

Silver Nanoparticles as an Electrochemical Bio-Label

Paul K. Wilson¹, Mateusz Szymanski², Robert A. Porter^{1*}

1. Argento Diagnostics Ltd., Knowledge & Innovation Centre, National Physical Laboratory, Teddington, Middlesex, TW11 0LW
2. Analytical Science Team, National Physical Laboratory, Teddington, Middlesex, TW11 0LW

Introduction

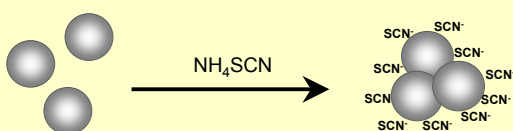
Immunoassays with electrochemical detection of metal marker generally follows the same procedure. That is the dissolution of metal nanoparticle (NP) and the consecutive quantification of solubilized metal ions by anodic stripping voltammetry (ASV) at carbon electrode.

The dissolution step is very important as it ensures the high sensitivity due to release of huge number of metal ions from one single NP. However, it requires the use of harmful reagents (such as HBr/Br₂ mixture for gold or HNO₃ for silver).

This work presents a new strategy for using silver nanoparticles (AgNPs) as a metal marker with the dissolution step that does not require a chemical oxidant and thus offering advantages for application in terms of fast response, reduced cost of analysis and procedural simplicity.

Silver Nanoparticles Aggregation

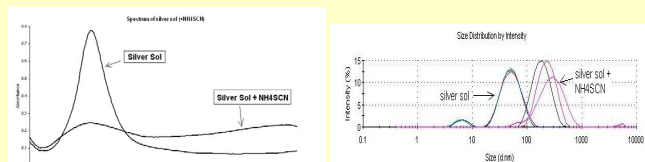
AgNPs in the presence of thiocyanate forms aggregates surrounded with the SCN⁻ ion layer.



$\varnothing = 40 \text{ nm}$
Zeta Potential = -50 mV

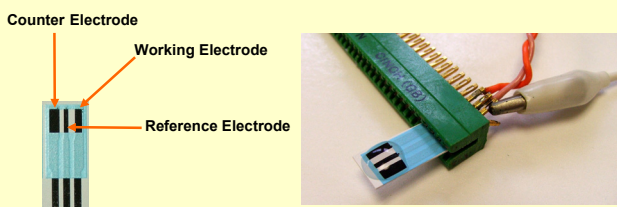
$\varnothing = 400 \text{ nm}$
Zeta Potential = -10 mV

Both UV-Vis and Dynamic Light Scattering confirm the aggregation process.

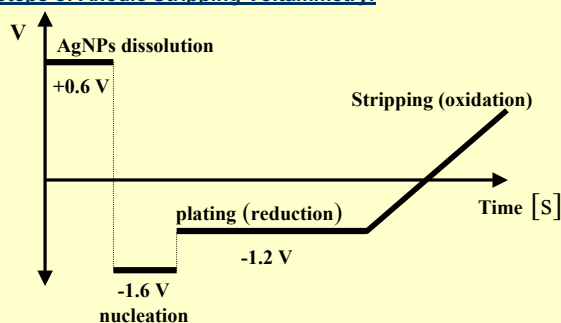


Carbon Screen Printed Electrodes

The measurement takes place in 50- μL droplet on the surface of a carbon screen printed electrode.



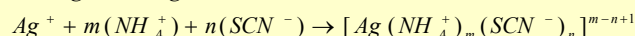
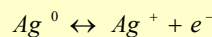
Steps of Anodic Stripping Voltammetry:



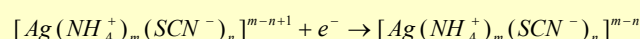
Electrochemical behaviour of AgNPs

Electrochemical reactions at the working electrode.

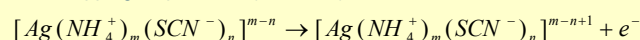
1. Silver sol dissolution and formation of electroactive chelate: ammonium thiocyanatosilver(I) at +0.6 V for 15 s.



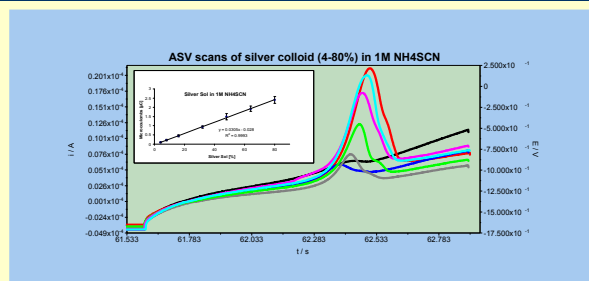
2. Accumulation step of ASV (reduction) at -1.2V



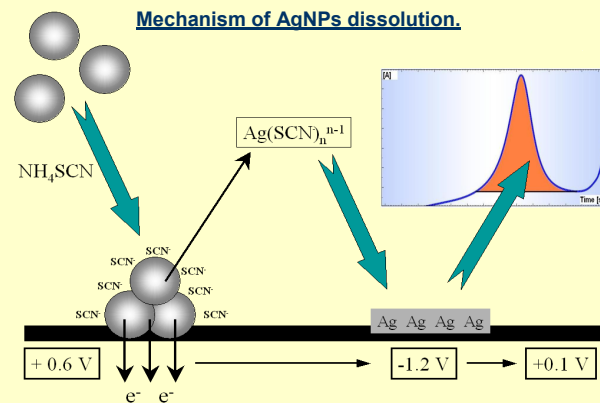
3. Stripping step of ASV (oxidation) -1.2V \rightarrow +0.1V



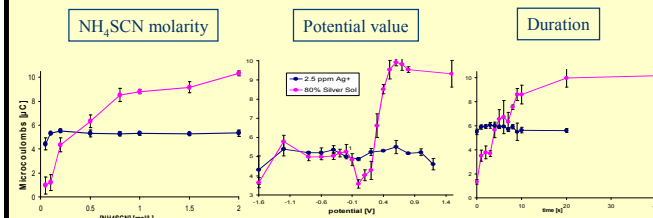
The analytical signal of different concentration of Silver colloid.



Mechanism of AgNPs dissolution.



The influence of dissolution step parameters on ASV signal.



Conclusion

We have demonstrated and explained the mechanism of AgNPs dissolution on the surface of carbon electrode without the need of any oxidant. This process can be applied for development of electrochemical metalloimmunoassays. Removing the need for using harsh oxidant is very advantageous especially in terms of building new point of care tests.

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* Contact: robert.porter@argentodiagnosics.com