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Experiment and simulation on the nanobubble burst under high frequency ultrasonic signals

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Cleaning is a critical step for any manufacturing processes. However, it consumes a significant amount of energy and resource. It also produces un-dischargeable waste. There is a significant need to find a clean energy-efficient cleaning process which uses less resources. The nanobubble has been shown to have cleaning effect for various of contaminant without using any other detergent and excessive amount of water. However, the cleaning efficiency of nanobubble is not high enough to remove heavy contamination on the surface. We intended to improve the cleaning efficiency of nanobubbles with the help of ultrasonic energy by promoting the burst of the nanobubble to generate shockwave toward the contaminant. We studied process of the nanobubble burst under high frequency ultrasonic signals. The parameters of interest are the size of the bubble, the frequency, pressure amplitude and duration of the ultrasonic signals. We obtained the size and concentration distribution of nanobubbles in particle-free water under several ultrasonic signals (470 KHz, 800 W and 950 KHz, 100W) with different pressure amplitudes and durations. The data confirms the bubble bursting of the nanobubbles under 470 kHz of ultrasonic signal before 1 min as the concentration of the nanobubbles drops to the 50% of initial concentration. However, the concentration of nanobubbles starts to grow after 1 min and generated higher concentration of the nanobubbles than the initial number after 8 minutes of operation. When the nanobubbles were treated with 950K kHz signals, we observed high ratio bubble burst (90%) after 10 minutes. Numerical simulation was used to explain the burst and generation of bubbles with different sizes under different frequency and pressure amplitude. Based on the results, we proposed the interaction mechanism between the high frequency acoustic signals and the nanobubbles.