Ultrasound Heating with Pickering Droplets

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Abstract. Ultrasound-induced hyperthermia is a therapeutic approach that uses acoustic waves to raise tissue temperature for the treatment of cancer and other conditions. The efficiency of ultrasound hyperthermia can be improved by using sonosensitizers—materials that enhance the attenuation and dissipation of acoustic energy. In this study, we explored the use of iron oxide nanoparticles and Pickering emulsions stabilized by magnetic particles as innovative mediators to enhance a local ultrasound heating. Computer simulation of the spherical inclusions doped with Pickering droplets, incorporated within an agar phantom, resulted in different enhancement of achieved temperature elevation, depending on the core radius and shell thickness. Moreover, nanodroplets demonstrated better heating performance compared to microdroplets [1]. Experimental studies confirmed that emulsion-injected phantoms achieved the highest heating rates, as they efficiently enhanced ultrasound absorption and scattering while limiting deeper penetration. The results demonstrate that not only the distribution but also the composition of sonosensitizers play a critical role in determining the inner thermal effects of the system. The use of sonosensitizers also enables control over the size of the region where acoustic energy is focused, by adjusting the amount and distribution of the incorporated agents [2].

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[1] B. Jameel, Y. Harkavyi, R. Bielas, A. Józefczak, Optimization of ultrasound heating with Pickering droplets using core–shell scattering theory, Ultrasonics Sonochemistry 109 (2024) 106965.

[2] F. Ratajczak, E. Prajwos, R. Bielas, A. Józefczak, Nanoparticle-enhanced focusing of ultrasonic waves for local hyperthermia, Ultrasonics Sonochemistry (2025) submitted.