BIOPOLYMERS IN NANOCAPSULE SYNTHESIS FOR BIOMEDICAL APPLICATIONS

Katharina Landfester

Max Planck Institute for Polymer Research, Ackermannweg 10, 55128 Mainz, Germany

ABSTRACT

Molecularly designed materials are increasingly attracting attention not only because of the variety of applications in which they may be applied, but also due to the challenging strategies necessary for their design and synthesis. Highly complex and functional nanoparticles and nanocapsules are obtained by exploiting simple tools and concepts from different disciplines, introducing the desired properties in the final product. This talk shows that by combining fundaments from organic chemistry, polymer and materials science, stimuli-responsive nanoparticles are easily generated.

Responsiveness can achieved by exploiting photo-cycloadditions, which are extremely selective, react in good yields without the formation of side products, proceed under benign conditions, and present the great advantage of being reversible. The respective sensitivity can also be achieved by the utilization of cleavable crosslinking points which represents a method for triggering the complete decomposition of the network. Based on *o*-nitrobenzyl derivatives, functionalized crosslinkers were synthesized to build up photodegradable PHEMA-*co*-PMAA particles as pH and light-sensitive nano-scaled materials. The particular combination of the mentioned stimuli is designed to exhibit two different degradation profiles. In both cases, particles are highly swollen for pH values higher than the pKa of the nanogels, whereas decreasing pH leads to deswelling of the networks. Disintegration of the collapsed particles by direct irradiation represents a one-step degradation profile. In contrast, by transferring the collapsed particles to phosphate buffer solution slightly swollen particles are obtained, which subsequently can be degraded by application of UV-light, therefore characterizing a two-step swelling/degradation profile. With regards to potential delivery applications, a slow release based on diffusion out of the slightly swollen network can either be combined or replaced with a fast on-demand release upon irradiation. This versatile behavior represents a great potential for the loading and release of active compounds.

We will also present the synthesis of hybrid nanocapsules, made of peptides and hydrophobic comonomer in inverse miniemulsion. Polyurea were prepared from the interfacial polyaddition of diisocyanate with the peptide as amine. The peptide sequence can be cleaved selectively by an enzyme as monitored by fluorescent recovery of a FRET-system incorporated in the sequence around the site of recognition. Moreover, the successful encapsulation of a hydrophilic fluorescing polymer can be demonstrated. The results show that we prepared hydrophobic, polypeptide based nanocapsules with hydrophilic payload, which are enzymatically cleaved.

The uptake of the different nanocapsules into a wide variety of cells is an effect that seems to be specific for materials in the range of 50-200 nm. Surface modifications (positively or negatively charged side groups of the polymers, amino acids, or peptides/proteins) enhance this uptake. Knowledge about factors influencing cellular uptake, like size, surface properties, cell type, and endocytotic pathways, enables optimization of labeling and selection of cells and nanoparticles for applications in vitro and in vivo.