**Nucleation location prediction in Acoustic Droplet Vaporization**

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**Abstract**

Superheated fluorocarbon micro- and nanodroplets vaporized by ultrasound have the potential to be highly localized and non-invasive drug delivery and embolotherapy agents. The creation of strong flow and pressure fields during vaporization can increase the permeability of the cell membrane, while the increase in volume can be exploited for arterial occlusion. Models based on pressure focusing inside the droplet and classical nucleation theory have been proposed to explain nucleation inception with the final goal of reducing the pressure intensity needed for vaporization. However, the effect of rapidly varying pressure fields on vapor embryo creation has not been fully explored yet. In the present work, the wave transmission problem inside the droplet is solved theoretically and successfully compared with simulations. A map for the average excess tension below the spinodal is then calculated using the following equation:

with P(x, y, t) being the local instantaneous pressure and the spinodal pressure. Where nucleation inception is more likely, i.e. in areas with high and lasting tension during sonication, this parameter is expected to assume a higher value. Experimental verification is carried out by detecting nucleation spots in single droplet ADV experiments by means of ultra-high-speed videomicroscopy. Results for droplets with radius R = 9.0 ± 0.3 μm are shown in Figure a). Figure b) presents the map calculated using the experimentally recorded acoustic wave as input for the theoretical model. The location of the maximum value for correlates well with the average nucleation position, suggesting that this parameter can be used to predict the initial nucleation spot. Moreover, the theoretical results reveal the compressive phase of the incoming wave to play a major role in creating high tension areas in the droplet bulk, a feature that has not been reported previously.

