Electrodeposition of Gold Nanoparticles on Electrodes Toward Improvement of Impedance Sensing of Interfacial DNA-Drug Interactions

C.Z. Li & J.H.T.Luong

Nanobiotechnology/Biosensor Group, Biotechnology Research Institute, National Research Council Canada, 6100 Royalmount Avenue, Montreal, Canada H4P 2R2.
E-mail: chenzhong.li@cnrc-nrc.gc.ca

Abstract:

The interfacial interactions between immobilized DNA probes and the DNA specific sequence binding drugs were investigated using electrochemical impedance spectroscopy towards the development of a novel biosensor device. The electrochemical deposition of gold nanoparticles on a gold electrodes surface showed a significant improvement in the sensitivity over existing approaches, in which a self-assembled monolayer of DNA was formed on the flat gold surface. DNA-capped gold particles on electrodes act as selective sensing interfaces with controlled porosity and tunable sensitivity due to higher amounts of DNA probes and the concentric orientation of DNA self-assembled monolayer. The processes of gold nanoparticle deposition, DNA immobilization, as well as drug-DNA interaction were analyzed by electrochemical impedance spectroscopy (EIS). In the analysis the measurements of interfacial electron transfer resistance and atomic force microscopy (AFM) directly reflected the changes of surface topography upon gold nanoparticles deposition and DNA immobilization. The specificity of the interactions of two classical minor groove binders, mythramycin, a G-C specific DNA binding anticancer drug, netropsin, an A-T specific DNA binding drug and an intercalator, nogalamycin at poly (AT) DNA modified substrate and poly (GC) DNA modified substrate are compared. Using gold nanoparticle deposited substrates, the impedance spectroscopy resulted in 20-40 fold increase in the detection limits. Arrays of deposited gold nanoparticles on gold electrodes offered a convenient tool to subtly control the probe immobilization to ensure suitable adsorbed DNA orientation and accessibility of other binding molecules. The experimental approach described in this study may be applicable to fast analysis of other interfacial molecular interactions between DNA-binding molecules and selected target DNA sequences.