Abstract

This doctoral thesis is dedicated to the synthesis and characterization of novel functionalized hybrid structures for biomedical purposes. Systems reported in this work can be subdivided into the two main groups: natural-based materials and synthetic amphiphilic block copolymers. Both groups were studied as perspective theranostic agents for medical applications. In the first group, natural polysaccharides glycogen and mannan were selected as starting materials for preparation of novel nanoconjugates that possess ability for multimodal detection \textit{in vivo}. Because grafting of natural macromolecules with synthetic polymers generally slows down the biodegradation rate, both polysaccharides were modified in two different ways to form nanoprobe\(s\) with or without poly(2-methyl-2-oxazoline)s chains. The prepared nanoconjugates were functionalized with \(N\)-hydroxysuccinimide-activated fluorescence and magnetic resonance imaging labels. The resulting materials were tested both \textit{in vitro} and \textit{in vivo} and were shown to be completely biocompatible, biodegradable and exhibit some extra benefits in terms of their practical usage in biomedicine. Glycogen was functionalized with allyl and propargyl groups with following freeze-drying from aqueous solutions to form nano- and microfibrous materials. The presence of both double and triple bonds ensures the possibility of electron radiation crosslinking and modification of resulting polymer with biologically active molecules, respectively. The obtained self-assembled structures reveal a great perspective for wound healing application.

The second part of this thesis is devoted to the preparation and characterization of novel amphiphilic diblock copolymers as a model for studying the micellar behaviour of the complex self-assembled architectures with stimuli-responsive properties. Nitroxide-mediated radical polymerization was used for the synthesis of well-defined diblock copolymers of styrene (S) and 2-dimethylaminoethyl acrylate (DMAEA), where the first block consisted of gradient copolymer and the second one was a homopolymer of DMAEA. As a result, due to the pH- and temperatureResponsiveness of DMAEA units, polycationic amphiphilic block copolymers capable of reversible self-assembling behaviour were obtained. Moreover, one chosen copolymer was modified using thiol-ene click reaction and further functionalized with fluorescence label in order to perform the \textit{in vitro} examination and to study its potential for biomedical applications.

All the prepared polymers were characterized using a wide range of methods, including \(^1\)H magnetic resonance and Fourier-transform infrared spectroscopies, size exclusion chromatography and dynamic light scattering. Additionally, for the amphiphilic diblock copolymers small angle neutron scattering was performed to study their solution behaviour.

\textbf{Keywords}: nanomedicine, polysaccharides, glycogen, mannan, nitroxide-mediated radical polymerization, amphiphilic block copolymers, self-assembling.