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Dynamics of encapsulated microbubbles for contrast ultrasound imaging and drug delivery: from pressure dependent subharmonic to collapsing jet and acoustic streaming[1]

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Intravenously injected microbubbles used as ultrasound contrast enhancing agents are encapsulated by a nanometer-thick layer of lipids, proteins or polymers to stabilize them against premature dissolution. Over the years, we have developed interfacial rheological models for the encapsulation and used them to characterize several contrast agents by acoustic means. We will present an overview of our research emphasizing recent efforts in two directions. The first is on using subharmonic signals from the contrast microbubbles for non-invasive pressure estimation. Experimental measurement and modeling show that the subharmonic signal can both increase or decrease with pressure depending on frequency. Secondly, we will discuss boundary element (BEM) simulation of the collapse of an encapsulated microbubbles forming a jet near a blood vessel wall. Different rheology models of the encapsulation have been rigorously implemented in the BEM formulation. We will discuss the resulting stresses and the acoustic streaming near the wall leading to sonoporation and other bioeffects.

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