

Spontaneous Nucleation of Two-Phase Janus Droplets for Ultrasound Imaging and Therapy

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Background, Motivation and Objective

Phase-change contrast agents are low boiling point liquid perfluorocarbon (PFC) based emulsions. In liquid phase, droplets are acoustically transparent, with excellent stability and long recirculation times. Using a sufficiently high-intensity acoustic pulse, they can be selectively vaporized to form bubbles up to five times larger than the initial droplet. Phase-change contrast agents can be synthesized with diameters under 200 nm, enabling diffusion into diseased tissues and making them well suited for ultrasound diagnostic imaging and therapy applications. In this study, we present a new method of synthesizing two-phase Janus droplets for ultrasound theranostics.

Statement of Contribution/Methods

Two-phase Janus droplets had a liquid PFC core partially coated by an oil phase (see figure 1A). They were synthesized using spontaneous droplet nucleation, more commonly referred to as the ouzo method. The PFC and oil phases were dissolved into an ethanol solution containing a 20:1 molar ratio of DPPC and 2K-PEG DSPE lipids. Once PFC and oil phases were fully dissolve in ethanol to form a true solution, a 7:2:1 volume ratio of water, propylene glycol, and glycerol was added to the PFC and oil saturated ethanol solution to nucleate droplets. Because the solubility of PFC and oil was much better in ethanol than water, adding a water-based solution reduced solvent quality, forcing the PFC and oil out of solution and spontaneously forming droplets.

Results/Discussion

Using the ouzo method, two-phase droplets <100 nm could easily be synthesized (see figure 1B). The interfacial properties of PFC and oil phases drive the two-phase droplets to naturally self-assemble from isolated populations. The activation threshold was unaffected by the addition of the oil phase relative to single-phase PFC droplets. By including an oil phase, hydrophobic drugs can be loaded into these droplets for potential ultrasound theranostic applications.

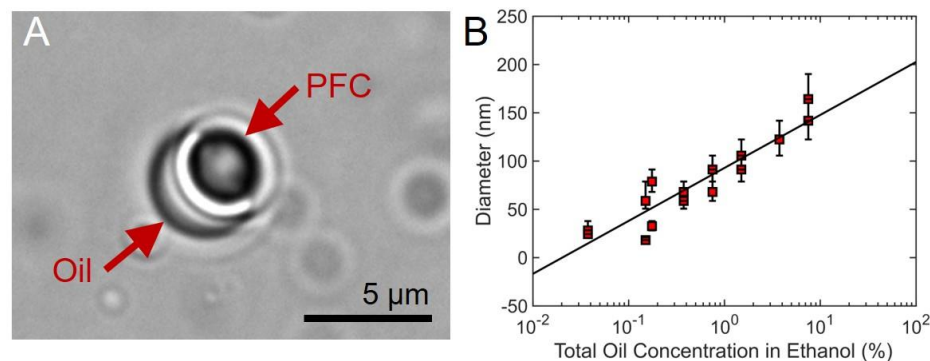


Figure 1: (A) A two-phase perfluorohexane and olive oil droplet synthesized through self assembly of two independent perfluorohexane and olive oil droplets. (B) Size of spontaneously nucleated two-phase droplets as a function of total PFC and oil concentration used.