

Investigating physical and chemical properties of individual silver nanoparticles through electrochemical impacts

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Recent results will be reported toward the development of a relatively simple and inexpensive electrochem. method for the anal. of individual nanoparticles and their chem. reactions. Our focus has been on silver nanoparticles (AgNPs) because of their com. availability, wide use as a biocide in consumer goods, and largely unknown consequences of their release into the environment. Understanding the surface properties and chem. reactivity of AgNPs can provide insight into their heterogeneous catalysis, dissolution mechanisms, and effects on microbiomes. The electrochem. approach involves placing a microelectrode into an electrolyte solution containing the AgNPs, stepping the potential at the electrode to a predetermined value, and measuring the current as a function of time. When a AgNP comes into contact with the electrode, mostly due to diffusion, and if the applied potential is well beyond the oxidation potential, Ag atoms in the NP will oxidize and generate an anodic current over the brief duration of the particle's impact with the electrode. The resulting current response for each AgNP is different, giving information about the in situ phys. and chem. diversity of the AgNP population. This capability is not possible with traditional nanoparticle characterization methods. The magnitude of the current spike depends on the thermodyn., kinetics, and mass transport of that AgNP. The frequency of the current spikes is proportional to particle concentration. Integration of the current of each spike with time (coulombs) is proportional to the number of Ag atoms from which the size of the particle can be determined by assuming a specific geometry. The oxidation potential provides insights into the stabilization of AgNPs by their capping ligands and varies depending on the surrounding electrolyte that leads to insoluble precipitates or soluble complexes. Applying lower potentials allows exploration of the kinetics of the oxidation reaction. Also, groups of multiple current peaks can be assigned to multiple impacts of the same NP. In our presentation, we will compare the current responses and how they evolve during an electrochem. experiment for AgNPs having sphere and cube geometries, which are dispersed in aqueous solutions of potassium chloride, potassium nitrate, and lithium perchlorate.