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Small Angle X-ray Scattering Study on Nanoparticles Colloidal Stability in Biological Media

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Nanoparticles (NPs) applications in biomedical fields and medicine are increasingly broad. However, after transferring NPs to a biological environment, their interactions are incredibly complex and poorly understood. Different ionic strength (IS) and pH conditions in biological media and the presence of biomolecules such as proteins initiate alterations in NPs structure and their colloidal stability state. NPs colloidal stability in a biological environment is a crucial property for colloidal products and their applications in nanomedicine. As it strongly influences their safety and efficiency, there are growing requests for detailed investigations on NPs interactions and their structural changes. My thesis aims to design and develop a characterization method based on small-angle X-ray scattering (SAXS) for in-situ, label-free, and dynamic studies on the NPs interactions after exposure to a biological environment. In a first step, a micromixer system is designed and fabricated, which is combinable with SAXS instruments. Silica NPs are selected to individually investigate the effect of changes in IS, pH, and the presence of protein on NPs colloidal stability. It is concluded that the presence of the protein reduces silica NPs colloidal stability drastically. In the next step, gold NPs interactions in the presence of different protein concentrations are studied in more detail. The effects of NPs size and surface modification are considered. Gold NPs with 5 and 40 nm in diameter, and two surface modifications, citrate and polyethylene glycol (PEG), are investigated. Citrate NPs in appropriate protein concentrations stabilize by protein adsorption on their surfaces. However, 5 nm PEGylated NPs show stabilization by generating self-assembled 3D ordered domains in higher IS. In the last part of my thesis, the self-assembly behavior of 5 nm PEGylated gold NPs is studied in different protein concentrations.

Jury:

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