SIGNAL AMPLIFICATION OF IMPEDIMETRIC GENOSENSING USING GOLD-STREPTAVIDIN NANOPARTICLES

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Electrochemical Impedance Spectroscopy is an electrochemical technique which is rapidly developing as a tool for studying DNA hybridization [1]. The technique is an effective method to probe the interfacial properties (capacitance, electron transfer resistance) of modified electrodes [2]. Many different protocols have been recently used in DNA detection by this technique. Some of them employ different types of nanoparticles as a way to increase the sensitivity of the method [3-4].
In this work, gold nanoparticles coated with streptavidin are used for the amplification of DNA hybridisation detection by Electrochemical Impedance Spectroscopy. The used protocol is as follows.
A graphite epoxy composite transductor (GEC) was used as working electrode. The probe oligomer was adsorbed onto the electrode surface and the impedance measurement was performed in a solution containing the redox marker ferrocyanide/ferrycianide [5]. A biotinilated complementary oligomer (target) was then added, its hybridization was allowed and the measurement performed in the same way as above. The change of interfacial electron transfer resistance (R_{et}) between the solution and the electrode surface, experimented by the redox marker at the applied potential, was recorded to confirm the hybrid formation. The increment of R_{et} value is due to a more difficult arrival of marker species to the electron transfer sites on the electrode surface. As showed in Figure 1, when target oligomer hybridized with the probe, the double helix film formed on the electrode led to a strong increase of the interfacial electron transfer resistance value (R_{et}).
The same electrodes were then incubated in a solution containing gold streptavidin nanoparticles. Streptavidin modified nanoparticles bound to biotinilated target oligomer thanks to the strong streptavidin-biotin interaction. This additional surface modification led to a further increment of R_{et} thus obtaining significant signal amplification.
The same experiments performed with a non-biotinilatet target, or a biotinilated non-complementary target (negative controls) showed a non significant increment of the signal when gold-streptavidin nanoparticles were added (Figure 2). Gold nanoparticles on the electrode surface were observed by Scanning Electron Microscopy (SEM) after Silver Enhancement treatment. This silver treatment, visualized on Figure 3, also featured an additional R_{et} increment in the impedance spectra.

References:

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[4] J. Wang, Anal Chim Acta, **500** (2003) 247
[5] A. Bonanni, M.J. Esplandiu, M.I. Pividori, S. Alegret, M. del Valle, Anal. Bioanal.Chem, **385** (2006) 1195

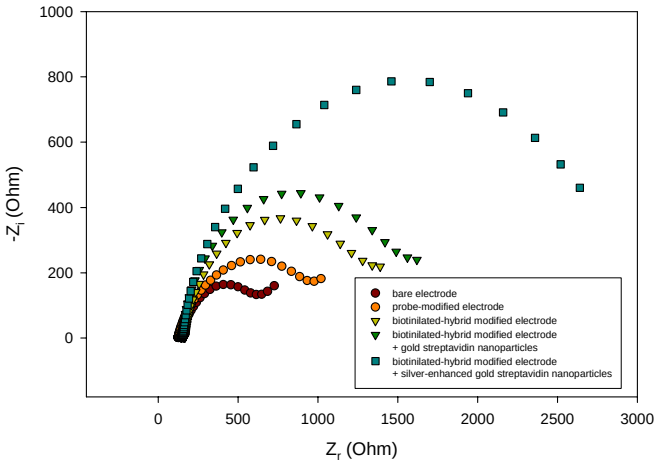


Figure 1. Nyquist diagrams for EIS measurements. All measurement were performed in 0.1 PBS buffer solution containing 10 mM $K_3[Fe(CN)_6]/K_4[Fe(CN)_6]$.

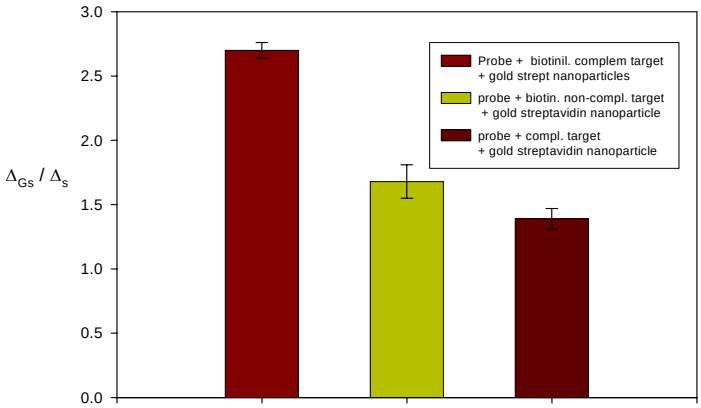
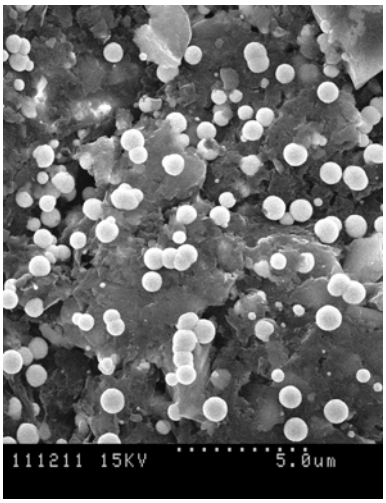
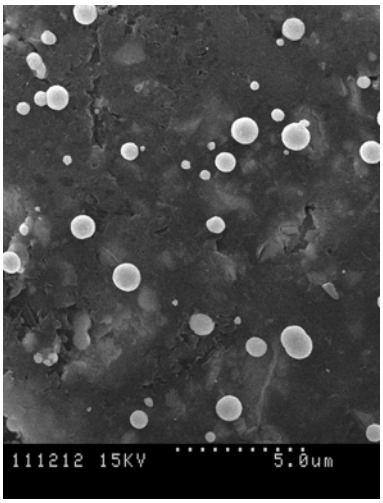


Figure 2. Histograms representing comparison between experiments and two different negative controls.



(a)



(b)

Figure 3. SEM images of (a): experiment using probe + biotinilated complementary target + silver-enhanced gold streptavidin nanoparticles (b) negative control using a non-biotinilated complementary target.