Nanoluminophores with an excitation band in the near infrared range (NIR), especially in the so-called therapeutic windows (NIR-I, 700-900 nm and NIR-II, 1000-1400 nm) where substances contained in tissues show minimal absorption, allow using them in medicine or pharmacy, e.g. in bioimaging. The selected silver sulphide (Ag_2S) quantum dots (QDs), thanks to the excitation band in NIR-I and the emission band in NIR-II, allow the imaging of the tissues in in vivo and in vitro studies research. On the other hand, nanoluminophores doped with lanthanide ions, show the phenomenon of up-conversion of energy (UCNPs), which as a result of the absorption of photons in the NIR-I range and emitting higher-energy photons in the visible range, can be used as biological probes. However, even the most advanced methods of synthesis allow to obtain the nanoparticles with good spectroscopic properties, and to narrow the size distributions, getting the hydrophobic crystals that are non-dispersible in aqueous solutions, hence using them in biology is impossible. To obtain water-stable colloidal solutions. Thus, to ensure biocompatibility, physical and chemical stability of these nanoparticles, it is necessary to modify their surface.

The main goal of the presented doctoral thesis was to design and develop the methodology for surface modification of highly hydrophobic inorganic nanoparticles, and to give them a hydrophilic character without compromising of photoluminescent properties. The doctoral dissertation focuses on two modifying methods of the hydrophobic nanoparticles surface using alkoxysilanes and phospholipids.

The first goal of the research was to cover inorganic nanoparticles with a layer of amorphous silica (SiO_2). Coating the hydrophobic core with a layer of SiO_2 ensures low toxicity, biocompatibility as well as the possibility of further functionalization of the obtained material. The method used in this study consists of covering the core of UCNPs with a layer of SiO_2 in the two-phase system. In this system the silica precursor (tetraethyl orthosilicate) is heterogeneously supplied from the upper organic layer to the lower water layer, containing the surfactant-stabilized UCNPs and the catalyst. The aim of the work was to determine the influence of various synthesis parameters, such as: temperatures, type of catalyst, solvent or surfactant, on the process of SiO_2 coating formation. The use of transmission electron microscopy (TEM) imaging made it possible to determine the morphology, thickness and porosity of the obtained silica coatings. The use of the N_2 adsorption/desorption technique and the UV-Vis spectroscopy method made it possible to determine whether the dye molecules can be adsorbed - in the pores of the silica coating or only on its surface. The experimental results allowed proposing a mechanism for the formation of a silica coating on UCNPs. The proposed mechanism allows to explain how individual synthesis parameters affect the morphology of the obtained silica coating.

The aim of the second studies was to develop an effective method of encapsulating QDs Ag_2S in phospholipid nanostructures with the most efficient encapsulation possible. The advantages of using phospholipids are their natural occurrence in nature, and the formation of various structures in aqueous solutions (micelles, liposomes), as well as the possibility of further functionalization. Using various research methods (e.g. TEM, zeta potential measurements using laser Doppler electrophoresis, dynamic light scattering or ICP-OES) allowed to determine how the nature of the hydrophilic group (cationic, anionic, neutral or containing a polyethylene glycol chain) of the used phospholipid influenced the size, charge, degree of encapsulation, and emission efficiency. On the other hand, using ^{31}P NMR method enabled determining types of the formed aggregates. It is worth noting that the interactions in solutions between the atoms which are on the surface of the quantum dot, and the particles surrounding the nanocrystals, significantly affected the photoluminescence. Therefore, one of the most important parameter was the assessment of the colloidal stability of the obtained carriers during the storage, which was monitored by fluorescence, zeta potential, and measurement of size in a function of time.