# Nanoparticles and Their Applications

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## Abstract

The advancement of cancer treatment needs the development of novel strategies. One of the novel solutions to be applied in the anticancer treatment is based on the nanotechnology. Nanomaterials, characterized by their tunable physico-chemical properties, can function as theranostic agents, providing tailored treatment alternatives. Notably, superparamagnetic iron oxide-based nanoparticles (SPIONs) and their composites are an interesting treatment agent by their facile fabrication and the ability to modify their surfaces with biologically active compounds including cytostatic drugs as well as photoactive compounds to be used in photodynamic therapy. For the unique magnetic properties superparamagnetic nanoparticles can be used for the imaging with magnetic resonance imaging (MRI), where the contrast mode can be moderated with doping of nanoparticles with different metals. Furthermore, SPIONs can generate localized heat on demand using alternating magnetic field.

Magnetic nanomaterials can be incorporated into various matrices to improve their functionality in applications such as wound dressings and scaffolds for tissue regeneration, where depending on the surface properties the physicochemical characteristics of the material can determine its final application. Besides working as drug nanocarriers, the functionalization of these magnetic nanomaterials with organic molecules is crucial for maintaining their colloidal stability, reducing of aggregation within tissues, and controlling drug release in specific environments. Depending on the coating of the nanocarriers, drug release can be synergistic with the application of against local hypoxia in cancerous and photodynamic therapy, thereby providing multifunctional capabilities that enhance treatment efficacy while minimizing side effects. These controllable carriers offer remarkable precision in medical applications, positioning magnetic nanomaterials at the cutting edge of advanced research and clinical practice.

### Relevant references

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## Biography of the presenting author

**Dr. Magdalena Osial** is a researcher at the Institute of Fundamental Technological Research, Polish Academy of Sciences in Warsaw. Her research focuses on the fabrication and characterization, nanomaterials and their application in medicine, environment, and electronics. She works on several interdisciplinary projects including electrochemical sensors, medical diagnostics, pollution monitoring, and engineering. She is a laureate of the TOP500 Innovators program in University of Cambridge and University of Oxford. She has held internships abroad in Adelphi University and Brookhaven National Laboratory in US, and Universite Libre in Brussels. Besides research she actively popularizes science and mentor students sharing her passion to science.