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Application News

Hyper Vision™ HPV™-X3 High-Speed Video Camera

Observation of High-Frequency Oscillations of Water Vapor Microbubbles Using the HPV-X3

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User Benefits

- The HPV-X3 high-speed video camera enables high-speed imaging of up to 20 Mfps.
- The camera is capable of capturing high-resolution images of the high-frequency oscillations of microbubbles and the shape changes during their contraction process.

■ Introduction

In recent years, microbubble technology has been attracting attention, particularly in the medical field. For example, it is hoped that by encapsulating drugs in microscopic bubbles and delivering them to specific cells, the effectiveness of treatment can be improved. One method of generating such bubbles is to focus a laser on gold nanoparticles or $FeSi_2$ thin films to generate bubbles locally by applying heat. It has been reported that rapid convection on the order of 1 m/s occurs around the water vapor bubbles generated by this method, with one contributing factor being the oscillations of the bubbles.[1)]

In this paper, a high-speed video camera (HPV-X3) (Fig. 1) was used to capture the expansion and contraction of water vapor bubbles generated by laser irradiation. The HPV-X3 enables high-speed imaging at up to 20 Mfps. This feature allows for observing not only the oscillations of the water vapor bubbles but also the detailed shape changes during the contraction process.

Fig. 1 Hyper Vision™ HPV™-X3 High-Speed Video Camera

■ Measurement System

The observation setup, the microscope section, and a schematic diagram of the microscope section are shown in Fig. 2, 3, and 4, respectively. Fig. 3 is an enlarged view of the white-framed area in Fig. 2. A glass cell containing the substrate and degassed water was set in the microscope. The laser was focused from the back of the glass substrate to generate bubbles. The generated bubbles were observed using the HPV-X3 from a horizontal directive relative to the substrate surface. A laser light source with a wavelength of 640 nm (Cavilux) was used for illumination.

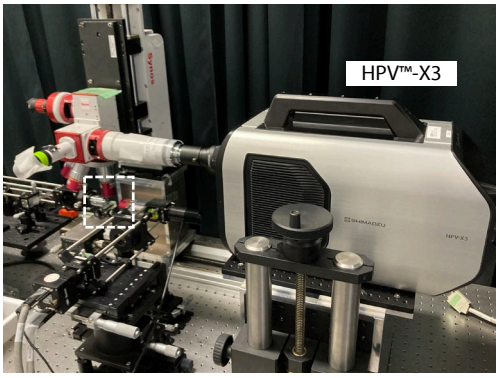

Fig. 2 Observation Setup

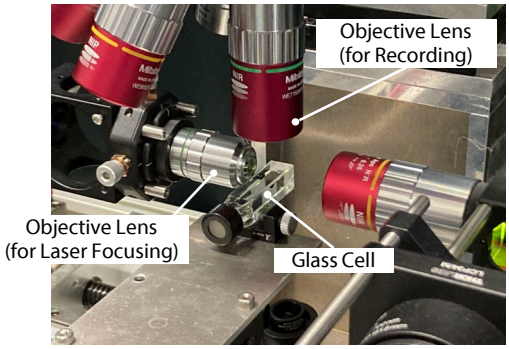

Fig. 3 Microscope Section Appearance

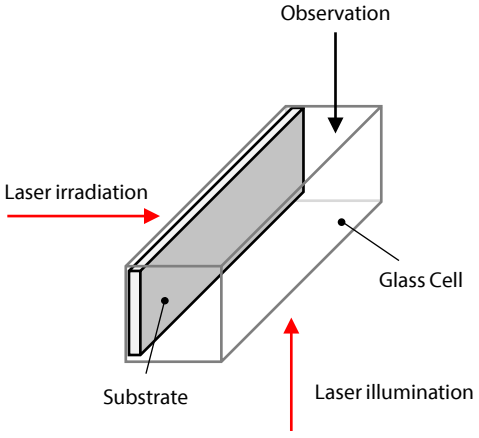

Fig. 4 Schematic Diagram of the Microscope Section

■ Observation Results

Initially, the entire phenomenon of water vapor microbubbles vibrating was captured at a speed of 1 Mfps, and it was confirmed that the microbubbles undergo repeated expansion and contraction. The process from bubble generation to disappearance is shown in Fig. 5. As seen in Fig. 5(14) and (15), the behavior of the bubbles just before disappearance cannot be captured in detail at 1 Mfps.

Next, the image capture speed was changed to 20 Mfps. The results are shown in Fig. 6. The shape of the bubble tip during the contraction process appears arc-shaped in Fig. 5 and 6(1) and (2). However, as contraction progresses, this changes, and in Fig. 6(5), it can be seen that the tip shape momentarily becomes sharp.

■ Conclusion

Using the HPV-X3 high-speed video camera, the repeated expansion and contraction of water vapor microbubbles generated by laser irradiation was captured. The HPV-X3 is capable of high-speed imaging at up to 20 Mfps, and by recording at this maximum speed, it was possible to observe the high-frequency oscillations of the bubbles as well as the shape changes during the contraction process.

Photography cooperation:
Department of Micro Engineering, Graduate School of Engineering, Kyoto University

<References>

1) Namura, K., Okai, S., Kumar, S., Nakajima, K., Suzuki, M.: Advanced Materials Interfaces, 7 (18) (2020) 2000483.

<Related Applications>

1. Oscillation Analysis of Water Vapor Bubbles Using High-Speed Video Camera – High-Speed Imaging of Sub-MHz-Order Oscillations –, Application Note No. 84

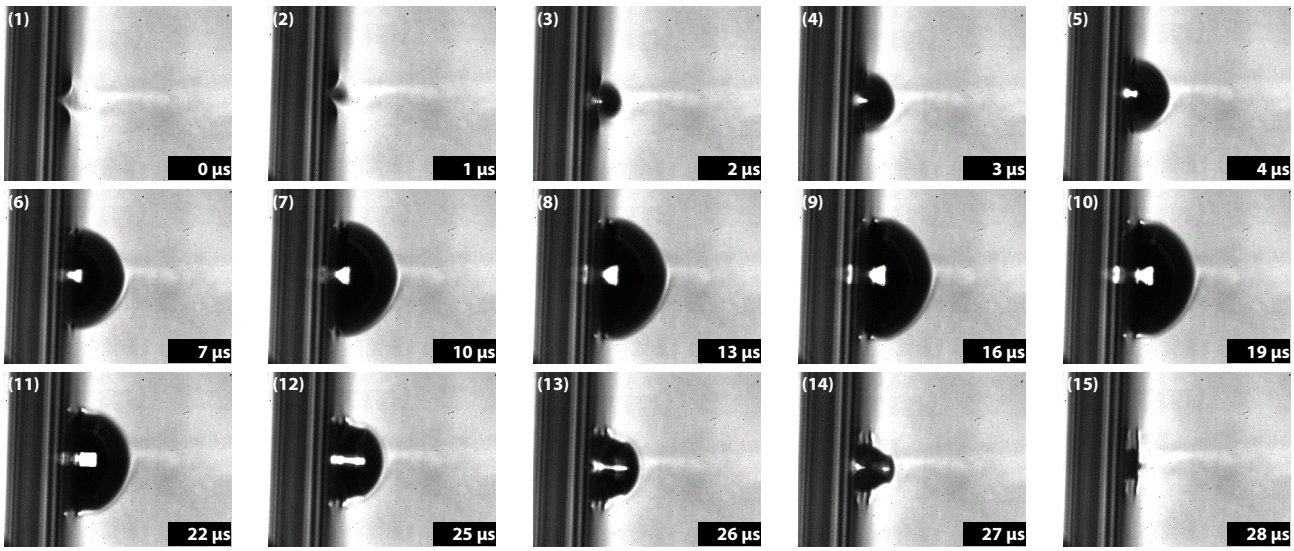

Fig. 5 Expansion and Contraction Process of the Bubble Captured at 1 Mfps

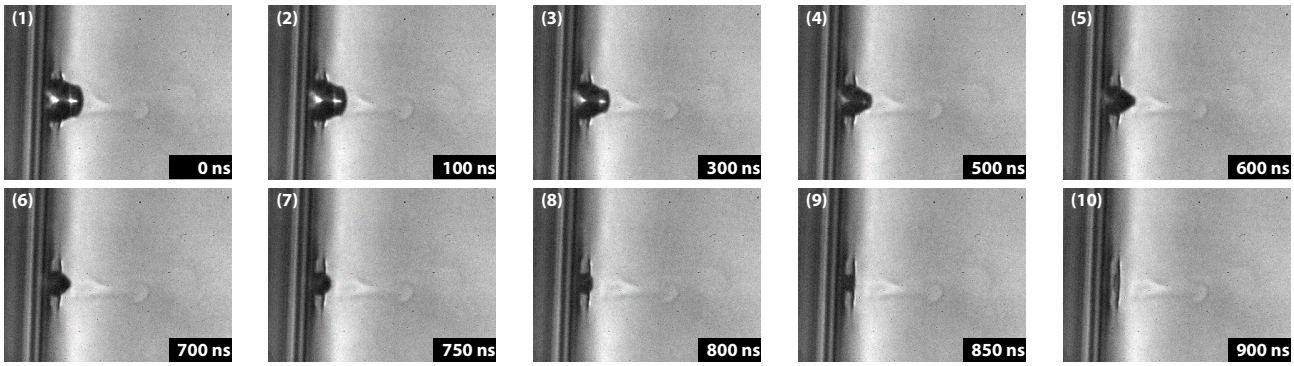

Fig. 6 Contraction Process of the Bubble Captured at 20 Mfps

01-00882-EN First Edition: May 2025

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