Developments in the area of precise determination of the field of irradiated tissue in the conventional radiotherapy are significant. However, resulting outcomes are still insufficient. Boron Neutron Capture Therapy (BNCT) with its biological targeting towards single cells has the potential to overcome this problem of conventional radiotherapy. BNCT is a promising type of therapy for cancers that are not treated by traditional therapeutic techniques due to two important aspects: a facility of neutron beam penetration across the human body and the creation of targeted carriers delivering boron to the tumor tissue. The result of such a procedure is the introduction of a non-radioactive boron isotope to the body, which is designed to selectively penetrate the tumor cells, followed by an exposition of the patient to irradiation with an epitermic neutron beam. Such irradiation is relatively safe for the body, except for tumor cells loaded with boron.

The most important issue currently faced by BNCT is to design selective carriers enabling accumulation of the required concentration of boron in the target tissue. We intend to verify the original hypothesis that boron nanoparticles will be taken up in the process of endocytosis by various. Such “cellular carriers will have the task of delivering boron to the tumor environment. The proposed project has an interdisciplinary character, it integrates material technology, cell biology and biotechnology.

The project is innovative and multifaceted. We intend to use inorganic boron carbides as well as hybrid (starch based) boron conjugates as boron-rich nanoparticles. We plan to employ unique methods of biofunctionalization of synthesized nanoparticles by modifying their surface with biological tropic molecules (antibodies, folic acid). An alternative approach will be to use the phenomenon of nanoparticle phagocytosis to deposit the boron in the environment of cancer cells. One of the main tasks we plan in this project is to study the biological activity of new compounds in several assays in vitro, including the evaluation of the interaction of modified boron nanoparticles with cells of selected mouse and human tumor lines.

Another main aspect of the research is to determine whether boron internalized by cancer cells can be secreted into the microenvironment directly or in the form of microvesicles (EVs), which impact the development or inhibition of the anti-tumor response. A number of in vivo experiments on murine tumor models is planned, in which we will analyze the potential toxicity of nanoparticles and their distribution in tumor tissues.