Chapter 2
Motivation

Since the discovery of microgels as a unique class of polymeric nanoscale materials, this research area has gained increasing attention. Especially the incorporation of stimuli-responsive properties into gel nanoparticles allows the preparation of highly functional materials exhibiting bespoken properties for a tremendous variety of applications. In general, the exceptional properties of microgels stem from the combination of their colloidal nature with their internal network structure. Since the latter is characterized by parameters as e.g. the mesh size, the polymer volume fraction or the interaction of embedded functional compounds with the network, the ability to control these factors by the appliance of external triggers represents the underlying concept to stimuli-responsive microgels. The response mechanism of these nanomaterials crucially depends on two important features. First, the overall sensitivity of microgels is defined by the specific type of stimulus to which these materials respond. This is governed by the particular nature of functional groups responsible for the sensitivity of the gel. Second, the location of these moieties in the network structure as well as their specific triggered response mechanism determines the overall stimuli-dependent behavior of the microgels.

Among a broad variety of triggers described in the literature, light-induced responses have attracted much attention since they represent one of the most desirable methods for economical, easy, rapid, and efficient control of the material properties. This can be achieved by tuning light parameters such as wavelength, power, and time of irradiation in a non-contact approach. Therefore, the concept of photo-sensitive nanomaterials such as nanoparticles or microgels is a highly interesting approach not only for applications in nanotechnology and biomedical related fields, but also holds promise for creating ideal model systems for fundamental studies on molecularly controlled structure variations. Moreover, photochemistry in combination with microgels enables the preparation of a multitude of materials with different response mechanisms precisely tailored for a desired application by taking two main design criteria into account:

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(i) The large number of various chromophores and their specific photoreactions allows for tuning the sensitivity of the microgels with respect to the light parameters.
(ii) The potential to incorporate the respective light-induced changes to a multitude of locations in the polymeric network structure (i.e. polymer backbone, crosslinking points, polymeric side groups) gives rise to a variety of response mechanisms. This facilitates the preparation of different materials based on the same chromophore but exhibiting diverse photolytic variations of their properties.

As these characteristics render photo-sensitive microgels and nanoparticles very versatile materials with respect to their design, preparation and application, the implementation of new materials in this area represents an extremely attractive field of research. In this context, polymeric gel latexes for light-triggered loading and release applications are of special interest. Here, controlling the rates of diffusion of embedded functional substances within the swollen (hydro)gel matrix by light is the underlying concept.

Based on these considerations, the aim of this thesis is the design, synthesis and characterization of novel photo-sensitive microgels and nanoparticles as potential materials for the loading and light-triggered release/accessibility of functional compounds. A crucial prerequisite to resolve the potential of these materials for possible applications is a profound understanding of their stimuli-responsive behavior. Therefore, particular attention is paid on combining the design and characterization of specific response mechanisms on a molecular level with detailed investigations on the influence of these features on the overall sensitivity of the nanoscale polymeric gel particles.

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