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温度差マランゴニ効果による液柱内粒子集合現象への周囲強制熱対流場と周囲壁の影響

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Effect of Ambient Gas Flow and External Shield on Particle Accumulation Structure (PAS) Due to Thermocapillary Effect in HZ Liquid Bridge

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We focus on particle accumulation structure (PAS) as shown in **Fig. 1 (a) to (c)** that can be seen in the particular range of Marangoni number at the three-dimensional rotating oscillatory flow. The PAS is a unique phenomenon that the particles in liquid bridge gather like a three-dimensional closed spiral loop structure.

In the present research, we pay special attention to the effects of the ambient gas flow and the external shield size on the PAS and its existing range. This research is conducted as preliminary research under normal gravity condition for Japanese-European Research Experiments on Marangoni Instabilities (JEREMI) in the Japanese Experiment module ‘Kibo’ aboard the International Space Station.

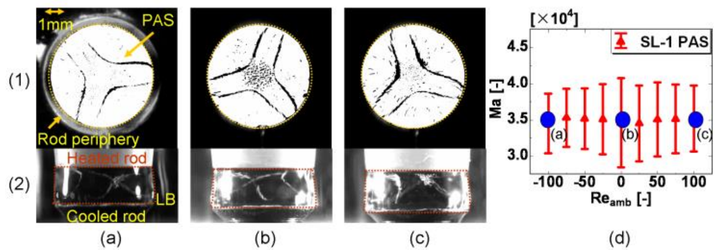

Fig. 1: Typical example of the PAS under Ma = 3.5×10^4 in the cases of the Reynolds number for the ambient gas Re_{amb} ($= QL/(\pi(D_{ES}^2 - D_{LB}^2)\nu)$) = (a) -100; (b) 0; (c) 100 observed from (1) the top and (2) the side for the inner diameter of the external shield D_{ES} = 25 mm and the liquid bridge diameter D_{LB} = 5 mm, where $L = D_{ES} - D_{LB}$, Q and ν are the flow rate and viscosity of ambient gas, respectively. Frame (d) indicates occurring region of the PAS against Re_{amb}. Circles indicate the position of the observation in the cases of (a) to (c).

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空気圧を利用した関節機能向上で目指す宇宙活動支援

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Pneumatic Power Improvement of Joint Functions in Space Exploration Activities

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Pressure conditions of spacesuits applied to ISS activities have been designed to decrease to around 0.3 atm as inner pressure, which should require at least 150 minutes for denitrogenation to prevent decompression sickness of astronauts. This means that astronauts cannot start their extra vehicular activity quickly after attaching spacesuits. If emergent maintenance is needed, the inner pressure of 0.58 atm would be suitable for prompt activity. Therefore, designs of next generation spacesuit should be higher than 0.58 atm would make extra vehicular activity more efficient. However, larger gap of air pressure between inside and outside of the spacesuit causes cloth expansion as balloon, resulting in extra torque for joint bending.

In this study, application of pneumatic power is proposed to improve flexibility of joint. The ideas shown in this presentation have been selected by considering space environment, elasticity and flexibility as human muscle.

Fig.1 shows the torque calculated for the arm joint angle with 0.6 atm inner air pressure using following formula (1).

$$N = L\pi r^2 P \sin\theta \cdots (1)$$

N: Torque (N·m), r: Joint radius (m), θ : Arm joint angle (º)
L: Arm length (m), P: Inner pressure (Pa).

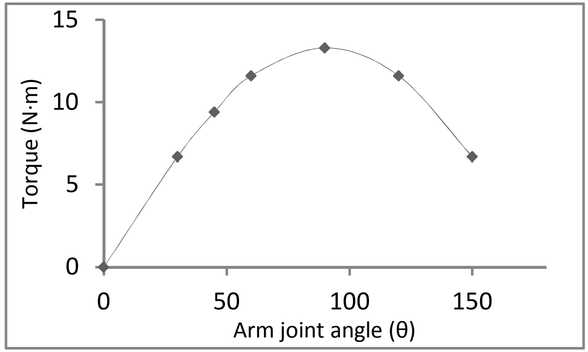

Fig.1 Torque for the arm joint angle (r = 0.075m)

From Fig.1, maximum torque of 13.3N·m is required when the arm joint angle is 90°.Therefore, the present achievement of torque is focused at least more than 13.3N·m. Judging from the design with muscle-like motions, response speed and repeating motion should be also less than 0.1 second and more than 10^6 cycles, respectively.

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その場資源活用（ISRU）に資するサバチエ反応生成メタンの貯蔵と輸送

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Storage and Transportation of Methane Synthesized by a Sabatier Reaction Through an In-situ Resource Utilization Process

Satoshi YONE, Anna GUBAREVICH, Hiroyuki WADA, Osamu ODAWARA (Tokyo Institute of Technology)

In space exploration beyond low earth orbit, long-term manned space activities require closed-loop life support system and a limited amount of supply from the Earth. In order to make human activities there in convenience, an ISRU (In-situ resource utilization) would be essential. Effective ISRU technologies can provide materials, which play an important role for manned activities in space.

As a part of ISRU developments, the present study focuses on efficient utilization of methane synthesized by a Sabatier reaction. The Sabatier reaction produces methane and water when carbon dioxide reacts with hydrogen; a proposal for the ISRU is the use of the Sabatier reaction.

$CO_2 + 4H_2 = CH_4 + 2H_2O$ ($-\mathit{\Delta H}$ = 165.3 kJmol^{-1}) ··· (1)

Produced water can be used in manned activities. Hydrogen can be produced from the water by electrolysis. Co-generated oxygen can be used for various purposes. Fig. 1 shows the optimum loop designed for the achievement of the present study.

Methane synthesized by the Sabatier reaction can be utilized for manned activity and constitute the in-site resource. For instance, methane can be used for combustion with oxygen. This reaction produces thermal energy.

$2O_2 + CH_4 = 2H_2O + CO_2$ ($-\mathit{\Delta H}$ = 802.3 kJmol^{-1}) ··· (2)

It is also considered that thermal pyrolysis of methane produces hydrogen and carbon.

$CH_4 = 2H_2 + C$ ($-\mathit{\Delta H}$ = -74.8 kJmol^{-1}) ··· (3)

Storage and transportation of methane synthesized by the Sabatier reaction through the ISRU are also discussed in this presentation.

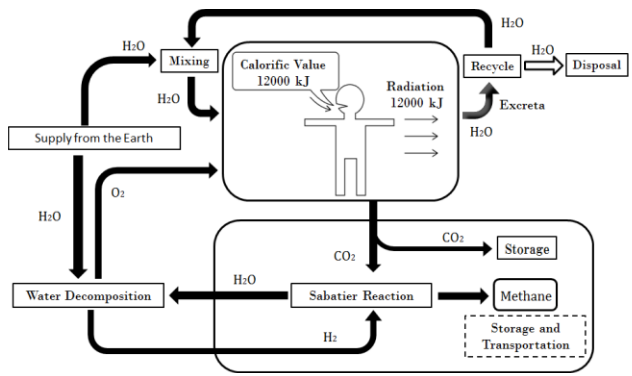

Fig. 1 Optimum closed-loop designed in the present study

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サブクールプール中に射出した単一蒸気泡の凝縮・崩壊過程に対する重力方向の影響

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Effect of Gravity on Condensation/Collapse Behavior of Vapor Bubbles Injected into Subcooled Pool

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We try to extract the vapor-liquid interaction by employing a vapor generator that supplies vapor at designated flow rate to subcooled pool through the orifice. This system enables ones to detect growing, condensing and collapsing processes of a single vapor bubble[1]. Temperatures of the liquid in the pool and injected vapor are controlled to realize a designated degree of subcooling ΔT_{sub}, and temperature difference from the saturation temperature. Vapor injection rate is another controllable parameter in this system.
In the present research, we focus on effect of gravity on growth and condensation process, and on the instability of the interface between vapor and liquid.

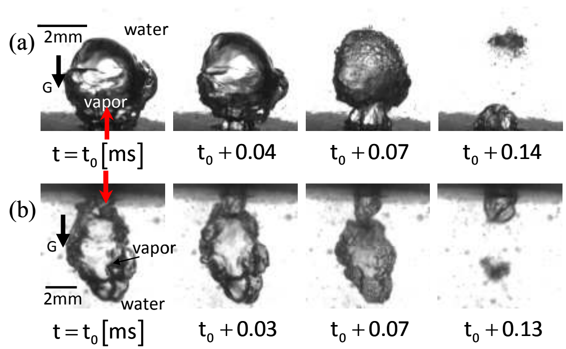

Fig.1 Typical example of condensing & collapsing processes of vapor bubble injected (a) upward and (b) downward under ΔT_{sub} = 49 K, vapor temperature T_{vap} =102℃, the flow rate of vapor = 56 mm^3/ms, and orifice diameter = 2.0 mm.

References

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ゼオライトによる湿潤空気からの CO_2 吸着特性と ISS 用 CO_2 吸脱着装置への適用

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CO_2 Adsorption Characteristics of Zeolite From Wet Air and Application for CO_2 Adsorption/Desorption Device on ISS

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We developed a CO_2 removal device using zeolite 5A as CO_2 adsorbent. A high CO_2 recovery efficiency is necessary for practical use of the device as a part of life support system in ISS. However, zeolite adsorbs water vapor more than CO_2, which decreases the efficiency. We performed CO_2 breakthrough experiments with varying humidity (amount of vapor) of air to elucidate the effect of vapor on the CO_2 recovery efficiency of the device.

Zeolite 5A (2750g) was filled up in an adsorption bed (ϕ108.3mm x 443mm). Mixture gas of air/CO_2 with various water vapor amounts was inlet to the adsorbent bed. The amount of water vapor was ranging from 0.5 to 4.0 g/m^3. The gas flow rate was set at 90L/min (mixed air) and 360mL/min (CO_2) so that the CO_2 concentration C_0 in air/CO_2 mixture gas was about 4400ppm. The CO_2 concentration C in the gas flowed through the adsorption bed was analyzed by CO_2 meter. The breakthrough time was measured as the period when C/C_0 changed from 0.05 to 0.95.

The obtained breakthrough curve (**Fig.1**) shows that the breakthrough time is 219min at vapor amount of 3.59g/m^3.

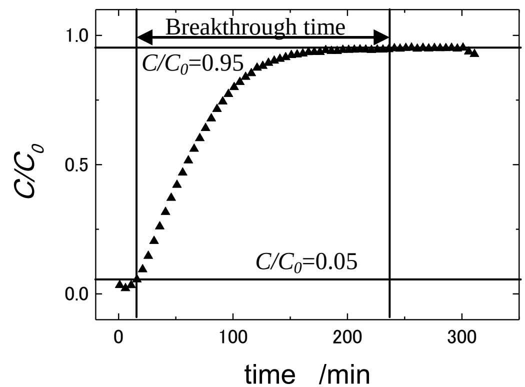

Fig.1 Breakthrough curve of vapor amount of 3.59g/m^3

The obtained results showed that the breakthrough time and CO_2 removal efficiency decreases with increasing amount of vapor.

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2波長マッハツェンダー干渉計を用いたソーレ係数測定における誤差原因と測定精度の改善

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上野一郎（東京理科大学），稲富裕光（JAXA)

The Error Sources and Improvement of Accuracy of Soret Coefficient Measurements using Two-Wavelength Mach-Zehnder Interferometer

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Shinsuke SUZUKI (Waseda Univ.), Ichiro UENO (Tokyo Univ. of Sci.), Yuko INATOMI (JAXA)

When a temperature gradient is applied to a solution having a uniform concentration, a concentration gradient is established, which is called Soret effect. The measurements of Soret coefficients S_T using a two-wavelength Mach-Zehnder interferometer on the ISS is planned (Soret-Facet experiment). The possible error sources of this experiment are convective disturbance and errors of temperature dependence of refractive index $\partial n/\partial T$, and so on. Especially, it is difficult to measure the exact $\partial n/\partial T$ because of evaporation of sample. Thus, one of the purposes of the present study was to measure the $\partial n/\partial T$ with low dispersion without the evaporation.

Sample was molten salol-4mol% *tert*-butyl alcohol alloy in a quartz cell sealed with adhesive. First, the sample melt in the cell was set in the interferometer having 532nm and 780nm wavelength light sources. Next, both top and bottom sides of the cell were kept at 60 °C with Peltier devices so as to homogenize the temperature and concentration. Then, the both sides of the cell were cooled to 50, 40 and 35 °C every hour, and the temperature of the melt was measured with two thermocouples and the movie of the change of interference fringe was taken with CCD camera, the visual field of which was set between both thermocouples. Finally, the change of refractive index Δn of each wavelength was obtained from the movie (**Fig. 1**).

The $\partial n/\partial T$ values calculated by a least-squares method are as follow; 532nm:$\partial n/\partial T$=-4.53×10^{-4} K^{-1} and 780nm:$\partial n/\partial T$=-4.26×10^{-4} K^{-1}. The R^2 values (**Fig. 1**) are close to 1 and the low dispersions attest enough suppression of the evaporation.

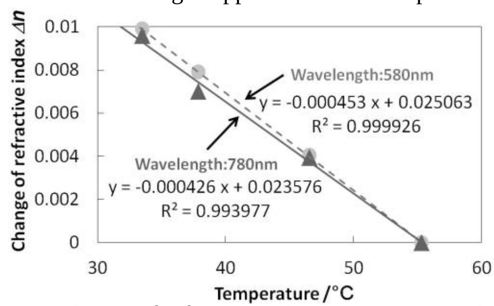

Fig. 1 Change of refractive index as temperature change

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教員研修のための無重力実験の実施とその成果

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The In-Service Training for Teachers using Micro Gravity Experiments

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1. Outline

The Advanced Support Center for Science Teachers (ASCeST) was established in April, 2010 to support teachers in elementary, secondary, and high schools continuingly. The center provides teachers training programs and organizes various workshops in order to solve today’s educational problems and meets the needs of school teachers.

We report here the results of micro gravity experiments using an air plane for elementary and secondary school teachers as part of teacher training programs.

2. The Feature of Training

The feature of training is the following three points.
1. The training that regarded a true experience as important.
2. Training which can do an inquisitive action.

The micro gravity experiments were performed the experiment contents which a participant thought about and ASCeST prepared.

3. The training to be able to make use of in a class.

The situation of an experiment is photographed by video and is applicable to a lesson as image teaching materials.

3. The Experiment Description

1. The dynamics experiments (pendulum and inertial masses)
2. The diffusion experiment of the smoke
3. The surface tension experiment
4. The observation of the movement of the fish
5. the experiment of mass and the weight

And so on

Fig. 1 The situation of an experiment

4. The effect of an experiment

A participant's questionnaire and the situation of a lesson are due to be shown by the poster.