Detection of fM Concentrations of 4 nm Diameter Gold Nanoparticles by Stripping Voltammetry Following Electrophoretic Deposition and Electrochemical Seeded Growth Amplification

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Abstract

Electrodeposition followed by anodic stripping voltammetry (ASV) is a traditional electrochemical method for the detection of various metal ions at low parts-per-billion (ppb) concentrations. ASV can also perform biological sensing in combination with metal nanoparticles (NPs) as biological labels. The detection of metal NPs in solution is important for environmental monitoring and indirect detection of chemical and biological analytes when NPs are used as labels. There are different methods of metal NP detection, including microscopy, absorbance, fluorescence, Raman scattering, dynamic light scattering, single NP electrochemistry, and single NP blocking of ionic current. These methods have different advantages and disadvantages. In our work, we detect 4 nm diameter Au NPs by a two-step amplification strategy on indium tin oxide-coated glass electrodes (glass/ITO). The two steps are i) electrophoretic deposition (EPD) at 0.8 V (vs. Ag/AgCl) in an aqueous solution of hydroquinone with varying concentration of 4 nm Au NPs and varying EPD time (30 sec to 1 h) and ii) electrochemical deposition (ECD) at a potential of 0.8 V (vs. Ag/AgCl) in a solution of 1 mM $HAuCl_4$ plus 0.1 M $KClO_4$ solution for 1 min to 15 min to selectively grow the 4 nm Au NPs already deposited into larger structures. The ASV detection occurs by performing linear sweep voltammetry (LSV) in 0.010 M KBr plus 0.1 M $KClO_4$, which leads to anodic current through the oxidation of Au to $AuBr_4^-$. For varying concentrations from 170 nM down to 0.017nM (in terms of Au) and a constant 1 min ECD time, the EPD time required to achieve a maximum ASV signal increases with decreasing Au NP concentration.

Biography of Miracle Amechi

Miracle is a third year PhD student at the University of Louisville, working under the mentorship of Dr. Frank Zamborini. She hails for Nigeria, where she obtained her bachelor's degree in industrial chemistry and focused on nanoparticle synthesis for her thesis project. She currently works in the Zamborini laboratory on the investing the limit of detection of gold nanoparticles by electrochemical amplification means- electrophoretic deposition (EPD) and electrochemical deposition (ECD).