Coupled impact of proteins with different molecular weight and surface charge on nanoparticle mobility

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The widely present proteins in the natural environment interact with the released nanoparticles, which change the stability, transport, and fate of nanoparticles. Since proteins with different molecular weights contain various amino acids, the surface properties of the protein are different, and the mechanisms that affect the stability and mobility of nanoparticles are also distinct. Until now, the effects of proteins with different molecular weights and surface charges on nanoparticles have received little attention. In this study, the effects of concentrations and three different molecular weights of protein on the stability and mobility of TiO\textsubscript{2} nanoparticles are investigated.

Our study found that with the increase in bovine serum albumin (BSA) concentration from 2 to 16 mg L\textsuperscript{-1}, the capacity of the BSA adsorption on the TiO\textsubscript{2} surface increased from 37 to 85 mg g\textsuperscript{-1}, and the thickness of the BSA adsorption layer increased from 4.7 to 5.8 nm, causing stronger steric repulsive interaction. When the proteins had similar negative surface charge, the molecular weight decreased from 68 to 14 kDa, the capacity of the protein adsorption on the TiO\textsubscript{2} surface increased from dozens to more than 100 mg g\textsuperscript{-1}, and the thickness of the protein adsorption layer increased from 5.4 to 7.5 nm, resulting in stronger steric repulsion. For the proteins with different molecular weights and negative surface charges, the thickness of the protein adsorption layer is the dominant factor for TiO\textsubscript{2} stability, and both the steric and electrostatic repulsion played the critical role in TiO\textsubscript{2} mobility. This study emphasized that the steric repulsion induced by the thickness of the protein adsorption layer increased nanoparticle stability in aqueous environment, and the coupled impact of steric and electrostatic repulsion due to different molecular weights and negative surface charges of proteins strongly affects nanoparticle mobility in saturated porous media.