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Ultrasound induced bubble clusters and tunnels in tissue-mimicking agar phantoms[1] POOYA MOVAHED, Univ of Illinois - Urbana, WAYNE KREIDER, ADAM D. MAXWELL, MICHAEL R. BAILEY, Univ of Washington, JONATHAN B. FREUND, Univ of Illinois - Urbana — Soft tissue fractionation induced by acoustic cavitation is desired for non-invasive tissue removal in histotripsy, while being a potential injury mechanism in other therapeutic ultrasound treatments such as lithotripsy. In this work, we investigate the formation of bubble clusters and tunnels in tissue-mimicking agar phantoms by focused ultrasound bursts to inform a class of damage models. Agar phantoms of different stiffness were subjected to a series of multi-cycle ultrasound bursts, using a burst wave lithotripsy (BWL) protocol [Maxwell *et al.*, J. Urol., 193, 338-344 (2015)], and simultaneously imaged at 200 frames per second (1 image per ultrasound burst). Some bubbles become visible in images (˜200 microns) due to the negative pressure (˜7.5 MPa) in the initial bursts, and the number of visible bubbles increases continuously during the subsequent bursts. A Rayleigh—Plesset-type bubble dynamics model, which accounts for viscoelastic confinement of agar gels, is developed. Material fatigue leading to eventual irreversible fracture-like failure in this model is proposed to explain the key observations. In addition to isolated, approximately spherical bubbles, long tunnel-like features are observed, which are seemingly lines of joined bubbles along a possible fracture or defect. The geometry of these tunnel-like features is quantified, and a physical explanation for tunnel formation is proposed in terms of bubble expansion and unstable collapse.

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