P01

泡花の成長

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Bubbles Flower Development

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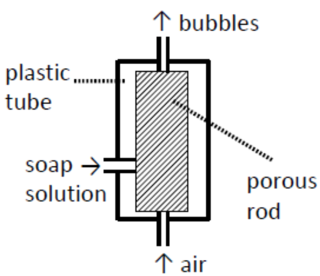
We have studied the bubbles development that looks like a flower growth. Experiments were done on the ground and under a micro-gravity prepared by the 20-sec-microgravity parabolic flights.

For the bubbles formation, a hand-made nozzle was prepared. Following figure shows the structure of the nozzle that a porous rod is embedded in a 13-mm-outer-diameter, 50-mm-height plastic tube with two inlets and a 2.3-mm-diameter outlet.



The bubbles are generated by feeding air and soap-sugar solution (soap: sugar: water = 1.0 g: 1.0 g: 10 mL) with air and liquid pumps into a porous rod through the two inlets of the nozzle and the bubbles are pushed out from an outlet of the nozzle as shown in the figure. To decide the concentration of the solution, we made pre-experiments with changing a quantity of sugar and soap from 1.0 g to 5.0 g each in 30 mL water. Consequently, we adopted 3.0 g for both of them. The flow rate of solution-feeding was 0.50 mL/min, and that of air-feedging was made to change between 1.75 mL/min to 0.50 mL/min.

To observe the surface structure of the bubbles generated from the top of the nozzle, they were photographed under a dark-field illumination.

Generally, the bubbles development depended on the soap-sugar concentration and the feeding rate. As well, directions of the gravity and where the bubbles were pushed out are also concerned.

We focused on the development of the bubbles just behind an outlet of the nozzle. When the bubbles were pushed out in the reverse direction of the gravity, the developed bubbles collapsed. But in the same direction of the gravity, the bubbles developed in a linear manner. Under a micro- gravity, we observed a twisting movement in the bubbles development.

This work was done with a support of the 10^{th} micro-gravity experiment contest program.

P02

微小重力下における土壌粒子モデル間隙中の水分移動

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Water Movement in Experimentally-Modeled Soil Void Spaces under Microgravity

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1. Introduction

Plant growth systems for crop production under microgravity may be the part of a life supporting system designed for long-duration space missions. Plant growth in soil in space environments requires the understanding of water movement in soil void spaces under microgravity. In this study, water movement in experimentally-modeled soil void spaces was observed under microgravity.

2. Materials and Methods

We conducted a 2-day parabolic flight experiment. Round-bottomed glass flasks (32.7mm in dia.) were used as a 2-layer model of soil particles and fixed in an acrylic column to avoid contact with the inside walls of the column. Water stained with annatto was filled in a water reservoir before starting parabolic flights, and was injected by a syringe to raise water level at 0, 10, 20 s during a parabolic flight. We filmed water movement with a video camera (SONY/HDR-CX700V).

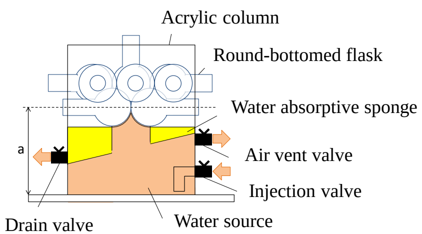

Fig. 1 Experimentally-modelled soil

To evaluate the water movement recorded with the video camera, we analyzed the contact angles between water and the round-bottomed flask and water content in void spaces in a upper layer.

2. Results and Discussion

When supplying water was stopped at 10 s after injection, water was held and maintained between the void spaces. Furthermore, water content in the void spaces and the contact angle between water and the particles sensitively varied with changes in gravity.

Acknowledgments

This research was partly supported by the 10th students contest of microgravity experiments using an aircraft sponsored by JAXA.

P03

重力変化における右心機能の非侵襲測定

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Non-Invasive Measurements of the Right Heart Function During the Gravity Changes

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1. Introduction

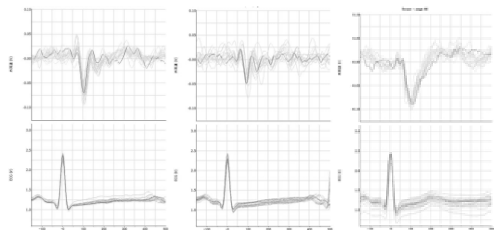
We developed the device for measurements of pressure in the ear canal to understand the jugular venous pressure without invasion. This device is effective for diagnostic equipment to know the right heart function. The vein is affected to change in gravity with the extensibility itself. In this study, we showed the pressure in the ear canal corresponding to changing gravity during parabolic flight.

2. Experiment

The experiments carried out to understand the venous hemodynamics from the pressure of ear canal. The measurement was carried out continuously during takeoff to landing on parabolic flight. The subject kept the sitting position during the measurement.

3. Result and Discussion

The significant results of pressure change are shown in Fig. 1. Figure 1(a) is the timing before the increasing of gravity as 1G. The result at maximum gravity measured as 2G is shown in Fig. 1(b). At the end, Fig.1(c) is the data at minimum gravity as μG. An upper of figure is the result of pressure in ear canal, and the bottom result shows the data from the ECG. In comparison to 1G, the amplitude of the pressure in the ear canal decreases 2G. To the contrary μG increases. These results were effect of body fluids shift to changing gravity. Therefore, the results suggested the venous hemodynamics from the measurement of pressure inside the ear canal.



(a) 1G (b) 2G (c) μG

Fig. 1 Averaged pressure in an ear canal during 20 beats. Subscribe corresponds to the significant timing in a cycle of gravity change.

P04

静電力を利用した小惑星からの粒子採取システムの開発

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Sampling of Small Regolith Particles from Asteroids Utilizing Alternative Electrostatic Field

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1. Introduction

Hayabusa successfully returned a sample of regolith from Itokawa to the Earth [1]. It was programmed to fire a small projectile on the surface and collected the resulting spray using its deployable collection horn. However, because of a slight error, the bullet was not fired, and large samples were not captured. The sampling technique employed in Hayabusa was very challenging, because a series of operations—landing on the asteroid, firing the bullet, and collecting a sample—were required to be conducted autonomously in a short duration without delay. To realize more reliable sampling of asteroid regolith in space, we have developed a new sampling system that employs electrostatic force [2,3]. In 2012 we demonstrated its performance in the zero-G environment created by the parabolic flight.

2. Experiment

A high voltage was applied between parallel screen electrodes of the sampling device as shown in **Fig. 1**. Owing to the electrostatic force, particles were captured by the electrodes. The captured particles were then transported to a collection capsule. It has been demonstrated that a large amount of lunar soil simulant can be sampled if the end of the screen electrode is in contact with the regolith for a short period, within 1 s.

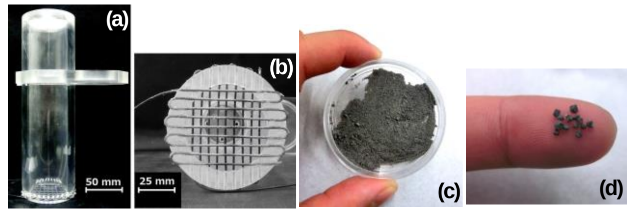

Fig. 1 (a) Sampler horn, (b) screen electrodes, (c) captured regolith and (d) captured large particles.

3. Conclusion

Our system succeeded in the capture of substantial amount (916 mg) of lunar regolith. In addition, it included large particles more than 1 mm in diameter.

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P05

気泡表面における氷核形成の“その場”観察

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In-Situ Observation of Ice Crystal Nucleation at Bubble Surfaces

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1. Introduction

It has been suggested that the heterogeneous nucleation start from dusts or fine crystal particles. However bubbles in liquid should also play a role of cores of the heterogeneous nucleation. In microgravity the movement of bubbles due to the density difference between bubbles, liquids and crystals in water could be suppressed and the detail observation at the interface can be possible. In this study, we observed crystallization of ice, which is the most popular material in the world, under microgravity in order to see the onset of crystallization from the bubble surfaces.

2. Experimental method

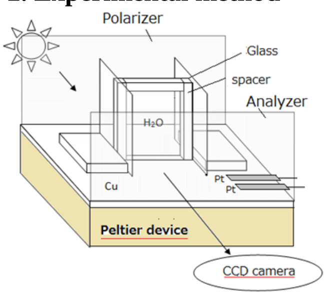

Fig.1 Observation setup

We monitored crystallization of super-cooled water (ΔT= 5, 10, 15[℃]) in the observation cell under microgravity with a CCD camera and a Pt thermocouple. **Fig.1** shows the observation setup.

The temperature of the cell was measured by the Pt thermocouple. And a video of ice nucleation was recorded using the CCD camera. Microgravity condition is achieved by a parabolic flight. The observation cell is composed of a pair of cover glasses and spacers. This cell is mounted on a cupper board, which covers the underside of the cell. We injected water into the cell in advance and cooled it with a peltier element under microgravity. In addition, since CCD camera has difficulty to distinguish ice from water obviously, we sandwiched the cell between a pair of intersected polarizing plates like a polarization microscope; crystal system of ice-Ih is hexagonal and water is not crystal, so we can definitely distinguish between ice and water.

3. Result and discussion

We observed ice crystallization from super-cooled water by simple handmade polarization microscope under microgravity. First, the dendrites were crystallized , after that, they covered by polycrystalline blocks of ice. Result of observation, it was difficult to see crystallization at the bubble surfaces. The speed of crystallization and the number of bubbles inside the ice crystals under microgravity were almost the same as the results under gravity.

P06

超音波浮遊液滴の界面変形および並進運動の制御

○古川 拓，長谷川浩司，大竹浩靖（工学院大学），下西国治，阿部 豊（筑波大学）

Manipulation of the Deformation and Translation on an Acoustically Levitated Droplet

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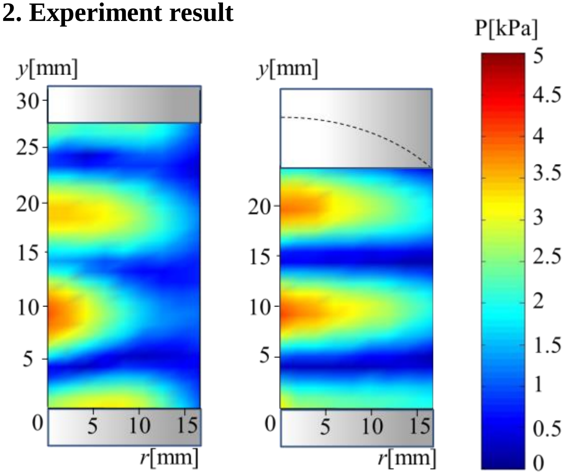
1. Abstract

Container-less processing could prevent the heterogeneous nucleation and contamination due to the container wall. Acoustic levitation is expected to be used in the field of manufacturing new materials. It is important to understand the non-linear behavior of an acoustically levitated droplet.

The purpose of the study is to manipulate the deformation and translation on an acoustically levitated droplet. In this study, translation of the droplet was estimated quantitatively with different reflectors. It is shown that the translational amplitude of the droplet with the concave reflector(R=36 [mm]) was drastically smaller than that with flat type($R=\infty$).

Fig. 1 shows sound pressure distribution with each reflector. Fig. 1(*a*) and Fig. 1(*b*) show sound pressure distributions with flat type and concave type, respectively. According to sound pressure distributions, local pressure gradient drives a translational motion of a levitated droplet.

2. Experiment result



(*a*) Flat type($R=\infty$) (*b*) Concave type(R=36 [mm])

Fig. 1 Sound pressure distribution with each reflector (Horn-Reflector distance: 28[mm], Horn radius: 17[mm])

P07

電磁浮遊炉を用いた微小重力環境下での表面張力測定

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水野章敏，渡邉匡人（学習院大）

Surface Tension Measurement of Molten Metals by Electromagnetic Levitation (EML) under Microgravity Condition

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1. Introduction

Oscillating droplet method using electromagnetic levitation (EML) is one of the most processing methods to measure precise surface tension of metallic melts. When this technique is employed on the ground, theoretically-derived Cummings and Blackburn equation [1)] is required to calibrate the influence of gravitational acceleration and strong electromagnetic force. However experimental validation of this calibration is insufficient due to lack of consideration on the influence of oxygen partial pressure (Po_2) of atmospheric gas though oxygen is strong surfactant for molten metals [2)].

In this study, surface tension of molten copper were measured under microgravity condition during parabolic flight of airplane to validate the Cummings and Blackburn calibration in consideration of the influence of the Po_2 on surface tension. The employment of reducing gas including a little hydrogen was considered under aviation laws to control the oxygen partial pressure during the e flight experiment.

2. Results

Cubical copper was electromagnetically levitated and then melted under the microgravity condition during the parabolic flight experiment. The safety of the employment of Ar-He-3 vol.%H_2 gas was experimentally and theoretically ensured under the aviation laws. We successfully observed the single surface oscillation in the levitated droplet under microgravity in consideration of the effect of the oxygen partial pressure of atmospheric gas. Based on this result, we plan to measure the surface tension at constant Po_2 using gas phase equilibrium between H_2 and H_2O mixture under microgravity.

References

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P08

浮遊落下高速圧縮法を用いた Pr-Fe-B 磁石材料の主相単磁区組織生成と高保磁力発現に対する V 添加効果

○加藤 悠也，永山 勝久（芝浦工大）

Effect of V Addition the Formation of Pr2Fe14B Single Domain Structure and Appearance of High Hc in Pr-Fe-B Permanent Magnet Material by using the Levitating Melt Droplet Compaction Process

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Katsuhisa NAGAYAMA (Department of Materials Science , Faculty of Engineering , Shibaura Institute of Technology)

We have reported the magnetic anisotropy of Pr-Fe-B by using electromagnetic levitating melt droplet compaction process. In this study, V added to the Pr-Fe-B quaternary melt solidified the uniaxial compaction in the two plates for the purpose of Pr2Fe14B single domain structure and appearance of high Hc in Pr-Fe-B permanent magnet materials[1,2].

Fig.1 shows M-H loops and SEM images of the melt droplet compaction Pr17Fe76B7(a) and Pr17Fe71B7V5 samples (b) compacted by Cu (Ⅰ) and SUS304 plates (Ⅱ). The both samples were obtained high coercivity, Hc ＞ 15kOe, especially. In addition , the microstructure of V added sample was compacted by Cu plates were observed single domain size of Pr2Fe14B (0.3μm) and less than domain particles (＞0.3μm) .

Microstructure of sample (a) was composed Pr2Fe14B grain size about 1μm, which is surrounded by Pr-rich phase. But microstructure of sample (b) was single domain size of Pr2Fe14B (0.3μm), which is surrounded by Pr(V)-rich phase, was contained V elements (Pr(V)-rich) .

We have suggested the effect of V addition the formation of Pr2Fe14B single domain structure and appearance of high coercivity in Pr-Fe-B permanent magnet material by using the levitating melt droplet compaction process.

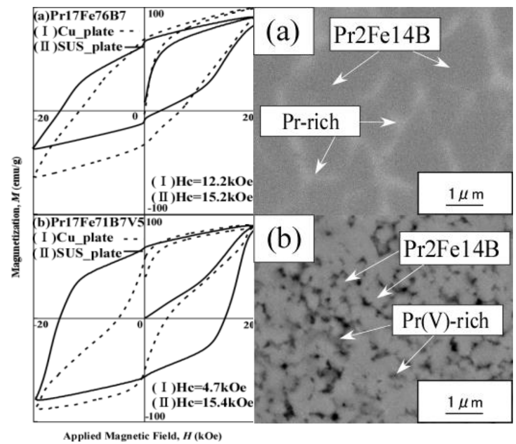

Fig.1 M-H loops and SEM images of melt droplet compaction samples by SUS304 plates

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