Electrically-Induced Acoustic Oscillations of Gas Bubbles

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Electrical discharges in liquids have been used for water disinfection and decontamination, nanoparticle production, and many other chemical and biological applications. Gas bubbles are introduced into these processes to reduce the voltage needed for the electrical breakdown of liquids. The oscillations of gas bubbles induced by electric discharge and electric fields pose important questions on understanding and harnessing the acoustic energy of bubble oscillations for technologies in water disinfection and medical applications. However, limited data exists on the frequencies and acoustic energies of such oscillations. 8-24 kV, 1μs duration voltage pulses were applied to 4-12 mm argon bubbles submerged in distilled water. The input electrical energy and discharge energy were determined using voltage and current measurements and bubble oscillations were studied using fast frame imaging at 10,000 –25,000 fps and a novel laser detection technique. A diode laser was positioned to skim the bottom of the bubble and the transmitted light was detected by a fast photomultiplier tube. Changes in laser light intensity reflected minute changes in the bubble radius over time. This novel approach determined the frequency spectrum of the bubble acoustic oscillations. The oscillation frequency spectrum showed an increase in the fundamental frequency as the radius of the bubble decreased. Fast frame imaging revealed volume and surface oscillations of the bubble and was used to determine the acoustic energy emitted by the bubble. Acoustic energies of oscillations can be manipulated to optimize water disinfection techniques and minimize cavitation damage.

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