Acoustic bubbles in soft matter and their application to rheological measurement

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Abstract

A fundamental understanding of acoustic bubbles in soft matter is of great importance in medical applications of high-intensity focused ultrasound (HIFU) for lithotripsy and histotripsy. In these applications, cavitation often appears as a cloud of cavitation bubbles that are nucleated from gas bubble nuclei existing randomly in human tissue. However, it is yet a challenge to model and simulate bubble cloud dynamics. Here, as a fundamental study, we consider the simpler case with a single bubble in gelatin gels under ultrasound irradiation and show the potential use of acoustic bubbles for rheological measurement of their surrounding media at spatially and temporally small scales. A single spherical bubble nucleus can be created by focusing a laser pulse into gels under dissolved-gas supersaturation. The size of nucleated bubbles can be controlled in quasistatic manner by their mass-diffusion-driven growth. With ultrasound irradiation, one can observe oscillations of the single spherical bubble with a high-speed video camera. From comparisons of the observed bubble dynamics to Rayleigh-Plesset-type simulation, one can obtain viscosity and elasticity of the gel surrounding the bubble. In my talk, I will summarize previous studies on acoustic bubbles in soft matter from my research group [1-4] and then present recent studies on thermal effects on dynamics of a bubble in a gel under long-term ultrasound irradiation.

Keywords: Cavitation, acoustic bubbles, soft matter, viscoelasticity, ultrasound, rheological measurement

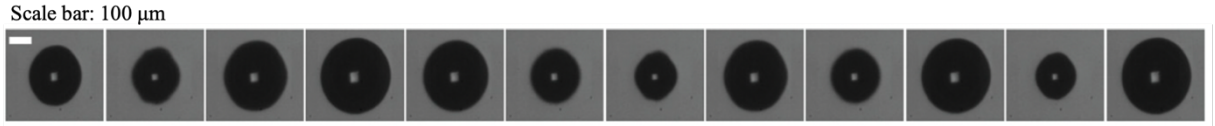

Figure 1: An example of visualization of a spherical bubble oscillating in a gel under 28-kHz ultrasound irradiation

References

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