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Acoustic droplet vaporization is initiated by superharmonic focusing OLEKSANDR SHPAK, University of Twente, MARTIN VERWEIJ, Delft University of Technology, RIK VOS, NICO DE JONG, Erasmus MC, DETLEF LOHSE, MICHEL VERSLUIS, University of Twente — Acoustically sensitive emulsion microdroplets composed of a low boiling point liquid perfluorocarbon have the potential to be a highly efficient system for local drug delivery, embolotherapy or for tumor imaging. The physical mechanisms underlying the acoustic activation of these phase-change emulsions into vapor bubbles, termed acoustic droplet vaporization, have not been well understood. The droplets have a very high activation threshold, its frequency dependence does not comply with homogeneous nucleation theory and focusing spots have been observed while the wavelength is at least an order larger than the droplet size. Here we show that acoustic droplet vaporization is initiated by a combination of two effects: highly nonlinear distortion of the acoustic wave before it hits the droplet, and focusing of the distorted wave by the droplet itself. At high excitation pressures, nonlinear distortion causes significant superharmonics with wavelengths below the diameter of the droplet. The proposed model is validated with experimental data captured with an ultra high-speed camera on the exact locations of the nucleation spots. Moreover, the presented mechanism explains the hitherto counterintuitive dependence of the nucleation threshold on the ultrasound frequency.

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