Title:
FY2001 Ground-based Research Announcement for Space Utilization Research Report

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Research Fields: Microgravity Science

Research Categories:
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Research Theme: Gas bubble removal with suspended droplet under microgravity

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Summary of Research:
Figures 1 shows the detail of the experimental apparatus for drop tower experiment. A wooden box was made to hold the water-oil sample, a video recording kit and fluorescence lights. Oil-water sample consists of silicone oil (KF-96-1, 10,20,100 cSt, specific gravity 0.950 by Shin-etsu Kagaku Co.) and Na$_2$CO$_3$ solution, which are filled in a plastic case (60×60×60 mm). This case was combined with a video camera and fluorescent tubes, and the whole things were fixed on an aluminum board to assemble a single unit apparatus. After this box was stuffed with sponges, it was then suspended with rubber strips within an aluminum framework.

Gas bubble formation was initiated by adding citric acid particles to Na$_2$CO$_3$ solution. Then the apparatus was released from the seventh floor and dropped to the first basement of the building structure which is located in the properties of the Institute of Space and Astronautical Sciences (ISAS) in the City of Sagamihara: The vertical distance is ca. 32.5 m and the flight time ca. 2.6 seconds. During the free fall flight, the video camera can capture the bubble images in the liquid. After the experiment, the video recording was recovered and the images were analyzed.
Figure 2 is one of the typical images obtained during freefall experiment. These pictures were shown at 0.2 second per frame. Here, silicone oil and sodium carbonate solution were filled in a plastic case (60×60×60 mm). The upper layer, colored in red (Dyed with Sudan Red 7B) is the silicone oil phase. The lower phase is the sodium carbonate solution. The viscosity of the oil phase is 10 cSt. From these pictures, it is clear that gas bubbles can be adsorbed from water phase to oil phase in quite a short period of time.

There seems to be a correlation between the absorption time and oil viscosity. Figure 3 is a tentative plotting for such a relationship. It seems that absorption time decreases with decreasing oil viscosity. Accordingly, it can be concluded that, if the oil viscosity is substantially different from that of water phase (i.e., substantially higher than that of water phase), the bubble removal becomes more difficult. After all, it may be said that the migrating velocity of bubbles is inversely proportional to the oil viscosity, which allows us to similarly treat this problem as in case of the Stokes terminal velocity.

![Figure 2: Observed bubble migration from the aqueous phase to the oil phase (viscosity:10 cSt) during the free fall experiment (0.2 sec/frame)](image)

![Figure 3: Absorption time as a function of oil viscosity](image)

**Publication List:**
2. Kudo, K., Date K., Ebihara, T., and Jimbo, I.: Gas Bubble Removal using Suspended Droplets, Proceedings to the 5th China - Japan Workshop on Microgravity Sciences, held in Dunhuang, Gansu, China on September 3-6, 2002, China Academy of Science.

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