Synopsis of the PhD thesis entitled:

Synthesis and physicochemical properties of hybrid materials containing ferrite spinel nanoparticles

By Emilia Zachanowicz

The thesis presents studies of the plan and optimization of the synthesis hybrid materials with a core-shell structure of magnetic inorganic core and thin polymeric shell. This thesis consists of two main parts. The first part of the work describes method of the synthesis ferrite spinel nanoparticles MFe2O4 by a microwave-stimulated technique under nonhydrolytic conditions. $Co_{1-x}Ni_xFe_2O_4$, $Co_{1-x}Mn_xFe_2O_4$ and $Mn_{1-x}Ni_xFe_2O_4$ferrite nanoparticles, full range of concentrations have been prepared by modify Bradley's microwave-stimulated synthesis without the use of any kind of surfactant. Research provided information about influence of the synthesis conditions on properties of final products. Special attention in this part was paid to the analysis of effects associated with the ions doping and the analysis of influence that substitution carried out on the structureand magnetic properties of the obtained spinels.

In this work structural, chemical, and morphological characterizations were carried out using a number of modern research methods such as: XRD, TEM, SEM-EDS, IR, Raman spectroscopy techniques and magnetization measurements. The obtained nanoparticles were characterized by a high crystallinity and narrow distribution of grain sizes in the range 8 to 23 nm. Substitution of a ferromagnetic material with divalent transition metal cations caused a change in the magnetic properties of these nanomaterials, including saturation as well as change of coercivity and remanence. The values of the elemental cell parameters a and V have been also changed. The next part of the work presents the results of studies, which carried out the development of the method of synthesis hybrid nanoparticles with controlled thickness of poly(methyl methacrylate) (PMMA) and polyrhodanine (PRHD) coatings.

It has been also shown that the organic shell doesn't change the crystal structure of spinels and doesn't affect the magnetic properties of hybrid nanoparticles. To investigated the usefulness of the obtained nanomaterials for bio applications, the interaction of nanoparticle with selected cell lines were studies: macrophages (J774,E), osteosarcoma tumor cells (U2OS, D17) and stem cells (ASC). Results of these studies proof that the use of polymer coatings (PMMA and PRHD) has been effective in reducing the cytotoxicity of magnetic nanoparticles.

Analysis of the proliferation mouse macrophages revealed that the compounds of the PMMA@$Co_{0,5}Ni_{0,5}Fe_2O_4$ and PMMA@$Co_{0,5}Mn_{0,5}Fe_2O_4$ series didn't show cytotoxic activity at concentrations of 50 μg/ml in contrast to unmodified nanoparticles that didn't induce hemolysis above 1 μg/ml. In this thesis three compounds: PMMA@$Co_{0,5}Mn_{0,5}Fe_2O_4$, PMMA@$Co_{0,5}Ni_{0,5}Fe_2O_4$ and PRHD@$CoFe_2O_4$ were selected as promising targets for applications in biomedical applications. Evaluation of the antibacterial activity of the PRHD@$CoFe_2O_4$ hybrids showed bactericidal properties against both gram-negative gram-positive bacteria (*E. coli* and *S. aureus*). Preliminary tests has confirmed effectiveness of the nanoparticles dispersion in terms of light-to-heat conversion upon exposure of the samples to NIR irradiation. This effect can be potentially attractive in thermal based bio-related applications like cancer treatment by hyperthermia without use of external AC magnetic field.