Surface Plasmon Resonance Analysis of Plasmonic Nanoparticles In Free-Solution with OpenSPR

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Overview

Metal nanoparticles exhibit unique optical characteristics, and characterization of these properties is essential for the development of next generation biosensors, evaluating new synthesis techniques, understanding the underlying physics and many other applications. OpenSPR is a powerful tool for the characterization of the plasmonic properties of metal nanoparticles. Its advanced optical platform and powerful algorithms allows for convenient and real-time tracking of plasmonic peak properties of nanoparticles in solution. Coupled with its user-friendly software, OpenSPR allows for minimal post processing of spectra data that can be automatically acquired at faster rates than traditional spectrophotometers. The stabilized plasmonic background necessary for accurate analyte detection is achievable with OpenSPR. In this Application Note, we compare the properties of 1% gold plated silver decahedral nanoparticles (Au@AgDeNPs) to pure silver decahedral nanoparticles (AgDeNPs). Plasmonic changes due to ligand binding are correlated with structural changes observed using TEM.

Materials & Equipment

- OpenSPEC Instrument (OpenSPEC1) or OpenSPR Instrument (SPR-01)
- OpenSPR Cuvette Holder (CUV-1) *if using OpenSPR Instrument*
- Nanoparticles in solution
- 1 cm path length micro cuvette

Safety Notes

Follow the safety precautions outlined in the MSDS for all materials.

Procedure

1. Following the startup procedure found in the OpenSPR manual, setup the OpenSPR instrument with the Cuvette Holder. If using OpenSPEC, follow the typical start up procedure found in the OpenSPEC manual to set up the OpenSPEC instrument and software.

Procedure

2. Pipette the nanoparticle solution into a micro cuvette and record the absorbance spectrum in real time. Save spectrum as .csv file.
3. Pipette desired solutions into cuvette and observe interactions in real-time.
4. Repeat the procedure for each nanoparticle mixture.

Results

The real time SPR maxima changes and corresponding TEM (transmission electron microscopy) images of 1% gold plated silver decahedral nanoparticles (Au@AgDeNPs) and precursor AgDeNPs nanoparticles after the addition of ampicillin are summarized in **Figure 1**.

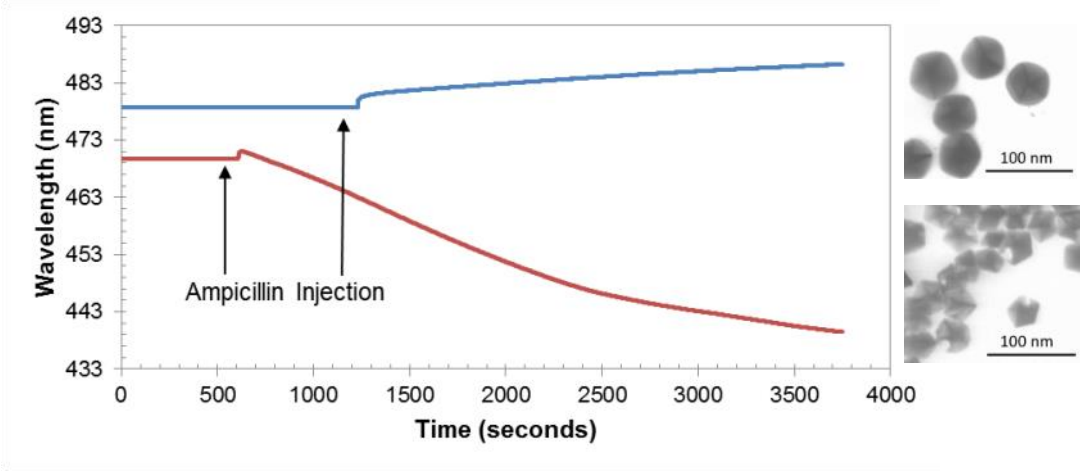

Figure 1. Real time SPR maxima changes and corresponding TEM (transmission electron microscopy) images after addition of 10^{-2} M ampicillin to 1% Au@AgDeNPs and precursor AgDeNPs.

Au@AgDeNPs have a noted plasmonic response upon addition of ampicillin (a sulfur containing β-lactam antibiotic) **(scaled in Figure 2 below)**. The observed shift in wavelength is evidence of chemisorption of sulfur (S) with the gold surface of the Au@AgDeNPs. The red spectral shift is a result of shared surface electrons with S requiring less energy for oscillation. The resulting morphology of the Au@AgDeNPs exhibits a partially degraded or

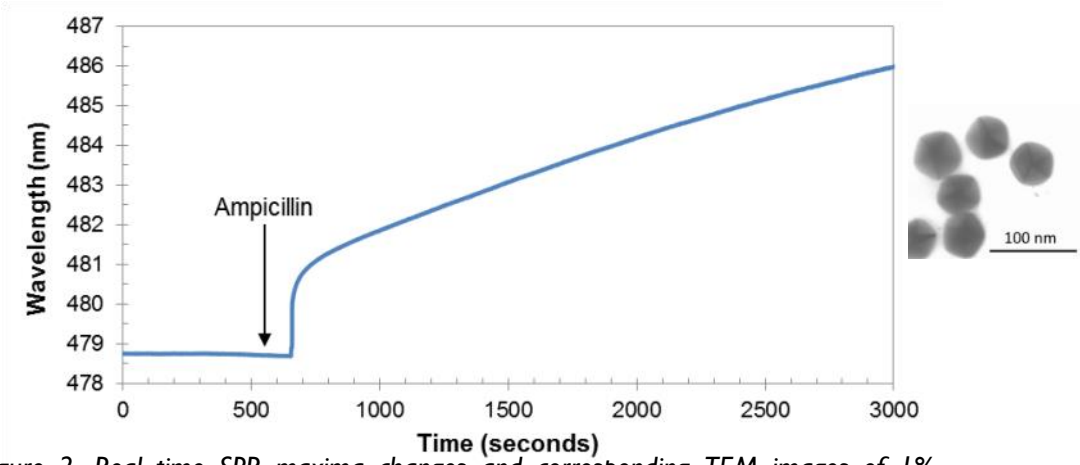

Figure 2. Real time SPR maxima changes and corresponding TEM images of 1% Au@AgDeNPs after addition of 10^{-2} M ampicillin.

The real time SPR maxima changes and corresponding TEM image of Au@AgDeNPs after the addition of cysteine are summarized in **Figure 3**. Upon addition of cysteine (a thiol containing amino acid), an increase in plasmonic response is present as a spectral red shift. The change in wavelength is indicative of surface-ligand interactions of the sulfur containing thiol group with the gold surface of the Au@AgDeNPs. This interaction results in a slightly etched morphology.

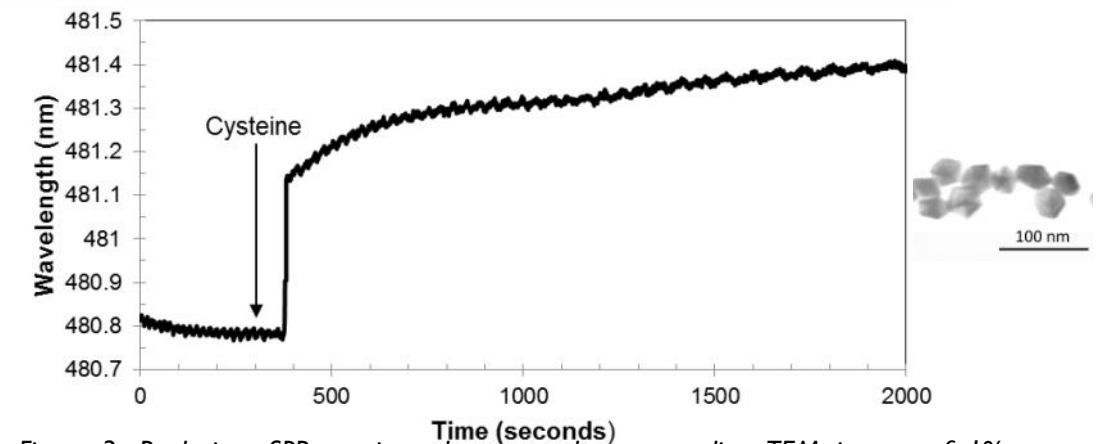

Figure 3. Real time SPR maxima changes and corresponding TEM images of 1% Au@AgDeNPs after addition of 10^{-5} M cysteine. Noise less than 20 pm is achieved.

These results demonstrate that the OpenSPR is a great tool for surface plasmon peak tracking of plasmonic nanoparticles in solution to give greater insight for the characterization of nanoparticles.