Nikita Reznik[1], Ross Williams[2], Peter N. Burns[1,2]
[1]*Department of Medical Biophysics, University of Toronto, Toronto, Ontario, Canada,* [2]*Sunnybrook Health Sciences Centre, Toronto, Ontario, Canada*

Submission ID: 969
Subject Classificiation: MCA - Contrast Agents
Presentation Preference: Poster
Student Paper: Yes **Participate in the Student Paper Competition:** Yes
Invited Speaker: No
Keywords: perfluorocarbon, contrast agent, vaporization, droplet, nonlinear

Optical and Acoustic Characterization of Vapourized Perfluorocarbon Droplets as Ultrasound Contrast Agents

Nikita Reznik[1], Ross Williams[2], Peter N. Burns[1,2]
[1]*Department of Medical Biophysics, University of Toronto, Toronto, Ontario, Canada,* [2]*Sunnybrook Health Sciences Centre, Toronto, Ontario, Canada*

Background, Motivation and Objective

Submicron perfluorocarbon (PFC) droplets offer a new potential ultrasound contrast agent for extravascular diagnosis. Droplet detection is done by vapourizing the droplet with ultrasound, converting the submicron droplet into a micron-sized bubble. In this study, we investigate the size, stability and echogenicity of the newly created microbubbles, properties which are crucial for successful non-linear ultrasound imaging, in the first second after conversion using optical and acoustic methods.

Statement of Contribution/Methods

Droplets of dodecafluoropentane (DDFP) coated with fluorosurfactant (Zonyl FSP), with diameter of 415 ± 20 nm, were vapourized in a 200 µm polyethylene tube with a single 10-cycle pulse from a focused 7.5 MHz transducer. Subsequent acoustic detection was performed with a series of 10-cycle pulses at 1.75 MHz and peak negative pressure (PNP) of 120 kPa, at times from 1ms to 1s after excitation. Converted droplets were also studied under a microscope (4 pixels per micron resolution) connected to a camera operated at 1000 fps for time periods of up to 1s after excitation.

Results

Echoes from droplets excited at sufficiently high PNP (above 1.7 MPa) had a significant increase in power at both the fundamental (1.75MHz) and second harmonic (3.5MHz) bands 1ms after excitation, indicating phase conversion and subsequent resonant oscillation. In the first 100ms the fundamental signal was shown to further increase while the harmonic signal decreased prior to stabilizing for a time interval of at least 1s. Vapourized droplets were successfully detected with pulse inversion imaging. Optically, converted droplets were shown to grow in size over approximately the first 100ms, from 1.79 ± 0.67 µm in diameter to 6.43 ± 1.80 µm, and were then stable over the next 900ms.

Discussion and Conclusions

Gas bubbles formed from excited droplets undergo increase in size in the first ~100ms, attributed to the uptake of dissolved gases from the host liquid. Following initial expansion, the bubbles stabilize in size for at least 1s, sufficient for diagnostic detection. Bubble size dynamics are also reflected in nonlinear acoustic scatter. The simultaneous power increase in the fundamental band and decrease in the harmonic band suggest that bubbles grow through their resonant size. Such characteristic behavior may serve as a basis for converted droplet specific detection techniques in-vivo.