Liquid marbles manipulated via magnetic fields

R. Bielas,[1] T. Kubiak,[1] M. Molčan,[2] I. Šafařík,[3] and A. Józefczak[1]

[1] *Faculty of Physics, Adam Mickiewicz University in Poznań, Uniwersytetu Poznańskiego 2, 61-614 Poznań, Poland*

[2] *Institute of Experimental Physics, Slovak Academy of Sciences, Watsonova 47, Košice 040 01, Slovakia*

[3] *Department of Nanobiotechnology, Biology Centre, ISB, Czech Academy of Sciences, Na Sádkách, 7, 370 05, České Budějovice, Czech Republic*

In biotechnology and biomedicine, one of the crucial issues is the efficient storage and transportation of active species such as drugs and enzymes. When encapsulated within the droplets, the active substances can be delivered and released in the site of interest. Recently, the enhanced reaction rate was shown, e.g., for particle-stabilized droplets with magnetotactic bacteria, i.e., the microorganisms that possess the intracellular chains of the magnetic nanoparticles (so-called magnetosomes). When exposed to the rotating magnetic field, such bacteria acted as nano-stirring bars [1].

The alternating magnetic fields with a frequency of hundreds of kHz can be used to prepare colloidal capsules from particle-stabilized emulsions with the rigidified shell to protect the inner substance better [2]. However, not only the droplets immersed in another liquid can be potential precursors for capsules. The droplets covered by solid particles have been shown to exist also in the air as the so-called liquid marbles. A facile rolling of the droplet in a powder bed results in the formation of droplets coated by particles. In our work, liquid marbles consisted of a water-based magnetic fluid core with either magnetosomes or pristine spherical nanoparticles entrapped within a polymer shell from modified polystyrene microparticles. Such magnetic liquid marbles were exposed to the static and alternating magnetic fields and showed magnetoresponsiveness. Due to relaxation and hysteresis losses, the temperature increased when liquid marbles were exposed to the alternating magnetic field. Depending on the concentration and the sort of magnetic agent in the liquid core, the partial fusion of the polymer shell was observed [3].

References:

[1] 1. X. Zhou, C. Chen, C. Cao, T. Song, H. Yang, W. Song, Enhancing reaction rate in a Pickering emulsion system with natural magnetotactic bacteria as nanoscale magnetic stirring bars. Chemical Science 9.9 (2018): 2575-2580

[2] 2. R. Bielas, D. Surdeko, K. Kaczmarek, A. Józefczak, The potential of magnetic heating for fabricating Pickering-emulsion-based capsules, Colloids and Surfaces B: Biointerfaces 192 (2020): 111070

[3] 3. R. Bielas, T. Kubiak , M. Molčan, I. Šafařík, A. Józefczak, The influence of external magnetic fields on liquid marbles with magnetosomes (in preparation, 2023)

The work was supported by the Polish National Science Center through the project no. 2019/35/N/ST5/00402.