Description for the general public

Early diagnosis of cancer and advanced tools for its treatment are factors that can decide about the life of many persons. The observed development of science in recent years has allowed for the recognition of one of the worst diseases of affluence and often effective treatment. But, still the cancer disease carries a high risk of death. In the area of diagnosis and treatment of cancer, nanotechnology may be very helpful. This science discipline deal with the production of objects having a size not larger than 100 nm. Appropriately designed nanoparticles, may enable detection of tumor and its treatment.

The main goal of the project is to obtain nanoparticles doped with lanthanide ions (Ln^{3+}) showing intense luminescence upon excitation by near infrared light from the range of second and third biological windows (NIR-II and NIR-III). As a result of absorption of radiation from the range of 1000 - 1350 nm (NIR-II) or 1500 - 1870 nm (NIR-III), up-conversion process in nanoparticles may occur, which result in the emission of radiation of a shorter wavelength than absorbed. The mechanisms responsible for the observed up-conversion will be studied and optimized in order to improve the luminescence effectiveness. This emission can be used for cells imaging, including cancer cells. The above mentioned ranges correspond to minima of the absorption of biological systems, such as skin or blood, allowing for the efficient excitation of nanoparticles embedded in the media. The properties of nanoparticles being the subject of planned research also allow for deeper imaging of objects embedded in the body such as internal organs. In addition, the phenomenon of up-conversion may be also used to kill tumor cells by local release of the transported drug under the influence of radiation, or by the production of singlet oxygen, which is toxic to cells. Both of these phenomena will also be examined during realization of the project.

Since the energetic processes, which result in luminescence are often ineffective in nanoparticles or even impossible to occur, the synthesized nanoparticles will have the core/shell structure where chemical composition or type of Ln^{3+} dopant ions of the core may differ from the shell. Thanks to the core/shell structure of nanoparticles the surface quenching of luminescence may be minimized. What is more, it is possible to design systems in which energy transfer between Ln^{3+} ions located in the area between the core and coating shell will occur what is impossible or inefficient when these ions are in the same phase.

Another important aim of the project is to obtain water colloids containing nanoparticles, stable in the environment close to the physiological and examine their physicochemical properties. This effect will be achieved by functionalizing the surface of nanoparticles by different organic compounds. The resulting nanoparticles will be tested for their cytotoxic properties by *in vitro*. Also their suitability for the bioimaging of cells using confocal microscopy will be tested.