Description for the general public

Biochemical processes carried out in living organisms with high efficiency, in relatively low temperatures and leading selectively to selected products usually proceeed in small objects inside the cells that act as chemical reactors. Individual cellular organelles provide different environments, optimal for individual processes, and the product of one reaction is often a substrate or catalyst of another one. Typically fusion of isolated microreactors or exchange reagents occurs in such systems. Mimicking nature in this aspect has led to fabrication of the artificial systems of sizes in the range of micro- and nanometers that can serve, for example, as reactors for efficient chemical synthesis or as systems supporting environmental protection and detoxification. The fabrication of such nanoreactors and the examination of processes that are carried out in such confined systems with the volumes on attoliters (10^{-18} L) level is therefore very important for many potential applications ranging from the synthesis of new biologically active substances through the decomposition of hazardous environmental pollutants to modeling of biochemical processes.

It is planned, within this project, to produce nanocapsules containing a liquid, oil core and a thin polymer coating that will be dispersed in an aqueous environment. Thanks to the application of well-defined synthetic polymers containing ionic groups, it will be possible to examine the fusion processes of nanocapsules formed from the oppositely charged polymers. Both the formation of the nanocapsules themselves acting as nanoreactors, as well as their fusion will be studied as a function of the composition of the core and shell as well as external conditions such as pH and ionic strength. Thanks to the use of fluorescent probes, it will be possible to examine in detail the fusion process and the structure of the reactors resulting from it. After optimizing the fusion of nanoreactors, selected processes (eg fluorescence quenching) and model chemical reactions in will be examined the merging nanoreactors. Modern research methods that allow observation and investigation of phenomena occurring at the level of individual nanocapsules will be applied.

The results of the project will greatly contribute to the development of knowledge about design and farbication of micro(nano)reactors based on core-shell polyelectrolyte capsules and their fusions, which have not been studied for this type of new systems so far. The presented approach is innovative in the field of formation of multi-compartment microreactor systems as well as studying of mutual interactions. Thus, the results of the projects may be beneficial for many disciplines using structurally similar systems (liposomes, cells) and may lead to their practical applications in the future, among others, for more energy-efficient syntheses of new substances, the construction of drug nanocarriers, or supporting in the removal of hydrophobic water pollutions.