Protein Coated Gold Nanoparticles: Bio-Inspired Multi-Responsive Plasmonic Nanomaterials

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Stimuli-responsive nanoparticles (NPs) are highly interesting for their potential applications as sensors due to their keen sensitivity towards environmental changes and thus, pronounced response. A plethora of stimuli-responsive nano-systems based on plasmonic nanoparticles have been developed, which are sensitive towards environmental temperature,[1] pH[2] and light[3]. However, the modern trend for stimuli-responsive systems is moving towards multi-responsive systems, where the sensitivity towards various environmental factors is condensed on one single device.[4] Hence, many strategies have been developed to combine such responsive properties on a single system, in order to obtain multi-responsive materials. One of the major fields is based on polymer-particle hybrid systems, where the particle is capped with multifunctional polymers, consisting of block copolymers or mixed polymers.[4] However, nature has developed multi-functional polymers since the evolution of life, such as DNA/RNA, polysaccharides and proteins. Proteins are natural copolymers of polar, nonpolar, and ionic (anionic and cationic) monomers (in total 21 aminoacids) and are highly sensitive to temperature, pH, ionic strength, solvent and metal ions.[5-7] Hence, protein coated nanoparticles provide access to a multi-functional and multi-responsive hybrid materials with controlled properties and bio-functions.

In this work, we present protein capped metal nanoparticles, which are extremely sensitive to pH, temperature and heavy metals, exhibiting a pronounced optical response, which can be monitored even by naked eye. The NPs aggregate in the presence of heavy metals in a dissimilar manner, representing a simple tool for studying metal-protein interactions, and eventually for heavy metal sensing in biological and ecological systems.