Non-magnetic shell coating of magnetic nanoparticles as key factor for cytotoxicity

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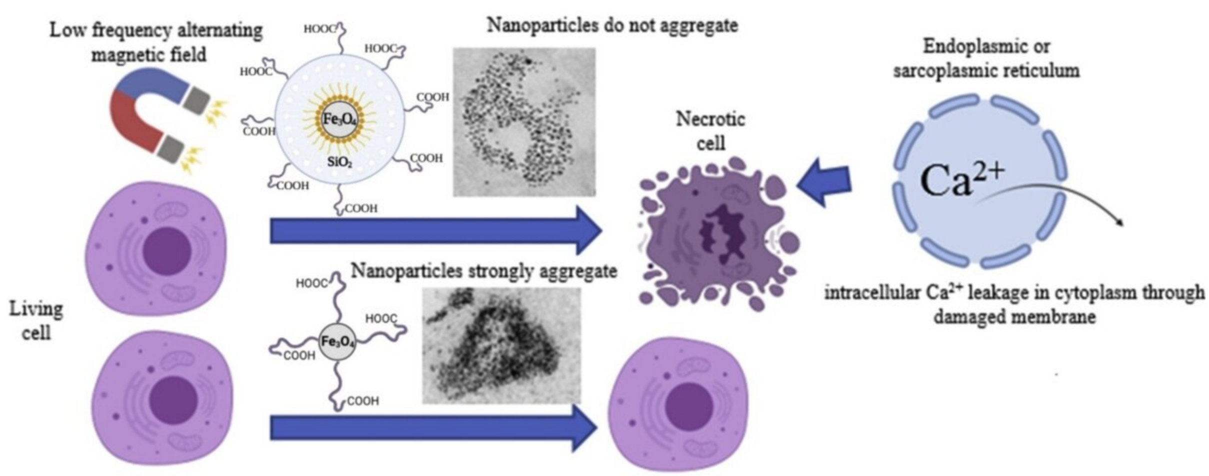

Graphical abstract. Credit: DOI: 10.1016/j.colsurfb.2021.111931

Russian scientists have found that coating magnetic nanoparticles with a non-magnetic silica shell coating significantly decreased the viability of cancer cells in a low frequency alternating magnetic field. The coating increases nanoparticles stability, preventing aggregation in endosomes and keeping them as effective magneto-mechanical actuators in a low-frequency alternating magnetic field. The study was published in *Colloids and Surfaces B: Biointerfaces.*

Biocompatible magnetic nanomaterials have been intensively studied for various applications in biomedicine. They can be remotely controlled over by an external magnetic field, which makes it possible to specifically affect target molecules on the molecular level.

Magnetic nanoparticles cytotoxicity depends on acting magnetic field parameters, the most significant of which are magnetic field amplitude, frequency, and the duration of action. In a low frequency alternating magnetic field, they rotate, causing mechanical damage to cells.

Scientists from NUST MISIS, M.V. Lomonosov Moscow State University, V. Serbsky National Medical Research Center for Psychiatry and Narcology, Siberian State Medical University, National Research Tomsk Polytechnic University, Skoltech, D.I. Mendeleev University of Chemical Technology of Russia and N.I Pirogov Russian National Research Medical University have found that a non-magnetic shell coat significantly increases the cytotoxicity of magnetic nanoparticles. Two types of iron oxide nanoparticles with the same magnetic core with and without silica shells were synthesized. Nanoparticles with silica shells significantly decreased the viability of human prostate cancer cells in a low frequency alternating magnetic field according to the cytotoxicity test, unlike uncoated nanoparticles.

The study has shown that cell death results from the intracellular membrane integrity failure, and the calcium ions concentration increase with the subsequent necrosis. Transmission electron microscopy and dynamic light scattering images showed that uncoated nanoparticles are etched by acidic media in the endosome and form aggregates. As a result, they encounter high endosomal macromolecular viscosity and become unable to rotate efficiently.

The scientists assume that effective rotation of nanoparticles causes cell death in a low frequency alternating magnetic field. In turn, silica shell coating increases nanoparticles stability, preventing aggregation in endosomes.

"Our fundings have both theoretical and practical value. We discovered that the non-magnetic phase increases the colloidal stability of nanoparticles, thus being the key to their effective magneto-mechanical actuation. This is important for the fundamental understanding of the mechanism of magneto-mechanical actuation and what the structural features of nanoparticles should be in order to maximize their cytotoxicity. On the other hand, we have shown that our nanoparticles work, they do cause cell death. The next step would be testing their effectiveness in vivo," noted Artyom Ilyasov, NUST MISIS Biomedical Nanomaterials Laboratory.

More information: A.R. Iliasov et al, Non-magnetic shell coating of magnetic nanoparticles as key factor of toxicity for cancer cells in a low frequency alternating magnetic field, *Colloids and Surfaces B: Biointerfaces* (2021). DOI: 10.1016/j.colsurfb.2021.111931

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