

Synthesis and physicochemical characterization of multifunctional luminescent-plasmonic-magnetic core/shell nanocomposites based on FeS₂ semiconducting nanocrystals and inorganic nanoluminophores doped with Ln³⁺ ions.

1. Goals of the project

The main goals of the project is the synthesis and physicochemical characterization of the multifunctional core/shell nanocomposites which exhibit simultaneous luminescence, plasmonic and magnetic properties. In the synthesis of materials, two approaches of the nanocomposites synthesis will be done: 1) synthesis of the core based on the FeS₂ nanoparticles, and coatings with inorganic nanoluminophores doped with lanthanide ions (e.g. YOF: Yb³⁺, Er³⁺, YVO₄: Eu³⁺, etc.); 2) the core synthesized from inorganic nanoparticles, doped with lanthanide ions, and shell based on FeS₂ structures. To improve the luminescent properties of the obtained materials, the additional inert SiO₂ layer or an inorganic nanoluminophores matrix without dopant ions will be synthesized on the core.

2. Research realized in the project

The project will consist of four stages of the research: (I) the synthesis and characterization of the FeS₂ cores, (II) the synthesis and characterization of inorganic nanoluminophores doped with lanthanide ions, (III) the synthesis and characterization of core/shell nanostructures based on the obtained cores (stage I), coated with doped inorganic nanoluminophores, (IV) the synthesis and characterizing of the core/shell nanostructures based on the inorganic nanoluminophores core doped with Ln³⁺ ions (step II) and FeS₂ shell. The obtained products will be examined for the morphology, particle size, crystal structure and chemical composition. The obtained nanocomposite materials will be tested due to their luminescence and absorption properties. The impact of the plasmonic materials on the luminescence properties of the final product will be investigated. Core/shell nanomaterials will also be tested for their magnetic properties.

3. The reasons for the research subject

The aim of the research is to obtain and extend the knowledge about the plasmonic properties of iron sulfides, and their impact on luminescent properties of phosphors, e.g. increasing the intensity of luminescence and tuning of the luminescence color of these materials. The use of materials based on iron will allow not only to study plasmonic effects, but also to use the magnetic properties of the composite materials obtained. Multifunctional luminescent-plasmonic-magnetic materials can be used in bimodal imaging as luminescent and magnetic markers, optoelectronics, and in the catalysis.