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Abstract

Single Domain Magnetic Nanoparticles as Magneto-Mechanical Actuators for Remote Drug Release from Polyelectrolyte Microcapsules †

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Abstract: The modification of capsule shells with synthesized magnetic iron oxide nanoparticles aims not only to control the localization of capsules, but also to tune their permeability. The application of a super low frequency non-heating magnetic field (100 Hz) for these purposes offers prospects for high penetration ability into tissues, high locality, and safety, which makes this method preferable for use with in vivo rather than magnetic hyperthermia. In this work, we develop a proof of concept for the remotely controlled release of an encapsulated drug from polyelectrolyte microcapsules under exposure to an alternating super low frequency magnetic field. The characteristics of the tailor-made nanoparticles for the polyelectrolyte shell modification were analyzed to confirm their perspectives as magneto-mechanical actuators due to their abilities with the Brownian relaxation. Polyelectrolyte microcapsules were obtained using the well-known method of sequential deposition of polyelectrolytes on the surface of vaterite particles. We studied the time dependence of the amount of released fluorescently labeled high-molecular weight substance on the frequency of the applied magnetic field (100 mT, 20–100 Hz) and demonstrated that the application of a magnetic field with a frequency of 50 Hz leads to the most pronounced selective increase in the permeability of the shells. Our findings provide a promising application of composite magnetic microcapsules with permeability triggered by a super low frequency magnetic field for the controlled release of drugs without dangerous heating or overheating of the biological tissues. This work was supported by the grant of the President of the Russian Federation (MK-1109.2021.1.3).

Keywords: polyelectrolyte microcapsules; remote release; iron oxide nanoparticles; magnetic actuators; Brownian relaxation mechanism; non-heating low-frequency magnetic field

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