Abstract

Magnetic nanoparticles offer a plethora of application possibilities in various fields of human endeavors. The fundamental understanding of their physical properties, related to the constituent magnetic phase, surface termination, and possible coating, synthesis method, size, shape, or even clustering, is crucial for their effective use and optimization for the intended applications. This thesis aims to contextualize original results, concerning especially the structure and magnetic properties, obtained during fundamental research on nanoparticles of selected iron-containing systems and employ these findings in testing the nanoparticles in chosen applications.

Iron presents an ideal constituting element due to its low cost, high abundance in the Earth's crust, exploitability, and low toxicity. The selected systems involved in this thesis comprise iron-containing oxides (ferrites, and various polymorphs of iron(III) oxide, including ε-Fe_2O_3 and doped counterparts), and sulfides (greigite, chalcopyrite), all of which exhibit specific properties such as magnetic or structural transitions. Among the studied applications, the largest attention is devoted to the use of magnetic nanoparticles as contrast agents in magnetic resonance imaging, and the analysis of their efficacy in contrast enhancement – their relaxivity – with respect to various factors. Since this application is directed to medicine, some of the promising systems were also subjected to cytotoxicity studies. Further, magnetic solid-phase extraction is included as a representative analytical application of magnetic nanoparticles with possible use for example in environmental protection, food analysis, and medicine. Finally, the thermoelectric applications of nanostructured phases are briefly introduced.