Neurodegenerative diseases (e.g. Alzheimer's, Parkinson), psychiatric disease (e.g. schizophrenia), cancer, bacterial infection and many others are still a challenge for medicine. One of the major drawbacks of current conventional therapies is lack selectivity of preparations, since administered drugs are more or less equally distributed within the body. This results in many of the negative side effects due to the impact of the drug in the whole body, also on the healthy part of it. It seems reasonable to find the a route of controlled delivery of therapeutic, which would result in an action of the active substance only in strictly defined, pathologically changed place in the body. The solution of this problem is the drug targeting, i.e., delivery of the therapeutic component selectively and simultaneously monitoring its distribution.

Nanotechnology is an interdisciplinary and multidisciplinary research field involving chemistry, physics, material science, biology, and medicine. In particular, the nanotechnology is currently offering various exciting possibilities in biomedical fields, and this application is referred to as ‘nanomedicine’. It is the field of research with huge expectations for the development of personalized medicine based on the application of nanoparticles (NPs) as nanoscale materials interact effectively with biological systems. In particular, the simultaneous use of nanodiagnostics in vivo imaging and nanotherapeutics for drug delivery may allow overcoming many intractable health challenges. Although in the past decades a large effort has been devoted to the development of functionalized targeted drug delivery systems, some challenges still remains unsolved: delivery drugs to specific cells, the real time monitoring of drug delivery and monitoring and control the drug release.

The term “theranostic” is defined as a material that combines the modalities of therapy and diagnostic imaging. Thus, theranostics deliver therapeutic drugs and diagnostic imaging agents at the same time within one dose. The ultimate goal of the theranostics is to gain the ability to image and monitor the diseased tissue, delivery kinetics, and drug efficacy with the long-term hope of gaining the ability to tune the therapy and dose with heretofore unattainable control.

The main project objective is to develop the scientific background for a completely new strategy for theranostics by applying biodegradable and biocompatible nanocarriers that are able deliver the therapeutic components to the site of its action, image a diseased tissue and monitor the delivery without simultaneously imposing side effects. The use of theranostic nanocapsules may be the ideal solution for future personalized therapy e.g. for cancer treatment.

In this project we will concentrate on the development of biocompatible liquid core polyelectrolyte nanocapsules and micro/nanogels for theranostic application with the MRI imaging. MRI characterization will be performed to demonstrate possibility of visualization of the synthesized nanocapsules. The cell viability or cytotoxicity tests will be performed to prove that they can be tolerated by organism without inducing harmful effects.

The results obtained will broaden our knowledge concerning the technology of formation of functional drug nanocarriers. The obtained results will be very significant; they will bring new knowledge concerning application of nanotechnology in modern molecular pharmacology and medicine.