Popular scientific abstract of the project

Amphiphilic copolymers – copolymers containing hydrophilic (*water-loving*) and hydrophobic (*fat-loving*) parts – found many applications, mainly in medicine as drug carriers and materials for fabrication of medical devices, carriers of catalysts (including enzymes), stabilizers of emulsions in food, oil and construction industries and in many other fields. The most important property of amphiphilic copolymers is their ability for self-organization in water and in hydrophobic organic liquids. Currently, this class of amphiphilic compounds almost exclusively consists of block (hydrophilic and hydrophobic) and, to lesser extent, of graft copolymers (with hydrophobic main chain and hydrophilic grafts). Until now, properties of amphiphilic copolymers are tailored by choosing blocks and grafts with particular chemical structure. Our project aims at exploration of a new approach for tailoring properties of amphiphilic copolymers, namely, not by modification of their chemical composition but by modification of chain architecture. According to this idea, we will develop methods for synthesis of copolymers with hydrophobic linear polystyrene blocks and hydrophilic polyglycidol parts with following architecture: linear block, (polyglycidol graft)-on-(polyglycidol block) and [(polyglycidol graft)-on-(polyglycidol graft)]-on-(polyglycidol block). These polyglycidol constructs will be attached at one or at both ends of polystyrene chains. In our studies we would like to find out how by changing blocks' length and architecture of polyglycidol part(s) one could influence copolymer properties in solution, especially their self-assembly into particular types of aggregates. The copolymers will be synthesized by precisely controlled polymerization of styrene and polyglycidol with blocked hydroxyl groups. At various stages, when necessary, and always at the end of the synthesis, the hydroxyls will be deblocked. Some copolymers will be modified by introduction of anionic (carboxyl) and cationogenic (amine groups). Structure of copolymers will be determined by ^{1}H, ^{13}C, IR, GPC methods, and in addition, when possible, by MALDI-TOF spectrometry. Behavior of copolymers in solution will be evaluated using computer modeling based on molecular dynamics approach. Processes of self-assembly of synthesized, extensively characterized copolymers will be investigated by using static and dynamic light scattering, fluorescence spectroscopy of fluorescent probes sensitive to hydrophilic and hydrophobic microenvironment (i.e. to presence of copolymer aggregates in their nearest vicinity), and microscopy: cryo-TEM and AFM. Our attention will be concentrated on comparison of morphology and size of aggregates of copolymers with the same length of polystyrene chains and the same content of differently arranged polyglycirol monomeric units.

Remembering about various applications of amphiphilic copolymers, we would like to end the project with some preliminary studies of adsorption of copolymer aggregates onto polymer films used as simplest models of biological membranes. In these studies we will use polymer films with varied hydrophobicity and copolymer aggregates labeled with fluorescent labels. Attachment of the aggregares will be investigated by monitoring fluorescence of polymer films exposed to suspension of aggregates and by AFM observations. We intend to perform also studies of encapsulation of selected enzymes (lipase and alkaline phosphatase) into copolymer aggregates. Comparison of efficiency of enzyme encapsulation and activity in standard reactions (in the case of lipase hydrolysis of 4-methylumbelliferyl butyrate and in the case of alkaline phosphatase hydrolysis of p-nitrophenyl phosphate) as a function of aggregate structure and morphology will be investigated. In this way, the project will provide results of comprehensive studies of a new class of amphiphilic copolymers, which in the future might be used in application-oriented studies.