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Model for lipid-encapsulated microbubbles using transient network theory BASHIR M. ALNAJAR, University of Colorado Colorado Springs, SHANKAR L. SRIDHAR, MARK A. BORDEN, FRANCK J. VERNEREY, University of Colorado Boulder, MICHAEL L. CALVISI, University of Colorado Colorado Springs — Encapsulated microbubbles (EMBs) are widely used to enhance contrast in ultrasound sonography and are finding increasing use in biomedical therapies such as drug/gene delivery and tissue ablation. EMBs consist of a gas core surrounded by a stabilizing shell made of various materials, including polymers, lipids, and proteins. Lipid-coated EMBs present a unique challenge for modeling due to their relatively large oscillations and nonlinear, viscoelastic properties. We propose a novel model for a lipid-coated, spherical EMB that utilizes a statistically-based continuum theory based on transient networks to simulate the encapsulating material. The use of transient network theory permits the viscoelastic properties of the encapsulation – such as stress, elastic energy and entropy – to be calculated locally based on the configuration of lipid molecules. The model requires a minimum number of parameters that include the lipid concentration, and the rates of attachment and detachment of lipids to and from the network. The model closely reproduces the experimentally-measured radial response of an ultrasonically-driven, lipid-coated microbubble. The model also reproduces experimentally-observed nonlinear behavior, such as compression and expansion-dominated oscillations.

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