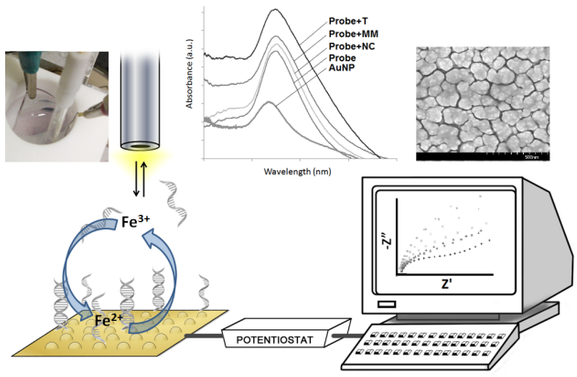
Fabrication of a DNA sensor based on simultaneous electrochemical impedance spectroscopy and localized surface plasmon resonance

Xin R. Cheng,[a] Ben Y. H. Hau,[a] Nan Li,[a] Tatsuro Endo[b] and Kagan Kerman[a*]

[a] *Dept. of Physical and Environmental Sciences, University of Toronto Scarborough, 1265 Military Trail, Toronto, ON, M1C 1A4, Canada*
[b] *Dept. of Applied Chemistry, Osaka Prefecture University, 1-1 Gakuen-cho, Naka-ku, Sakai-shi, Osaka, Japan.*

DNA sensors are in high demand for fast and early detection of single nucleotide polymorphisms that are correlated with diseases. In this study, electrochemical impedance spectroscopy (EIS)[1] and localized surface plasmon resonance (LSPR)[2] were performed on the same Au nanoparticle (AuNP)-modified indium tin oxide (ITO) coated film glass in a dual-detection format. This was possible due to the unique transparent and electrically conducting properties of ITO glass substrate.[3] A simple and economical voltammetric approach was taken to deposit Au nanoparticles on ITO surface directly. The surface plasmon band characterization of AuNP was initially studied by controlling the electrodeposition conditions. It was found that the size of Au nanoparticle clusters was significantly affected by the applied potential and KCl concentration in solution. The dual-detection platform was applied to detect DNA hybridization events related to apolipoprotein E gene (ApoE). Studies have shown that the inheritance of one or more mutations in this gene increases an individual's risk of developing atherosclerosis and Alzheimer disease.[4] Therefore, fast detection of such mutations is cardinal in disease prevention. The dual-detection platform showed concentration-dependent hybridization of the target DNA with a detection limit of 500 nM using LSPR and 250 nM using EIS. A single nucleotide mismatch sequence could be distinguished from a fully complementary target DNA. The preliminary results facilitate the development of a reliable and versatile system that can be easily miniaturized and integrated into a high-throughput detection format.



Scheme 1 Conceptual illustration of DNA sensor with the dual-detection platform for LSPR and EIS measurements. A DNA probe was immobilized onto the AuNP-modified ITO surface as the biorecognition layer. In the second step, a target oligonucleotide is hybridized to the probe on the surface. EIS was measured with $[Fe(CN)_6]^{3-/4-}$ as the solution-based electroactive indicator. LSPR was also detected using a microfibre bundle in connection with a miniaturized UV-vis spectrophotometer.

References:

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