Title: ***"Tailor-made" perovskite quantum dots as an element of new functional nanomaterials***

It is well known that optoelectronics is one of the fastest developing fields in science and technology. It is involved in the study of systems and production of devices that emit, modulate, transmit, or detect light. Optoelectronic devices include the commonly used displays in tablets, laptops, TVs, or smartphones as well as photovoltaic cells, which are used to convert solar energy into electricity. These devices function in almost every area of our life and it is hard to imagine the development of information society without the intensive development of optoelectronics.

The determining factor for the further growth of this field is the development of methods for the manufacture and modification of new materials, including semiconductor nanomaterials with controlled optical and electrical properties. It is hoped that the intensive development of nanotechnology will bring breakthrough in optoelectronics, as it is involved in, among others, the design and production of nanomaterials. Thanks to their microscopic size (below 100 nm), they often have the properties that are unattainable by macromaterials. It is expected that in the upcoming years, nanotechnology processes will be used to manufacture the majority of new materials for optoelectronics.

In the last few years, scientists have become more and more interested in perovskite quantum dots (PQDs). PQDs are nanocrystals which are limited with potential barriers in all directions, i.e. X, Y, and Z axes. The term "quantum dots" is commonly used for the nanocrystals whose size does not exceed 10 nm. Perovskites include crystalline materials with a general formula of $APbX_3$, where A is a monovalent cation (e.g. Cs^+, $CH_3NH_3^+$) and X is a halide anion (e.g. Cl^-, Br^-, I^-). The name "perovskite" is derived from a crystallographic structure of a mineral that was discovered in the early 19th century in the Ural Mountains. The PQDs developed in a laboratory have extraordinary optical and electrical properties, which often exceed the properties of standard inorganic semiconductors. They are characterized with easy processing and very intense luminescence in the full visible light spectrum. Due to their unique properties, these nanomaterials are identified to be one of the most promising materials that can bring breakthrough for both display technologies and photovoltaic cells.

It has been found that these nanomaterials have an unusual nature and that they are metastable due to their crystal structure, that is the arrangement of individual atoms with respect to each other. Some of the ions and cations that form the nanocrystal are displaced over time, which is why it is said the perovskites have an ionic structure. In consequence, continuous perovskite sheets as well as PQDs are very unstable. These nanomaterials deteriorate very quickly, especially under moist or UV-light conditions. Another problem is the presence of lead, which is a toxic element. Toxicity and low stability hinder the expected development in this field.

The main aim of the project is to answer the fundamental question: are we able to effectively solve the problems of instability and toxicity of the PQDs? The most important achievement of the project will be the knowledge about effective stabilization of the PQDs while preserving all the extraordinary properties of the nanocrystals. It is also planned to test their application in optoelectronic devices including a new type hybrid, organic-inorganic photovoltaic devices.