DESCRIPTION FOR THE GENERAL PUBLIC

Nanotechnology is a rapidly growing field that allows obtaining new and previously unknown nanomaterials with unique properties and versatile. They may have altered properties, e.g. magnetic, structural.

A diametrical change in physicochemical properties of many nanomaterials is conditioned by the fact that the surface atoms and ions are in different environment coordination. The number of nonsaturated coordination sites and defects of the crystal lattice stress increase. Therefore, the behavior of nanomaterials compared to their counterparts in the micro scale seems very interesting.

The main objective of the project is to explore in details the way non-stoichiometric nanocrystaline zinc ferrite **$Zn_xFe_{3-x}O_4$** (where $0 \leq x \leq 1$) of different ion distribution in the crystal structure decompose at high temperature, and to learn how to control the parameters of the process in order to obtain specific final products of controlled properties, namely nanometric dimensions and desired chemical composition
(a mixture of nanoparticles of zinc oxide ZnO and iron oxide III α Fe_2O_3).

Reducing the particle size of the magnetic substances, including ferrites, from micron to nanometer size results in a significant change in their properties. Zinc ferrite at micron and larger size at room temperature is paramagnetics, while the nanosized zinc ferrite due to the size of grain and non-stoichiometry at room temperature is superparamagnetics or ferromagnetics.

Therefore, it is reasonable to question whether non-stoichiometric zinc ferrite nanocrystallites $ZnFe_2O_4$ undergo thermal decomposition in the same way as their counterparts at the micro level. To know the non-stoichiometric properties of zinc ferrite $Zn_xFe_{3-x}O_4$ (where $0 \leq x \leq 1$) in nanoscale at high temperature it is necessary to conduct systematic research.

Studies carried out so far on the thermal decomposition of zinc ferrite material is comprised of micro-sized and larger and aimed at the reclaiming of zinc from waste material containing zinc ferrite or the production of hydrogen from water splitting under the action of concentrated solar energy.

The project will examine the disintegration of a material having a nanometric size; the process can be used in casting or in the technology where active oxygen is needed, e.g. splitting water into H_2. In the casting (in the technology of molding sands and core), the nanoparticles of metal oxides such as: ZnO, MgO and Al_2O_3 in the organic solvents are used as modifiers of the foundry binder – water glass (aqueous sodium silicate). As shown modification of water glass with metal oxide nanoparticles occur in both of two stages: at ambient temperature and under the influence of high temperature during the casting of the liquid alloy into casting mold.

Therefore, the implementation of this project, because of its innovative nature and results concerning the behavior of the zinc ferrite nanoscale high temperature, will certainly contribute to the knowledge of any possible danger related with the use of safe nanoparticles in future innovative technologies e.g. foundry technologies.

An **additional objective** of the project will be testing the spatial distribution of the nanoparticles in the resulting composite of sodium silicate ($Na_2O \cdot SiO_2 \cdot H_2O$) and quartz matrix and the ability to control the local concentration of nanoparticles using an external magnetic field (using the magnetic properties of zinc ferrite nanoparticles). Checked is also the behavior of the composite / matrix exposed to high temperatures. **These pioneering studies will have to determine the possibility of functionalizing the surface of the composite/quartz matrix in terms of the concentration of zinc ferrite nanoparticles within a given site (e.g. in the surface layer).**

Research methods

Synthesis of nanoparticles of zinc ferrite is preparing by chemical method e.g. co-precipitation from solution or preparation at high temperature. The definition of the output material and products of the thermal decomposition is performed using a transmission electron microscopes and diffractometers. Determination of the level of defects in the output material and the degree of decomposition of zinc ferrite will be made by means of X-ray and gamma spectroscopy. Transition temperatures and specific heat of phase transformation, as well as control of gaseous products released in the process of decomposition will be conducted using the thermal analysis/differential scanning calorimetry coupled with mass spectrometry.

Thermal decomposition of nanoparticles of ferrite zinc and composite of water glass with nanoparticles of ferrite zinc-quartz matrix type will be conducted **up to 1400°C**.