High-Resolution Instrument for Measuring the Surface Viscoelasticity of Nano-Bubbles in Water by Ripplon Surface Laser-Light Scattering Method

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The purpose of the present study is to detect Nano-Bubbles (NBs) in water by measuring the differences of surface properties (apparent surface tension and viscosity) between ultrapure water and NBs in water using ripplon surface laser-light scattering (SLLS) method. SLLS method has a potential to detect NBs in the vicinity of the liquid surface by measuring surface properties because this method is capable of observing near liquid surface with the sensitivity of nm order. In order to measure surface properties, we observe surface wave known as ripplon which is excited by thermal fluctuations. The new SLLS instrument we have developed makes it possible to measure surface tension and viscosity with high resolution (less than±3 % in the case wavelength of observed ripplon is 100 μm). A YAG laser (532nm, laser power 750 mW) is employed and irradiated to the liquid surface as incident light and reference light. We detect both scattering light generated by the incident light and the reference light to take cross correlation. We have observed difference of surface properties between ultrapure water and O_2-NBs in water at 25.0 ℃. The bubbles were generated for 30 minutes by pressurization and dissolution oxygen. As a result, surface tension of NBs in water decreased about 13 % and viscosity of NBs in water increased about 1.7 times compared to those of ultrapure water after 6 hours from generating NBs. In addition, we have measured temporal change of O_2-NBs in water from 40 to 375 minutes after generating NBs. As a result, surface tension decreased and viscosity increased simultaneously. This result suggests that we have observed levitation and stagnation of NBs. We propose the relationship between number density of NBs at the liquid surface and surface viscoelasticity which is related to apparent surface properties.