Encapsulated microbubbles for contrast ultrasound imaging: From noninvasive pressure estimation to targeted drug delivery

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Micron-size gas bubbles encapsulated by a nanometer layer of lipids, proteins and surfactants are injected into a patient’s body to improve ultrasound imaging. We are the first to propose and subsequently develop an interface model of the encapsulation—has an intrinsic surface rheology with surface viscosities and elasticities—that addresses the wide disparity of scales between the overall bubble size and that of the encapsulation. In this talk, I will discuss material characterization of these contrast agents that includes determination of rheological properties of a contrast microbubble’s encapsulation using one set of in vitro experiments, followed by model validation using another set. I will present a hierarchical approach with increasing sophistication in constitutive modeling of the encapsulation as warranted by the determining experiments and underlying physics. I will discuss subharmonic signals used for noninvasive monitoring of organ-level blood pressure, and explain their unusual behaviors in sharp contrast to “plausible expectations” and classical bubble dynamics results. Targeted and triggered drug delivery from “echogenic liposomes” will be discussed.