Measurement of Film Thickness of Antibubble Using Interference of Transmitted Light

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Antibubbles are water droplets covered with a thin film of air. It can be made by dropping a liquid into a dilute soap solution by using dropper. The generated antibubbles sink into the water with great force momentum of its fall, but slowly rise to the surface due to buoyancy. Its speed of ascent is almost constant, so it may float at the terminal velocity. If the viscous resistance of the liquid is known, the film thickness of the air can be estimated. On the other hand, optical interference fringes can be observed on a thin air film in the center of the antibubbles. At the critical angle of these antibubbles, it was discovered that the optical path difference between the light beam transmitted only by refracting the air film and the light ray reflected twice inside the film and transmitted is zero. According to this fact, we succeeded in finding the average film thickness from the number of interference fringes. We were able to model the interference fringes and confirm that they were close to how they appear in reality. The film thickness of a 10 mm antibubble was about 0.5 μm when calculated from the terminal velocity, and about 1.7 μm when calculated optically. It was found that the estimation of viscous resistance was incorrect. We tried to measure the resistance received from water when a sphere of the same size as an antibubble rises. However, we couldn’t get sufficient accuracy estimated film thickness from the terminal velocity.

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