DESCRIPTION FOR THE GENERAL PUBLIC

Presently, the magnetic nanostructures in the form of nanowires are very interesting materials due to their application in various fields such as: medicine, pharmacy, military industry, spintronics, energy storage and conversion, and catalysis. Therefore, a lot of physical and chemical methods of their manufacture have already been developed. However, most of them use a highly advanced technology or quite complicated chemical reagents and it is associated with the high costs of production of such nanostructures as well as the difficulties with the implementation of their production technology on a large industrial scale. For this reason the basic research aimed at development of the new processes of their preparation are in continuous progress. One option is an innovative method which combines a preparation of magnetic metals nanoparticles through a simple chemical reduction reaction of an aqueous solution containing magnetic metal ions (precursor) with an aqueous solution of a strong reducing agent e.g. sodium borohydride ($NaBH_4$) or hydrazine (N_2H_4) and an application of an external magnetic field. This leads to an ordering of nanoparticles forming in the reaction along the lines of applied magnetic field and causes the formation of long straight chains of nanoparticles – nanowires.

Up till now, iron, nickel and cobalt nanowires can be synthesized using the above described method. Nevertheless, it is worth underlining that as-prepared iron nanowires revealed core-shell structure; i.e. a core of the system being metallic iron was covered by a thin layer composed of iron oxides (shell). Hence, the material as a whole exhibited a metal-metal oxide composite structure.

The core-shell nanomaterials can be also manufactured in the high temperature oxidation process (up to 1000 ºC) in the atmosphere containing oxygen. This leads to the oxidation of the surface layer of initial material and causes a formation of the oxide shell. The new functional core-shell nanocomposite will be produced in this manner in the proposed project, where the starting materials for their production will be nanowires containing various compositions of iron and cobalt as well as iron and nickel. So far, this type of nanowires has not been fabricated using the method of chemical reduction with a participation of the external magnetic field. This constitutes a novelty of the project. Moreover, these nanowires will also provide a valuable base for further research.

All of the nanomaterials produced in the project will be examined using a variety of complementary methods of structural studies, such as: electron microscopy, X-ray diffraction (XRD), Raman spectroscopy (RS) and Mössbauer spectroscopy (MS), as well as the methods used for a thermal analysis of materials, such as: thermogravimetry analysis (TGA) and differential thermal analysis (DTA) or differential scanning calorimetry (DSC). Information originating from the applied experimental techniques will allow determining the morphologies and chemical structures of the as-prepared and thermally-treated nanowires. Moreover, the measurements related to the thermal analysis will enable the investigation of the resistance of the starting nanomaterials against oxidation as well as prediction of their possible oxidation mechanisms in the atmospheres with different oxygen contents. It is worth adding that the obtained results will help maintaining the quality and stability of the studied nanocomposites as well as to predict and to control the amount, type and thickness of the growing shell (oxide layer) on the surface of nanostructures with similar chemical compositions and different shapes than the materials studied in this project. This is extremely important from the viewpoint of their utilization in the future biomedical applications (e.g. magnetic hyperthermia treatment against tumor cells) and energy storage devices (e.g. lithium-ion batteries).