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Cavitation-induced damage in soft tissue phantoms by focused ultrasound bursts[1] POOYA MOVAHED, Univ of Illinois - Urbana, WAYNE KREIDER, ADAM D. MAXWELL, MICHAEL R. BAILEY, Univ of Washington, SHELBY B. HUTCHENS, JONATHAN B. FREUND, Univ of Illinois - Urbana —
Cavitation in soft tissues, similar to that in purely hydrodynamic configurations, is thought to cause tissue injury in therapeutic ultrasound treatments. Our goal is to generalize bubble dynamics models to represent this phenomenon, which we pursue experimentally with observations in tissue-mimicking polyacrylamide and agarose phantoms and semi-analytic generalization of Rayleigh–Plesset-type bubble dynamics models. The phantoms were imaged with high-speed cameras while subjected to a series of multiple pressure wave bursts, of the kind being considered specifically for burst-wave lithotripsy (BWL). The experimental observations show bubble activation at multiple sites during the initial pulses. After multiple pulses, a further onset of cavitation is observed at some new locations suggesting material failure due to fatigue under cyclic loading. A nonlinear strain-energy with strain hardening is used to represent the elasticity of the surrounding medium. Griffith's fracture criterion is then applied in order to determine the onset of material damage. The damaged material is then represented as a Newtonian fluid. By assuming that such a decrease in the fracture toughness occurs under cyclic loading, the fatigue behavior observed in the experiments can be reproduced by our model.

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