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Analysis of coatings on Au@Ag nanoparticles using Surface-Enhanced Raman Spectroscopy (SERS)

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Engineered inorganic nanoparticles (EINP) are being implemented in a wide variety of fields and products due to their unique properties compared to their bulk material. The diversity of application reaches from cosmetics and medicine over textiles to catalysis and electronics. The increasing use and production of engineered inorganic nanoparticles escalates the risk for their unintended release into the environment. The fate of the nanoparticles in the environment is mostly dependent on their surface properties and also the stability of the nanoparticles in terms of dissolution and aggregation. To evaluate toxicity and transport of the nanoparticles, it is important to study the chemical nature of nanoparticle clusters as well as their coatings. Coating of nanoparticles can change their stability. For example sorption of Suwannee River Humic Acid to silver nanoparticles has been reported to increase the stability of nanoparticles.
Analytical methods to investigate organic coatings on nanoparticles in are scarce. Among different methods which are used to characterize the coating of nanoparticles, surface-enhanced Raman spectroscopy (SERS) has been proved to be a promising method to detect the coating on noble metal nanoparticles. With developments and innovations in nanotechnology, core-shell nanoparticles have been observed to be more appropriate than pure metal nanoparticles in different fields and also for SERS studies by reaching a higher enhancement factor which helps to accomplish more knowledge regarding the coating of nanoparticles.
The objective of this study is to implement SERS in order to study the exchange and competition of different coating agents with different binding abilities on Au@Ag nanoparticles to simulate the release of nanoparticles into a water body with a number of potential coating agents. Suwannee River Natural Organic Matter (SRNOM), 4-mercaptobenzoic acid (4-MBA) and 4-Mercaptopyridine (4-MPY) were selected molecules for the experiments. The results show that coating agent with a higher binding ability can successfully compete with a coating agent which has a lower binding ability. 4-MPY bonds stronger than the other two coating agents to the nanoparticles if two of the coating agents are available at the same time in the system. In addition, concentration of the coating agents plays also a role in this competition.

Keywords: Au@Ag, SERS, coating, SRNOM