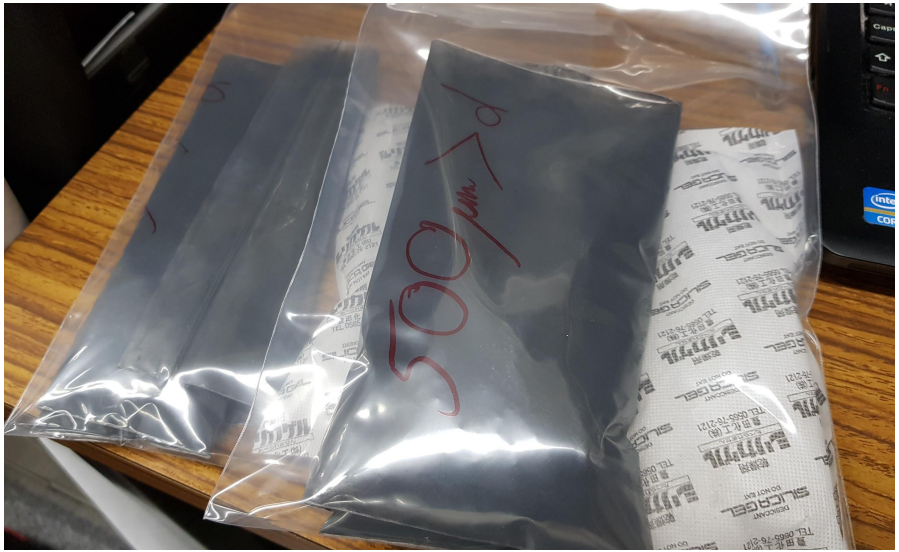
Determining the Thermal Inertia of the UTPS-TB simulant for different grain sizes and densities

Bernadett Pál, Hideaki Miyamoto, Takafumi Niihara, Naoya Sakatani, Amiko Takano, and Ákos Kereszturi

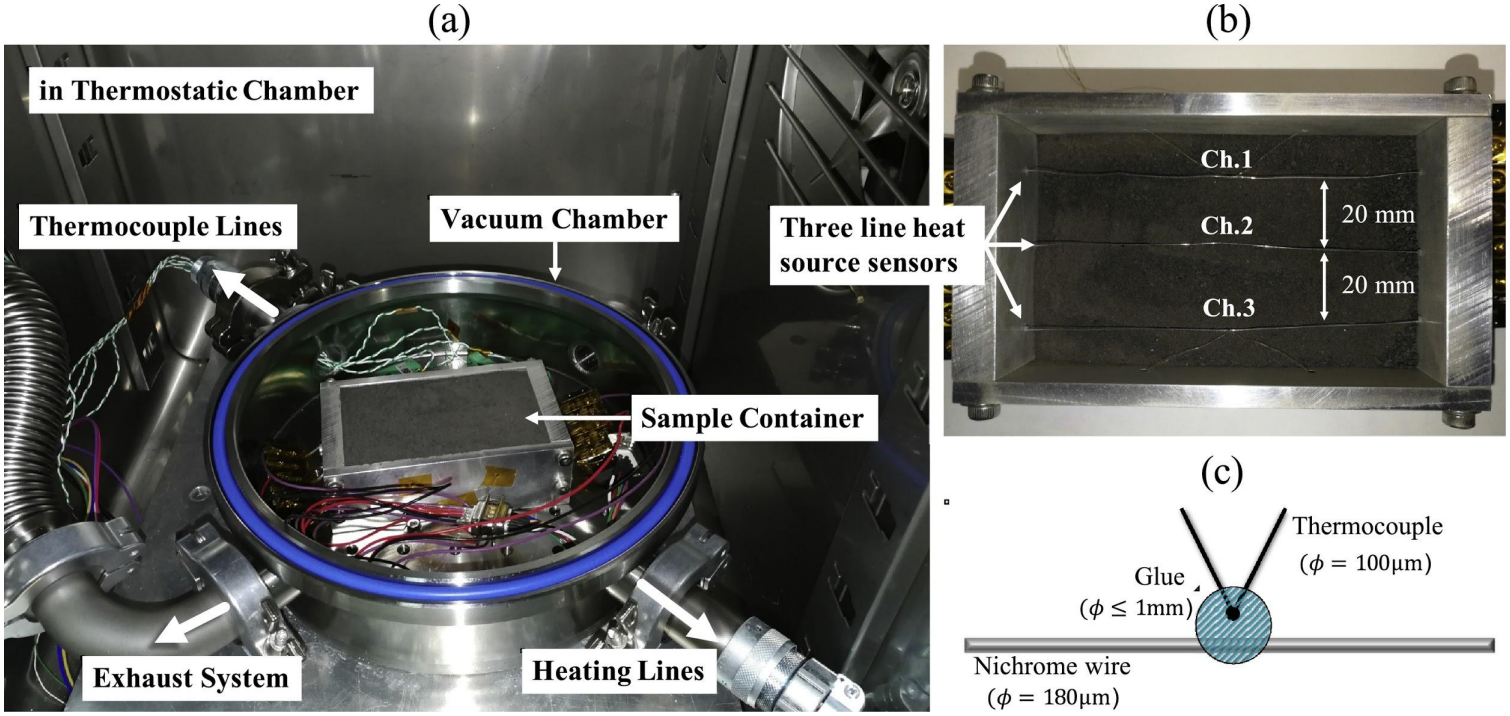
Supported by the ÚNKP-19-3 New National Excellence Program of the Ministry for Innovation and Technology and by the GINOP-2.3.2-15-2016-00003 project of NKFIH

Preparing the samples

1. Separate the UTPS-TB (1,2) material by grain sizes using an ultrasonic sieve
2. Bake the samples at 100 °C for 24 hours
3. Carefully bag the samples with silica gel packets to keep dry
4. Load the samples into sample holders for experiment



Experimental setup



(Sakatani et al., Icarus, 2018)

Calculations & data

$$k = \frac{q}{4\pi s}$$

k: thermal conductivity, **q:** heat generation per unit length of the line heater

$$q = RI^2$$

$$R = 42.35\,\Omega m^{-1}, \quad I = 0.020A$$

R: electrical resistance of the nichrome wire
I: constant current induced in the nichrome wire

$$T = s \times ln(t) + b$$

T: temperature of the heater at heating time **t**
s: slope, **b:** constant

$$I = \sqrt{k\rho c}$$

$$\rho_{500\mu m} = 1140 kgm^{-3}, \quad \rho_{106\mu m} = 927 kgm^{-3}$$
$$\Phi_{500\mu m} = 60.71\%, \quad \Phi_{106\mu m} = 68.03\%$$

k: thermal conductivity, **ρ:** density of the sample, **c:** specific heat

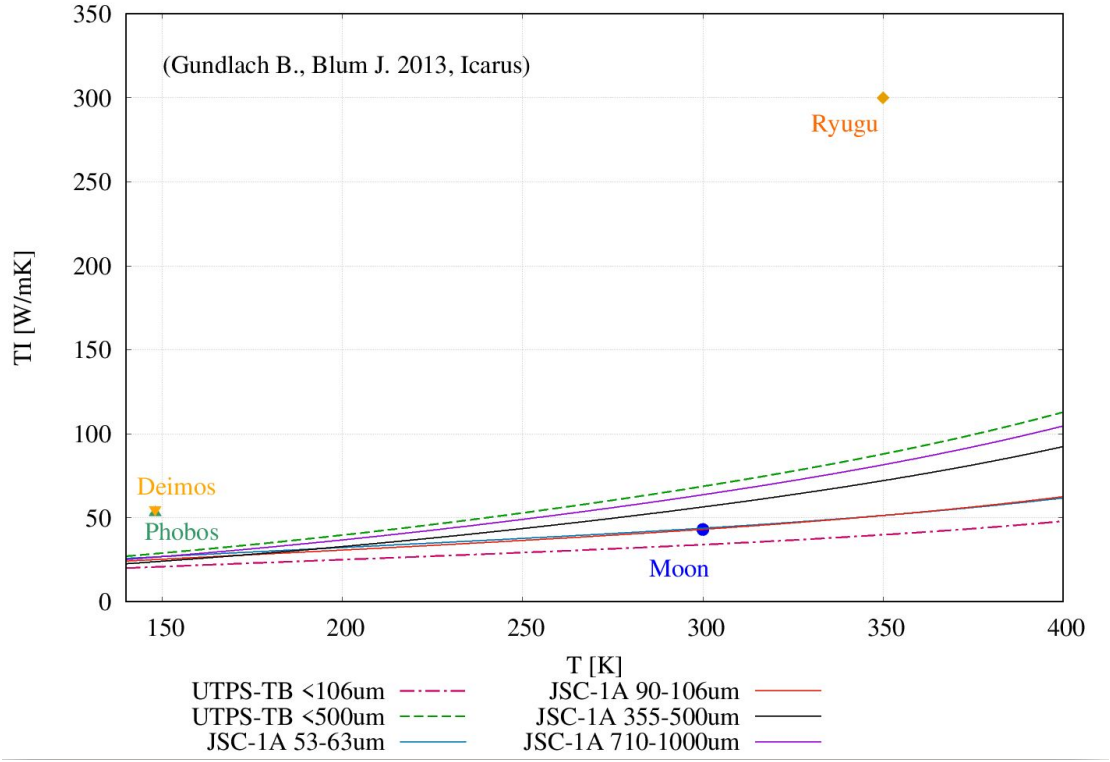
(1)
$$c_p = -23173 + 2.127T + 1.5009 \times 10^{-2}T^2 - 7.3699 \times 10^{-5}T^3 + 9.6552 \times 10^{-8}T^4$$

c_p: specific heat capacity in J $kg^{-1}K^{-1}$ **T:** temperature in K

(2)
$$k(T) = A + B \times T^3$$

A: temperature independent non-dimensional constant,
B: constant (W m^{-1} K^{-1}) representing the solid and radiative conductivities

Fit result



- <500μm sample is halfway between Phobos and the Moon
- <106μm sample behaves more like Moon regolith

It is difficult to interpret based on limited experimental data. It could mean larger grain sizes, or higher density on Phobos and Deimos.

However there is much to learn about thermal inertia, so it could be something entirely different.

Future plans

In Hungary and in Japan

- Thermal conductivity measurements using UTPS-TB samples and glass beads with **various densities and grain sizes**
- Study the effects of **micro-porosity** within grains on thermal conductivity
- High resolution optical studies and spectral measurements of **bulk UTPS-TB samples**

References

(1) Miyamoto, H. et al. (2018) LPSC XLIX, abst#2083.

(2) Miyamoto, H. & Niihara, T. (2020) Nat. Resour. Res., 1-10.

(3) Wada et al., (2018), *Asteroid Ryugu before the Hayabusa2 encounter*, Progress in Earth and Planetary Science

(4) Sakatani et al., (2018),*Thermal conductivity of lunar regolith simulant JSC-1A under vacuum*, Icarus