Sensing of Apparent Surface Properties of O_2 and N_2 Nano-Bubbles in Water by Observing Ripplons: Experimental Study on the Influence on Lifetime of Bubbles under a Reduced Pressure Environment

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The purpose of the present study is to detect Nano-Bubbles (NBs) in water and reveal the mechanism for stability of NBs by sensing surface properties using a ripplon laser-light scattering (SLLS) method. A ripplon is a very small wave excited by thermal fluctuations. The wavelength is micrometer-order and the amplitude is nanometer-order. Therefore the SLLS method has the potential to detect NBs in the vicinity of the water surface. We have observed the difference of surface properties between ultrapure water and O_2-NBs in water at 25 °C. The bubbles were generated for 30 minutes by pressurization and dissolution of oxygen. As a result, the apparent surface tension of O_2-NBs in water decreased by about 10 % and viscosity of NB-water increased to about 3 times relative to those of ultrapure water after 6 hours from generating the NBs. In addition, the surface properties of NB-water showed a tendency to return to ultrapure water with the passage of days, and the surface tension of O_2-NB water coincided with ultrapure water within one week. These results show that we detected the existence of NBs and observed the process of disappearing NBs. Based on these results, we think the lifetime of NBs is the period that the apparent surface properties of NB-water return from values of just after generating NBs to those of ultrapure water. Also, we have studied the influence of pressure on NB's lifetime. We have observed surface properties of N_2-NB water for 20 days with two cases: closed atmosphere and reduced-pressure of the gaseous pressure above the N_2-NB water down to -95 kPa (gauge) at 25 °C. In 20 days, there was no difference on N_2-NB's lifetime between the two cases. This result shows the possibility that diffusion resistance of the gas in the bubble exists at the NB interface, and this resistance provides stabilization of NBs.