

Shogo Tachibana (Univ. Tokyo) and Hayabusa-2 pre-project team
Hayabusa

✓ Sample return mission from an S-type near Earth asteroid, Itokawa
Hayabusa

✓ Sample return mission from an S-type near Earth asteroid, Itokawa
Sample container
Grains recovered from container

Al Al Olivine Al Al Pyroxene

5 mm

50μm
Grains recovered from container

Grains from Itokawa!

Grains from container with Al, Al, Olivine, Al, Al, and Pyroxene.
However, dust was not sampled in a scheduled way.
However, dust was not sampled in a scheduled way
Impact sampling

- Sample catcher
- Projectile
- Sampler horn
- Projector
- Ejecta
- Surface
Impact sampling

- Collect sufficient amount of samples (>several 100 mg) compliant with both monolithic bed rock and regolith targets
- Projectors designed to fire a 5-g Ta projectile at 300 m/s

Hayabusa's Impact Sampling System

- Projectors
- Conical Horn
- Extendable Fabric Horn
- Metal (Al) Horn with Dust Protection Skirt and LRF Trigger Target
- Collect sufficient amount of samples (>several 100 mg) compliant with both monolithic bed rock and regolith targets
- Projectors designed to fire a 5-g Ta projectile at 300 m/s
- Powder cartridge and sabot to conceal residual gas during sampling
- “Ta” projectile not to spoil sample analysis with enough material strength
Sampler updates for future missions

✓ Impact sampling
  – shape & angular momentum
  – effects on hydrous phases and organics: Target for Hayabusa-2

✓ Adhesive-pad sampling
Impact sampling

✓ Projectile shape

Crater Forming Efficiency of Impact Sampling by Projectile Shapes

90° Conical Projectile: Hayabusa-2 Model for Porous Asteroids
Hemispherical Projectile: Hayabusa-1 Model for Consolidated Asteroids

\[ y = 0.83x^{0.76} \]
\[ y = 1.36x^{0.25} \]

Manabe and Yano (2008)
Impact sampling

✓ Projectile angular momentum

The higher projectile velocity is, the higher rps is.

In the same velocity region, the higher rps is, the larger ejected mass becomes.

The variation of rps depends on the ratio of projector inner diameter and sabot diameter (Manabe and Yano, 2008).

![Graph showing the relationship between projectile velocity and ejected mass with and without rotation. The graph includes data points for various rps values, such as 289 rps, 333 rps, 316 rps, and 502 rps, and demonstrates the effect of rotation on the ejected mass.]
Impact sampling

✓ Effects on hydrated phases and organics

- Murchison (CM) impacted by a 300-m/s projectile

✓ No textual change
✓ Cronstedtite, tochilinite survived
✓ No effects on insoluble organic matter
Adhesive-pad sampling

Adhesive pad → capsule

Sample catcher

Sampling

Capsule

SUS convex tape
Other updates

✓ Direct sampling site investigation by a spacecraft and a mini-rover

✓ Light curtain system for detection of sampling

✓ Metallic sealing of sample container
Summary: Sampling from surface of small bodies

✓ Impact sampling
  – shape & angular momentum
  – effects on hydrous phases and organics

✓ Adhesive-pad sampling

✓ Hayabusa-2 (2014-2020)